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VOLUME XXIX (1943)

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
—SENECA, *Naturales Quaestiones*

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ECOLOGICAL STUDIES OF PIERPORT, BEAR LAKE, AND EDGEWATER BOGS IN MICHIGAN

IRVING E. W. OLSON

DURING the summer of 1935 I became interested in the large number of bogs in the west-central portion of the Southern Peninsula of Michigan. I observed that they differed somewhat in floristics and structure from the generally accepted concept of bog succession as set forth by the earlier investigators of bogs in the Huron River valley, and, more recently, by others in the region of Douglas Lake, where the University of Michigan Biological Station is located. Furthermore, I noted that there was a scarcity of literature, especially on floristics and succession in bogs.

Up to the present time ecological studies of bogs in Michigan have been limited almost entirely to two widely separated regions: the Huron River valley, in the southeastern part of the Southern Peninsula, where the earlier investigations were conducted, and the Douglas Lake region far to the north, where more recent studies have been carried out by students and staff of the Biological Station. The only other places where bogs have been studied are: North Manitou Island (Transeau, 1903); on Isle Royale, in Lake Superior (Cooper, 1912); in the extreme southwestern part of the state, at Baroda, in Berrien County (Kurz, 1928) and at Hartford, in Van Buren County (Osvald, 1935); and numerous bogs occurring throughout the Southern Peninsula as listed by Davis (1907), who has done much work on peat deposits in Michigan. According to Davis, bogs are frequent throughout the state; however, a number listed by him in 1907 have since changed considerably because of drainage of lands for agricultural purposes. For example, Four Mile Lake, west of Dexter, in Washtenaw County, which used to have a bog, shows the effect of drainage in that the characteristic bog plants have disappeared, and this once large lake is now little more than a grassy lowland and mud flat with a small stream draining it.

During the summers of 1935, 1936, 1939, and 1941 I visited twenty bogs in the west third of the central region of the Southern Peninsula of Michigan. This area is

bounded roughly by a line extending from Grand Rapids, in Kent County, northward about 250 miles to Kalkaska, in Kalkaska County, and westward to Lake Michigan. Since it was not practicable to visit every bog within this area, those chosen will serve, for the purposes of this paper, as examples of the types that occur in it. That many more than those listed might be found in this section is quite possible, for in driving through it one often sees in the distance the characteristic trees — tamarack and spruce — that grow on bogs.

From the studies made to date of the bogs in this area I suggest that many of them have followed different courses in their development from those given in the generally accepted concept of plant succession on bogs. Since field investigations of succession thus far made are not conclusive, further studies are planned.

Plant succession on bogs as outlined by Weaver and Clements (1929) is reviewed briefly as follows:

1. Submerged stage: plants in open water up to 20-foot depths, prominent among which are Potamogeton, Myriophyllum, and Elodea.
2. Floating stage: plants in water 6 to 8 feet deep, largely Nymphaea and Polygonum.
3. Floating mat stage: composed essentially of Carex species; occasionally Decodon is the mat former.
4. Moss — low-shrub stage: Sphagnum, Menyanthes, Drosera, Sarracenia, and others, followed by shrubs such as Andromeda, Ledum, and Chamaedaphne.
5. Bog-tree stage: principal trees, Larix and *Picea mariana*.
6. Climax forest: *Pinus Strobus* in the Great Lakes forest.

This report will be restricted to three bogs in a region in which no bogs have been described, with notes on their floristics and physiognomy. Two lie near Bear Lake, in Manistee County; one is in the Platte Plains, in Benzie County.

BOGS VISITED

The bogs studied are grouped according to stability of substratum and physiognomy of vegetation:

Group A. Bogs with stable substratum and open water; mainly low plants;
Group B. Bogs with stable substratum and no open water;
Group C. Bogs with stable substratum and more or less tree cover.

GROUP A. BOGS WITH STABLE SUBSTRATUM AND OPEN WATER; MAINLY LOW PLANTS

Water is present; mat is quaking or partly quaking; Chamaedaphne scrub with few to many tamaracks; spruce may or may not occur; when it does, it becomes well established; pine, when found, is usually on the firmer areas of the mat.

1. Pierport Bog. Along Highway M-22, in Manistee County, midway between Frankfort and Manistee, and one mile east of the village of Pierport.
2. Bog at Big Bay of Bear Lake. In Manistee County, northwest of the village of Bear Lake, along Highway U.S.-31.
3. Mud Lake Bog. In Newaygo County, along Highway M-37 just south of Bitely. The lake was formerly known as Placid Lake.
4. Greenan Bog. Just south of Mud Lake Bog. Named for the owner of the property on which it is located.
5. Newaygo Bog. In Newaygo County, about two miles north of Newaygo, to the west of Highway M-37.
6. Aman Lake Bog. At Aman Park, in Ottawa County, eight miles west of Grand Rapids, along Highway M-50.
7. Bog about four miles east of Grand Rapids, in Kent County, along Highway M-50.
8. Bog about three miles north of Grand Rapids, in Kent County, along a county road.
9. Dead River Bog. In Benzie County, lying between the two Platte lakes.
10. Sugar Loaf Bog. In Kalamazoo County, just south of Portage, along Highway U.S.-131.
11. Spring Run Bog. In St. Joseph County, at Spring Run, about three miles north of Moore Park, along Highway U.S.-131.
12. Prairie River Bog. In St. Joseph County, about two miles south of Three Rivers, at Prairie River, along Highway U.S.-131.

GROUP B. BOGS WITH STABLE SUBSTRATUM AND NO OPEN WATER

Chamaedaphne meadow with tamarack or spruce or both; open water not present; mat not quaking.

13. Bog west of Blue Lake. In Newaygo County, about one and one-half miles south of Brohman and east of Highway M-37.
14. Mud Pond Bog. In Benzie County, near the mouth of Platte River, along Highway M-22.
15. Walkerville Bog. In Oceana County, about two miles north of the village of Walkerville, along either side of county road.
16. Gordon Lake Bog. In Manistee County, about four and one-half miles south and west of the village of Bear Lake.
17. Bog near Grass Lake. In St. Joseph County, three miles west of White Pigeon, along Highway U.S.-112.
18. Bog along county road. In Kalkaska County, about five miles west of the village of Kalkaska.

GROUP C. BOGS WITH STABLE SUBSTRATUM AND MORE OR LESS TREE COVER

Chamaedaphne meadow being shaded out by spruce and pine; mat is becoming quite firm as the forest advances on it.

19. Edgewater Bog. In Benzie County, about thirteen miles north of Frankfort and one-eighth mile east of Benzie County State Park, along Highway M-22.
20. Little Bay Bog of Bear Lake. In Manistee County, north and west of the village of Bear Lake, along Highway M-51, at Little Bay.

GEOLOGY OF THE REGION

The Southern Peninsula of Michigan lies in the eastern lake section of the central lowland province east of the Mississippi River (Fenneman, 1938). In this part of the state at least five distinct glacial periods can be traced back by moraines that are the result of numerous advances and recessions of continental glaciers. Although it is not the purpose of this study to include a detailed discussion of the history and development of these glaciers, a brief account of some of the outstanding physiographic features of the area about each bog will be given.

The general region in which the bogs studied in detail are located is roughly that lying between the terminal moraine of the Lake Michigan glacial lobe (Chamberlin, 1883) and the present shoreline of Lake Michigan in Manistee and Benzie counties.

The texture and composition of the soils in this area vary greatly and include rich humous soils formed from peat beds, loamy and gravelly soils of outwash plains, and rather extensive areas of sandy soils, both ice- and wind-borne. These sandy soils are acid in reaction and were often covered with nearly pure stands of pine, commonly referred to as “pineries” in the prelumbering days.

The Southern Peninsula is dotted with lakes, large and small, which resulted chiefly from glacial action. Some are pits in outwash plains where stagnant ice blocks melted; others have been formed by wind-blown sand deposited across outlets of large shallow basins or in depressions between ridges. In many of these lakes in places where drainage was retarded or completely shut off conditions were favorable for the development of bogs, which are quite common throughout the Southern Peninsula.

DESCRIPTION OF THREE BOGS IN WEST-CENTRAL MICHIGAN

The three bogs in west-central Michigan that were studied in detail lie in the lowlands between ridges in the Manistee moraine, which extends northward from Manistee along the shores of Lake Michigan through Benzie County and into Leelanau County. This moraine curves around the ends of transverse sand ridges that come out as headlands along this part of the shore of Lake Michigan. Between these ridges the ice pushed into the lowlands for several miles from the shore of the lake, so that the moraine makes a series of loops in crossing the lowlands between the prominent ridges.

Bear Lake was formed as a pit on an outwash plain between two spurs of this moraine. One of the largest bogs in the region has its origin on Big Bay of the lake.

The first bog to be described lies in a small depression on the moraine itself. The second occurs on Bear Lake. The third lies between two sand ridges in the extensive sand plains known as Platte Plains.

1. PIERPORT BOG

Location

Owing to its proximity to the village of Pierport, just one mile to the west on the shores of Lake Michigan, the bog surrounding a small lake known locally as Kuenzer's Lake will be designated “Pierport Bog” (Fig. 1). It is in the extreme northwestern section of Onekama Township, Manistee County, Section 3, R. 24 N., T. 16 W. It is readily accessible and begins approximately 300 feet to the west of Highway M-22, about midway between Frankfort and Manistee.

The bog has formed completely around a somewhat circular lake in a depression in the morainal deposits along Lake Michigan. It covers slightly over seven acres, of which about three are open water. The level of the lake at the present time is approximately fifty feet below the general level of the upland, which rises rather abruptly in all directions from the edge of the bog except to the north, where a narrow ravine extends gradually to the upland for a distance of about 500 feet.

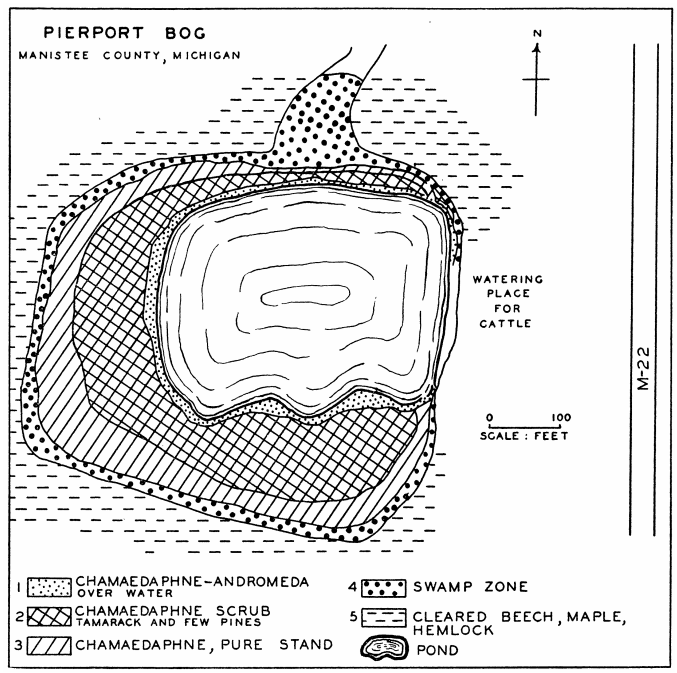

FIG. 1
(In the text the various areas of Figures 1-3 are called “zones.”)

The lake and surrounding bog are a part of a 160-acrefarm owned in 1936 by Mrs. R. W. Todd, of Bangor, Michigan. Nearly all the farm has been under cultivation for many years, most of which is at present in pasture land. There is no apparent drainage and the lake is probably still fed by hidden springs. A large one at the head of the ravine to the north formerly fed the lake, but ceased flowing some thirty-five years ago. The entire bog is accessible to cattle, which graze on the surrounding upland. The swamp zone at the east end of the lake is devoid of vegetation.

