

chant, and a great many more, are the builders of libraries, which Carlyle once called 'the true universities.' When Western learning is needed in Turkey and the Levant, it is a merchant of New York who founded Robert College, near Constantinople, and another merchant, William E. Dodge, and his associates, who established the Syria College of Beirut. When it was a question of Arctic research Henry Grinnell and George Peabody equipped the expedition of Kane and his successors, and when a museum of natural history was required, or a gallery of fine arts, it was from the members of this chamber that support was secured. Thus commerce generously has contributed to the maintenance of learning. Is it not that the pursuit of commerce broadens the mind? To promote among the nations of the earth those exchanges which benefit alike the buyer and the seller enlarges human sympathy. The study of the world's resources, requirements and conditions of prosperity produces wisdom, courage, forethought and generosity.

*PRIMITIVE MAN IN THE DELAWARE VALLEY.**

INTRODUCTORY.

A FEW years ago, as a result of extended explorations, conducted by the Bureau of American Ethnology, questions were raised with reference to the soundness of the then existing evidence relating to glacial man in the Eastern States, and the correctness of the conclusions drawn from it. Since that time, until quite recently, investigation has progressed slowly and but little has been brought forward likely to change the status of the case. Now, however, strong claims are being made of the discovery of new and confirmatory evidence of antiquity, and discussion is invited with a view of deter-

mining its merits; but before taking up this phase of the subject it is desirable that the earlier phases of the investigations be passed briefly in review.

The questions raised by me were not those of the age of man in America. I have always taken the view that the race must have occupied this continent for a very long period. Great antiquity is clearly proved by facts derived from other than archæologic or geologic sources. It does not require argument to show that the development of many well differentiated nations and tongues means a prolonged occupation. It does not take argument to demonstrate the proposition that, notwithstanding the potent influence of local environment upon human art and effort, a thousand distinct cultures could not spring up in a day.

The only questions I have ventured to discuss and the only ones that now claim my attention are as to whether the evidence already brought forward to demonstrate the antiquity of man on the Atlantic slope will stand the test of scientific scrutiny. There is a record of man in the valleys and among the hills throughout the entire country. There is an important record in the geological formations of the Delaware valley. Has the key to this record been discovered? Has the true combination been worked out, or are our pioneer investigators struggling through a phase of this particular research corresponding to that encountered by the predecessors of Champollion in the reading of the Egyptian hieroglyphs? The earlier readings at Trenton seem to indicate possibly three distinct peoples and periods of occupation, referred to by some as paleolithic, Eskimo and Indian; but are we sure of more than one and are the others mere figments of the imagination? Time will tell, but this year or the next may not finally decide it.

*Read at the Detroit meeting of the American Association for the Advancement of Science.

THE ALGONQUIAN OCCUPATION.

The first step in acquiring a knowledge of the past is to seek to understand the present. An acquaintance with the historic peoples of a region is the best key to the prehistoric peoples. In the study of the question at issue in the Delaware valley correct method demands that we look first to known conditions for explanations of all doubtful phenomena. The only occupants of this region known to us were a group of Indian tribes of what has come to be known as the Algonquian stock. The history of these tribes, as dimly shadowed forth by tradition and archæology, extends back indefinitely into the past. They were found by the whites living in villages, cultivating corn, navigating the waters, hunting, fishing and warring; weaving simple fabrics, practicing the potter's art in its most primitive form, and employing stone as the chief material for implements and weapons. They used metal to a very limited extent and employed shell, bone and wood in various arts. Their culture status is made clear by actual observation of the peoples themselves, as well as by a study of the relics of many village sites known to have been occupied by them. The local tribes, the Leni Lenape, had relatives of like culture extending along the coast from Carolina to Maine and from the mouth of the St. Lawrence to the head of the Great Lakes. They had neighbors of other stocks, all occupying about the same simple level of neolithic culture. Researches long continued in the whole vast territory occupied have developed no definite trace of other people or other conditions of culture. No one can say how long they had been here or whence they came, but their coming was doubtless long ago. Wandering bands pushed their way over the hills or along the shores and gradually took possession of this beautiful region. One group, known to us as the Delawares, occupied the Dela-

ware valley, adopting it as a permanent home. Their dwellings were established along the banks of the rivers and creeks; they multiplied and spread, and, being an active and enterprising race, gradually acquired a knowledge of the resources of the country, and especially of the varied mineral products, which were of the utmost importance to their welfare. On local sites they worked the varieties of stone available for implements. They dug them out of the loose deposits of the stream beds and bluffs. They advanced into the hills and mountains, and little by little discovered the deposits of desirable rock in place, and quarried deeply into the bowels of the earth. The work of search and exploration was so thorough that nothing escaped them, and the archæologist looks with amazement on the still existing evidences of their energy in quarrying argillite, jasper and soapstone.

