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THE TRENTON ARGILLITE CULTURE

BY

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THE TRENTON ARGILLITE CULTURE.

By Leslie Spier.

PREFACE.

The assumed antiquity of the culture deposits at Trenton, New Jersey, has been the subject of controversy for nearly fifty years. The so-called "Argillite Culture," a deposit of stone implements and bone fragments uncovered by Abbott, Putnam, and Volk in a sand layer of intermediate geological position and undetermined age, has presumably some fair claim to antiquity. The larger aspects of the deposit have been sketched by these investigators: the following report records the relations discovered by a more detailed study.

The proposed destruction of the site for railway extension led Dr. Charles C. Abbott, owner and discoverer, to invite reëxamination by this Museum. Trial trenching was begun in May, 1914, by Mr. Alanson Skinner with my assistance, and in October, 1914, Mr. Skinner made extensive excavations. During the summer of 1915, I reëxamined and extended these excavations as the stratigraphic relations dictated. Other sites suggesting similar conditions were examined from time to time from 1913 to 1915.

Thanks are due to Dr. Abbott for his courteous invitation, to Mr. Skinner for his mass of evidence, to Mr. Louis R. Sullivan for an examination of the skeletal remains, and to Dr. Chester A. Reeds for a geological examination of the site, which to our mutual regret was not extended enough to be decisive. The coöperation of Mr. Ernest Volk, Dr. Henry B. Kümmel, Prof. J. Volney Lewis, Dr. William K. Gregory and others is appreciated, as well as the assistance of Mr. B. E. Hoover in the field.

LESLIE SPIER.

October, 1918.

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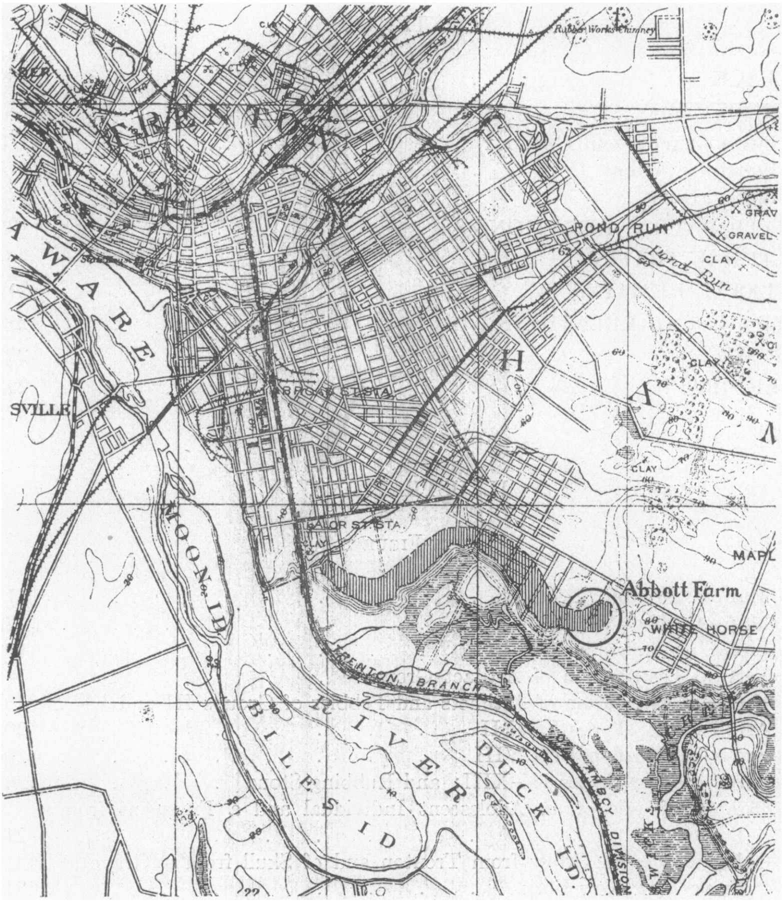

Fig. 1. Map of Trenton, showing the Location of the Area of the Argillite Culture (shaded).

INTRODUCTION.

Physiography and Geology.

In the vicinity of Trenton the Delaware River flows southeast past the city, swings in a wide semicircle east to Bordentown, and again resumes a straight course from Burlington south of west to Philadelphia (Fig. 1). In the vicinity of the bend the land on the Pennsylvania side is low and slightly rolling, with an elevation of ten to twenty feet. On the eastern or New Jersey side the city of Trenton north of Assanpink Creek is relatively high, rising to an elevation of ninety to one hundred feet. South of the creek a bluff rising forty or fifty feet above the river level swings in a wider arc a mile or so east of the river so as to leave a stretch of lowland between river and higher terrace. Crosswicks Creek, flowing from the terrace, divides the arc of the bluff almost at its midpoint. North of the creek the terrace presents two divisions. The northernmost quarter of the arc, from Assanpink Creek south to the Abbott farm, is occupied by the southern half of Trenton. The surface is very flat and slightly rolling, elevation fifty to sixty feet, and extends northeast along the valley of Assanpink Creek in the direction of Princeton to Baker's Basin. The second quarter of the arc, from Abbott's farm to Crosswicks Creek, is higher and with greater relief, being in fact a succession of gravel terraces.

Geologically considered the terrace is characterized by a succession of gravels of Quaternary age above bedrock. The oldest gravel with which we need be concerned is the Pensauken formation. This deposit was formed during a submergence of the southern and central portions of New Jersey to about present elevation 130. Subsequent to this deposition the Jerseyan ice sheet overrode the northern part of the state, descending in the Delaware Valley to a point thirty miles from Trenton. On its withdrawal the land was uplifted to an elevation somewhat above its present level with a consequent erosion of the Pensauken deposits. In the vicinity of Trenton the deposits in the valley of the present Assanpink Creek were scooped out, leaving the present higher gravel terraces south of the Abbott farm referred to above. Late in the Post-Jerseyan stage a portion of this valley may have been refilled in part by Jerseyan drift. The next invasion of the ice sheet, the Wisconsin stage, left its terminal moraine on an irregular line extending from Belvidere on the Delaware eastward to Dover, southward past Plainfield, and again east and north through Perth Amboy and Staten Island. With the withdrawal of the ice sheet the streams draining southward were heavily overloaded with rock débris and consequently aggraded their valleys. Such a deposit lies in the Delaware Valley, extending to Trenton where it merges into coeval estuarine deposits of different origin. During the later part of this stage the southern part of the state subsided to forty or fifty feet below its present level with resulting erosions and depositions. At this time (Cape May Submergence) the sixty-foot plain of gravel extending from southern Trenton northeastward along Assanpink Creek to Baker's Basin was formed. It is composed partly of glacial material from up the Delaware and partly of non-glacial material from the southeast. After the withdrawal of the Wisconsin ice sheet came a differential uplift and subsequently a slight subsidence. This change of elevation has caused the Delaware to erode its valley in the vicinity of Trenton to a depth of forty or fifty feet below the sixty-foot gravel plain, thus forming the existing physiographic relations of bluff and terrace. Post-glacial conditions have brought minor superficial changes, such as the deposition of the stratum or perhaps strata of yellow sand which caps the mixed gravels.

From the broader geological viewpoint this sand forms an integral part of the glacial and post-glacial gravels descriptively referred to as the Cape May formation. It cannot be too strongly emphasized that these recent sands and gravels are avowedly of heterogeneous origin and can only be classed together from the angle of geologic history as a whole. From an archaeological viewpoint a distinction has been drawn between them; by some authorities the gravels have been associated with one prehistoric culture, the sand with another.[1]

Broadly speaking then a trench sunk into the terrace at any point from the Abbott farm northward discloses three strata which the archaeologist has seen fit to recognize as distinct, while knowing that the geologist has not sufficient criteria to discriminate between them. The present surface soil is a black humus six inches or more deep; below this is a stratum of yellow sand from one to six feet deep resting on stratified gravels extending at least to the flood plain of the Delaware.

The black soil is the upper surface of the stratum of yellow sand discolored by decayed organic matter. The surface is under cultivation and repeated plowing has produced a uniform mixture of organic material and discolored sand. It seems clear that the sharply marked plane of contact of black and yellow soils is simply the plow-line. Minor erosive and aeolian changes have given the black soil a differential depth from a few inches to several feet, but it is fairly uniform at about six inches.

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[1] This description has been drawn largely from the convenient summary by Lewis and Kümmel and from the Geologic Atlas, Bascom.

The yellow sand ("yellow drift") varies in thickness from one to six feet and more. It is loose, relatively structureless, and varies locally in coarseness, the gravel constituent gradually becoming more noticeable two or three miles from the river northeast of south Trenton. In the vicinity of the escarpment the sand is relatively free from gravel, but encloses pebbles from the size of peas to boulders of three and four feet diameter. The pebbles and boulders vary in character and position in the sand: the distribution of some will be discussed later. The sand is traversed by red layers or films (the "red bands" as seen in section), composed of clay, iron, and sand, which appear at frequent intervals from a few inches below the surface down. They extend throughout the deposit from the south end of Trenton to the Abbott farm. As seen in section they appear as irregular, wavy bands, usually four to six inches apart, thin near the surface but increasing in thickness with the increase in depth. The sand deposit has been ascribed variously to aeolian and fluvial origins, the red bands to fluvial origins or as marking ancient surfaces.[1]

Within the last fifty years archaeologists have alleged three cultures associated with the three strata, black soil, yellow drift, and gravels. The black soil contains the relics of historic Indians, the Delaware and perhaps others. Below this the yellow sand was believed to contain a ruder culture, chipped blades and hammerstones, but no pottery or finer stonework. Chipped pebbles taken from the gravels or associated with them have been styled "palaeolithic" and assigned a great antiquity.

In this paper we are concerned with the alleged culture of the yellow sand, the so-called "argillite culture."

Previous Work.

The work of earlier investigators extends over a period of fifty years. The literature is voluminous and in part irrelevant. The ideas presented concerning the "argillite culture" are obscured by the evidence adduced for a still earlier "paleolithic" culture. Since we are not concerned here with that evidence, it will be necessary to point out those facts brought forward which bear strictly on the "argillite culture."

The earlier stages in the development of the problem were almost entirely the work of Dr. Charles C. Abbott. As early as 1872 he found near Trenton crude implements associated with remains of the historic Delaware Indians.

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[1] Kümmel; Salisbury; Wright; etc. For further details of the sand see Volk, (b), 1–13.

When later similar crude specimens were found at various depths in the underlying gravels in the vicinity, his inference was that these were the remains of a paleolithic culture. This had flourished on the spot while the gravel terraces were forming and in some instances had become accidentally associated with the remains of the historic culture. We get our first hint, however, that there may be a third or intermediate culture in his "Primitive Industry" (1881). Our attention is called to the predominance of argillite over flints deep in the soil when compared with surface finds. It is suggested that these finds may be examples of a link between the paleolithic remains and those of the historic Indians.[1] More than ten years (1883) after his first finds, Dr. Abbott crystallized his conception of a third culture intermediate in geological position and cultural type. This comprises the group of implements, made wholly or largely of argillite, lying in the stratum of sand capping the gravels in which the paleolithic finds occur and underlying the surface soil containing Delaware relics.

> ....Below the base of this deposit of [black] soil, at an average depth of about two feet, the *argillite* implements occur in greatest abundance.[2]

This third culture is not isolated nor is it intermediate and transitional between paleolithic and Indian cultures: it is the lineal descendant of the paleolithic, but not the ancestor of the Indian culture.[3] It is conceived that the argillite culture did not develop in the area occupied by the yellow sand, but rather on the high ground bordering the small streams in the vicinity at a time when their normal water burden was at the present freshet stage, and that the implements were subsequently washed into the position in which they were found.[4] Later, however, (1908) Abbott changed his conception of the cultural leanings of these finds, their similarity to Delaware remains suggesting that they gradually merged into the historic types.[5]

Much of the irrelevance of subsequent discussion must be laid to the lack of clearness and precision in Abbott's presentation.

In his discussion of the general situation, Holmes (1893), is properly critical of the proofs for the existence of a paleolithic culture and a culture of the glacial epoch but he fails to note Abbott's discrimination among the supposed pre-Delaware finds.[6] Subsequently he dismisses the argillite

[1] Abbott, (d), 467, 276, 515 and 517.
[2] Abbott, (e), 318 and 321.
[3] Abbott, (f), 21 *et seq.*
[4] Abbott, (g), 147 *et seq.*
[5] Abbott, (i), II, 29.
[6] Holmes, (a), (b).

culture rather cavalierly, contending that these implements represent an arbitrarily selected series from historic Indian remains and failing to note that Abbott's attention was directed to them by their association with the yellow sand.[1] In 1897 Holmes assumed a more compromising position. The three reputed cultures are not such, but by assigning some historical relief to the Delaware occupation may be explained in the following way. The first Delaware utilized for their implements the only available material, the argillite boulders at Trenton, and left behind on the spot the quarry refuse, the supposed paleoliths: later as they spread and explored the upland, flint and jasper became available. Yet Holmes seems to indicate that this explanation is inadequate, since he expresses his intention to treat subsequently of the superficial sand deposits.[2] I am unable to find any further discussion of the point.

At the same time (1897) Putnam contributed a significant statement.

> If you will dig a trench anywhere in that region [Lalor Field], you will find many more implements of this character [objects of the argillite culture] in the upper bed of sand than in the black soil; you will find that they are most abundant just at the border line of the black soil and the sand.[3]

This observation, like Abbott's noted above, was not valued at its true worth.

Mercer's contribution to the subject (1897) is to the point. Concerned only with the alleged culture in the yellow sand, he concludes as the result of his own excavations that implements of argillite, jasper, and chert occur *in situ* in the sand, that there is no marked difference from surface finds in the kind of material used, their patina, or mode of fracture, but that animal bones and pottery are absent. His remarks on the position of the artifacts are interesting: —

> [Stone chips and fractured pebbles] showed thickest under the latter [the black soil], growing thinner downward.... The artifacts were scattered at irregular depths in the sand, nowhere suggesting by their collocation a floor of occupancy or workshop abandoned by primitive man.