Early History

For data on the early history of this bog and the surrounding area I am indebted to Mr. O. C. Kuenzer, R. F. D. 1, Bear Lake, Michigan. In an interview in August, 1936, he gave me a vivid description of conditions as they existed in 1875, the year in which the general tract containing his father's farm, on which the bog is located, was homesteaded. He was nine years old when he came to this farm, on which he worked until the forest fires of 1885 forced the family to move to a near-by farm. He was in a position to describe many changes in the vegetation resulting from the clearing of the forests as well as to give information on which the historical account of this paper is based.

When this tract was homesteaded, the farm and the land around it were completely forested with beech, maple, and hemlock — the beech and maple predominating to the south, west, and north. To the east, across the present Highway M-22, there was a nearly pure stand of hemlock covering several square miles of land. On the upland to the north were two spruces, the only ones known in the vicinity. These were cut for Christmas trees in 1895. A small number of pines were scattered throughout the region, and a few balsam firs were seen as recently as 1900.

In 1885 a local fire that devastated several square miles of forest land began to the southeast of the bog and spread to a three-mile front. It burned all the vegetation to the ground and reached the shores of the lake on the west and the south. On the upland to the east of the lake two white pines with diameters of 22 and 30 inches were not damaged by the flames and are still standing. A pine and two hemlocks on the south shore survived the fire, as did a pine and a hemlock on the north shore. All of these trees were large. The pines were cut for lumber about 1900; the hemlocks, in 1910.

The water level of the lake, which, as has been stated, was fed by a large spring coming from the upland to the north, has been lowered about six feet. The flow of water from it gradually decreased after the fire and the clearing of the subsequent second growth of trees until it ceased in 1910. Before the lake dropped to the present level a moat with an average depth of six feet of water and a width of from ten to twelve feet had to be crossed to get on the mat. The mat was accessible by foot in only one or two places; a boat was generally used to reach the mat for the gathering of cranberries. A number of the large logs, all of which were under water until 1905, can still be seen at the south edge of the present mat.

Witch-hazel and lady-slipper orchids used to be found here in abundance, the former in the swamp zone along the wooded upland and the latter on the bog mat. In this area there have been no oaks since the fire of 1885. Three species of cranberry, one red, one red and white, and one grayish, were plentiful on the mat. The grayish berry may have been the creeping snowberry now sparsely distributed over the mat. Before the lowering of the level of the lake, limeweed, a local name for pondweed, covered the water along much more of the shoreline than it does now.

During the years 1917-18 a considerable amount of peat was removed from the south border of the present mat and hauled to the uplands to the south as a fertilizer. In this disturbed area some grasses have come in from the surrounding upland, which has been in pasture for many years.

About 1930, when the larch sawfly killed many tamaracks in the general area, the tamaracks on the mat began to show a decided lack of vitality and growth, and many of the larger trees have since died, probably because of the ravages of the fly.

Floristics and Zonation

In the lake are three distinct areas of *Nymphaea advena* Ait.,[1] the largest of which is along the east shore. The other two lie along the east and west shores.

In Zone 1 (Fig. 1) rooted in a dense mat of Sphagnum is a heavy stand of *Chamaedaphne calyculata* (L.) and *Andromeda glaucophylla* Link. The branches of many plants of both species extend out over the water from two to four feet, and where the tips of these branches touch the water, roots develop at the nodes. This suggests the possibility of these shrubs appearing as pioneer plants or mat formers in the development of bogs in this general area. This zone is well defined and reaches completely around the lake, except for a small area along the east shore, where vegetation has been trampled out by cattle coming for water. On the south are two protrusions where the Chamaedaphne-Andromeda mat appears to be spreading over the water at a rate faster than that on the rest of the mat. To the east and northeast such protrusions are smaller and less obvious, although readily recognized. According to local testimony, the mat has advanced noticeably and rather uniformly over the water about ten feet since 1905.

In Zone 2 Chamaedaphne is the dominant shrub, with Andromeda less frequent. This portion of the mat is also quaking and contains a heavy stand of Sphagnum, with which the following plants are commonly associated: *Vaccinium Oxycoccus* L., *Drosera rotundifolia* L., *Kalmia polifolia* Wang., *Sarracenia purpurea* L., *Eriophorum angustifolium* Roth., and *Eriophorum viridi-carinatum* (Engelm.) Fernald. Less common plants are *Menyanthes trifoliata* L., *Chiogenes hispidula* (L.) T. & G., *Eriocaulon articulatum* (Huds.) Morong., and *Hypericum spp*. Only two plants of *Habenaria blephariglottis* (Willd.) Torr. have been observed on the mat, both of which blossomed in July, 1935. *Larix laricina* (DuRoi) Koch, is very abundant in this zone and also in Zones 1 and 3. In Zone 1 a number of the trees grow along the water's edge; in Zone 2 an exceptionally heavy stand of tamarack is becoming established south of the pond at the east and at the west and northwest portions of the mat. As previously stated by Mr. Kuenzer, many of the larger trees have died since 1930. Examination based on a count of growth rings in several

large dead trees indicated growing periods ranging from 90 to 120 years. Some of these trees may have been killed by the sawfly, which is known to have destroyed many tamaracks in this part of the state.

In Zone 3 the mat is partly quaking, with a practically pure stand of Chamaedaphne. In some sections Chamaedaphne appears to be thinning out, especially in the southwest, where the large trees on the edges of the upland partly shade the mat. Tamarack is common in the zone, but white birch (*Betula papyrifera* Marsh.) is invading the mat and reaching into Zone 3 and even to the edge of the water in Zone 1. Ten or twelve trees of *Pinus Strobus* L., together with a few seedlings, are on the mat. These have probably developed from cones from the two pines on the upland to the east that survived the fire of 1885. Two or three small hemlocks (*Tsuga canadensis* (L.) Carr.) and several beeches (*Fagus grandifolia* Ehrh.) have also invaded the quaking portions of the mat to the south of the pond.

In Zone 4 the swamp zone is relatively dry. Since about 1900, when the large spring feeding the lake from the uplands began to fail, the level of the lake has dropped about six feet, as has already been noted. In 1905 the logs of hemlock, which are still found in the moat, began to show above the water, which at one time was six feet deep. In this zone the following plants occur: *Cephalanthus occidentalis* L., *Sambucus canadensis* L., *Lonicera caerulea* L. var. *villosa* (Michx.) T. & G., *Salix sericea* Marsh., *Ilex verticillata* (L.) Gray, *Rubus idaeus* L. var. *aculeatissimus* (C. A. Mey.) Regel & Tiling, *Polentilla palustris* (L.) Scop., and *Alnus incana* (L.) Moench. In the portions of this zone to the south, where peat was dug in 1918, and to the east and north of the watering place for cattle *Scirpus cyperinus* (L.) Kunth var. *pelius* Fernald, *Carex trisperma* Dewey, and *Juncus effusus* L. are found. Other plants growing locally in the swamp zone are: *Polytrichum spp., Maianthemum canadense* Desf., seedlings of wild cherry (*Prunus virginiana* L.), *Ribes vulgare* Lam., *Fragaria virginiana* Duchesne, *Rosa Carolina* L., *Solanum Dulcamara* L., and *Woodwardia virginica* (L.) Sm.

On the upland slope to the east there are a number of large hemlocks, red maples (*Acer rubrum* L.), hard maples (*Acer saccharum* Marsh.), white birches (*Betula papyrifera*), and sweet birches (*Betula lenta* L.). Under these trees are also bracken (*Pteris aquilina* L.) and wintergreen (*Gaultheria procumbens* L.). A species of blueberry (*Vaccinium* sp.) is invading the mat over the more stable portions. Along the southwest edge of the mat is a clump of wild cherry (*Prunus virginiana*), with white birch (*Betula papyrifera*). On the edge of the mat winterberry (*Ilex verticillata*) and service-berry (*Amelanchier canadensis* (L.) Medic.) are thriving locally to the north and northwest.

On the upland to the north and extending eastward around the swamp zone and south to the watering place for cattle one finds the following plants: white birch (*Betula papyrifera*), sweet birch (*Betula lenta*), hard maple (*Acer saccharum*), large-toothed poplar (*Populus grandidentata* Michx.), hemlock (*Tsuga canadensis*), white pine (*Pinus Strobus*), and serviceberry (*Amelanchier canadensis*). Ground plants among these trees include bracken (*Pteris aquilina*), blueberry (*Vaccinium spp*.), *Polytrichum spp*., and cinnamon fern (*Osmunda cinnamomea* L.).

In July, 1941, it was noted that the level of the lake had dropped about one foot since 1925, exposing the mud of the Nymphaea zones above the surface of the water, but the reason for the lowering is not known.

Borings were made in a number of places on the mat to the south of the lake. The greatest depth, 27 feet 4 inches, was reached in Zone 2, about 100 feet south of the edge of the mat, where the peat was found to be deposited on sand.

According to Mr. Kuenzer, the mat was very narrow in front of a pine tree which stands near the edge of the mat along the northwest shore of the lake, for there was just room for him to stand on the mat between the tree and the water when he fished in the lake for the last time in 1905. In July, 1941, it extended out over the water from the base of the pine tree exactly fifteen feet. The mat has apparently grown out over the water at this point at the rate of about one foot every three years. The diameter of the pine tree was nine and one-half inches four feet above the mat.

2. BEAR LAKE BOG

Location

Bear Lake Bog (Fig. 2) lies in Sections 25 and 36 of Arcadia Township and Sections 30 and 31 of Pleasanton Township, Manistee County, Ranges 15-16 and 23-24 N.

The floating mat is most easily reached by following the improved road south and west around the south shore of Bear Lake to the lakeside cottage camp and by hiking from this point northward to the area of Big Bay along the shore of the lake. The more mature portion of the bog, indicated on the map as Zone 3, is readily reached from any place along the beach of Bear Lake in the area of Big Bay.

The bog itself has formed over Big Bay along the shores of Bear Lake to the uplands and extends northwestwardly for nearly a mile.

Geological Features

Bear Lake is in the northwestern part of Manistee County about midway between Manistee and Beulah. At the east end of the lake is the village of Bear Lake.

This lake, an open expanse of water of very regular outline and with dimensions of about two and one-fourth and one and one-fourth miles (Scott, 1921), covers an area of 1,744 acres. The longer axis lies in an east-west direction. The western part of the basin hardly exceeds fifteen feet in depth, but depths of fifty to sixty feet are known for the eastern part. The original outlet, which

flowed from the east end, was shifted somewhat to the south when the road was built. The present lack of a definite channel and, possibly, the obstructing road may account for occasional higher water levels of the lake. However, the cause of high water has not been definitely determined.