The stones available to such a people in the earlier periods of their occupation would be the loose cobbles and masses of the rivers and bluffs. In the Trenton region the only material well fitted for flaking—the chief shaping process of the early days—was argillite, a compact slaty-looking rock especially plentiful in some parts of the glacial gravels. It follows that on and about the margins of the glacial terraces flaking at first dealt chiefly with this material. The beds of argillite found in place farther up the valley would next be utilized and later the flints and jaspers of the distant uplands would be discovered and used. How long it was from the time of the first occupation to the period of complete exploration and utilization of resources thus outlined no one can guess. It may have been 500 or it may have been 5,000 years. During this prolonged period the work of shaping stone implements went on. The raw material was sought and worked up with a persistence and energy that might

almost be regarded as a foreshadowing of the vast mining and manufacturing industries of to-day. The knives, scrapers, drills, projectile points, etc., the implements upon which everything in the savage economy depend, were roughed out, specialized and carried away, and the refuse in vast quantities, consisting of flakes, fragments and failures representing all stages of development, was left upon the ground. The rejectage must have been especially plentiful along the bluffs at Trenton, where the argillite was found in the shape of bowlders and partially worn masses, and in the valleys and hills above, where it occurs in place. The rude rejected forms left upon these sites were large or small, long or short, according to the shape of the implement made and the nature of the material used. They were rough or well developed according to the stage of the shaping process at which they were cast aside. No type of flaked stone has been found in the whole region that was not necessarily produced again and again and for centuries along the banks and bluffs of the Delaware by these historic peoples, and in the course of years and geologic mutation it is readily seen that this rejectage of implement-making would become intermingled in various ways with the superficial deposits of the sites of manufacture. Every bank that crumbled, every grave dug, every palisade planted, every burrow made, every root that penetrated and every storm that raged took part in the work of intermingling and burial; and following in turn came the resettling, the leeching-out and the recementing of these deposits, making it difficult to distinguish the old from the new. It follows, therefore, that the student of the history of this valley, and especially of that part of it recorded in the soil and superficial deposits, should not for a moment lose sight of these conditions and events of recent and comparatively recent history, and should seek

first to explain all phenomena from the point of view thus afforded before conjuring up shadowy images of other races.

INVESTIGATION IN THE GLACIAL GRAVELS PROPER.

It happened, however, that before the investigation of the phenomena referred to above and now so definitely assigned to the Algonquian peoples had begun to attract the attention of archaeologists the presence of other people had already been assumed. Evidences of very primitive paleolithic races had been associated with glacial formations abroad, and the glacial deposits of the Delaware region were accordingly searched with the hope of finding similar traces. Relics of art were soon secured, and as they were rude and exclusively of flaked stone they were regarded as supporting the theory of a glacial paleolithic man. A large body of evidence was soon accumulated and passed into literature without particular scrutiny.

When, finally this subject came into prominence and questions began to arise as to the determinations made, it was found that the flaked stones which formed the exclusive evidence furnished, though rude as reported, were not of special or peculiar types, such as seem to characterize paleolithic times abroad, but that they corresponded in every particular with the ordinary rude work, and especially with the rejectage of manufacture, of the Algonquian and other American tribes; and it happened further that they were found along the very bluff faces where argillite bowlders outcropped and where the Indian tribes had naturally resorted to secure the raw material and block out their implements; then it came to be asked whether the finds had really been made in the true gravels, whether they were not obtained from deposits associated with the gravels but not belonging, in their present deposition, to

the glacial age; such deposits as accumulate in depressions, or along the faces of bluffs and banks subject to crumbling and sliding. When later it was realized that the questions involved, the nice discriminations to be made in collecting this evidence, were really geologic rather than archæologic a new phase of the investigation was initiated and geologists were asked to participate in the examinations. It was imperatively demanded that the gravel should be re-examined and the evidence sifted and placed on a safe footing. In meeting this demand for re-examination of their evidence the advocates of an American paleolithic man have claimed that the criticisms made were to be classed with those encountered by Boucher de Perthes when he began to present his evidence regarding early man in Europe; that such criticisms meet every advance of thought. But the cases are by no means parallel. The discoveries of Boucher were not acceptable because of their revolutionary character with respect to accepted beliefs. On the other hand, the Trenton determinations were popular and almost universally accepted as final until attention was called to the true nature of the objects found, and especially to the unsatisfactory methods pursued in collecting evidence. The climax came when it was understood that the advocates of a glacial paleolithic man were gathering all classes of rudely flaked stones from the surface of the country generally (entirely disregarding an Indian occupation) and employing them to establish a peculiar theoretic culture for America.