While he recognized that all his finds were made in a "shallow zone of discovery, ceasing at about three feet below the surface," yet his statement concerning their frequency of occurrence is incorrect, as I shall show later on the basis of his concrete data. Nevertheless, Mercer's must be recognized as the first precise account of the argillite culture.[4]

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[1] Holmes, (c), 30 *et seq.*
[2] Holmes, (d), 365–366.
[3] Putnam, (g), 346.
[4] Mercer, (c).

Systematic explorations in the Trenton district began in 1889 when Mr. Ernest Volk started operations. In 1893 [1] he found that the following conditions held for the argillite culture: both on the terrace and on the meadow at river level he found argillite flakes, alone except for quartzite pebbles, at the junction of the black soil with the yellow sand "and sometimes two or three inches in the yellow deposit." Further evidence seemed to indicate a progressive technical development, with the use of new materials, at higher points in the black soil. Volk's report of 1911 gives the results of his twenty years labor in full and in fairly definite form. He finds a progressive complexity and technical perfection in the historic Indian remains in the black soil on the terrace and lowland.[2] The argillite culture in the yellow drift had the following characteristics: —

1. The numerous artifacts were scattered in isolation or were grouped through several square miles of the yellow drift; these groups are called "pits" and "workshops" evidently because Volk believed the artificers lived on the drift during the process of its deposition.
2. The implements are of five types, spear head, arrow head, an implement with a jagged cutting edge, a drill-like specimen, and hammerstone. Their material is argillite, quartzite, and chert. Fire-fractured pebbles also occur, but nothing else.
3. The red bands are of fluvial origin and indicate a similar origin for the greater part of the yellow drift.[3]

Volk's attention centered on the deepest specimens with disproportionate neglect for the distribution of the majority. This attitude was seemingly dictated in part by a desire to rule out all finds which might possibly be intrusive from the surface soil. Traces of man in the gravels give Volk corroboration of a third culture. This need not concern us here. Volk's contributions are invaluable, for he showed that the artifacts are numerous, occur over a wide area, and are of a type distinct from the Delaware remains, but he neglected to make the fullest use of his data.

Excavations.

Our operations were begun at Dr. Abbott's invitation at his farm on the terrace. This is at the extreme southern end of the area over which Mr. Volk found the argillite culture. The point we selected for trenching lies in a short tongue of yellow sand, mapped as "Cape May formation" on the U. S. G. S. Trenton map, extending south into the Pensauken formation

[1] Volk, (a).
[2] Volk, (b), 55, 71.
[3] *Ibid.*, 103–109, 125.

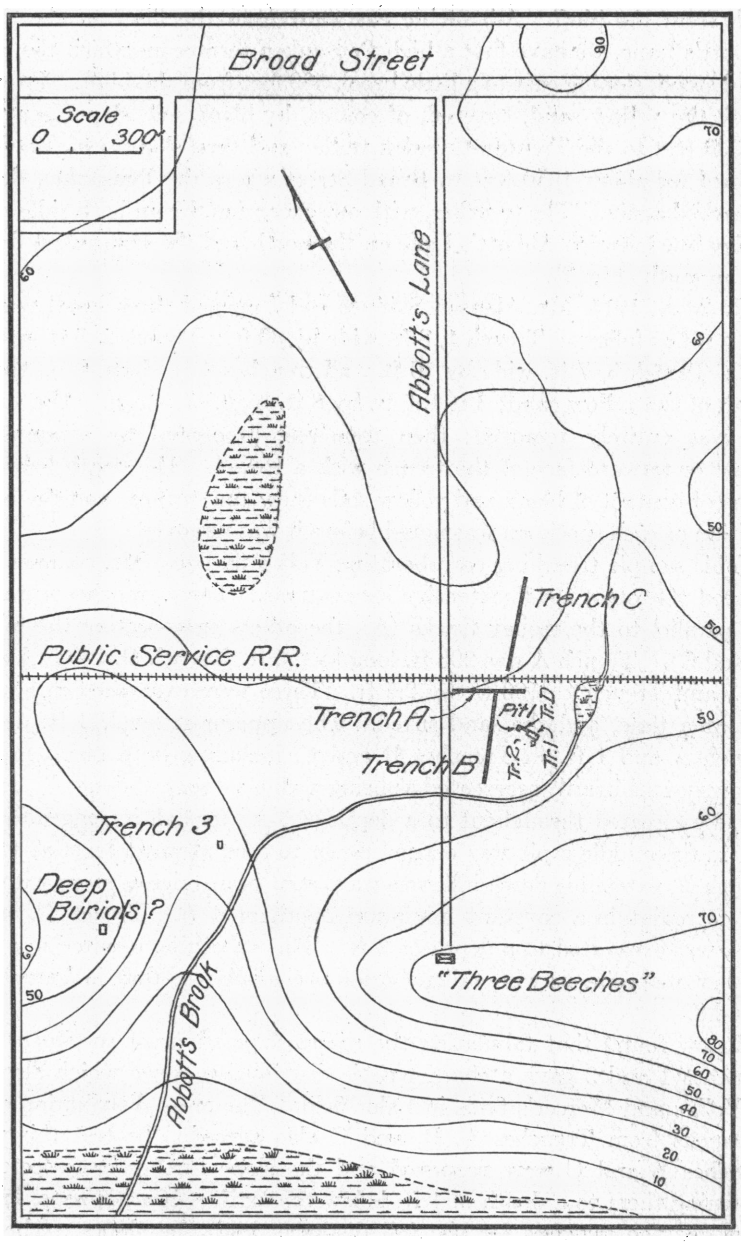

Fig. 2. Map of Abbott's Farm, showing the Position of the Trenches.

back from the bluff. Advancing eastward from the bluff on the line of Abbott's Lane, we have first a high Pensauken terrace on which the homestead stood, sloping east to a little brook 500 feet from the bluff. From the brook the yellow sand, covered, of course, by black soil, slopes gently up for 330 feet to the Trenton-Camden trolley and then slopes very gradually upward for about 1650 feet to Broad Street where the Pensauken deposit is reached again. The trenches, with one exception, lie on both sides of the trolley line between Abbott's Lane on the north and the Pensauken deposit on the south (Fig. 2).

In May, 1914, Mr. Alanson Skinner and I opened three small trenches and a pit as follows: Trench 1, 8 ft. wide by 30 ft.; Trench 2, 5 ft. wide by 8 ft.; Trench 3, 7 ft. wide by 10 ft.; all trenches 4 ft. deep, i. e., the full depth of the yellow sand; Pit 1, 7 ft. by 8 ft. by 6.5 ft. deep. The surface soil was entirely removed; then trenching proceeded by scraping the breast or forward face of the trench with a trowel. The depth below the plane of contact of black and yellow soils (now the surface) and the lateral position of each specimen was noted before it was removed.

This sample trenching corroborating Volk's findings, Mr. Skinner commenced (October, 1914) extensive excavations. Three trenches were dug, one parallel to the trolley tracks (A), the others cross-secting the hillside (B and C). Trench A was 206 ft. long by 8.5 ft., Trench B, 150 ft. long by 3 ft., and Trench C, 190 ft. by 2.5 ft. These were excavated in levels, a foot at a time, and the sand sifted. The uppermost level, 2 ft. deep in Trench A and 1 ft. in Trenches B and C, including both black soil and yellow was arbitrarily segregated as being within a "zone of doubt." Trench A was excavated throughout to a depth of 3 ft., for half its length to 5 ft., and in the middle a pit was carried down to ground-water level at 12.5 ft. Trench B, extending down hill, was excavated in a series of steps with 1 ft. lifts to maintain a constant minimum depth of 4 ft. Trench C, on the level, was excavated to a depth of 2 ft. This trenching resulted in a large number of specimens whose distribution was similar to that in Trenches 1, 2, and 3.

I now found that tabulating the recorded positions of specimens from Trenches 1 and 2 gave a characteristic distribution curve which also held for Volk's and Mercer's finds in Lalor field. The gross distribution of the specimens from Trenches A, B, and C also agreed. To test this result Trenches B and C were reopened and the slope further cross-sected by deepening them to a depth of 1 ft. below the artifact-bearing zone, and by extending the trenches for the full distance down the slopes. The neat line of these excavations is shown on the profile of Trenches B and C (Fig. 3). The sand from the trenches was sifted a shovelful at a time and depths of specimens below the plane of contact immediately recorded. The greatest error in these records due to the screening method is 2 inches. Other artifact curves were obtained by troweling sections along the line of trench. In all four hundred specimens were found. At the suggestion of Dr. Chester A. Reeds the location of pebbles was recorded. Troweled sections similar to those used to obtain artifact curves and yielding pebble curves were dug as close to the artifact sections as possible. The red bands traversing the yellow soil were carefully mapped.

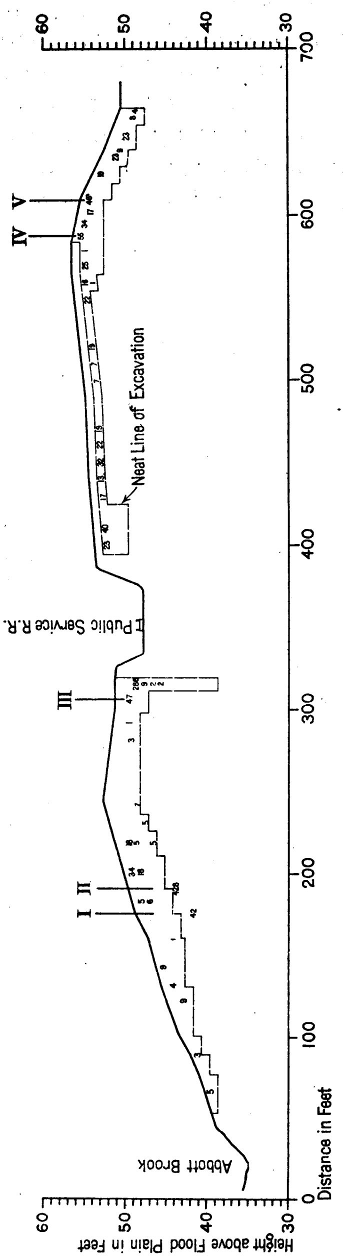

Fig. 3. Profile of Trenches B and C, looking north.

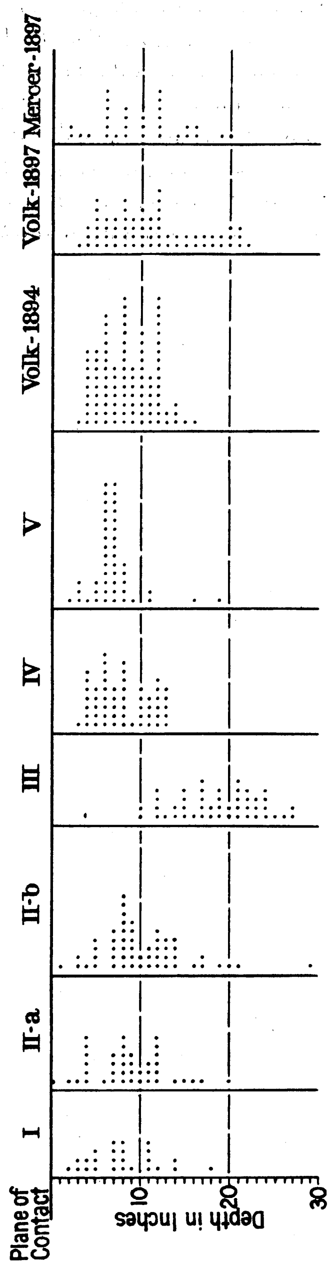

Fig. 4. Vertical Distribution of Artifact Groups.

STRATIGRAPHIC RELATIONS.

The area of yellow sand from which objects of the argillite culture have been taken is not large (Fig. 1). Volk's excavations define it as beginning, "at the so-called Riverview Cemetery at the south end of Trenton, where the bank strikes the Delaware River, along the top of the terrace directly east and then southeast following its windings and finally south altogether to the little stream which runs through Dr. Abbott's farm; a strip of land about three [?] miles in length and about three to four hundred feet or more in width," [1] to which our excavations add a few hundred feet at the south end. While the area specified is a narrow strip along the escarpment of the terrace, I am not certain that objects have not been found further back from the bluff. Mr. Volk is not clear as to whether he has not found objects inland or whether he carried on no systematic excavations there. On the Abbott farm, where the Museum party operated, artifacts were found as far as 1430 feet from the bluff.

The distribution of the specimens within the yellow soil shows a suggestive arrangement. The bulk of the specimens lie in a plane located from six inches to a foot below the black soil. I have indicated on the profile of Trenches B and C, (Fig. 3), the distribution of all the specimens by figures representing the number of specimens found near the position occupied by each figure. Beginning at the western end, it will be noted that only isolated specimens were found in the first 180 feet, east of this the mass of the specimens lie in a single plane at a grade of 1.5 percent to 2.0 percent for the first 400 feet, and roughly parallel to the surface for the remaining distance. This plane lies from 12 to 18 inches below the surface. To these data we must add that of the work of 1914 in Trenches 1, 2, and 3, which is in entire agreement. Trenches 1 and 2 lie beyond the crest of the slope and therefore not in the plane of the profile, but they are, nevertheless, indicated at II and I, respectively. As indicated in the profile, distribution in this plane is not uniform. The objects occur in groups, the lateral distribution of which is of normal frequency or accidental type.[2]

The vertical arrangement of these groups is given by the following series. I have tabulated the number of specimens for each inch of depth for groups I–V on the profile and from Trench 3. Comparable data by Volk and Mercer from Lalor field (more than a mile north) are also given. Mercer's data are recorded depths of individual specimens from several trenches; [3]

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[1] Personal communication.
[2] Spier, (c), 183–185.
[3] Mercer, (c).