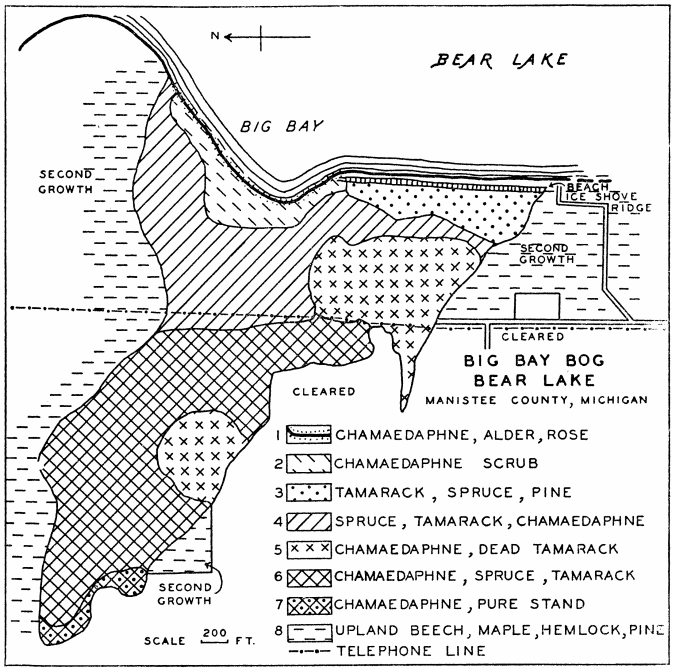

FIG. 2

The glacial formations may readily be made out as one approaches the lake on the road from the south. At first the route is through a rugged moraine, from the crest of which a broad outwash plain below reaches northward to another moraine some six miles away. Beyond the crest the moraine slopes sharply to the north, and the entire lake appears to view; it extends from the foot of the slope to the outwash. The basin is bounded on the east by upland, but stretches eastward as a low heavily wooded swamp to Bear Creek several miles distant. In brief, the lake basin is part of a depression in the outwash at its junction with the moraine. The soil map for the county shows that the soil for about a mile north of the lake and west about two and one-half miles is classed as Rubicon loamy sand. The entire area of the several bogs around the lake, together with that of Pierport Bog, is included in the region of this sand.

Early History

Information regarding the vegetation of the area before the days of lumbering was obtained from Mr. O. C. Kuenzer. According to him, the area for many square miles between Lake Michigan and Bear Lake was heavily forested with beech, maple, and hemlock, and a pure stand of hemlock grew just east of the Pierport Bog, about two miles distant from the shores of Bear Lake. Along the south and west shores of Bear Lake was a rather extensive area with a nearly pure stand of white pine. Local fires did not occur in this immediate vicinity; the nearest one stopped at the edge of the lake on which Pierport Bog is located. The heavy timber was removed during the lumbering operations from 1880 to 1900. With the exception of a small patch of mixed second-growth timber along the north half of the west shore of Bear Lake, now used as a resort, all the upland along this shore is now under cultivation. To the north the cultivated areas extend to the edge of the bog at Big Bay.

Floristics and Zonation

The sandy ridge indicated on the map (Fig. 2) as "ice-shove ridge" is about five feet high and from five to ten feet wide. According to report, this sandy ridge was built up during the lumbering days by the action of lake ice. On it the following plants occur: *Acer rubrum*, *Acer saccharum*, *Alnus incana*, *Amelanchier canadensis*, *Pyrus arbutifolia* (L.) L. f., *Betula alba* (L.), *Betula papyrifera*, *Gaylussacia spp*., *Ilex verticillata*, *Nemopanthus mucronata* (L.) Trel., *Pinus Strobus*, blueberries (*Vaccinium spp*.), *Viburnum cassanoides* L., *Viburnum acerifolium* L., *Viburnum Opulus* L. var. *americanum* (Mill.) Ait., and *Woodwardia virginica*.

Along the beach to the east of the sand ridge the following plants appear: *Scirpus americanus* Pers., *Scirpus validus* Vahl., *Eupatorium perfoliatum* L., *Scutellaria galericulata* L., *Mentha piperita* L., *Utricularia resupinata* B. D. Greene, *Hypericum spp*., *Gerardia spp*., *Aster spp*., and *Solidago spp*.

The bog at Big Bay is the largest of the many which I visited. It extends in a southwesterly direction from the shore of the lake more than 4,000 feet. Its width is about 1,400 feet in the region of the telephone line, which crosses the mat at a line approximately 1,000 feet west of the shore of the lake. All along the edge of the floating mat it reaches around Big Bay northward some 2,400 feet from the north end of the "ice-shove ridge."

Zonation on this bog is probably not so readily observed as the map would indicate. Along the edge of the floating mat is a narrow fringe (Zone 1) in which *Chamaedaphne calyculata*, *Andromeda glaucophylla*, *Alnus incana*, and *Rosa Carolina* are the dominant plants. Other plants are: *Sarracenia purpurea*, *Kalmia polifolia*, *Sphagnum spp*., *Menyanthes trifoliata*, *Larix laricina*, *Calopogon pulchellus* (Sw.) R. Br., and *Picea mariana* (Mill.) BSP. At the southern tip of this zone a large bed of *Nymphaea advena* borders the mat. Just back of the Nymphaea, *Decodon verticillatus* (L.) Ell. is the principal plant at the edge of the mat. Throughout this zone, in a mat made up largely of Sphagnum, branches of Chamaedaphne, Andromeda, and Rosa extend out over the water and roots appear to develop at nodes on the submerged portion of the stems. Tamarack and spruce are both found at the water's edge.

Zone 2 is indicated on the map as Chamaedaphne scrub, which covers the remainder of the quaking mat. In this zone numerous plants grow. Tamarack and spruce are abundant, but are so scattered that they offer little if any shade. The chief plants in this zone are:

Chamaedaphne calyculata, *Andromeda glaucophylla*, *Kalmia polifolia*, *Calopogon pulchellus*, *Pogonia ophioglossoides* (L.) Ker., *Habenaria blephariglottis*, *Eriophorum spp*., *Vactinium Oxycoccus*, *Drosera rotundifolia*, *Menyanthes trifoliata*, *Sarracenia purpurea*, *Sphagnum spp*., *Xyris caroliniana* Walt., *Aspidium spinulosum* (O. F. Müller) Sw., *Chiogenes hispidula*, *Eriocaulon articulatum* (Huds.), *Rynchospora alba* (L.) Vahl., *Habenaria clavellata* (Michx.) Spreng., *Eleocharis spp*., *Larix laricina*, *Picea mariana*, and *Picea canadensis* (Mill.) BSP.

The portion of the bog which may be classed as mature is indicated as Zone 3. It lies just west of the "ice-shove ridge," a sandy ridge that apparently prevents flooding during the high water stages of the lake. It is firmly grounded and is so heavily shaded that ground cover of herbs and shrubs is sparse as compared with the vegetation in Zone 4.

On this mature mat there is a rather heavy stand of beech, hard maple, red maple, and serviceberry, and, occasionally, white oak and white pine. The ground plants include blueberries (*Vaccinium spp*.), *Coptis trifolia* (L.) Salisb., bracken, wintergreen, *Corallorrhiza trifida* Chatelain, *Cornus canadensis* L., *Cypripedium acaule*, *Woodwardia virginica*, *Monotropa uniflora* L., Sphagnum locally, *Melampyrum lineare* Lam., *Osmunda cinnamomea*, and *Aspidium Thelypteris* (L.) Sw.

In Zone 4 there is a heavy stand of tamarack and spruce. These trees are on the firmer portions of the mat and have produced such dense growth that Sphagnum has been almost completely shaded out, as have been many of the other plants associated with Sphagnum. In this entire zone Chamaedaphne persists as the dominant mat covering. Locally small hummocks of Sphagnum may occur with *Vaccinium Oxycoccus*, *Chiogenes hispidula*, and a dwarf blueberry (*Vaccinium sp*.). *Cypripedium acaule* Ait. is common in the dense shade under the large spruces.

The northern dwarf mistletoe (*Arceuthobium pusillum* Peck) is widely distributed on spruce in Zones 1, 2, and 4, but not on spruce that occurs on the drier portions of the mat in Zone 6. Although the host trees were heavily infected, no noticeable disturbance to growth was apparent other than occasional "witches'-brooms" on some of the taller trees.

Beyond the zones of trees, toward the cultivated uplands, is a region of pure stand Chamaedaphne. In this zone all the smaller ground plants appear to have been replaced by Chamaedaphne which thrives wherever it occurs on the mat.

At the southern tip of the larger area in Zone 5 a small waste section is covered with weeds and swamp grass. This has resulted from cutting during the harvesting of hay on the uplands. In the uplands to the north of the bog the forest of second-growth hardwoods is largely made up of hard maple and beech, with an occasional *Populus grandidentata* and *Prunus virginiana*. *Amelanchier canadensis* appears nearer the edge of the mat. On the edge there is a shrub zone in which *Ilex verticillata, Nemopanthus mucronata, Pyrus arbutifolia*, and *Salix spp*. are the principal shrubs.

Two regions on the mat with no spruce are indicated in Zone 6. In them Chamaedaphne occurs in almost pure stand. Tamaracks were once widely distributed, as is shown by the large number of dead trees still standing. Many were killed by the larch sawfly in 1930.

Throughout Zone 6 the heavy stand of Chamaedaphne is broken only by rather widely scattered tamaracks and spruce. The trees are small and do not show the luxuriant growth manifested by spruce in Zones 1, 2, and 4.

In July, 1941, a number of borings were made on the mat. The maximum depth of peat was 25 feet 4 inches at a point about 800 feet to the southwest of the north end of the "ice-shove ridge" and about 175 feet in from the edge of the lake. About midway between this boring and the center of Zone 4 the greatest depth of peat was 10 feet. A boring some 150 feet farther to the southwest showed the depth of peat to be only two and one-half feet.

All borings except one indicated that peat was deposited on sand. At the point where peat was bored to its greatest depth the upper 12 to 16 feet of the mat was rather firm and yielded cores of peat, but the lower 8 to 10 feet produced only an unsolidified mass, with no deposition of peat on the sand bottom.

3. EDGEWATER BOG

Location

The Edgewater Bog (Fig. 3) is located along Highway M-22 about one-eighth mile east of the Platte River bridge in Benzie County. It lies in almost the center of Section 27 of Lake Township, R. 86 W. and 15 N. It is situated between two sand ridges, one of which separates the bog from the Platte River to the south. Lake Michigan lies just a mile to the north, and the intervening area is made up of a series of sand ridges that parallel the shores of the lake.

The bog is roughly 850 feet in length, with an average width of about 300 feet. The longest axis is in an east-west direction. It covers an area of between five and six acres and is easily accessible at any point of its periphery.

Geological Features

The region in which the bog is located was once a great bay in Lake Algonquin, the site of which is now occupied by a series of sand ridges with depressions between, known as the Platte Plains (Waterman, 1917, 1922a, 1922b). This area may be described as a right-angled triangle, the base of which extends east and west eight miles and the east side about the same distance north and south. The hypotenuse is formed by the shoreline of Lake Michigan from the moraine south of Empire to a point almost three miles northwest of Point Betzie.

Between the sand ridges and the Algonquin bluff is a wide crescent-shaped trough of relatively slight depth containing a series of lakes or ponds more or less connected with and draining into the Platte River, which meanders through the sand ridges and reaches Lake Michigan about the center of the hypotenuse of the right-angled triangle. From east to west these lakes are Long Lake, Rush Lake, Platte Lake, and Little Platte Lake. On the east three small lakes are connected by Otter Creek.

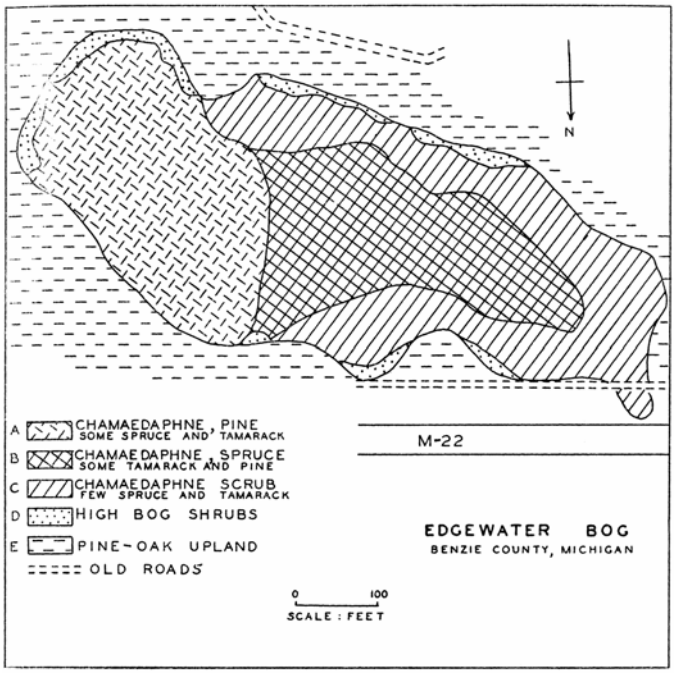

FIG. 3

There are two small lakes, Loon Lake and Mud Lake, on the lower stretches of the Platte River. When the glaciers were finally melting and opening the Straits of Mackinac, the waters of Lake Algonquin gradually receded and formed a series of sand bars with lagoons between them. On these bars the winds have built up low dunes, which now constitute the sand ridges of the Platte Plains. The larger depressions remain as lakes, but the smaller ones have been more or less filled by the growth of aquatic vegetation.