It was not conservatism, and especially it was not conservatism in religious thought, that led such men as Powell, Brinton, McGee, Chamberlin, Salisbury, Mercer, Mason and others intimately acquainted with the field of investigation to seriously question the methods and the evidence. The charge of conservatism must rather be urged against

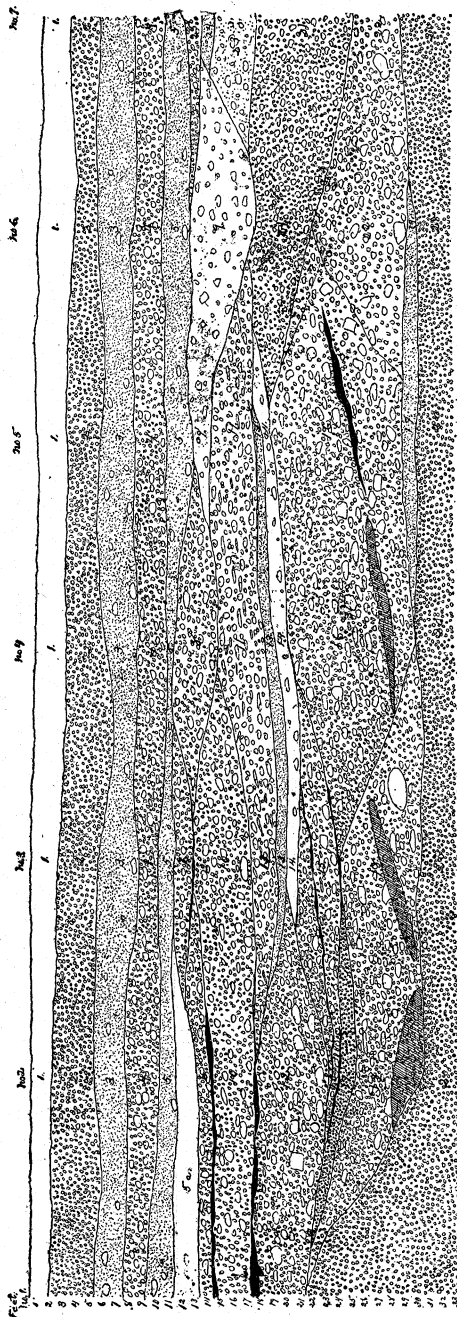


FIG. 1. Section of the Trenton gravels showing relation of productive to non-productive profiles.

those students who have held to their original views and especially against such scholars as Topinard, Boulé and Keane, who accept without serious scrutiny any evidence that tends to confirm accepted theories with respect to a uniform history of the race on both sides of the Atlantic.

Fortunately opportunities for a re-examination of the evidence have arisen in several cases. The principal discoveries of shaped stones attributed to the gravels were made in the slope of the bluff facing the river at Trenton (*A* in the section, Fig. 1) and in

mile or more in length, are indicated at *e*.

Identical results have been reached on the river front *A*. In 1892 a great sewer trench, *C*, 33 feet deep, was cut, parallel with the river bank, at the very point where so many shaped stones had formerly been found. Though we kept up the search in this trench for five weeks as the work of excavation went on—the whole body of gravel being subjected to rigid examination—not a chip was found, not a trace of man. No other examination has been made that compares with this for thoroughness and length

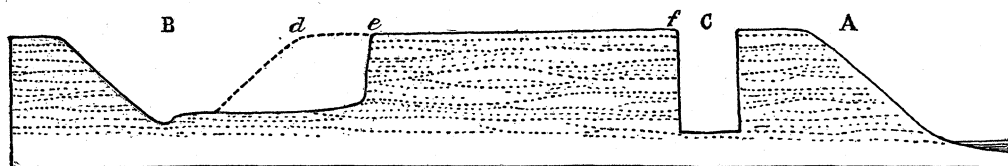


FIG. 2. Portion of section of gravels exposed in sewer trench, fac-simile of the original notes by Mr. Wm. Dinwiddie.

the banks of Assanpink Creek at the point where the Pennsylvania railway makes its way from the station near the creek level to the terrace above (*B* in the section). Finds continued to be made in the crumbling river bank at *A* until accumulating city refuse covered up the deposits.