Volk's chart series was checked from a chart in the Museum,[1] and his 1894 and 1897 series represent the frequency of positions mentioned in his report, not the number of specimens.[2]

Depth Below Plane of Contact. (Inches)	Frequencies										
	I	IIa Arti-facts	IIb Bone	III	IV	V	Trench 3	Mercer 1897	Volk Chart	Volk 1894	Volk 1897
0	..	1	..	..	..	..	..	..	..	..	..
1	..	..	1	..	..	..	..	..	..	..	..
2	1	1	..	..	..	1	..	2	..	..	..
3	2	1	2	..	1	3	3	1	1	1	1
4	2	6	1	..	7	1	2	1	2	9	3
5	3	..	4	..	5	3	2	..	2	9	6
6	..	1	..	..	9	14	3	6	5	13	4
7	4	4	5	..	5	14	2	1	6	7	4
8	4	6	9	..	8	5	2	4	3	15	6
9	1	4	6	..	1	1	3	..	1	7	4
10	..	2	2	2	5	..	..	3	1	11	5
11	4	3	3	..	4	2	1	..	..	6	4
12	1	6	5	4	6	..	..	6	..	15	7
13	..	..	4	1	4	..	..	..	3	2	2
14	2	1	4	2	..	..	..	1	1	3	2
15	..	1	..	4	..	..	..	2	..	1	2
16	..	1	1	1	..	1	..	2	..	1	2
17	..	1	2	5	..	..	..	..	..	..	2
18	1	..	..	2	..	..	..	..	..	..	2
19	..	..	1	4	..	1	1	1	1	..	2
20	..	1	1	2	..	..	1	1	..	..	3
21	..	..	1	5	..	..	..	..	..	..	3
22	..	..	..	4	..	..	..	..	..	..	1
23	..	..	..	3	..	..	..	..	..	..	..
24	..	2	..	4	..	..	..	..	..	..	..
25	..	..	..	1	..	..	..	..		..	..
26	..	..	..	1	..	..	..	..		..	..
27	..	..	..	2	..	..	..	..	..	..	..
28	..	..	..	..	..	..	..	..	..	..	..
29	..	..	1	..	..	..	..	..	..	..	..

Some of these series are shown graphically in Fig. 4. The following gross distributions are in accord. The series from Trench A results from

[1] Volk, (b), 90.

[2] *Ibid.*, 85 *et seq.*

Skinner's excavation by levels, the upper twelve inches or so of yellow soil having been discarded (see above); the other two are the roughly recorded occurrences from Trenches B and C, other than the series given above.

Depth Below Surface. (Feet)	Trench A	Depth Below Plane of Contact. (Inches)	Trench B	Trench C
2–3	286	0–6	13	27
3–4	9	6–12	43	86
4–5	2	12–18	29	45
5–6	2	18–24	29	15
		24–30	6	20
		30–36	3	2
		36–42	8	
		42–48	10	
		48–54	2	

An inspection of the detailed series shows their similarity in range and manner of dispersion. The ranges are similar, varying from 11 to 29 inches. In each series the position of maximum frequency is at the middle of the range, and the distribution is symmetrical about this point with the frequency of occurrence progressively less from the center to the extremes of the range. We recognize the close resemblance, if not identity, between the form of distribution common to these eleven series and the typical frequency curve.

The following averages and variabilities have been calculated for the above series.[1]

Series	Number of Cases	Average	Variability
I.	25	8.1	±3.80
IIa.	42	9.9	±4.35
IIb.	53	10.2	±4.67
III.	47	18.8	±4.84
IV.	55	8.0	±3.21
V.	46	7.0	±2.88
Trench 3	20	7.6	±4.66
Mercer–1897	31	9.8	±4.87
Volk–Chart	26	8.0	±3.68
1894	109	7.8	±2.87
1897	65	11.2	±5.22

[1] I follow Wissler, (a), in the statistical treatment.

With the exception of III the averages are similar. There are no artifacts in the first 9 inches of this series; if this is deducted, the average is 9.8. The maximum difference between any two series is 4.2 (V and Volk — 1897) and the certainty of this is ±0.77. This approaches a real difference, but it is the extreme case. As a further but not altogether accurate test we find, assuming the series to be homologous, the average for all series combined to be 8.9 ± 3.57 (correcting III) and the error of this average is 0.16 ± 0.11. The extreme averages differ from this by 1.9 and 2.3. These are, therefore, within the range of variation of the general average. The series are probably more strictly homogeneous, since the values are not rigorous but include as variables: —

1. Measurement from the planes of contact of the black and yellow soils; this being a warped plane, it introduces a small error in the observations;
2. A possible change in the plane of maximum frequency, as indicated in III, probably due to a subsequent change in the superficial deposits;
3. Observations grouped from several trenches in one series, as Mercer, 1897, and Volk, 1894 and 1897;
4. Values dependent on the frequency of positions mentioned, not on actual count of all recorded positions.

If deduction be made for these variables we have still less reason to believe the series independent. These series are, therefore, homogeneous; that is, they are samples of a single series. The vertical distribution of the groups is such as to conclude that a single cause of deposition has acted on all, giving a single plane of maximum deposition throughout the deposit.

It is of interest to note that previous investigators obtained evidence in agreement with the above, the significance of which they failed to note; viz., Abbott found implements in greatest abundance at a depth of about two feet,[1] or again, in greatest abundance at the "base" of the deposit of black soil;[2] Kümmel noted that they occur within less than four feet of the surface;[3] Putnam generalizes that they are most abundant "just at the border line of the black soil and the [yellow] sand";[4] Wright notes their occurrence from fifteen to thirty-five inches below the surface;[5] and Mercer found a "shallow zone of discovery, ceasing at about three feet below the surface."[6]

It must now be obvious that the objection often expressed that these objects are intrusive from the black soil will no longer hold; this aside from their cultural distinctness. If they had been let down from the black soil into the yellow, we would find the maximum frequency at the plane of con-

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[1] Abbott, (a), 318.
[2] Abbott, (f), 313.
[3] Kümmel, 348.
[4] Putnam, (g), 346.
[5] Wright, 357.
[6] Mercer, (c), 377.

tact with frequencies diminishing with depth. This is not so; there is a distinct gap between the distribution of artifacts in the surface soil and those below.

A few of Volk's finds have been interpreted at variance with these results. His "workshops"[1] in the yellow soil seem to be nothing but normal artifact groups. Four "fireplaces" and "pits" showed disturbed soil, broken red bands, "burnt" soil, or "charcoal."[2] I would suggest that the identification of these was an error. In connection with groups of artifacts, discolored strata of sand and colored clay fragments may easily be mistaken for traces of fire. The deep "burials" of human bones on the Abbott farm (three groups, 4 feet to 4 feet 6 inches below the black soil) are below the plane of maximum frequency for artifacts. They were found, however, at the extreme edge of the deposit, close to Abbott's brook which has cut a deep gully along the boundary between the sand deposit and the Pensauken terrace. There is just a possibility that the yellow sand has been worked over and redeposited by the brook, at which time the remains were either moved within the deposit or introduced from elsewhere.

Let us now consider the relation of artifacts to other features of the yellow sand, namely the pebbles and the red bands.

Artifacts occur among the pebbles in the sand and are found in general only with the pebbles. This does not mean that artifacts are found at every point where pebbles lie, nor that pebbles are always associated with artifact groups, but the association occurs with great frequency. The gross relations are given in the table on p. 188 which shows the vertical ranges of pebbles and artifacts at various points in the trenches. Thus, at least ten of the sixteen cases where pebbles and artifacts were noted at the same points show that they have identical vertical ranges, or the range of the artifacts is included in that of the pebbles.

To determine the distribution of the pebbles more exactly and their relation to that of the artifacts, series were obtained at III and V on the profile (Fig. 3). These series were taken from sections of sand in the trench wall as near as possible (within a foot or so) to the corresponding artifact series.[3]

Tabulating the number of pebbles in each inch of depth below the plane of contact, and comparing corresponding data for the artifacts, I obtained the series on p. 189. These series are shown graphically in Fig. 5. The proportion of artifacts to pebbles has no significance, since the series were taken from adjacent sections, and these sections differed in size.

[1] Volk, (b), 87 — Oct. 17, 88 — May 20 and 23, 89 — July 30.

[2] *Ibid.*, 85 — April 26, 87 — Oct. 24, 89 — Aug. 6, 98 — July 25.

[3] These sections were 4 feet long by 6 inches wide for III and 1 foot wide for V, with depth to grade.

GROSS AND SERIAL DISTRIBUTION OF PEBBLES AND ARTIFACTS.

Position on Horizontal Scale of Profile (Fig. 3)	Depth of Pebbles Below Plane of Contact (inches)	Depth of Artifacts Below Plane of Contact (inches)
53–101	No pebbles	6
101–146	Pebbles sparsely scattered through yellow sand, with groups as below.	
102	0–6 — group	6
115	0–12 — "	6–16
130	6–21 — "	6–20
145	17–41 (extreme limits) — group	5–39
155	20–32	24
168	20–32	21
196	34–42	6–45
211	32–44	12–41
235	46–grade — many pebbles	14–38
264	39–44; 47–grade — very many tiny pebbles in brown sand	
271	36–48 — very many	
271–311	5–38 — many	10–27
315	18–36 — many	12–66
398	26–48	6–18 (?)
409	33–46	6–18 "
416	34–48	6–18 "
584–594	0–24 — scattered tiny pebbles	3–13
596	0–20	0–23

Depth Below Plane of Contact (inches)	Frequency			
	III		V	
	Artifacts	Pebbles	Artifacts	Pebbles
0	..	2	..	..
1	..	4	..	4
2	..	4	1	6
3	..	4	3	3
4	..	1	1	10
5	..	2	3	16
6	..	5	14	20
7	..	5	14	20
8	..	3	5	22
9	..	5	1	18
10	2	9	..	14
11	..	5	2	10
12	4	9	..	8
13	1	8	..	10
14	2	9	..	12
15	4	17	..	2
16	1	21	1	6
17	5	32	..	4
18	2	32	..	2
19	4	32	..	..
20	2	41	..	2
21	5	30	..	2
22	4	40	..	1
23	3	33	..	..
24	4	33	..	1
25	1	24	..	..
26	1	24	..	..
27	2	23	..	1
28	..	20	..	..
29	..	31*	..	..
30	..	40	..	..
31	..	34	..	..
32	..	30	..	..
33	..	21	..	..
34	..	14	..	..
35	..	13	..	..
36	..	9	..	..
37	..	7	..	..
38	..	1	..	..
39	..	1	..	..
40	..	1	..	..
41	..	1	..	..

* Change of observers.

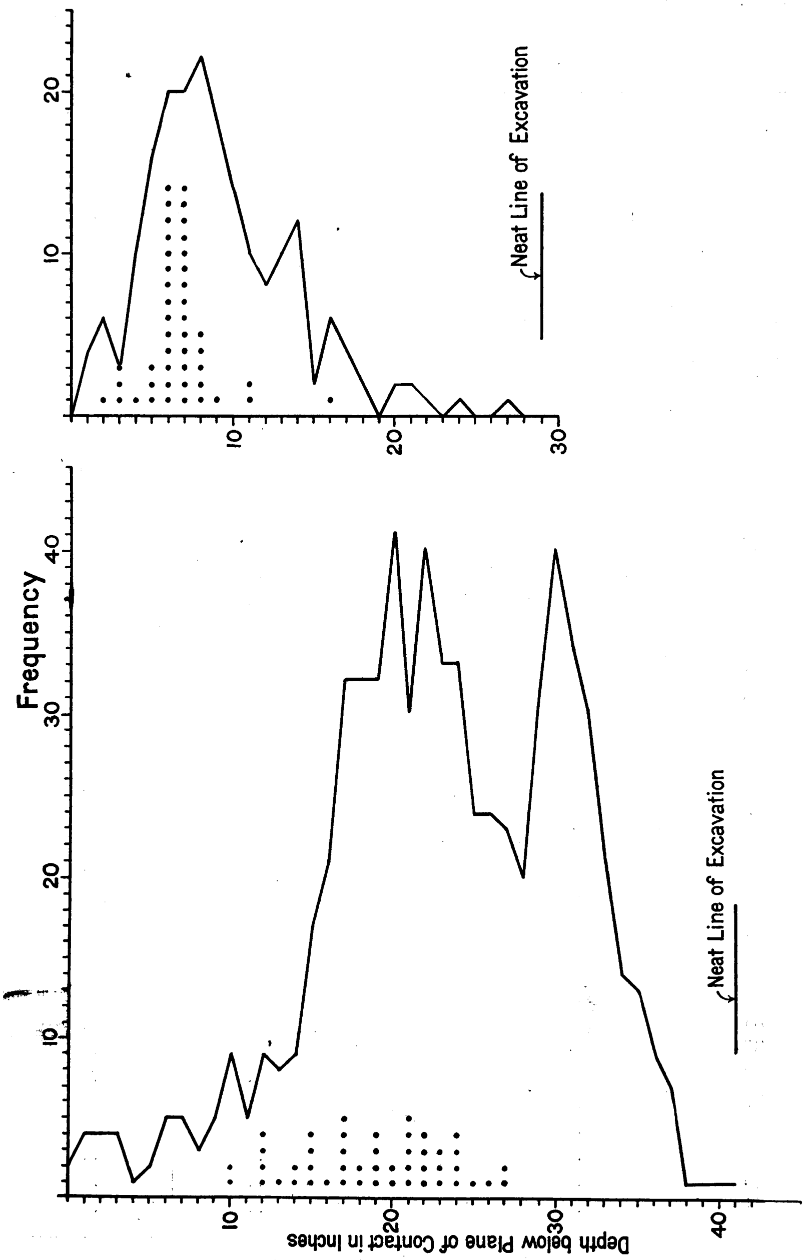

Fig. 5. Vertical Distribution of Artifacts and Pebbles of Groups III and V: Artifacts....; Pebbles —.