Early History

The bog is appropriately named "Edgewater Bog," for during the lumbering days a logging community was established along the Platte River about where the present Highway M-22 crosses the river. When lumbering operations ceased, the community disappeared, although the name "Edgewater" still appears on the maps of the region.

In many areas of the Platte Plains the vegetation has been influenced by local fires in prelumbering days (Waterman, 1917). The region in which the bog is located appears to have been disturbed only by logging operations. Whether or not any large trees were removed from the bog is not known.

Floristics and Zonation

The zonation of the vegetation on this bog is less distinct than that on any of the other bogs studied. Zones A, B, and C, as shown in Figure 3, grade into one another almost imperceptibly, the most noticeable difference in the zones being perhaps the somewhat less frequent occurrence of spruce and the smaller size of trees in Zones B and C than in Zone A.

In Zone A there is a heavier stand of conifers, white pine, red pine, tamarack, and spruce. The dense stand of Chamaedaphne appears to be giving way to trees that are now producing heavy shade. Sphagnum is found locally in small hummocks, accompanied by *Vactinium Oxycoccus*, *Sarracenia purpurea*, and *Drosera rotundifolia.* It appears to be dying out wherever it occurs on the mat.

In the more heavily shaded portion of this zone, to the east, the principal ground plants that are becoming established in areas where Chamaedaphne has been killed are: *Pteris aquilina*, *Gaultheria procumbens*, *Eriophorum spp*., Polystichum and Polytrichum moss, and blueberries (*Vactinium spp*.). *Cypripedium acaule* occurs under the larger pines.

The east end of the mat also shows invasion of trees from the upland such as *Quercus alba* L., *Acer rubrum*, *Populus grandidentata*, and *Betula papyrifera*.

The vegetation in Zone B differs only slightly from that in Zone A. The conifers are not so densely distributed since spruce is slightly less abundant, and it is smaller. Chamaedaphne, however, makes a heavy and luxuriant growth in this zone, with fewer areas in which it has been killed, apparently by shade. Sphagnum is the only plant found locally with *Vaccinium Oxycoccus* and *Chiogenes hispidula*.

Zone C is a narrow zone in which the conifers are slightly less abundant than in either Zone A or Zone B. In it Chamaedaphne is vigorous and occurs in almost pure stand, and Andromeda appears only occasionally here and also on other parts of the mat. Beside the highway and along the west margin of the mat the upland trees are invading the mat, the principal species being white oak and large-toothed aspen.

Zone D is the zone in which the high-bog shrubs grow on the mat. It is narrow but quite extensive along the south and southwest margins of the mat. At the north margin these shrubs occur only in three small clumps. The principal shrubs in this zone are: *Nemopanthus mucronata*, *Pyrus arbutifolia*, *Ilex verticillata*, *Hamamelis virginiana* L., and *Salix spp*. Arbor vitae and spreading junipers grow in clumps along the north margin.

The mat has become quite firm. The Chamaedaphne stage is apparently giving way to the bog forest, which at present is made up chiefly of red pine, white pine, tamarack, and spruce. In the more mature Zone A upland trees are rapidly invading the mat, as they are in

Zone C at the west end. *Picea canadensis* is occasionally found in Zones A and B.

The surrounding upland has a vegetation typical of the sand ridges of the Platte Plains. The dominant plants of the ground cover are: *Pteris aquilina*, *Gaultheria procumbens*, *Epigaea repens* L., *Campanula rotundifolia* L., *Arctostaphylos Uva-ursi* (L.) Spreng., and blueberries (*Vaccinium spp*.). Among the trees characteristic of this area the most important are: *Quercus alba*, *Acer rubrum*, *Populus grandidentata*, *Prunus virginiana*, and *Amelanchier canadensis*.

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[1] With the exception of the genus name Polytrichum, the names used in the identification of plants listed in this study are those of *Gray's New Manual of Botany*.

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SOME APPLICATIONS OF AERIAL PHOTOGRAPHS TO GEOGRAPHIC INVENTORY

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AN AERIAL photograph is a reasonably permanent record of a part of the earth's surface at a certain time. Its use as a surveying method and as an aid to a more complete understanding of the nature of the land is justified by the detail which it provides, the accuracy of location it makes possible, the speed it permits in the accomplishment of various tasks, and its economy as compared with other techniques. Aerial photographs contain a vast amount of geographical, sociological, and geological data. This encyclopedia of information does not become available, however, unless methods are developed to translate the shadows, tones, geometric forms, and photographic textures into a vocabulary which speaks in terms of previous experience.

One such method is the establishment of regional keys or legends for the natural and cultural phenomena shown on the pictures. Common knowledge may make it easy to identify certain features, such as lakes and streams, forest as distinguished from cleared land, orchards, buildings, and communication networks. The more subtle differences in texture and tone need explanation. The development of such a system offers a new inventory method to the geographer.

There are direct and associative keys. Direct keys are valuable for reading the nature of an object from the tone, texture, shape, or shadow of its image. Thus the billowy texture and dappled tone of northern Michigan upland hardwoods (maple, beech, birch, poplar, and so on) are easily distinguished from the smooth, uniformly dark appearance of swamp conifers (cedar, spruce, balsam, tamarack). Associative keys make possible the deduction of the nature of an object from an interpretation of its surroundings, and must be used when identification of an object alone is difficult.

Most of the phenomena in which the geographer is interested are best recognized by combining direct and associative ways. The forest type and the density of the trees, the drainage system, certain information about cultivated land, the presence and the nature of buildings, and the communication pattern are among the quantitative facts which can be read by applying direct keys, but the quality of most of them must be implied by associative facts. The location of surface features, the boundaries of broad soil types, and the functions of various structures can be deciphered in this manner. The procedure followed in determining the use of a structure may be shown by pointing out the photographic

differences which appear between a rural school, a country church, and a farmhouse. Direct keys identify all three as buildings, but other than that there is little to differentiate them unless the church steeple shows prominently. Positive identification of each depends, then, upon associative keys, such as those presented on pages 333-334.

Both direct and associative keys must be firmly based on field experience and should be applied with an understanding of the land-use technique in the area concerned. The first step in setting up the keys is a careful analysis of several areas to determine the characteristic vegetation associations, the correlation between vegetation and site, crop combinations, house types, and other regional landscape phenomena. All these aspects should be studied on the photographs until identifiable differentiating tones from black to white, variations in texture, and geometric forms become apparent. Identifications should then be made on the basis of the photographs alone, and the results carefully checked in the field. The regionality of the keys will be recognized if attempts are made to utilize them in areas having different ecological conditions.

The field worker who is interested in interpretation will probably have neither the time nor the ability to use the methods employed by the photogrammetric engineer. Where the research is of such a nature as to demand exactness it will usually be found that the preliminary work of correcting for distortion and other discrepancies of a technical nature has already been accomplished. The establishment of ground control and the application of the radial-line or slotted-templet method of plotting are tasks that will normally be left to the specialist. With the photographs available through the many governmental agencies and private concerns numerous ways can be devised for mapping physical and cultural data of value to the geographer. The system will vary with the nature of the problem and the character of the terrain. The methods discussed below have all been used in the field with satisfactory results.

It is often desirable to map directly on the print. In rural areas with a great many roads or in places where varied cover is interspersed with open country, traverses can be made with little regard to pace or compass. Enough landmarks can usually be identified to enable one to maintain a constant check on position. Photographs are seldom available for use during the season in which they are taken. It is accordingly necessary to correct them for the numerous changes that have occurred since they were made, such as new field lines, road relocation, and recent timber operations. Ink or brightly colored pencils are best for making identification symbols.

As a variation of this method the photographs may be used on the plane table. With the table compass set to the north magnetic pole and the print oriented to true north, mapping proceeds in the usual manner. This system is of particular value in heavily wooded country or in regions which lack roads, railroads, or other cultural markings.

When it is undesirable to write on the prints transparent material is placed over the photograph. Sheets of cellulose acetate offer a fairly good surface for writing and drawing. Clear acetate is perfectly transparent, but does not take pencil well, and ink gives poor results unless the sheet is kept free of dirt and oily substances. The acetate with a matte surface is much better suited to marking, but lacks complete transparency even when in direct contact with the photograph. When the elements being mapped present a great deal of detail or when there is little contrast on the print it is often necessary to lift the sheet away from the photograph so that the objects beneath may be recognized. By fastening two pieces of acetate over one another special items can be mapped separately, as, for instance, soil and vegetation.

For one reason or another it may be impossible to take the photographs into the field. Under these circumstances the major pattern is easily traced on vellum. The resulting outline when properly oriented on the plane table offers a very satisfactory base for mapping.

When inventory is concerned with some selected item, such as vegetation boundaries in heavily wooded sections, it is often desirable to run an ordinary plane-table or compass traverse. Then photographs carried along provide a ready reference and aid greatly in plotting, especially if the distances are being paced.

Temporary or permanent mosaics are often available, but they are too cumbersome for direct mapping. Their chief value is in the composite picture they present. Work is more easily planned and the relationships, problems, and complexities of any region are better understood when they are employed. The following method has proved satisfactory: The pictures are assembled before the worker goes into the field; once the area is visualized as a whole, the photographs are separated and used for mapping; when the task is completed they are reassembled and employed as a basis for correlation.

The stereoscope is an invaluable aid to field and office interpretation. With a small pocket-type instrument the vertical aspects of a location are examined as it is mapped in the horizontal plane. Surface features and other areal variations along the traverse may be viewed under the stereoscope and their extensions plotted in detail. In this manner slope, landform boundaries, and different sorts of vegetation can be mapped with considerable accuracy. The lens type of stereoscope gives a great deal of vertical exaggeration and covers only a small part of the stereoscopic field at any one time. The instrument using mirrors has a much wider field, but relief is less pronounced and hence less decipherable.

The professional geographer is interested in four phases of the landscape: How much? What kind? Where? Why are conditions as they are? The first question is quantitative, the second qualitative, the third locational, and the fourth logical. Their solution involves: (1)

determination and location of the boundaries of each type of phenomenon; (2) determination of its nature; and (3) reasons for its being as it is in regard to both position and nature. In general, it may be said that controlled aerial photographs and mosaics are superior to other field methods in defining location and boundaries; that the usual field methods are superior to photographic techniques in the characterization of the nature of an object, although the regional keys allow certain definite identifications; and that each technique has advantages (and disadvantages) in explaining the nature and position of the object under consideration. Photographs allow for a greater part of the landscape to be studied at a single view, and therefore introduce broad relationships which might be obscured because the student on the ground "sees the trees and not the woods."

Geographic field work may take the form of a reconnaissance survey to establish broad types of distributions or of a microstudy intended to set up the minute geographic relationships which constitute the broader patterns. Aerial photographs are of value chiefly in the first, broad type of field investigation, although many of the problems of detail can be recognized and solved through an interpretation of the prints.