They ceased to be made in the creek banks at *B* as soon as the cutting extended fairly into the gravels in place; and when, in 1889, I asked the principal explorer of this locality why the finds had ceased, he replied that when the railway cutting was made the excavations were carried up through a depression that must have been an old stream bed, and that the finds were in the filling of this channel. I do not think he understood the significance of the admission, but the statement must have been true, as nothing whatever is to be found in the present excellent exposures of the true gravels. The position of his finds are indicated at *d* on the dotted original profile in the section, and the present utterly barren exposures, half a

of time involved. The evidence thus furnished has been spoken of as negative and hence as unsatisfactory, but, in the continued absence of finds of implements at this and other points, it seems positive and convincing. The conclusion reached is that there must have been an error in the observations that could produce hundreds of flaked stones from obscure or partial outcrops at a given spot in a crumbling bank when not a trace can be found at the same point when the beds are fully exposed.

Geologists will be interested in seeing the detailed section made by my assistant in the trench. It tells the story of the deposits better than any other section that has been or probably ever will be made.

Considering the foregoing facts, it may be regarded as substantially proved that the glacial gravels proper contain no relics of art, and it would appear that now very few persons, indeed, expect them to yield any evidence whatever on the subject of human occupation. Five years have passed since the earlier observations and finds.

were challenged, and in that time, so far as I have learned, no single implement has been reported from the gravels, although the exposures are as extensive as they ever were. The first chapter in the prolonged search for glacial man at Trenton may, therefore, be regarded as practically closed; but some new evidence furnished by examination of certain superficial deposits of sand come up for consideration. My remarks upon this subject will appear in a subsequent number of SCIENCE.

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*ON SOME IMPORTANT SOURCES OF ERROR
IN THE PLANKTON METHOD.*

THE Hensen method of plankton collection consists essentially in drawing a silk net vertically through the water. A part of the column of water traversed by the net is pushed aside, hence the actual catch must be multiplied by some factor to obtain the amount of plankton present in the given column of water. This factor, 'the coefficient of the net,' has been calculated by Hensen, for a series of velocities, from empirical data, and is applied uniformly to all catches without regard to the character of the plankton. The coefficient of the net used at the Illinois Biological Station, according to Hensen's formula, is 1.32 (velocity 0.5 meter per second). A series of field tests in which a column of water, similar to that traversed by the net was pumped and strained, indicates that the coefficient of the net varies with the amount and constituency of the plankton, ranging in the case of our net from 1.5 to 5.7. This variation is, in part at least, due to the increased clogging in the case of heavy planktons. The effect of the progressive clogging upon the coefficient is shown in a series of horizontal hauls of 5, 10, 15, 20 and 25 meters, which were made successively in similar water. The coefficient rose from 1.5 in the 5-meter

haul to 4.83 in the 25-meter haul. A comparison of 15-meter hauls with those of 30 meters indicates that from 84% to 96% of the 30-meter catch is taken in the first 15 meters of the haul. Four places of decimals in a computed coefficient can hardly offer compensation for an error so fundamental as the variation in the straining capacity of the net. This error can be avoided by adoption of the pumping method and straining of a known quantity of water.

The plankton method as elaborated by Hensen and others depends upon the efficiency of the finest silk bolting cloth in removing the contained organisms from the water which it filters. It has been accepted by planktologists that the use of this cloth furnishes a satisfactory basis for the volumetric determination of the plankton and the enumeration of its constituent organisms. Hensen* (p. 75) states that the openings in the silk are so small that not many organisms can pass through them. Apstein† (p. 235) says: "With nets of this cloth almost all organisms are caught, only a few diatoms, which happen to meet an opening with their long axis, escape." Again‡ (p. 35) he maintains that almost all organisms are removed from the water by the use of No. 20 bolting cloth. No protest has been raised by our American workers§|| to these claims of the founders of the plankton method. The leakage of the plankton through the silk has thus been minimized or ignored, and without tests of the extent to which it occurs.

* V. Hensen. *Methodik der Untersuchungen bei der Plankton-Expedition.* Kiel und Leipzig. 1895.

† C. Apstein. *Über die quantitative Bestimmung des Plankton in Süßwassers:* in *Die Tier- und Pflanzenwelt des Süßwassers.* Dr. O. Zacharias. Leipzig. 1891.

‡ *Das Süßwasserplankton.* Keil und Leipzig. 1896.

§ J. Reighard. *A Biological Examination of Lake St. Clair.* Lansing. 1894.

|| H. B. Ward. *A Biological Examination of Lake Michigan.* Lansing. 1896.