An inspection of the two pebble series shows their similarity and their close resemblance to the typical frequency curve. On comparing each with the corresponding artifact series, we note that the modal points occur at about the same depth, that the manner of distribution is identical, and that the range of dispersion of the artifact series, if not identical with that of the pebbles, falls within it.

In calculating averages and variabilities for these series, it must be noted that III was obtained by two observers; by Mr. Hoover from 0 to 29 inches, by myself from 29 to 41 inches (at grade), the change occurring during the excavation of the twenty-ninth inch. I have apparently doubled the count. Both segments of the curve are apparently fragments of normally variable series with approximately the same ranges and modes, but differing in the total number of cases. An average for the two segments combined would obviously give too high a value, since my higher count is added to one end of the range alone. It seems permissible to use Hoover's segment alone.

Comparative data are obtained from Mercer's record for Lalor field.[1]

Series	Pebbles			Artifacts		
	Number	Average	Variability	Number	Average	Variability
III— Hoover and Spier	675	23.3	±7.55	47	18.8	±4.84
Hoover[2]	477	21.2	±3.8			
V	194	9.1	±4.37	46	7.0	±2.88
Mercer	56	11.7	±5.96	31	9.8	±4.87

In III the combined Hoover-Spier series differs from the corresponding artifact series by 4.5 ± 0.77. This is a certain difference. The difference with the Hoover series is roughly 2.4 ± 0.7. This, on the other hand, is not a certain difference. The difference for V is 2.1 ± 0.53, which approaches a real difference but is not certain. For Mercer's series, the difference is 1.9 ± 1.20, indicating the certain identity of the series. The series of bone fragments (II b) presents a comparable phenomenon; its average is 10.2 ± 4.67 and that of the artifact series (II a) is 9.9 ± 4.35, which with a difference of 0.3 ± 0.94 are certainly identical. These are

[1] Mercer, (c), 374–375. Mercer's pebble series is for the largest pebbles only, and particularly for those in the vicinity of 20 inches, i. e., near the only artifact in which he was interested. This grouping of observations about 20 inches gives a higher value for the average of the series than we need expect.

[2] This approximate average and variability were obtained by inspection. Accurate values could be obtained by Pearson's method of curve fitting (*Biometrika*, II, 1, 1902) but the data do not warrant the labor involved.

fragments of two human skeletons all found within a radius of three feet; it necessarily follows that the entire series was deposited at one time.

These data must be interpreted as indicating that the artifact series are identical with the pebble series, that is, both are components of the same series. This can only mean that a single cause of deposition has acted on artifacts and pebbles alike.

As Dr. Wissler observes: —

> While all the preceding leaves little ground for differentiating between the pebble and artifact series, it may be noted that in each of the three cases the average for pebbles is actually higher than that for artifacts. Should this hold for a few future cases, it would make it quite probable that there was a slight real difference between the two series. Yet this would not materially affect the main point, that the artifacts and pebbles occur together.[1]

It is, perhaps, significant that the difference in all three cases is approximately the same: 2.4, 2.1, and 1.9. Consonant with this is the approximation of all the variabilities, which would indicate that artifact and pebble series stand somewhat apart. On the other hand, the difference may have no significance whatever. Artifact and pebble series, as tabulated above, have approximately the same modal points; the artifact series is symmetrical but the pebble series is asymmetrical. If of two series which are identical and symmetrical, the number of cases in one be greater than the other, then according to the law of probability the range of the first series would be greater than the second. If further in this series cases at the lower end of the range were systematically eliminated (i. e., if one end of the curve is cut off), then this curve would be asymmetrical and its average would have a higher value than that of the curve with fewer cases. *In the nature of the case,* this is exactly what has happened to our pebble series, merely because it contains a larger number of cases (except Mercer's series [2]) than the artifact series, the additional cases appearing at the greatest depths more frequently than at the least. In fact when we do obtain an artifact series with a large number of cases we find asymmetry of the same type: for example, Trench A gave for the first foot, x specimens; second, 286; third, 9; fourth, 2; and fifth, 2. Any deduction from the observed differences because of this relation would give less reason for believing the series to be different.

All of these series have been discussed throughout as though they were true samples of a normally variable series. To be sure inspection of the

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[1] Wissler, (a), 194.

[2] Compare footnote, p. 191. Here we have reason to believe that but for selection the actual difference would be less than that observed.

series, in spite of the small number of observations available, shows their fairly close approximation to this form. However, we can advance no *a priori* reason why artifacts and pebbles should be distributed through the deposit in such a manner. We might reasonably expect that their distribution is actually asymmetrical and perhaps composite. It is of interest to test a series of all artifact observations combined for asymmetry. In the following table the averages for the component series have been equated and the values tabulated as variations from the average.

Deviation from Average (inches)	Observed Frequency	Cases per 1000	Theoretical Frequency	Differences	
10	1	1.9	7.1		−5.2
9	1	1.9	11.5		−9.6
8	6	11.7	18.4		−6.7
7	7	13.6	28.3		−4.7
6	19	36.8	39.5		−2.7
5	18	35.0	53.6		−18.6
4	38	73.9	67.9	6.0	
3	47	91.2	79.9	11.3	
2	57	110.8	90.2	20.6	
1	58	112.6	96.0	16.6	
0	58	112.6	96.0	16.6	
1	35	68.0	90.2		−22.2
2	40	77.6	79.9		−2.3
3	27	52.4	67.9		−15.5
4	35	68.0	53.6	14.4	
5	18	35.0	39.5		−4.5
6	16	31.1	28.3	2.8	
7	7	13.6	18.4		−4.8
8	4	7.8	11.5		−3.7
9	8	15.5	7.1	8.4	
10	7	13.6	3.8	9.8	
11	3	5.8	2.0	3.8	
12	2	3.9	1.0	2.9	
13	..	....	0.5		−0.5
14	2	3.9	0.2	3.7	
15	..	....	0.1		−0.1
16	..	....	0.03		−0.03
17	..	....	0.01		−0.01
18	..	....	0.01		−0.01
19	1	1.9	0.001	1.9	
Totals	515	1000.1	2(500.051)	118.8	−101.15

There is no certain evidence of asymmetry here, although this might be interpreted as indicating a moderate asymmetry similar to that of the pebble series and probably due to the same causes. While the test is not perfect, I do not believe that this is sufficient reason for regarding the series as other than normally variable. To a certain extent this emphasizes the slight difference between the artifact and pebble series. The data for the pebbles will not permit a similar inquiry into the character of its distribution.

So much for the distribution of the series as a whole: the data must next be examined for differential modes of occurrence.

Most of the artifacts, chips, arrow-heads and blades, are flat. Wherever possible their obliquity to the horizontal was noted. With only two exceptions the artifacts lay with their long diameters horizontal or nearly so. This conforms with Kümmel's experience in Lalor field.[1]

The yellow sand is relatively free from pebbles: these, including artifacts, are not large. They vary in size up to small boulders, the largest of which (10 × 5 × 5 inches) was found lying flat 18 to 24 inches below the black soil at the extreme eastern end of Trench C. At the eastern end of Trench B the pebbles were chiefly $\frac{1}{4}$ to $\frac{3}{8}$ inch diameter; at the eastern end of Trench C $\frac{1}{4}$ to 2 inches diameter, most frequently $\frac{1}{2}$ inch diameter. No artifact (i. e., selected pebble) is larger than the largest boulder, and the rarity of large artifacts and large boulders is strictly comparable.

I have investigated artifact and pebble series for a differential distribution of weights of objects with positive results. The table on the next page gives the total weight of artifacts at each inch of depth for the series I–V and Trench 3.[2]

These give the following average depths of occurrence by weight which I have compared with the corresponding values for average depths by frequency.

	I	IIa	III	IV	V	Trench 3
Weight	5.8±6.08	9.1±5.00	17.3±4.16	7.4±2.97	6.3±2.39	7.4±4.97
Frequency	8.1±3.80	9.9±4.35	18.8±4.84	8.0±3.21	7.0±2.88	7.6±4.66
Differences	−2.3	−0.8	−1.5	−0.6	−0.7	−0.2

[1] Kümmel, 348.

[2] Fourteen specimens could not be located for weighing. I have interpolated the average weight of 221 specimens, 13.9 gms., for them in the series I, IIa, IV, and Trench 3. Since the distribution of the interpolated values is random, this ought not to affect the result.

Distribution of Artifact Weights.

Depth Below Plane of Contact (inches)	Total Weight (grams)					
	I	IIa	III	IV	V	Trench 3
0		97.1				
1						
2	56.0	1.7			10.6	
3	171.9	5.6		8.1	7.2	22.5
4	2.8	208.6		18.5	18.1	17.8
5	13.7			19.1	115.1	15.1
6		2.3		34.3	87.3	8.7
7	17.7	140.5		4.3	68.6	4.2
8	38.8	68.9		7.8	27.3	1.6
9	2.8	58.3		0.4	11.1	13.9
10		31.4	7.1	24.8		
11	39.3	19.8		8.2	8.4	3.9
12	2.2	45.5	9.6	11.4		
13			2.6	6.3		
14	32.0	186.5	209.3			
15		13.9	7.7			
16		45.4	10.7		7.1	
17		31.8	51.1			
18	8.1		6.2			
19			10.0		2.8	1.2
20		13.9	9.8			13.9
21			30.8			
22			26.8			
23			27.9			
24		85.4	31.2			
25			10.5			
26			1.8			
27			8.9			
28						
29						
30						

In every case the average depth by weight is slightly less than that by frequency. This means that in these series the center of gravity is above the center of mass. I have not investigated whether the preponderance of weight on one side is due to the larger size or greater density of the artifacts; the former seems more likely.

Unfortunately, the pebble series tabulated above were not saved. An incomplete series was obtained near Series III (eight feet distant) from an area four feet by six inches. The pebbles were obtained by passing the sand through a screen of 7.75 meshes per inch. These samples were subdivided by a screen of 4.75 meshes per inch, the subdivisions weighed, and the number of pebbles larger than the 4.75 mesh counted. These values are given in the following table as well as the weight of smaller pebbles in percent of the totals.

Depth	Weights (grams)		Number of Large Pebbles	Percentages of Small Pebbles
	Small Pebbles	Large Pebbles		
0	5.0	65.3	20	7.1
1	7.1	20.2	16	26.0
2	6.9	55.3	12	11.1
3	5.7	52.5	16	9.8
4	5.3	64.5	24	7.6
5	4.4	88.8	18	4.7
6	5.2	207.0	14	2.5
7	5.4	51.6	16	9.5
8	5.0	14.8	19	25.3
9	5.7	7.2	14	44.2
10	4.8	13.4	19	26.4
11	6.9	14.1	8	32.8
12	7.6	89.1	19	7.9
13	8.5	20.5	31	29.4
14	10.9	24.1	21	31.2
15	11.4	104.7	24	9.8
16	10.4	17.8	23	36.9
17	10.2	13.3	25	43.4
18	14.0	13.4	26	51.1
19	18.7	21.6	37	46.3
20	21.2	29.5	40	41.7
21	19.9	53.1	55	27.3
22	31.6	29.7	53	51.4
23	32.0	49.4	51	39.3
24	38.3	36.4	58	51.3

We note that in this series the weight of small pebbles [1] and the frequency of large pebbles increases from about the twelfth inch down. Since this

[1] It is obvious that we obtain a smooth series for small pebbles but not for large only because both limits of the small pebble class are fixed and close together, giving pebbles of uniform size, while only the lower limit of the large pebble class is fixed giving pebbles of varying sizes.

corresponds closely with the nearby Series III, it seems likely that this incomplete series was symmetrical but was broken off at about the modal point. If this is so, then we have for both small and large pebbles a phenomenon comparable to that already noted for artifacts and counted pebbles. In other words it does not matter how we select our series — by size mechanically as just shown, or by count of pebbles of appreciable size, or by selection of worked objects — we always arrive at the same result. This can only be the case where pebbles of all sizes and artifacts form together a homogeneous series.

Pebbles (including artifacts) form an integral component of the sand. Within the vertical limits of a pebble group [1] the stratum has a variable composition. Beginning at the upper limit pebbles of any given size increase to the modal point and decrease to the lower limit. Not only do large-sized pebbles occur most frequently at the modal point but all pebbles of appreciable size occur most frequently there. That is, the sand is coarsest at the modal point. In the last column of the table above are given the proportions of small pebbles to all pebbles collected. While the values are rough, the percentages increase with depth, i. e., the small pebbles increase in proportion to all the components of the sand faster than the large pebbles. This means that the stratum has a differential composition.

It is obvious that the pebbles described above comprise only a minor fraction of all components. There is a smooth gradation of sizes of sand grains from impalpable dust up to the largest pebble or boulder, with an average size smaller than our smallest pebbles. The distribution of sizes varies from group to group. The following data giving proportions by weight and percent are available.

Sieves used in Separation (mesh per inch)	2	2–4.75	4.75–7.75	7.75–12.4	12.4–18.	18.—	Total Weight of Sand (grams)
Size $\left(= \frac{1 \text{ inch}}{\text{Lower limit of class}}\right)$	0.500	0.211	0.129	0.081	0.056		
Series tabulated above	1157.3		302.1				216150.[2]
Spoil-pile, Trench A	242.7	505.1	470.2				——
Sample collected by Volk	517.9 *7.9*	1632.7 *24.9*	422.8 *6.5*	101.4 *1.5*	372.5 *5.7*	3500.0 *53.5*	6547.3 *100.0%*

[1] These are only the limits within which I investigated, of course.

[2] Estimated.

The second sample has a decidedly asymmetrical distribution of sizes, with the average grain or pebble of very small diameter; the first may be similar.[1] Volk's sample apparently has a bi-modal distribution, with an average for pebbles about 0.3 inch and for sand grains less than 0.056 inch. In any interpretation of artifacts as pebbles, it must be noted that they are, for the most part, very flat, two diameters greatly exceeding the third.