A prime requisite for the translation of aerial photographs is a knowledge of the processes involved in the production of the particular natural or cultural feature that is to be identified. The trained observer may note a geometrical pattern associated with a field, but it has no significance unless he recognizes it as the intersection of the "dead" furrows, left at the time of plowing. (Such dead furrows ordinarily signify grain fields.) With this and other aids it may be possible to draw some conclusions about the kind of crop in the field when the picture was taken.

More generally, familiarity with the area under investigation is essential. Though the railroad, with its characteristic curves, is identifiable in any place, many other cultural forms are not. Farmsteads, road patterns, field shapes, and other features have different appearances in various parts of the world. Hence any problem of interpretation is partly solved by a knowledge of the physical and cultural conditions in the area investigated.

It is further essential that the observer have the proper perspective. Since most observations are made from the ground it is difficult to orient the viewpoint with a vertical position. The reading of aerial photographs requires that the appearance of an object from above shall be as easy a means of identification as the aspect of the same object in the horizontal plane. Appreciation of this fact from the very beginning will aid greatly.

Several examples of direct and associative keys are presented below. These by no means exhaust the possibilities of photographic interpretation, but are intended to be suggestive of the type of information required for identification of objects. In applying such keys the interpretation of an aerial photograph is accomplished through an evaluation of four factors: (1) the flat two-dimensional shape; (2) the tone, from black to white; (3) the texture, from smooth to rough; and (4) the shadows cast by the objects to be identified.

1. *Shape*. — Since it is customary to observe phenomena on a horizontal or, at best, an oblique plane, it is difficult suddenly to transfer the study of an object to the vertical perspective. For this reason it is necessary to develop a familiarity with the ground plan of the various types of objects, and to be able to translate this plan into a horizontal concept.

2. *Tone*. — The tone range from black to white in which an object appears is the result of the amount of light transmitted from the surface of the object to the camera. If the amount reflected is large, the object will appear light; if small, a darker shade prevails. This variation is due to differences in the angle of the rays with respect to the camera and in the nature and surface of the object.

The elevation of the sun above the horizon affects the tone, as does the position of the lens with respect to the sun. If the sun is behind the airplane, the features pictured ahead of the camera appear white or light-colored, whereas the same objects will be photographed in a darker shade if they are to the rear of the plane at the time of exposure.

There is considerable variation in the reflective quality of the different types of material and surface. Smooth surfaces reflect more light than rough ones, and dark objects less than light ones. For instance, roads are nearly always lighter than surrounding fields, and plowed or trampled fields are not so dark as those in which crops are standing. In addition, the varying intensity of development of individual prints is reflected to some extent in the shading of the photograph.

For these reasons it is difficult to use tonal variations to identify objects far apart on the same print or on neighboring prints. Tone is valuable in showing differences within a small area, in indicating changes in texture, and in the location of shadows.

3. *Texture*. — "Texture" means the number of tonal changes in any given part of the picture. Highly variegated or dappled sections indicate a rough surface or one which lacks uniformity in some other respect, whereas a smooth, even appearance shows homogeneity of surface and reflective quality. Striking differences appear between upland hardwoods and swamp conifers, for example. The broad leaves and the roughly globular shape of the tree crowns give the deciduous areas a spotty look, while the uniformly dark, spired evergreens are smooth in texture.

4. *Shadows*. — Shadows are dead-black images which intrude upon otherwise lighter shades. The form which casts the shadow can usually be located in the ground plan, but small objects such as telephone poles have only the shadow as a means of identification.

Shadows are important in photographic interpretation because the outline formed on the ground may be more readily identifiable than the plan, tone, or texture of the object itself. The shadow covers the side of the elevation which is away from the light. For this reason it is best to orient the photograph with the shaded part toward the observer. It is also desirable to place the light used in study in a position comparable to that of the sun at the time the picture was taken. This will usually put the top of the picture toward the south. The slight disadvantage which results is compensated for by the increased perception of relief. If the picture is improperly oriented, hills appear as depressions.

Shadows have value in determining the location, shape, height, or depth of any object, and the nature of the object through any of these facts. They are particularly important in areas of accentuated vertical differentiation or in winter. The more marked the break in surface, the sharper, and therefore the more distinguishable, will be the resulting shadow. In winter the dark tone stands out conspicuously against the white surface.

Shadows which are too long cover the details of the picture over considerable areas; therefore photography is limited to a few hours around noon. Objects cast shadows far out of proportion to their size when exposures are made early in the morning or late in the day, and, in addition, black out much significant detail. This is an obstacle especially during the low-sun period, so that desirable photographic flying time in winter is more strictly limited than in summer.

KEYS TO THE INTERPRETATION OF AERIAL PHOTOGRAPHS IN THE NORTHEASTERN PART OF THE UNITED STATES[1]

Topography

Relative relief, location of relief features, and direction of slope are often discernible by interpreting shadows, vegetation associations, drainage patterns, location and direction of roads, and cultivation characteristics:

1. Identification of relief through shadows: All shadows indicate unevenness of surface, either natural or cultural; shape of shadow must be evaluated to determine type of projection which casts it. See last paragraph on this page for manner of deducing cuts and fills.
2. Identification of relief through vegetation
   - *a*. Type of vegetation indicates relative relief if growth habits of the associations are known. Keys to associations have been established which distinguish between upland and lowland species (see below).
   - *b*. Long more or less continuous strips of trees projecting into otherwise nearly completely cultivated areas suggest land too steep to farm, particularly where tentacles extend from a continuous strip of vegetation into farmed area. Scattered fields also often indicate relief.
3. Identification of relief through drainage
   - *a*. Streams meander on flat land and flow in straight narrow valleys where gradient is steep.
   - *b*. Streams flow from high to low elevations, showing direction of slope.
   - *c*. Streams usually indicate areas lower than surrounding country.
   - *d*. Soil-drainage patterns, shown as dark markings in cultivated land, express direction of slope.
   - *e*. Erosion scars, light dendritic or washboard tracings, indicate slope. Associated fan-shaped accumulations mark base of slope.
4. Identification of relief through roads and railroads
   - *a*. Secondary roads are laid out with numerous curves, hairpin turns, and the like, in order to avoid hills and to descend steep slopes along easy angles.
   - *b*. First-class roads and railroads are engineered without reference to minor topographic forms, but such features are distinguishable by a study of the shadows indicating cuts and fills. If road is cut through a hill, shadow will fall across road, whereas it will fall away from road if depression has been filled.
5. Identification of relief through cultivation
   - *a*. Irregular boundaries of cultivated land in an area otherwise regular in pattern may be attributed to a sharp break in surface.
   - *b*. Arrangement of plow and drill lines, as in contour farming, may suggest relief, but since farm techniques vary widely this is not conclusive.
   - *c*. Absence of cultural patterns in area of moderately dense population may point to stretches of rough, broken land, associated with a patchy distribution of forest, bush, swamp, marsh, and lakes. A continuous strip of vegetation in area of advanced cultivation may mark a break in surface.

Certain physiographic forms may be identified as follows:

1. Fault lines
   - *a*. Sharp continuous soil change is evidenced by differences in tonal quality of soil, in natural vegetation, or in stand of crops.
   - *b*. Drainage displacement is apparent.
   - *c*. Scraps may be identified.
2. Anticlines
   - *a*. Drainage is radial.
   - *b*. Arching of streams follows bedding planes.
3. Sedimentary rocks
   - *a*. Erosion of these forms may look like hill contours from the air.
   - *b*. Contacts between overlying strata are often marked by linear distributions of denser vegetation.
4. Sinkholes
   - *a*. Shadows, if photograph is oriented properly, reflect characteristic funnel shape of depression.
   - *b*. Holes may be vegetation-choked.
5. Kettle holes
   - *a*. Round lakes or marshes in morainic country indicate kettle holes.
   - *b*. Shadows accentuate depression.
   - *c*. Concentric circles of vegetation may mark successive stages in lake filling.
6. Stream capture
   - *a*. Presence of dry gaps is indicative.
   - *b*. Decapitated stream system may be observed.
7. Alluvial fans
   - *a*. Characteristic shape may be identified by soil tone different from that of surrounding territory.
   - *b*. Fans are found in areas of sharp relief, where there will be evidence of abrupt flattening of grade.

c. Stream which formed fan spreads out at base of fan; distributary channels may be seen.
d. Spring line may appear as dark saturated zone along a line of equal elevation.

8. Ravines
   a. Broken bank lines may be apparent, usually accompanied by change in vegetation or by abrupt shift from cultivation to woods.
   b. Streams are not always visible because of trees, but when visible they fill entire floor of valley.
   c. Dendritic pattern of trees outlines streams and tributaries.
9. Moraines
   a. Unevenness of surface is revealed by road routes, gullied slopes, shadows, cuts, and fills.
   b. Tonal variation is great because of heterogeneity of soil types.
   c. Morainic hollows, kettle holes, and so on are darker than surrounding surface area, owing either to damp soil or to marsh vegetation. If still water-filled, lake is, of course, visible.
   d. Cultivated areas are interspersed with woodlots, and both are irregular in form.
   e. Stream courses are haphazard and winding; if outwash plain is associated with morainic belt stream will flow more regularly through this type of surface.
10. Outwash plains
   a. Road pattern is more uniform than in morainic area.
   b. Tonal similarity is due to greater homogeneity of material, but tonal variation is still that characteristic of glacial regions.
   c. Streams may be incised and banks wooded.
   d. Fields are more regular and agricultural land use more complete than in morainic area.
   e. Pitted outwash marked with small lakes and poorly drained depressions is strikingly revealed if land has been cleared.
11. Drumlins
   a. Stoss and lee slopes often give a “tadpole” appearance.
   b. Valleys between drumlins are poorly drained and hence darker; they are often uncleared or in hay or pasture.
   c. Fields are oriented with trend of drumlins; long, narrow areas of cultivation are characteristic.
   d. Numerous shadows appear at road cuts when highway is transverse to drumlins.
12. Eskers
   a. Sinuous nature of eskers is readily discernible, especially if they are forested and in an otherwise cleared zone.
   b. Eskers often break or dislocate pattern of cultivation.
   c. Gravel pits are common; shadows and white or light tone aid in their identification.
   d. Roads are usually cut through eskers and are hence often in shadow at point of crossing.
13. Youthful and mature surfaces: though youthful and mature surfaces are best identified through shadow and tone, distribution of cleared areas often aids in establishing stage of erosion. Location of fields and farms and their size and relative density reveal approximate extent of level land in valleys or on interfluves. Furthermore, irregularities of occurrence are a key to amount and degree of slope.