The second geological feature to be considered is the system of red bands. The yellow sand is traversed by red layers or films (appearing as bands in section), which occur at frequent intervals from a few inches below the surface soil down. I have mapped the red bands as seen along the side walls in Trench B, accessible parts of Trench C, and in Trench D, connecting Trench 1 with Pit 1 (Fig. 11). On account of their irregular character the bands were difficult to trace from point to point. Short breaks in the bands have been bridged over, so that the sketch suffers slightly from over-systematization. However, no breaks or changes of any importance were ignored. The width of the band is drawn approximately to scale. As a general rule, the thinner bands were also proportionately fainter.

The red bands generally lie from four to six inches apart. At any point along Trench B a vertical section shows the wavy bands progressively more distinct, compact, and wider from surface downward. The red bands are sections of warped planes tilted in the same direction as the present surface but on a lesser grade. They therefore approach and eventually reach the present surface. Each band becomes thinner as it approaches the surface, decreasing from two to four inches thick at its greatest depth to a mere thread at grade.

It will be noted that several bands are often fused into one, the width of which is variable, sometimes equal to the sum of the width of the individual bands, and again equal to the width of only one. Two bands may be pointed out which can be traced for a considerable distance and which exhibit this feature: the band AA′ beginning at 4 ft. 8 in. below the surface at the point 211 on the profile, reaching the surface soil 71 ft. west (point 140), the drop of the surface being 4 ft. 11 in. in this distance, that of the band 10 in.: also the band BB′ beginning 5 ft. 1 in. below the surface at the point 176, reaching the surface soil 74 ft. west (point 102), the drop of the surface being 5 ft. 4 in., that of the band 6 in.

I presume that the bands, or rather planes, are parallel with the surface of Trench C, throughout its length. In the eastern part of this trench, it will be noted that the bands parallel the surface: most prominent among

[1] Gilbert, (a), 177, tabulates data for a natural fluviatile mixture which shows the same asymmetry.

them being a wide and compact band in the central portion of this section which disappears abruptly.

On the sketch will be found several isolated portions of red bands, also others ending not at the surface soil but at some point in the yellow sand. These could not be traced beyond the limits shown.

Of interest is a hard layer of black material appearing at the western end of Trench B and in the middle of Trench C. This band closely resembles the red bands in position, thickness, compactness, etc. Fragments of the same material are frequently encountered throughout the yellow soil and might be mistaken for charcoal.

The bands extend throughout the deposit from Lalor field to the Abbott farm. They always occur "in the same order and composition" according to Volk, but showed a different arrangement [1] in a few instances.

Wright gives an analysis of a series of bands in Lalor field: —

Stratum	Thickness[2]	Percent of Clay	Percent of Iron
Sand	7″	18	—
Red Band	½″	24	—
Sand	6″	16	0.5
Red Band	2″–½″	27	1.5
Sand	4″	14	—
Red Band		27	—
Sand	2″–3″ } 10″	—	—
Red Band		37	1.5
Sand	—	7	—

These red bands, therefore, are not to any appreciable extent segregations of iron. The iron scarcely more than suffices to give the color. The analysis shows, therefore, that these red bands contain from 25% to 33% more clay than is found in the interstratified strata of sand.[3]

Kümmel states: —

that the 'red clay films' observed at various intervals in the sand are not, in my opinion, lines of stratification at all, nor are they always strongly clayey. They are partly, at least, zones or bands of infiltration and deposition of ferric oxide which has somewhat cemented the sand grains.[4]

Wright's analysis refers to the same trenches from which Mercer's 1897 series were taken. These gave average depths for artifacts 9.8 ± 4.87 and pebbles 11.7 ± 5.96. The bulk of artifacts and pebbles fell in the

[1] Volk, (b), 7, 103–15.

[2] Beginning below a "zone of doubt" of 15 inches.

[3] Wright, 358.

[4] Kümmel, 348.

second sand stratum. The red planes cross the group but may have no causal relation to it. Similarly with Series I (Trench 2) there were no red bands; Series IIa and IIb (Trench 1) thin, faint bands at 13, 15, and 18 inches with averages of series 9.9 ± 4.35 and 10.2 ± 4.67; Series III (Trench B) a heavy band at 44 inches with averages of artifacts 18.8 ± 4.84 and pebbles 21.2 ± 3.8; Series IV (Trench C) faint bands at 3, 5, and 19 inches and heavy bands at 28 and 33–35 inches with average of 8.0 ± 3.21; Series V (Trench C) a faint band at 12 and heavy bands at 24 and 30 inches with artifact and pebble averages of 7.0 ± 2.88 and 9.1 ± 4.37; and Trench 3 with a faint band at 5 inches and heavy bands at 11, 18, 26, 32, and 36 inches with the artifact average of 7.6 ± 4.66. In other words the seriation of red bands and pebbles is not the same, but occurs in variable relations.

Dr. Chester A. Reeds suggests that the red bands represent films of clay and decomposed iron bearing black mica (biotite) which have been subjected to the periodic oscillation of the ground water level and oxidation. The iron serves as a cement and if present in considerable amount binds the sand, pebbles, and clay together forming "peanut rocks" when indurated. The position of the ground water level at present is indicated by the following data.

Position	Point on Profile (Fig. 3)	Depth below Surface (feet)	Height above Flood Plain (feet)	Grades
Abbott's Brook	1061	Brook bed	47.5	
				1.21
Trench C, east end	664	7.3	42.7	
				1.26
Trench A	315	12.5	38.3	
				1.64
Trench B, west end	53	4.5	34.0	
Abbott's Brook	31	Brook bed	34.5	
Trench 1	(190)	3.3	43.9	
Well	−389	4±	25.5±	
Spring at Bluff	−554	Face of bluff	25.5−	

These grades are, of course, less than the surface grades.

These data show that the artifacts are one component of a series of pebbles which extend throughout the sand deposit, at least in the vicinity of the bluff, in a single plane of maximum deposition. Inasmuch as all the pebbles, from boulders down to sand grains, are an integral part of the sand deposit it necessarily follows that a single cause of deposition has acted on artifacts and sand alike. Earlier investigators have variously favored the following causes of deposition: occupation of the site with accidental inclusion of the artifacts in the sand by the action of wind or water, or the deposition of sand and artifacts by a stream aggrading its bed.

Assuming that the distribution curve characterizes the occupation of the site, it can be compared, Wissler suggests, with distributions in culture deposits. A number of pottery tables for the ash heaps of Southwestern ruins are available. Only the total number of fragments representing the fluctuations of the whole ceramic art give distributions comparable to the series at Trenton since that represents the culture as a whole. It is assumed that the intensity of the ceramic art was uniform, and therefore fluctuations in the quantity of sherds indicate corresponding changes of population. Nelson's San Cristobal table [1] shows relative uniformity in the total number of sherds at each level, at least there is no progressive rise or fall in these values. Kidder's Pecos tables [2] give similar results in all cases. In both pueblos certain types of pottery give distributions of the normal type: San Cristobal type I and type II redware, and Pecos Test X glazed ware. But these are not comparable to the Trenton series since they represent fluctuations in single cultural traits — stylistic pulsations — which attain their maxima at the expense of other similar traits. Similar series could be obtained at Trenton for every culture trait — various types of arrowheads and blades — but these would give normal curves merely because the entire group was of that form. These stylistic series are not comparable with the whole Trenton series. I have found that ash heaps at ruins in the Zuñi country give a variety of distributions.[3] Sites 97, 104, 121, 139, and 161 show relatively uniform distributions; Sites 71, 146, and 152 an increase in the number of sherds. At Site 140 the section within the pueblo gave a rather uniform series, possibly with a decrease at the start and an increase at the end, while the section outside the ruin shows an increase. At Site 48 the two sections are stylistically equivalent, but the second shows a decrease in the number of sherds. Site 33 alone gives a normal curve. This does not require individual treatment but is susceptible of explanation in common with the others. All of the fluctuations must represent either changes in the entire population or, as at Site 48, a shift in the use of the refuse heap. It is most probable that at Site 33 the distribution represents the growth and decline of the pueblo as a whole. A similar case is given by Gamio for Teotihuacan.[4] In the refuse at this city the pottery has a

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1 Wissler, (a), 195.
2 Kidder, 342–347.
3 Spier, (e), 256–262.
4 Gamio, Plate II.

distribution resembling the normal type, but with two maxima of frequency. Gamio suggests that the curve reflects the occupation of the city as a whole, with the two maxima coinciding with architectural changes. In this case also a single style, the Aztec type, gives a normal curve. I have checked out the distribution of objects in a shell-heap reported on by Loomis and Young [1]: since this series includes all artifacts it is more strictly comparable to the Trenton series than the pottery distributions. Aside from the well-known phenomenon of "rounding-off," the distribution is clearly uniform and therefore unlike the Trenton series.

So far as these cultural data go, they show that normal curves may be expected as a result of a rise and decline either of the intensity of a cultural trait or of the whole population. The first is out of the question at Trenton; the second seems unlikely, since the pebble distribution and the horizontal alignment of the artifacts over a wide area are against such an interpretation.

Direct comparison with the distributions in a known water deposit is possible with only one series, collected by myself; I have been unable to find any published records of others.

This series was taken from a superficial sand deposit [2] which presented conditions closely similar to those at Trenton. The sand was light and loose, and relatively free from pebbles. Smaller pebbles were more common at the modal point of the series than at the extremes of the range. Overlying the starting point of the series was 20 inches of clear sand.

Depth Below Surface. (Inches)	Frequency.
20	5
22	21
24	49
26	60
28	38
30	128
32	180
34	100
36	72
38	33
40	28
42	20
44	14
46	10
48	0
50	2

[1] Wissler, (a), 196.

[2] At the Havasupai Indian village in Cataract Canyon, a tributary of the Grand Canyon of Arizona. In 1910 a devastating flood completely redistributed the sand floor of the canyon. The series had to be made surreptitiously and is therefore not very accurate.

This series represents a normal frequency distribution, with perhaps a suggestion of asymmetry, i. e., with a slightly greater range in the lower depths.

Water deposited pebbles undoubtedly occur in other distributions, but the identity of this distribution with the Trenton series clearly indicates the possibility of water having deposited that series.

CULTURAL TRAITS.

Cultural traits preserved in this deposit are few. There is no evidence of the type of occupation with which the artifacts were associated. As the deposit stands, it clearly does not represent a village site: Volk's references to "work shops," "fireplaces," and "pits" which point in that direction are susceptible of other interpretations (p. 187).

The artifacts are of a few and simple types and all of stone. These are arrow-heads and larger chipped blades, pitless hammerstones, and one rubbing stone. The bulk of the objects found were mere flakes, which may include scrapers and, in addition, some fractured pebbles.

The several types of chipped forms were determined by a series of trial groupings: the types which are recognized are the groups with the greatest number of representatives. The number of specimens definitely recorded from the yellow sand is small, sixty-six. To these I added ninety-six others of the same general form and patination but taken from the layer of sand which Skinner had included in his "zone of doubt" (p. 180). While a few of these may be of Lenapé origin the majority belong with the older culture since I found the same relative distributions of both series of specimens in the type-groups. Thirteen types were determined by inspection, the specimens mixed and distributed into thirteen groups three times. Specimens, which fell twice in one group and a third time in another were included with the first group. Specimens, which fell successively in three groups were included with those nearest in form. The number in each group is given in the following table: —

Group	Arrow-heads								Large Blades					
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Totals
From yellow soil	17	11	2	7	2	4	7	1	4	3	2	6	0	66
From "zone of doubt"	35	13	3	3	0	13	15	1	3	1	4	3	2	96
Totals	52	24	5	10	2	17	22	2	7	4	6	9	2	162

The typical forms of arrow-heads are I, II, IV, VI, and VII, and of large blades IX, XI, and XII (Figs. 6, 7, and 8).

Type I is the so-called "fish-spear,"[1] a long slender blade of rather rounded cross-section, as frequently notched as stemmed and occasionally

[1] Abbott, (d), 267.

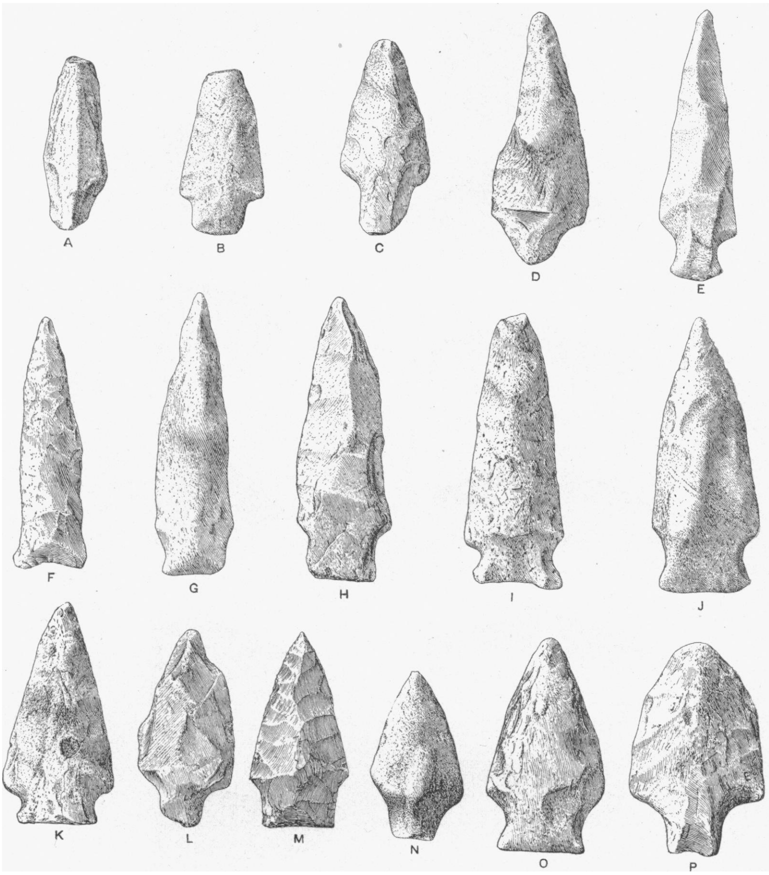

Fig. 6 (20.0–7414, 7319, 7310, 7307, 1448d, 7455, 8102, 7315, 7378, 8261, 8147, 8177, 8107, 7398, 7473, 7474). Arrow-heads: Types I (a–j) and II (k–p). ½ Nat. Size.

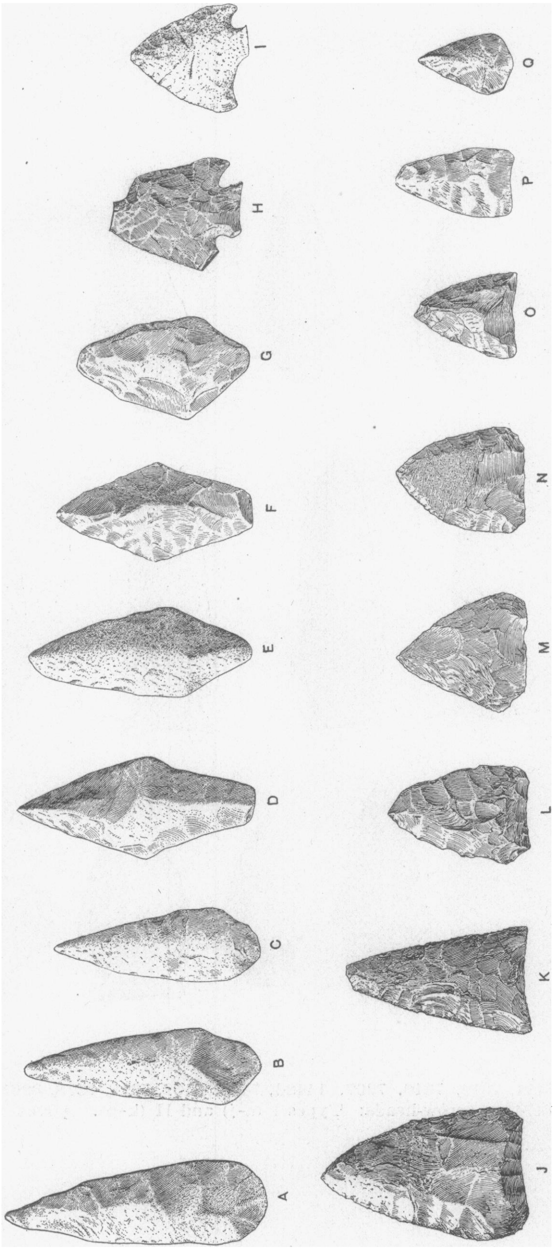

Fig. 7 (20.0-7420, 7382, 7379, 7309, 7533, 7350, 8187, 7530, 7311, 8118, 7401, 7526, 7539, 7536, 8175, 8165). Arrow-heads: Types III (h, i), IV (a-c), V (q), VI (d-g), VII (j-o), and VIII (p). ½ Nat. Size.

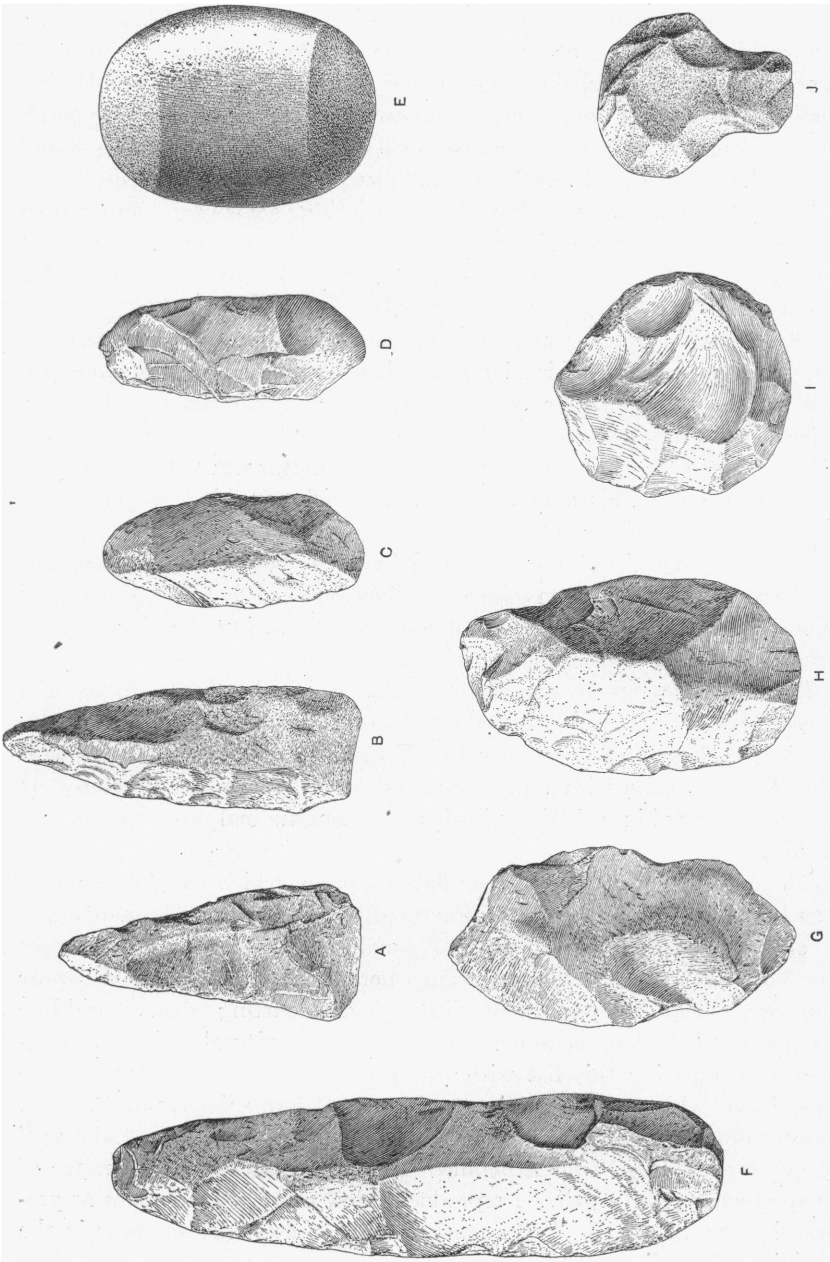

Fig. 8 (20.0–7312, 7306, 7515, 8135, 7328, 7296b, 7363, 7300, 7570, 7566). Large Blades: Types IX (a, b), X (f), XI (c, d), XII (g-i) and XIII (j); and Rubbing Stone (e. ½ Nat. Size.

with a marked flare of the edges at the base instead. Type II is a broader, thinner blade, notched or stemmed. Some of the smaller specimens of Type II are indistinguishable from smaller points of Type I. Type III is a small triangular thin point, deeply notched from the base edge. Type IV is a long slender point, like Type I of oval cross-section, and with a round base. Type V is a much smaller and broader point of the same type.

Type VI is small, lozenge-shaped, the base being somewhat blunter than the point; in the cross-section the blade is trapezoidal or oval. Type VII is small, triangular, and flat; the base is sometimes incurving. Type VIII is similar to Type VII, but the forward edges are convex.

Of the larger blades, Type IX is long, sharply pointed and with a straight or rounded base. Type X is a long, flat blade with parallel edges and round ends. Type XI is similar but is shorter and proportionately broader. Type XII is a flat oval or round blade equally chipped on all edges. Type XIII is shaped like a longitudinal section of a mushroom with the cutting edge at the top. This may be the butt of a longer blade which, when broken off, was worked over.

The workmanship of these chipped blades is not crude but does not equal the best of Lenapé specimens. They seem to be entirely chipped; some may have been ground or rubbed in addition but the disintegrated surface gives no clue of such operations.

Pitless hammerstones are merely more or less battered pebbles and without distinctive features. One of these, a small boulder (20.0–8211), has two parallel faces ground smooth. The single rubbing stone (20.0–7328) (Fig. 8) is a pebble with four ground or rubbed facets at the ends. It resembles a very blunt double-edged ax: in longitudinal cross-section it is six sided.

The additional finds were stone flakes some of which may be scrapers, a few broken pebbles, possibly fire-fractured, and fragments of human bones.

This exhausts the list of cultural remains. Our smaller series agrees with Volk's five types collected during a period of twenty years: the spear head, arrow-head, an implement with a jagged cutting edge, a drill-like specimen, and the hammerstone. The paucity of cultural traits is emphasized by comparing this list with the multitude of forms known to the Lenapé and which are found in the black soil immediately above. Dr. Abbott's older works "Stone Age in New Jersey" and "Primitive Industry" are not precise enough for a detailed comparison but cover the range of Lenapé remains fairly well. I reproduce below a list of Lenapé forms prepared by Mr. Skinner.[1] Types marked with an asterisk also occur in the "argillite culture."

[1] Skinner, (b), 53–54.

I Chipped Stone
- * Large blades
- * Spear points
- * Arrow points
- Drills
- * ? Stemless scrapers
- Stemmed scrapers
- Bizarre chipped forms

II Rough Stone
- * Pitless hammerstones
- Pitted hammerstones
- * Rubbing stones
- Arrow smoothers
- Sinew stones
- Pestles
- Mortars
- Grooved axes
- Celts
- Grooved mauls
- Grooved clubs
- Grooved sinkers
- Notched sinkers
- Perforated sinkers
- Ceremonial stone heads
- Gouges
- "Slick stones"

III Polished Stones
- Gorgets (two types)
- Banner stones
- Stone tubes (several types)
- Stone pipes
- Other objects

IV Engraved Stone Objects
- Portraits
- Animals, etc.

V Native Copper
- Spears
- Arrows
- Celts
- Beads

VI Pottery
- Vessels
- Pipes
- (Many types of both)

VII Bone and Antler
- Awls
- Cylinders
- Arrow points
- Other objects

VIII Shell
- Beads, etc.

This list is not exhaustive but shows the range of Lenapé forms. The number of types common to both cultures is small; whole classes of objects are not represented in the "argillite culture." Of course, it is possible that perishable materials, such as wood, shell and bone, played a large rôle in the older culture but have not been preserved. The absence of shell and bone artifacts is noteworthy, since parts of two human skeletons were found. While the remains were fragmentary, they were sufficiently preserved for identification.

In detail the types of arrow-heads in the "argillite culture" are fewer than in the Lenapé remains. While I have no precise data on the point, this can be easily seen in any representative collection.

The list of missing traits is impressive. Pottery is entirely absent: there is no evidence of drilling in stone: net-sinkers are also absent, as well as the finer types of stone implements. No foodstuffs were found so that is impossible to say whether the absence of pottery is conn ected with the absence of maize.

All of these finds corroborate the contentions of Abbott and Volk that we have a simple older culture here set over against the comparatively rich and varied culture of the historic Lenapé. While the older culture is rude, it is not crude.

Earlier investigators have objected to the asserted position of the "argillite culture" on the grounds that such objects had worked their way down from the black soil into the yellow sand through root holes, uprooted trees, by the agency of burrowing animals, or by other similar accidental means. It is inconceivable that such a segregation of objects should have brought about a cultural distinction.

All of the objects from the yellow soil constitute a homogeneous unit; that is, we have found nothing that we may not refer to a single culture. It would be interesting if there was a sufficient number of specimens to see whether there is any vertical differentiation of types. The tabulation above of the thirteen groups of objects gives us something of the sort. Here the "zone of doubt" includes the uppermost twelve inches or so of yellow soil; the other specimens are from a wider vertical range including this zone. There is no significant difference between the two groups. It is unlikely that any such differentiation would be found in view of the manner of distribution of the artifacts and pebbles.

The name "argillite culture" was applied to these remains by earlier investigators who asserted that the stone used was argillite alone or that argillite predominated.[1] Certainly most of the objects are alike to the superficial observer. They are characterized by an alteration of the surface to a chalky consistency with a characteristic greenish or yellowish gray color. A series of these objects with a few similar specimens from Staten Island were selected by Dr. C. A. Reeds and forwarded to Dr. J. Volney Lewis for identification. Dr. Lewis found that these were argillite, hornfels, sandstone, and siliceous oolite. Argillite constitutes over half of the series. The relative abundance of the materials is in proportion to the proximity to Trenton of outcrops of the same in northern New Jersey and adjacent sections of New York and Pennsylvania. The implements may have been made from river pebbles or from pebbles in the stratified drift of the Cape May formation, in which, of course, their relative abundance is naturally the same.

Dr. Lewis's statement concerning the age of the artifacts is worth reproducing in full.[2]

From the petrographic examination of the materials alone no very definite conclusions can be drawn as to their age, but some of them are manifestly very old. Several of the blackish argillites are so bleached and altered that they are now a pale

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[1] Artifacts of argillite were first recognized by Prof. M. E. Wadsworth.

[2] Lewis, 201.

yellowish gray, and the bleaching has penetrated so far that only the central portion, or even a small central spot, retains the original color. These conditions are notably shown in Nos. [20.0–] 7303, 7448, 7476, 7485, and 7517, from Trenton, and in No. 4227 from Staten Island. One specimen from Trenton (No. 7485), undoubtedly a bleached argillite, is pale grayish in color throughout. Also the reddish quartzite from Trenton (No. 7333), originally a dark grayish rock, now has only a small central spot of this color.

The great age of these specimens is beyond question. They have been bleached by long exposure to the weather and the shallow ground waters since they were worked into their present shape. This process, especially in the dense argillites, is a very slow one, as may be seen in the natural outcrops of these rocks, which are decolorized to only a shallow depth as a rule.

On the other hand, some of the specimens are in a comparatively fresh condition, even on the surface. Apparently these are either less ancient or they have been imbedded in soil of a denser texture and hence have not been so fully exposed to the weather and the percolating ground waters.