Drainage

Drainage features may be identified as follows:

1. Water bodies (except streams)
   a. Flat uniformity of tone occurs, its darkness being dependent on depth of water. Light tones indicate shallow water; darker tones, deeper water. This fact aids in identification of subaqueous forms such as bars and reefs.
   b. In some instances water is white if sun's rays are reflected directly into camera.
   c. Shore line is distinguished by abrupt change in tone and texture from land to water.
   d. Small lakes enclosed with concentric rings of varying tone and texture reveal vegetation sequence in course of extinction of lake.
   e. Waves and breakers are often visible.
2. Rivers, streams, and creeks
   a. Tone shades from black to white, depending on reflection of light.
   b. Most streams wind, and vary in width. This variation distinguishes them from roads or other continuous phenomena. In areas of particularly steep gradient where stream course is relatively straight there will be erosion scars, lack of vegetation on such scars, bank lines, and other signs of V-shaped valley.
   c. Streams are usually paralleled by a dense ribbon of vegetation, especially noticeable in cultivated country.
   d. Bridges occur; type can be identified by close inspection of shadow.
   e. When water itself is nearly invisible, through overhanging of vegetation, increased density of trees along stream may be a clue, especially if occasional fleck of light is reflected from water.
3. Rapids and falls
   a. Light tone of water appears between two darker areas, caused by turmoil of rapid motion.
   b. Banks may narrow.
   c. If streams are used for navigation there may be evidence of portage trails. If streams are canalized, locks, together with lock house and other evidences of use, may be discerned.
4. Braided streams
   a. Wide bank lines appear.
   b. Small winding meandering stream in valley bottom is characteristic; the many channels are darker than rest of valley bottom.
   c. Light-toned sand and gravel islands occur between channels.
   d. No cultivation is observable in valley bottom.
5. Flood plains
   a. Bank line borders plain on one side and stream on the other.
   b. As streams meandered over flood plains deposition may have been unequal and not of uniform composition. This unevenness is reflected in orientation of fields, which are aligned with reference to position of old meanders.
   c. Sometimes plains are densely cultivated, but cultivation lines (boundaries) are limited by their extent.
   d. Vegetation is absent except along bank lines or streams.
6. Bank lines
   a. In cultivated areas bank lines appear as discontinuous winding zones of vegetation between two areas of cultivated land, between flood plain and upland, or between cultivated areas and marsh or swamp zones. Lines roughly follow course of streams.
   b. Drainage cuts and gullies may be present.

c. Definite cultivation boundaries due to steep banks are observable.
d. Bank lines usually separate two soil zones of different tone.

7. Oxbow lakes and meander scars
   a. Dark concentric markings are observable, tone due to soil dampness and marsh vegetation.
   b. Oxbow lakes have tone and texture typical of water, whereas coarser texture appears if vegetation chokes scar.
   c. Oxbow lakes and meander scars are usually associated with flood plain of meandering stream, but in areas of uplift they may be well above stream.
   d. Inside of meander may be a slip-off slope, which in cultivated areas will often be wooded. Undercut bank on outside of meander may show light tone because of absence of vegetation.
8. Canals
   a. Tone and texture are those characteristic of water.
   b. Regular width and constant direction distinguish canals from streams.
   c. Banks of dirt, built-up roads, and so on may indicate artificial construction.
   d. Signs of use — locks, dams, and boats — may be apparent.
10. Dams and similar constructions
   a. Backwater resembles lake.
   b. Sharp break occurs in looks of water at dams, for white flow appears below dams.
   c. Dams show a light line, which will be straight in contrast to sinuous form of rest of shore line of backwater.
   d. Some indication of relief of area may be derived from shore line of backwater, since it is at a contour line.
11. Soil drainage: Dry soils are usually lighter in tone; damp soils are darker.

Soils

Broad generalizations about soils are possible from aerial photographs. No detailed identifications should be attempted on this basis alone unless the observer is a specialist, although in the field the problem of soil boundaries may be expedited by their use. Vegetation associations revealed by photographs also give some clue to the nature of the soil, since it is one of the important factors in plant ecology.

1. Broad generalizations
   a. Damp soils show darker than dry soils in same general area.
   b. Sands are light gray; clays, dark gray; loams, intermediate in color, but generally more mottled in texture.
   c. Soils in glaciated areas are almost invariably highly variegated in tone because of heterogeneous nature of till.
2. Correlation of vegetation and soil
   a. Marsh and swamp vegetation indicates peat and muck.
   b. Cultivation may mark loamy soils.
   c. Upland hardwoods are often expressive of loam.
   d. Certain species of conifers occur on excessively wet soils, others, on excessively dry soils; consequently, if species are distinguishable, they may give clues to soil type.

Mineral Resources

Most minerals are subsurface phenomena, and therefore difficult to locate with certainty on a photograph. An expert, however, is able to recognize signs which indicate areas that might prove profitable fields for more detailed surveys.

Aerial photographs have been used by petroleum geologists to determine geological structure. Both exploratory and detailed surveys have been aided by the application of direct and associative keys. It is not within the scope of this paper to present exact descriptions of the appearance of most geological phenomena, because others more experienced in the use of photographs for this purpose are already working in the field. One example is given to indicate the type of information required in their identification:

1. Salt domes
   a. Circular area which is faintly lighter or darker than surrounding area is characteristic.
   b. Drainage, soil erosion, and road pattern help determine domelike relief.

Weather and Climate

No details of value about the weather and the climate are obtainable from aerial photographs, although it is possible to develop a very general picture of the climate of an area on the basis of its vegetation, land forms, house types, and drainage.

Coasts and Shores

Shore-line phenomena, both subaqueous and emergent, are readily-studied on aerial photographs. Unless the water surface is light-struck (dead white) it photographs dark, the tone of the image varying from black to gray with the changes in depth. Deep water shows dark; shallows appear light. On this basis submerged forms can be identified by their shape and position.

1. Submarine deltas
   a. Submarine deltas occur where streams enter other bodies of water.
   b. Characteristic shape may be defined by light tone of water body, due to its shallowness on delta.
   c. It is often possible to tell direction of current of water bodies which streams enter by distorted shape of deltas.
2. Spits, bars, offshore bars, coastal reefs, submerged channels, terraces, tidal depths, and so on: All these forms betray themselves by tone changes from shallow to deep water.
3. Mud flats
   a. Flats occur on landward side of barrier beach and appear in photographs as uniform drab-gray slightly textured expanses; no signs of relief.
   b. Complicated system of drainage channels appears as dark tracings.
   c. Mud flats show less coarse texture than marshes because periodic inundation prevents growth of mesophytic vegetation.
4. Beaches
   a. Beaches appear as strips of uniform texture bordering water bodies.

b. Tone is light away from water, darker near water, as moisture content of sand or shingle increases.
c. Sand beaches show white; shingle beaches are darker and more mottled.
d. Fringe of vegetation or sand dunes may occur on landward side of beach.

5. Abandoned beaches
   a. Light tracings which show characteristic sinuous shape of beach lines may be followed, sometimes discontinuously.
   b. Abandoned beaches are often associated with more or less "washboard" appearance; many are arcuate and separated by marsh areas.
   c. All sand areas photograph nearly pure white, lack definite texture, and look very similar to light-struck water.
6. Sand dunes
   a. Appearance is that typical of sand, but modified by light and shadow characteristic of rough terrain.
   b. Drainage lines are absent where streams have cut through dune area. There is usually a sharp break in direction of stream where it has changed its course to find a place to cut through dunes.
   c. Distribution of vegetation is spotty, with irregular breaks where blowouts or slides have cut into sands.
   d. Type of dunes may be determined by study of shape. Ridge lines are often horseshoe-shaped or bowed.
7. Sea cliffs and bluffs
   a. Absence of well-defined beach lines may indicate formation dipping into sea or wave-cutting at base of vertical cliff.
   b. Water shows dark immediately adjacent to shore, and no terrace or other shelf features appear.
   c. Choppy white narrow surf lines may occur at contact between land and water.

Plant Life

One of the most important contributions to geographic inventory which can be made through the use of aerial photographs is the delimitation of vegetation zones. Forestry agencies, both private and public, have made forest surveys by interpreting vertical or oblique prints. Results indicate that this method of estimating volume and species is satisfactory for all except the most detailed surveys.

The keys presented here are regional and are intended to be applicable only to northern Michigan, northern New York, and areas which have similar vegetation associations.

1. Woodland in general: Identification of woodland is obvious, but determination of species and stand requires keys.
   a. Uniformity of tone and texture indicates uniformity of species, age, and stand.
   b. Changes in appearance of stand indicate a change in density, size, or species.
2. Hardwoods
   a. Billowy light and dark tone is characteristic. Broadleaf associations usually photograph lighter than conifers because broad leaves reflect more light to camera than do needles of conifers.
   b. Individual crowns show light on side toward sun, with a semicircular shadow on side away from sun. These shadows may be interrupted by neighboring trees, but texture of hardwood stand is characteristically mottled, "salt and pepper."
   c. Where individual hardwoods stand in fields, some hint as to species may be obtained through shadow; otherwise it is difficult to identify association with accuracy unless observer is intimately acquainted with regional associations. Once common upland hardwood association of an area is established, it is possible to guess at particular association under consideration. Changes in species will usually change photographic appearance of stand in some small but often recognizable way.
3. Conifers
   a. A smooth gray to nearly black photographic tone is characteristic. Degree of smoothness depends partly on size of individual trees and spacing of trees, but coniferous stand never displays mottled texture of hardwoods. Under comparable lighting conditions conifers will always photograph darker than hardwoods.
   b. Conic nature of most conifers is responsible for texture. Various sizes of crown allow some identification of species, as does fact that jack pine, cedar, and balsam are usually darker than spruce.
   c. In winter photographs identification of conifers as compared with hardwoods is unmistakable. In general it is desirable for observer to be familiar with plant ecology of area under study, although species identification may be made of individual solitary trees from inspection of shadow. Once familiarity with site characteristics of coniferous associations in any region is attained, it is possible to make rough identifications on basis of proximity to water bodies or other evidences of drainage or lack of it.
4. Mixed hardwood and conifers: As texture of photograph changes from smooth to billowy it shows that increasing numbers of hardwoods are entering association. This shift from one association to another may be determined by a count of individual crowns, under magnifying glass, if scale of photograph is large enough. Here, too, it is desirable to know local growth characteristics of various associations.
5. Coniferous trees on well-drained land
   a. Tone and texture remain roughly the same for this association as for lowland conifers.
   b. Individual trees are often discernible through study of crowns, pines showing a widespread branching which hydrophytic conifers lack.
   c. Site factors will help determine this association.
6. Estimates of stand
   a. Rough stand estimates may be made from a quick inspection of photograph, according to crowded or open condition of trees. Sometimes in an open stand ground will show as light or dark smooth patches in midst of coarser-textured area.
   b. More accurate, but still rough, estimates may be made by actual count of crowns with aid of high-powered magnifying glass. Height of trees is discernible from shadows if time of day, time of year, and latitude are known.
   c. Winter photographs are best for determining stand because deciduous species are instantly distinguishable from conifers, and shadows are well defined and measurable.
7. Swamps
   a. Coniferous swamps are usually dark gray and are distinguished by extremely smooth grain and by uniformity of tone and texture. Type of vegetation must be determined in the field, however, and appropriate adjustments in key must be made for region.
   b. Lack of evidence of human occupance such as roads, houses, fields, and the like is characteristic. If trails do

appear it is probable, in north-central region, that they are lumber trails, and further evidences of this mode of land use should be sought. Logging roads display many branching lines at right angles, or at regular oblique angles, to main trail, giving washboard appearance to photograph.

c. Stream courses which meander because of flatness of land are characteristic of swamps.

d. Drainage ditches may be observed; these will run straight and show white strips along their sides, where dirt has been thrown up and has dried.

e. There is a definite sequence of grain or textural characteristics on photograph, from grassy marsh types through swamp conifers and mixed hardwood sand conifers to upland hardwood associations. The closer the association approaches the upland hardwoods, the more billowy becomes appearance of stand. Rounded crowns of hardwoods are readily distinguishable from small spirelike crowns of conifers.

8. Marshes

a. Uniform tone and texture are characteristic, tone being dark gray and texture only faintly perceptible.

b. Patches of open water may occur, and if they do, there will be evidences of lake-filling, in that circular rings of apparently different vegetation associations will be distinguishable through varying tones and textures. Brush alder and willow will show lighter and more coarsely grained than marsh grass.

c. There will be few if any signs of human occupance.

d. Drainage patterns are often indistinct, but traceable; they may be augmented by straight canals.

9. Grasslands

a. Light-gray tone and smooth texture are typical, but grasslands are haphazardly splotched with darker tones and more definite texture where brush and trees enter the cover.

b. Fence lines are lacking except in areas which have been cultivated and abandoned, where, moreover, mottled tone becomes more apparent.

c. Houses, if any, are spaced more widely than in cultivated areas.

d. Evidences of trails may appear if areas have been utilized in past. Abandoned houses show as dark boxlike forms and are distinguished from occupied dwellings by lack of tone change in area around them.

10. Brush

a. Wide range of tone from light to dark is characteristic, mottled appearance being due to nonuniformity of brush types and heights. Texture smoother than that of trees, but coarser than that of grassland.

b. Brush cover is not complete, and open spaces accentuate mottling.

c. Evidences of lumbering may appear in signs of lumber trails, logging camps, lumber railroad beds, and the like. Old burns are distinguishable from cutover areas by irregularity of outline in contrast to regular outline of cutover after logging operations.

d. Location in relation to surrounding vegetation associations may indicate type of brush: uplands will have young poplar; lowlands along streams and in swamps will have alder-willow association.

11. Burns: Appearance depends on length of time between fire and aerial photography.

a. New burns

(1) Dead-white tone is characteristic; no texture is apparent, except that dead trees show as dark spots.

(2) Outline is irregular.

(3) Burns spread across vegetation boundaries.

(4) Region may be confused with some cultivated areas, but does not have fence lines, roads, or other regular elements.

b. Old burns

(1) Definite change in tone and texture appears between burns and surrounding vegetation, but area does not have dead-white, textureless quality of new burns.

(2) Vegetation types begin to conform to prefire vegetation boundaries imposed by edaphic conditions which were not changed by fire.

12. Cutover areas

a. Numerous trails are evidence of recent logging operations.

b. Isolated trees stand well above surrounding vegetation cover.

c. In locations which were predominantly conifer-bearing, especially in lowlands, logging trails will have a pattern reminiscent of backbone of a fish, with its lateral bony appendages.

d. Logged deciduous forest looks like ground fatty meat that has been poorly mixed.

Characteristics of Occupance

Among the chief characteristics of occupance are buildings, which are immediately recognizable on photographs. The problem in interpretation is the determination of the function of the structures, generally by means of associative keys. Indications as to use may be gathered from a study of the surroundings of the building under consideration. The factors to be considered are: (1) the shadow of the structure, which will give information as to the form of the building, its height, and its structural characteristics; (2) the tone of the ground surrounding the structure, light ground being evidence of use, since the vegetation has been destroyed; (3) the surrounding buildings, piles of materials, communication lines, and the like; (4) the site, position, and situation, including spacing of the structures with reference to the lot and to neighboring structures; and (5) any other helpful associative characteristics.

It is possible because of space limitations to give but a few examples of keys to the interpretation of specific types of buildings:

1. Rural schools

a. Structures are often square and boxlike, as shown by roof shapes and shadows.

b. Larger outbuildings are absent.

c. Well-defined driveways or paths to adjacent cultivated fields are lacking.

d. Ground surrounding schools usually light because of absence of grass.

e. Baseball diamonds or other evidence of recreational activity may be observed.

f. Shadow of buildings may show small bell tower at front.

g. Single photographs probably will not show many such structures, since it is not likely that two or three schools will occur within a short distance.

h. Schools are usually found near outskirts of small rural towns.

2. Rural churches

a. Ground plans are often in shape of cross.

b. Structure is centrally located.on plot.

c. Outbuildings are absent except in certain rural sections, where there may be parking sheds.
d. Ground around buildings is dark because of presence of grass.
e. Steeples or towers are distinguishable by their shadows.
f. Cemeteries may be discernible in adjacent lots.
g. Paths and trails to surrounding fields are wanting.

3. Farmhouses
   a. Design, revealed by roof and shadow, shows more variation than is found in barns, schools, or churches.
   b. Houses are smaller than adjacent barns, but larger than other buildings of farm group.
   c. Ground around houses is dark because of presence of grass.
   d. Houses are often set among trees, whereas other farm buildings may be in the open.
   e. Farm driveways do not end at houses, but continue on to barns.
4. Rural barns
   a. Barns are focal points for lanes, driveways, and paths of farmsteads.
   b. Shapes are distinctly boxlike, with peaked or rounded roofs, marked by their shadows.
   c. Silos or haystacks may be indicated by shadows.
   d. Ground around barns is usually light-toned because of absence of grass due to trampling by animals and wear of farm machinery.
5. Lumber mills
   a. If mills are dependent on railroad there will be a spur or siding.
   b. If mills are dependent on a stream there will be a millpond near-by for storage of logs. Dam will be distinguishable.
   c. Most lumber mills have a slash burner and tall stacks.
   d. Piles of seasoning lumber show as small rectangular light patches distributed in regular alignment over a large area.
6. Cottages
   a. Structures are located along shore of lake or river.
   b. Sand beaches and shallow water offshore are characteristic.
   c. Adjacent cultivated land is lacking.
   d. Cottages may be closely spaced.
   e. Haphazard placing indicates groups of cottages.
   f. A road will lead in to the group of buildings.
   g. Docks and floats lie offshore, and V-shaped wash left by speed boats may sometimes be perceived in summer.
7. Hunting shacks
   a. Solitary location in wilderness is characteristic.
   b. Cultivated land is lacking.
   c. Trails lead into woods, not to fields or other houses.
8. Abandoned buildings
   a. Where dwellings have disappeared, cellar outlines can usually be noted if cellars were made of stone or cement.
   b. No white ground is visible around houses or barns.
   c. When farms are in partial use there may be evidence of activity around barns but not around dwellings.
   d. Driveways are not marked by use.
   e. No signs of tracks appear where mailman would turn out to reach letter boxes.
   f. Roadways passing houses often have few signs of travel.
   g. Orchards are unkempt, with many trees missing from normal pattern.
   h. Fields are dark-toned and uncultivated.
   i. When abandonment has reached advanced stage, brush will be scattered through fields and small trees will be particularly in evidence along forest-cleared-land boundary.
   j. Roads will show a tendency to cut across field corners at road intersections.

Rural Production

Identification of cultivated land is immediate because of the regularity of pattern and texture it exhibits, in contrast to the coarser textures, irregular outlines, and more homogeneous tones of forest, grassland, or brushland. In photographs the tone of such areas ranges from white to black, but the lighter shades predominate. Tonal changes are usually sharp and may be emphasized by fence lines. Specific elements may be identified as follows:

1. Field lines
   a. Lines appear on photograph at more or less regular intervals, making a sharp break between areas of relatively homogeneous tone and texture.
   b. Stone and rail fences are distinguishable, being large enough to create a photographic image.
   c. Untilled land along field lines shows darker than cropland, and there may be trees, bushes, and brush along fence zones.
   d. Cattle paths and lanes may show along field lines.
2. Cultivated land: This land is distinguishable from uncultivated pasture by presence of drill or plow marks, and characteristic patterns of dead furrows.
3. Crop types: Hints as to nature of crops may be derived from texture of fields. Corn and potatoes produce a coarser texture than small grains. Regional crop keys may be established, and a knowledge of harvesting methods will aid in crop determination if pictures are taken during harvesting season.
4. Circular plowing and harvesting: Two definite tones sometimes show within same field. If inside zone is dark and outside zone is light, field is being harvested; if outside zone is dark and inside one is light, field is being plowed.
5. Orchards
   a. Round full crowns of trees are indicative.
   b. Spacing and alignment of trees are regular.
   c. Usual proximity of orchards to houses and roads differentiates them from planted forests.
   d. Orchards are ordinarily located away from natural forest areas.

Transportation

1. Trails: Chief significance is in what may be found at ends, and in hints they furnish as to movement of people within specific areas.
   a. Thin white lines running haphazardly through fields, forests, and grassland are characteristic.
   b. Extremely winding nature distinguishes trails from second- and third-class roads.
   c. Trails nearly always begin and end at some point associated with human occupance. At least one end will be connected with some more advanced form of communication.
   d. Trees may obscure trails in forested areas.
2. Roads: Roads range from black to white, and appear as lines. In general, concrete photographs lighter than asphalt, and dirt darker than gravel.
   a. First-class roads
      (1) Wide, cleared right of way is characteristic.
      (2) Curves are smooth and broad.
      (3) Routes cut across established patterns of field and town.
      (4) Construction is made without reference to minor obstacles such as hills and swamps, which may be

distinguished by cuts and fills. If roads are on a fill, shadow will fall away from them; if they run through a cut, shadow will fall across them.

b. Other roads
(1) Right of way is narrow.
(2) Sharp corners and turns are common.
(3) Established patterns of settlement are followed.
(4) Routes are controlled in part by minor topographic features, and so show numerous curves and bends.

3. Railroads
a. Width of line is determined by number of tracks, a single-track system being narrower than a first-class automobile road.
b. Railroads are usually dead white because of presence of stone fill for roadbed.
c. Direction of line is changed by long smooth curves.
d. Branch lines are few, and served by long curves.
e. Roads that cross railroads can be seen going over tracks.
f. Numerous cuts and fills are apparent where railroad engineers have attempted to smooth out trajectory of line.
g. Right of way of railroads becomes narrower over streams, whereas roads show wider paths across bodies of water.
h. Stations, sidetracks, trains, factories, and other forms characteristic of railroads may help in identification.

4. Fords across bodies of water
a. Fords occur at places where river bank breaks down, as shown by a light marking on picture. Break in bank gives access to body of water.
b. Roads, trails, tracks, and the like converge on stream at this point, disappear into the water, and emerge on opposite side. Sometimes tracks may be seen on bed of stream.

5. Transmission lines
a. Cleared band through woods, without apparent roads, is indicative. Trails may be discernible.
b. Change in direction takes place by means of sharp corners rather than engineered curves.
c. In cultivated country transmission lines may be identified by structural shadows, which are lined up without reference to established patterns.

6. Airports
a. Large cleared space without fields, fences, or other obstructions is characteristic.
b. Large building or buildings are grouped near periphery of field.
c. Long light-toned graded runways are visible, usually at odd angles.
d. Planes on field may show, being either dark or light.

7. Docks
a. Elongated rectangular projections from a shore line into a water body are indicative.
b. If docks are of a commercial size storage sheds, railroad tracks, and so on will extend along them.
c. Steamers may be identified by their form, and type of steamer may sometimes be revealed by the superstructure.

Urban Forms

The city, with its preponderance of cultural forms, lends itself more readily to interpretation that does the rural landscape. Custom, tradition, and utilitarian and functional demands have so standardized urban patterns that many features are easily recognized even in the most cursory examination. Downtown parking lots offer an illustration. Open areas, often with small buildings near the street, with two or more entrance ways, and with lines of parked cars, can seldom be confused with any other feature. It is more difficult, however, to distinguish between commercial parking lots and establishments where secondhand cars are sold. If the space is only partly filled, the car sales lot can probably be recognized by the fact that the cars are parked next to the sidewalks.

Urban interpretation can be accomplished with somewhat more certainty than can rural, if a comparable time is spent in the field. The use of shadows and associative keys is of particular importance. Water tanks, smokestacks, overpasses and similar superstructures can best be identified by their shadows. In fact, identification otherwise is often impossible. It can seldom be established with certainty that a building by itself is an industrial enterprise. Docks, railroad sidings, coal piles, water tanks, large parking lots, bare ground, and low-class residences, however, help give character to the factory structure. Recognition of most urban phenomena is aided by a consideration of the surrounding associated features, which indicate the function of the form observed.

1. Trees
a. Absence of trees aids in separating commercial and industrial areas from residential parts of city.
b. Size, or lack, of trees is of considerable value in recognition of areas of different periods of development.
c. A paucity of trees is indicative of a low-class residential district.
d, A great number of trees often reflects middle-class or upper-class residence zones.