SKELETAL REMAINS.

As a positive contribution to this subject I have only a mass of fragmentary bones without any definite character. In addition it is necessary to review some of the published accounts of skeletal material supposed to be associated with the argillite culture. It should be obvious that the only finds which can be considered in this connection are those with a definite association by virtue of their stratigraphic position.

The new remains are the series of bone fragments from Trench I considered above (Series II b). The fragments are very small and their identification was made possible only by the fortunate inclusion of three *ossa temporale* (Fig. 9). They have been identified by Dr. William K. Gregory and Mr. Louis R. Sullivan as the remains of two adolescents. Mr. Sullivan's report is given in the following paragraphs.

As a whole, the total series of several hundred bone fragments are very small and for the most part lack the distinctiveness necessary for specific identification. By far the greater number of them represent fragments of long bones. In only one instance does a fragment represent an entire cross-section of the shaft. About twelve of the fragments exceed an inch in length but the remainder are much smaller.

In the cranial fragments we are more fortunate in having preserved five fragments which may be positively identified as representing portions of the pars petromastoid of three ossa temporale of a mammal. Three of the five fragments represent that portion of the pars petrosa bearing the internal acoustic meatus and subarcuate fossa. In these specimens the subarcuate fossae are mere pits. According to the findings of Dr. William K. Gregory this condition of the subarcuate fossa is characteristic of man and the higher anthropoids only; all other mammals have the subarcuate fossae open. The higher anthropoids are at once eliminated by their absence from America.

When we compare these specimens with the pars petrosa of an adolescent individual we find almost an identity in the conformation and position of the internal acoustic meati, subarcuate fossae, and arcuate eminences. Two of these fragments, undoubtedly, form a pair while the third represents the pars petrosa of a third left os temporale. Further comparison with the same skeleton enables one to identify other fragments as follows: a portion of the processus fronto sphenoidalis of the os zygomatium, portion of the pars orbitalus of the os frontale, various portions of the os occipitale and other bones of the brain case, three portions of the shaft of the tibia, one fragment of the head of the tibia, two fragments of the femur, the inferior articular process of a lumbar vertebra and the superior articular process of a dorsal vertebra.

There is no reason to suppose that these fragments represent more than two individuals. It also seems safe to say that they represent the fragments of human skeletal remains of two adolescent individuals.

It was noted above that these fragments were found among artifacts having an identical distribution (Series IIa). Since the fragments were all

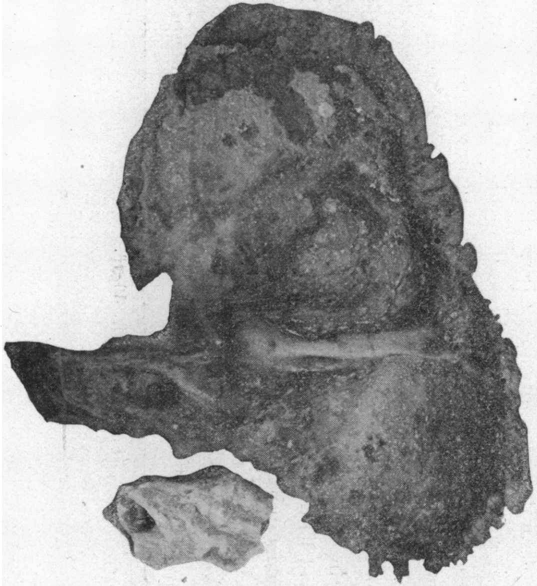

Fig. 9.

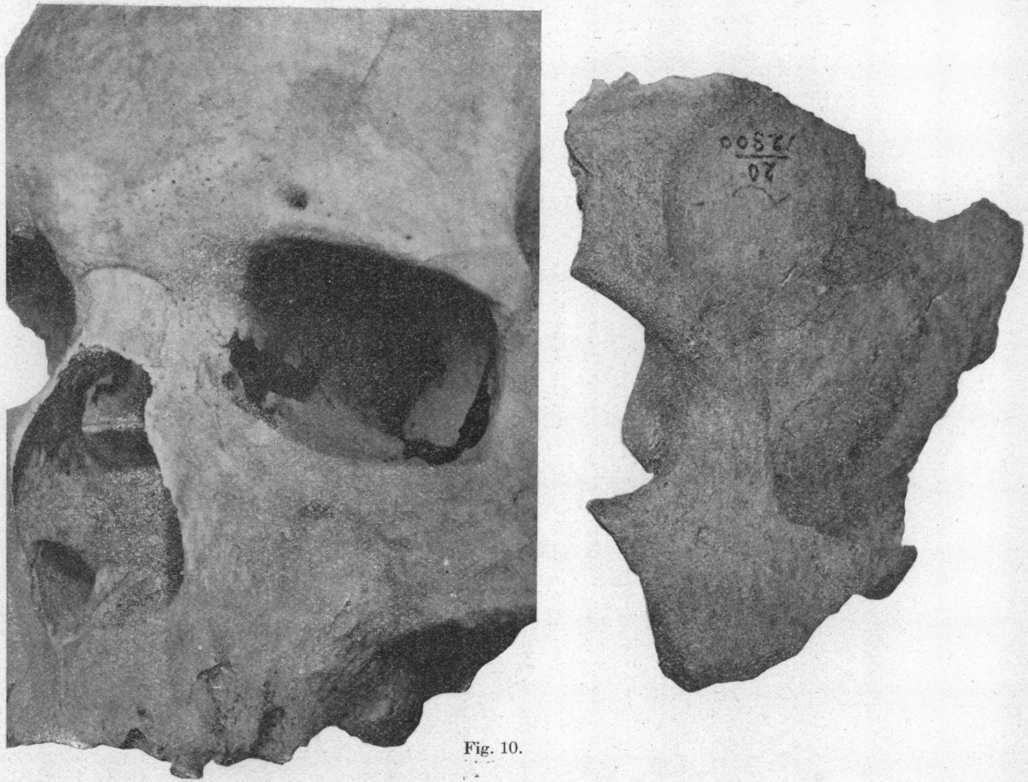

Fig. 10.

Fig. 9 (20.0–7107). Ossa Temporale of an Adolescent Individual and a Fragment from Trenton.
Fig. 10 (99–6598, 20–12300). Obliquely Placed Orbits from Trenton and of Skull from a Grave at Orangeport, New York.

found within a diameter of three feet and represent only two individuals, it is evident that the entire series must have been deposited at about the same time. There is nothing in their arrangement to suggest a burial. Since the fragments cannot be separated and assigned to the two individuals, I do not know whether the two occurred separately: it seems unlikely.

A number of skeletal remains from this region have been reported on by Russell and Hrdlička in view of their possible association with early remains. These consist of a piece of frontal bone, a fragment of a lower jar, a third molar tooth, a portion of a femur, three skulls named after the localities in which they were found, "Gasometer," "Burlington County," and "Riverview Cemetery," and pieces of crania, long bones, etc., from the "deep burials" on the Abbott farm. Abbott and Volk suggested the association of the frontal bone, the lower jaw, the molar tooth, and the femur with the gravels in which they were found (and with their "paleolithic culture"). They are then of no concern for the argillite culture. The "Gasometer" skull, found in the southern angle of the junction of Assanpink Creek with the Delaware at a depth of twelve feet, lay well outside of the area in which Volk found the remains of the argillite culture. The "Burlington County" skull which was found at Sykesville, Burlington County, about twelve and a half miles southeast of Trenton, where it rolled out of the bank of a brook, also lay outside of the culture area. While both of these skulls may have an intrinsic interest because of their geological position or morphological character, there is no legitimate reason for connecting them with the argillite culture. The "Riverview Cemetery" skull presents a slightly different case. It was found in an elevated part of the cemetery at a depth of about three feet. Since the point at which it is found is not far from the culture area and its depth not greatly divergent from the normal depth for cultural remains, there is a possibility that this skull should be considered with the culture. On the other hand, Volk defines the culture as beginning at the Riverview Cemetery and extending east and south. Presumably, he does not include the cemetery and nowhere else does he speak of cultural remains having been found there. The skull has certain peculiar characters which it shares with the "Burlington County" skull, according to Hrdlička, and is similar to a local European type.[1] The affiliation of this skull is, therefore, not clear: it seems unlikely that it is associated with the argillite culture.

The "deep burials" from the Abbott farm were found by Volk in 1899. They were taken from a trench running eight feet from the ravine cut perpendicular to the bluff by Abbott's Brook; the first two heaps of bones

[1] Hrdlička, (b), 36–46.

(Volk's Fig. 21, e and f) being found about twenty feet back from the bluff and the third (Volk's Fig. 21, d, catalogued as two heaps) about twenty-five feet further in. The heaps lay from four to four and a half feet below the black soil at the base of the yellow sand stratum.[1] In the heap "farthest south" (f?) was found an argillite implement. These groups lay below the plane of maximum frequency of artifacts. Their position is at the extreme edge of the sand stratum where it abuts on the higher Pensauken terrace. Abbott's Brook, which follows the margin of the two deposits, must be a comparatively old drainage trough. Since the heaps were so close to the brook, there is a possibility that at some time they were moved within the deposit or introduced from elsewhere at a time when the brook was reworking its bed. Inasmuch as the little brook has cut a ravine thirty or forty feet deep at this point, such a redistribution must be comparatively old. In any event the bones have some antiquity; whether they are in definite association with the argillite culture is not clear. In view of this possible connection and because of their intrinsic interest, Mr. Sullivan has furnished the following report: —

I have been asked to examine four lots of human bones representing the "deep burials" excavated by Mr. Volk. All the bones came from the same trench but from two distinct "graves" in lots of two heaps each. The bones now catalogued in the American Museum of Natural History as 20–12300 and 20–12302 (probably Volk's Fig. 21, e and f, respectively) were found close together in one part of the trench and those catalogued as 20–12321 and 20–12324 (probably Volk's Fig. 21, d) were found in close association in another part of the trench. Most of the bones were fragmentary and showed considerable degrees of disintegration. Lots numbered 20–12300 and 20–12302 were in a slightly better state of preservation than lots numbered 20–12321 and 20–12324. In all we have parts of at least seven skeletons, distributed as follows:—

Catalogue 20–12300:—

- Portion of a right parietal.
- A nearly complete frontal with small portions of the parietals.
- That portion of the left orbit consisting of a portion of the frontal, sphenoid, and malar.
- The atlas.
- The axis.
- A portion of the left parietal of a second skull.
- The proximal portion of a left femur.
- The acetabular portion of a right innominate bone.
- The distal ends of one right and two left humeri.
- Distal end of a left radius.

Catalogue 20–12302:—

- The right temporal with fragments of the parietal and occipital.
- Another fragment of the right parietal.

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[1] Volk, (b), 101, 102 and chart in American Museum.

A small piece of the left maxilla bearing two molar and one premolar tooth.

The right and left gonial region of a mandible and two fragments representing the right gonial region of two other mandibles.

The proximal and distal portions of a right femur.

A right humerus.

Catalogue 20–12321:—

A small portion of the right orbit.

Greater wing of the left sphenoid and fragments of the palate bones.

Another skeleton is represented by:—

A nearly complete right parietal with a portion of the frontals.

A large portion of the sphenoid.

The basi-occipital.

A nearly complete right femur.

A left tibia.

The acetabular region of the right innominate.

Catalogue 20–12324:—

A large portion of an occipital with a portion of the right parietal and temporal

The right and left femora.

The left ulna.

A right and left tibia.

Fragments of the clavicles and scapulae.

Uncatalogued parts consist of fifty fragments of ribs, thirty teeth, a nearly complete right tarsus and a left calcaneum and cuboid.

In spite of the fragmentary nature of the bones they show certain characteristics pointing to their racial identity. All of the bones must be considered together.

If we examine first the teeth we find among the lot one lateral and one mesial upper incisor. These teeth both show the marked infolded concavity on the lingual surface which is so characteristic of the incisor teeth of American Indians. This would seem to indicate that the bones represent the skeletons of American Indians. The other teeth show no marked peculiarities. Seventeen are molars, seven are premolars, and four are canines. They all conform to the normal dentition of modern Indian skulls.

Examining next the fragments of skulls we find that none of them are of sufficient size to warrant measurements of definitive value. The portions of frontal, parietal, and occipital bones appear to be more or less warped or distorted. One fragment about eight centimeters square representing the external half of the left orbit (20–12300) is of interest and in my opinion throws some light on the identity of the burials. That portion of the orbit remaining represents an unusually low and obliquely placed orbit. At first this appeared to be only an individual variation. Examination of a considerable number of skulls of American Indians showed this particular form of orbit to be of fairly frequent occurrence among Indian skulls coming from the eastern United States. To be more definite, this peculiar conformation of the orbit was found in some twelve eastern skulls. In skulls numbered 20–3190, 99–4717, and 99–6598 coming from Staten Island and northern New York State, the agreement amounted almost to an identity (Fig. 10). None of the other cranial bones showed features of peculiar interest.

The long bones have been described and measured in detail by Dr. Hrdlička. At that time the bones had not been catalogued and arbitrary numbers which have not been preserved were used. For this reason it is impossible to refer to specific bones listed by Dr. Hrdlička. These bones, undoubtedly, belong to large and strong individuals above the average stature. Of special interest are the femora. They show a marked flattening of the proximal portion of the shaft. The following measurements help define that flattening:—

Femora.

Catalogue Number	Side	Transverse Diameter	Sagittal Diameter	Platymeric Index
20–12300	left	3.6	2.3	63.9
20–12302	right	3.7	2.2	59.5
20–12321	right	3.2	2.3	71.9
20–12324	left	3.4	2.8	82.4
			Average	69.4

The absolute measurements of the transversal diameters are of interest. They are rather larger than the average for American Indians. Platymery is fairly common among American Indians yet by no means universal. The collections of the American Museum represent fairly well the distribution of this characteristic on the two continents. I was able to match this degree of flattening in association with femora of the same size only among Indian femora from the eastern United States. Again, to be more specific, comparisons revealing an approach to identity were found in skeletal remains from Long Island, Manhattan Island, and some of the southern New England States. However, very similar femora were found in a skeleton from Patagonia.

In conclusion then it seems safe to infer from the incisor teeth mentioned above that these bones represent the skeletal remains of American Indians. Furthermore, the peculiar conformation of the orbital region and the size and degree of flattening of the femora permit us to conclude with a very high degree of probability that these remains belong to that particular local type of American Indians inhabiting the eastern United States in the neighborhood of New Jersey, New York, and southern New England. The antiquity of the skeletal remains must be decided wholly upon geological considerations. The morphological characteristics do not necessitate any separation from the more recent Indians in physical type. On the other hand, this in itself does not militate against a considerable antiquity as estimated in years.

EXTRA-LOCAL RELATIONS.

The foregoing account of the argillite culture shows a localized deposit of remains culturally different from those of the Lenapé and lying in an older stratum. Since the artifacts are an integral part of the sand it follows that they were deposited with the sand. The features of the stratum seem to fit best, as far as our knowledge goes, with fluviatile deposits. As such, our finds may not represent the culture as a whole and the original associations of the culture may, therefore, be unknown. In any event, other similar sites must be found; either an undisturbed camp site or similar natural deposits. The following notes on a number of sites visited, as well as others which have been described elsewhere, give some suggestive points.

In 1913 I found anomalous camp sites at Plainfield, forty miles northeast of Trenton. These are in areas mapped with the Cape May formation, which also extends as a narrow valley train up the Millstone River and down Assanpink Creek to southern Trenton. There is a suggestion here that the Trenton area represents the delta of Assanpink Creek when that stream flowed the entire distance from Plainfield. Following this suggestion, I first examined the older Pensauken terrace south of the Abbott Farm (with negative results) and then searched northward along Assanpink Creek. A great part of this valley is semi-swamp, so that large sections of Cape May area could not be examined. I found nothing northeast of the city until I reached Franklin Corner, south of Lawrenceville, again at Port Mercer, and at a point one half mile further north.

At each site I found a small group of arrow points and chips scattered over an area of a dozen yards. So far as I can judge, these are mostly argillite, with the same characteristic disintegration of the surface as at Trenton.

The site at Franklin Corner, on the farm of Mr. William S. Duncan, lies at the edge of the Cape May deposit which is only three feet thick at this point. A fifty foot trench was dug. Artifacts and pebbles were infrequent. There were no red bands as at Trenton. The distribution of twenty-six specimens was as follows: —

Depth below surface (inches)	Frequency
4	4
5	6
6	1
7	0
8	5

Depth below surface (inches)	Frequency
9	0
10	0
11	1
12	0
13	3
14	4
15	2

The upper ten inches is within the plowed area. It is possible that the double grouping is due to this. These figures do not seem significant.

The second site is on the farm of Mr. William S. Schenck, near Port Mercer, in a field west of the Mercer-Somerset county line. The third lies a half mile north of Port Mercer, in a field east of the point where the Princeton trolley line crosses Stoney Brook. The deposits were also examined as far as Kingston. I have been told that similar disintegrated argillite specimens have been found along the Millstone River.

Further north all cleared lands from Somerville to the terminal moraine east of Plainfield were examined. Nothing was found about Somerville and Findern. Weathered argillite fragments (chips?) were found at South Bound Brook and a mile east of East Bound Brook.

In 1913 I found several sites near Plainfield where implements and chips of argillite or a similar material predominated.[1] There are many such objects in local collections. Trenches were dug in a site located just north of the entrance to the Lehigh Valley Railroad coal yards half a mile south of South Plainfield. The black soil, 5 to 7 inches deep, overlies a yellowish-red sand. The distribution of finds is as follows: —

Depth below Black Soil (inches)	Frequency
1	1
2	3
3	4
4	3
5	8
6	1
7	2
8	1
9	0
10	1
11	1
12	3
13	4
14	0

[1] Spier, (b), 77–79.

Many fire-cracked stones were found at one point in a compact group from 11 to 14 inches below the black soil. These figures probably have no significance. Here too the argillite specimens found showed the same greenish, chalky surface seen on Trenton specimens.

Mr. Skinner has also called attention to a site south of Bridgeton on Cohansey Creek where argillite implements occur alone.[1]

Reports of argillite implements led Mr. Skinner to examine the valley of the Susquehanna River and its tributaries in the vicinity of Bloomsburg, Pennsylvania, and I examined that of the Chemung River near Elmira, New York. These implements, argillite, rhyolite, etc., do not show any of the characteristics of the Trenton finds. Stratified sites with suggestive similarity in the Trenton finds are Mercer's Lower Black's Eddy site and Hawkes and Linton's Masonville and Medford sites.

Mercer's site is located at Lower Black's Eddy on the bank of the Delaware near Point Pleasant, Pennsylvania.[2] Two culture horizons were found: a surface layer of historic Indian refuse, $2\frac{1}{2}$ to $3\frac{1}{2}$ feet deep, below this a barren region $1\frac{1}{2}$ to 3 feet deep, resting on a layer of older remains 1 foot to 1 foot 10 inches deep. The upper layer yielded the following forms: polished celt, hammerstone, net-sinker, blades and arrow points of quartz, quartzite, chert, jasper, a red stone, and argillite (chert and jasper arrow points of triangular type), fire-cracked pebbles, bones, three types of native pottery, and European objects. In the lower level were the hammerstone, net-sinker, blades and arrow points of quartzite, chert, jasper, and argillite (arrow points chiefly of "fish-spear" type), and potsherds of coarse type. According to Mercer's identification of 1526 objects in the upper layer, argillite outnumbered other materials in the proportion 4 to 1, among 462 in the lower layer by 12 to 1. He also finds the difference in arrow point form significant. Since the whole site is known to lie within the sphere of freshet activity, no certain claim can be advanced for the antiquity of the lower layer.

The range of implement types, except for the two potsherds in the lower layer, suggests a resemblance to the Trenton finds. The occurrence of the "fish-spear" type and perhaps the proportion of argillite are specific similarities. Mercer says nothing whatever of the weathering of these objects. We do not know the exact mode of occurrence of these objects, whether this is a camp site or natural deposit, and the geological relations of the site are unknown. While the resemblances are strong, nevertheless it would be rash to assume that these necessarily refer to the Trenton argillite culture.

The Masonville and Medford sites are near Rancocas Creek, fifteen or

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[1] Skinner, (a), 55.
[2] Mercer, (b), 70–85.

twenty miles south of Trenton. Hawkes and Linton found Lenapé remains in the surface layer of black soil (six inches to one foot deep) overlying yellow sand (three to six feet deep) in which were older remains with a well-marked level of occupation at its junction with an underlying white sand. These remains consisted of chipped celts, hoes, hand hammers, small cylindrical stones, large blades, knives, ceremonial points, small projectile points, drills, banner stones, crude pottery, bones and fire-pits at the surface of the white sand. The material used was argillite or a stone of similar appearance, which had undergone considerable weathering. The yellow sand was deposited subsequent to most of these objects either by wind or water.[1]

While the blades and arrow points have a suggestive similarity in form and patina to the Trenton specimens, nevertheless, the Masonville-Medford culture contains chipped celts, drills, banner stones, and pottery, none of which occur at Trenton. The cultural difference is rather great. The geological positions of the Masonville, Medford, and Trenton sites have never been fully determined. All three are mapped with the Cape May deposits, but this means very little as all deposits not distinctly glacial or palpably recent are classed with this formation. I believe that my earlier objections to considering the Masonville culture as closely related to the Trenton culture holds for the Medford finds as well.[2]

Dr. Abbott and others have told me of similar deep finds near Rancocas Creek which bore a distinct resemblance to the Trenton finds. Dr. Hawkes refers to such material in local collections and especially to a site near Indian Mills.

This survey of finds in the neighborhood of Trenton leaves one distinct impression; that the subject is not a simple one. First, the argillite culture is characterized by a paucity of traits: these traits are the most generalized and therefore most likely to turn up in other cultures. Second, the Lenapé themselves used many implements which are practically indistinguishable from the Trenton finds both in form and patina. Inasmuch as the argillite implements lie only a few inches below the surface it is not unlikely that they have been repeatedly washed out and used by the Lenapé or we may find them among Lenapé remains simply because the plow has inextricably mixed the two cultures. For instance, the presence of similar objects at Plainfield and Staten Island [3] may be explained by the historic fact that the Trenton group of Lenapé had villages at all three places. Third, a fair amount of enterprise has succeeded in bringing to light several stratified sites. We do not know what cultures the region may contain. Therefore, it seems rash to align any of these finds with those at Trenton at present.

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1 Hawkes and Linton, (a) and (b).
2 Spier, (d): cf. Linton.
3 See Lewis, for objects from Staten Island.

RÉSUMÉ.

Of the three alleged superposed cultures at Trenton, that of the Delaware Indians, the "argillite culture," and the "paleolithic culture," the proofs for the intermediate horizon are subjected to a new analysis. This cultural deposit is found to extend in a narrow area along the river bluffs, being distributed through a sand stratum in a single plane of maximum distribution around which the finds occur according to a normal frequency distribution. These artifacts have a differential mode of occurrence; their center of gravity being above the modal plane. Pebbles of undoubted natural deposition occur with the artifacts, having the same dispersion and with distributional maxima coincident. Films of red clay which traverse the sand may be of secondary origin, not indicating separate strata but stages of the ground water level. The coincident occurrence of artifacts and pebbles indicate that a single depositing agent has acted on the entire sand deposit.

A comparison with deposits of known origin shows a general dissimilarity with artificial culture deposits but an identity with a water deposit. Such an origin for the Trenton "argillite culture" implies some antiquity.

The culture is simple, especially in contrast with that of the historic Delaware; the remains including only large stone blades and arrow-heads, the pitless hammerstone, the rubbing-stone, and fire-fractured pebbles. Most of the objects are considerably weathered. Remains of two human adolescents were also found.

Culture deposits in other localities with definite associations with the "argillite culture" have not been found. It remains an isolated find.

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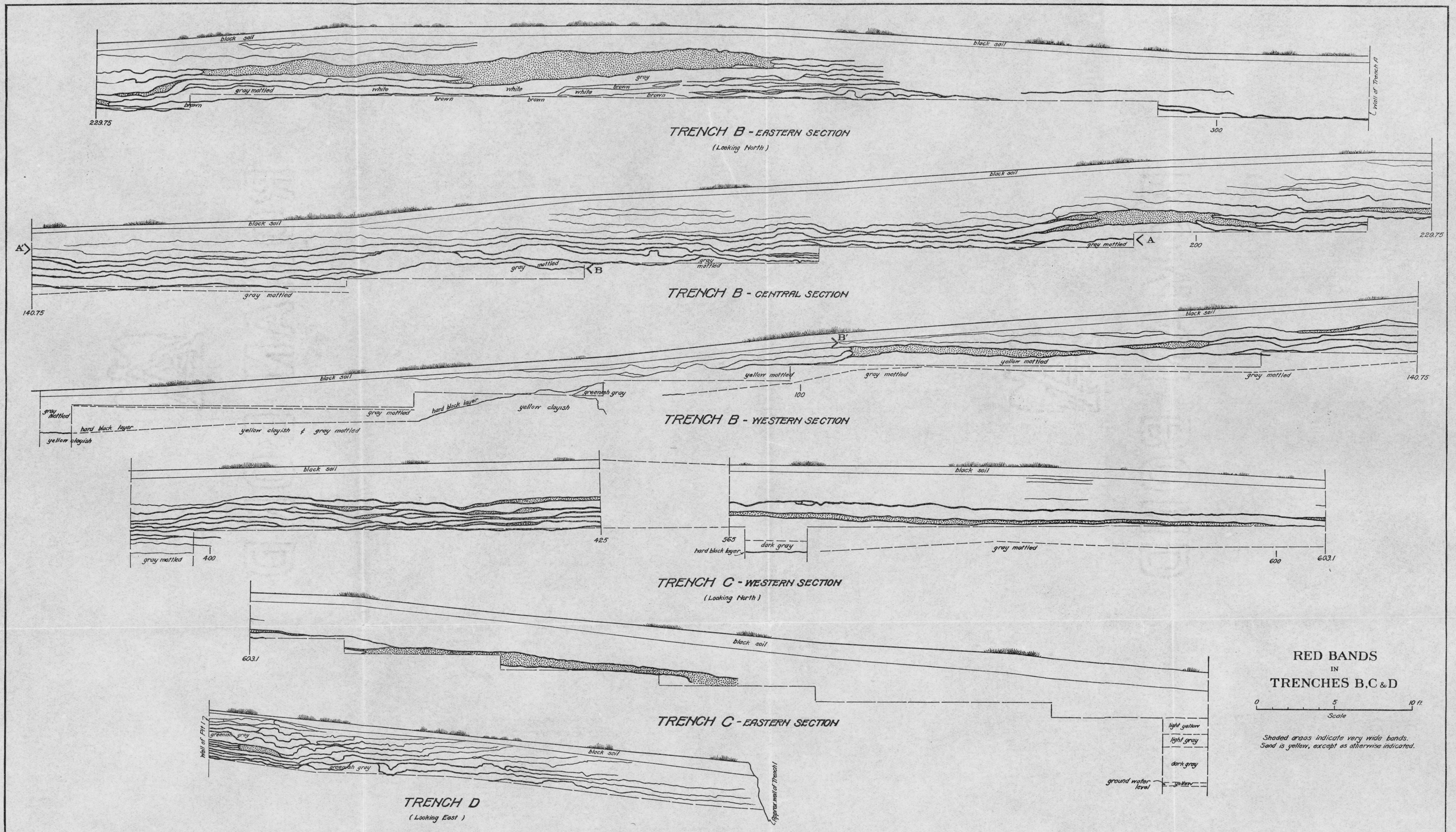

Fig. 11. Red Bands in Trenches B, C, and D.