2. Railroads
a. Routes cut across normal street pattern.
b. Curves are characteristic.
c. Cars may be seen on tracks even on small-scale photographs.
d. Sidings are numerous and fan out along right of way. Since their function is to serve establishments rather than allow for two-way traffic, they are often dead-end lines.
e. Belt-line position about city is common.
f. Roundhouses appear in almost all cities of any size. Their images usually resemble a section of a doughnut. If railroads cannot be identified immediately, markings can be traced to see if they lead to a roundhouse, with its car shops, coal piles, and networks of tracks.
g. Large stations are conspicuous because of tracks that enter into or pass through sheds.

3. Oil, gas, and coal storage
a. Oil storage
(1) Tanks appear as round white or light-colored spots.
(2) Shadow gives some idea of their elevation.
(3) Tanks are grouped along railroad or waterfront.
(4) Generally more than one size of tank occurs.
(5) Rectangular embankments surround tanks.
b. Illuminating-gas storage
(1) Generally tanks photograph black or some shade of gray.
(2) Image is ordinarily a much larger spot than that made by oil tanks.
(3) Superstructures surrounding tanks cast distinctive shadows.
(4) Name of city or directional marker may be painted on top.
c. Coal storage

(1) Railroad or waterfront storage is common.
(2) Coal is piled in long ridges, sometimes in many parallel ridges, or in circular form, and is deposited with a regularity not found in natural phenomena.
(3) Superstructure of overhead traveling crane often throws a characteristic shadow.

4. Industrial buildings: Industrial plants are most easily recognized if observer has some familiarity with functional character of many different factories, for use often determines form and pattern of plant layout.
   a. Smokestacks are apparent, and smoke in the vicinity often imparts a hazy tone to print.
   b. Coal piles and traveling cranes are evident.
   c. Enclosed or open conveying systems lead from one building to another.
   d. Water towers, usually built above one of the buildings, can easily be identified.
   e. Saw-tooth roofs, frequently with many skylights, are characteristic.
   f. Spur tracks and siding may be seen, with many cars on the tracks.
   g. A surrounding area with no buildings is common; light spots in this area indicate that much of ground is bare.
   h. Some industrial buildings have blotched look because dust-spotted roofs reflect light with varying degrees of intensity.
   i. Factory buildings may be laid out in courtyard effect, with many enclosed units.
   j. Office buildings are associated with many factories, usually near street, with landscaped lawn.
   k. Most factories occupy large area, with considerable room reserved for parking.
   l. Factory names or other information may be painted on roof.
   m. Adjacent blocks may be little built up, and such residences as do occur are usually low class, stereotyped, and crowded.
5. Streets
   a. Alleys are narrower than streets and usually reflect light as gray or white.
   b. In contrast to streets, alleys are seldom tree-lined, but are bordered with garages and other small buildings.
   c. Streets are grayer than alleys.
   d. Main streets may show two grease streaks, whereas side streets show only one.
   e. Blackness of grease streaks often shows direction of flow of traffic, particularly at corners.
   f. Car tracks show up as light lines in street.
   g. Grease streaks swing in toward curb around safety zones.
   h. Boulevards have dark segmented center areas.
   i. In business districts sidewalks, shown as narrow white lines, are immediately adjacent to street, whereas in residential districts they are separated from street by narrow band of darker hue.
   j. In some sections of city change in character or orientation of street pattern may indicate limits of a subdivision or a certain period of building.
6. The commercial core: Tall buildings of commercial core stand out on most photographs. Elevation of buildings is sufficient so that those not directly below camera are photographed with a large portion of wall exposed. Hence there is an impression of depth not found elsewhere.
7. Commercial zone
   a. Numerous parking lots or parked cars are evident along streets.
   b. Buildings are more or less continuous along street.
   c. Buildings are built out to sidewalk.
   d. Many skylights and flat roofs appear.
   e. Treeless alleys are characteristic.
   f. Alleys are immediately adjacent to backs of buildings.
   g. Signs on tops of store buildings often cast shadows.
   h. Variation in shade or tone of roofs is noticeable.
   i. If buildings are on streets that are diagonal or at right angles to long axis of rectangular blocks, alleys set off commercial establishments in a narrow zone at ends of blocks. Residential alleys usually bisect blocks.
8. Apartments
   a. Shadows show elevations not common to surrounding residential area.
   b. Many wings and courts are characteristic.
   c. Landscaping is often apparent in small area between building and street.
   d. Many cars are parked along curb.
9. Public buildings
   a. Public buildings are generally set back from street.
   b. They may occupy central portion of whole block or a considerable part of block.
   c. They often have many wings and courts.
   d. Peaked roofs are common.
   e. Generally much of area around buildings is landscaped.
   f. Parking areas are provided behind buildings.
   g. Curved walks and drives are characteristic.
10. Schools
   a. Playgrounds are large, with tennis courts, ball diamonds, and other evidences of recreational activity.
   b. Buildings are constructed with wings.
   c. Ventilators are usually numerous.
   d. Heating unit with large smokestack is an adjunct of many schoolhouses.
   e. Bare ground around buildings is indicated by large white area.
   f. Ground in front is landscaped.
11. House types: There is some possibility of identifying house types. Bungalows are easily recognized by low-pitched roofs and the dormer windows. Victorian houses with turrets and projecting bay-window-areas and flat-topped modernistic houses can also be recognized. It may be stated as a general rule that house quality improves as ridge-top system becomes more complex.
   a. Superior residences
      (1) Lots are large, and generally outlined by hedge or fence.
      (2) Lawns show considerable landscaping.
      (3) Drives curve, and entrance may be at any point along front or side of lot.
      (4) Houses are large, ridge-top system complex.
      (5) Large driveway areas and large backyards, often with summer-houses and tennis courts, are common.
   b. Ordinary residences
      (1) Houses are fairly close together and lots are small.
      (2) Over a considerable distance garages, drives, and entrance walks are in same position with respect to lot.
      (3) Houses seldom have more than two ridge lines; roofs are stereotyped.
      (4) Backyards are small and houses occupy most of width of lot.
      (5) Houses are regimented with respect to street.
   c. Inferior residences
      (1) Houses are small, with single roof form.
      (2) Lots are small, even when buildings are scattered.
      (3) There is no landscaping, few or no trees, little grass.
      (4) Garages are not so common as elsewhere.
12. Suburban area
   a. Building density varies greatly, though many areas have centers of marked density.

b. Reflection of light from freshly turned earth and numerous tracks in vicinity aid in identification of new buildings; hence suburban area can in part be outlined by building activity.
c. Streets may show use along only part of length.
d. Areas with sidewalks but no streets that show steady use are common,
e. Gardens, truck gardens, and greenhouses are evident. Gardens show up as small light-colored rectangular areas, truck gardens look the same but are on a larger scale, and greenhouses appear as large rectangular areas, often pure white. It is sometimes possible to distinguish larger supports that separate major sections of glass.
f. Large areas may show that they have been prepared for building by fact that streets and sidewalks are present, but there are few if any houses. Such streets and walks are often gradually being reclaimed by vegetation and so may fade out of picture.
g. Occasional farmsteads occur, but farm area is usually small.

13. Parks and cemeteries
a. Parks and cemeteries have curved drives and no through streets, and so interrupt street pattern.
b. A great many trees appear; pools are common.
c. White spots indicate tombstones and vaults in cemeteries. Outline of individual lots, or rather raised or fenced areas, are frequently in evidence on prints.
d. Park areas have more open spaces and, of course, no tombstones.

14. Recreational areas
a. Many of the areas devoted to recreation are large, and interrupt street pattern.
b. Much of areas is treeless.
c. Diamond shape of baseball fields, striped football fields, golf courses with their elongated fairways and numerous white sand traps, and rectangular tennis courts may easily be identified.
d. Areas given over to general play have many conspicuous white spots, where bare earth is exposed.
e. Amusement parks can be identified by shadow of ferris wheel, sinuous sweep of roller coaster, peaked top of merry-go-round, and midway.

* Mr. Russell's field and office work in connection with this paper was made possible by his appointment as Predoctoral Field Fellow of the Social Science Research Council, 1935-36.

†Part of the material for this paper was collected when Mr. Foster was an Earhart Fellow at the University of Michigan, 1935-36.

[1] Inspiration for several of the keys presented here was obtained from many sources, published and unpublished. The authors have tested and elaborated such keys. A complete bibliography of articles which contain examples of interpretations of aerial photographs is impracticable here.

GROUND-WATER EXPLORATION BY EARTH-RESISTIVITY METHODS

KENNETH K. LANDES AND JAMES T. WILSON

INTRODUCTION

SEARCHING for ground-water supplies by electrical-resistivity methods is by no means new; it has been carried on in various parts of the United States, and the methods are described in standard geophysical textbooks.[1] Exploration by these means has been particularly successful in areas floored by thick deposits of unconsolidated sediment such as valley fills. Because most of the Michigan ground-water supplies are obtained from fluvioglacial sediments in the great drift sheets which cover the state, it was believed by writers that earth-resistivity methods could be successfully applied in Michigan, and the Plymouth district was chosen as a test area.

The assembling and operation of the apparatus used in the project was under the direction of the junior author. The writers gratefully acknowledge financial assistance through a grant from the Horace H. Rackham School of Graduate Studies of the University of Michigan.

PLYMOUTH DISTRICT, MICHIGAN

The state geologist, Dr. R. A. Smith, was consulted for advice regarding a "guinea pig" area. He suggested the Plymouth district because the supply of water then available was inadequate to meet the needs of a growing municipality. The city manager of Plymouth, Mr. C. H. Elliott, was very cooperative. He not only provided logs of wells drilled in that vicinity, but also contributed a truck and a helper.

The Plymouth district lies along the northwestern edge of the lake plains, and the entire area under discussion is floored with lake sediments. The Whittlesey beach passes through the city, and three beaches of glacial lake Maumee lie between the Whittlesey beach and the upland about two miles to the northwest.

DESCRIPTION OF STATIONS

Station	*Location*	*Direction of line*
Plymouth 1	Northeast corner of intersection of Blanche and Karmada Sts.	N–S
Plymouth 2	650 feet S. 30° E. of Plymouth No. 1	NE–SW
Plymouth 3	825 feet north of Plymouth No. 1	N–S
Plymouth 4	South side of Junction Ave., 80 feet east of Arthur Ave.	E–W
Plymouth 5	West side of Holbrook Ave., at Caster St.	N–S
Plymouth 6	South side of Pearl St., at Holbrook Ave.	E–W
Plymouth 7	500 feet east of the Plymouth–Northville Road on the north side of Middle River Rouge	E–W
Plymouth 8	East side of Starkweather Ave., 525 feet north of Pearl St.	N–S
Canton 1	South side of Warren Road near Haggerty. Near the middle of the south boundary of the NW. ¼ NW. ¼ of Sec. 12, T. 2 S., R. 8 E.	Along Warren Road
Canton 2	North side of Warren Road at Lotz Road. About 500 feet southwest of station No. 3 and about 11 feet higher	E–W
Canton 3	SW. ¼ SE. ¼ NE. ¼ of Sec. 12, T. 2 S., R. 8 E., 405 feet from south and 990 feet from east line of quarter section. On edge of Tonquish Creek	E–W

The glacial lake sediments abut against the Inner Defiance moraine, which makes the upland north and west of Plymouth. Presumably the lake sediments rest on ground moraine which, in turn, overlies bedrock (Antrim shale). Three wells in Plymouth have gone through the glacial deposits, logging thicknesses of 135, 148, and 239 feet. These wells were all drilled at approximately the same elevation, so that the relief of the bedrock surface is greater than the relief of the present topographic surface.

According to the geologic folio of the Detroit area,[2] the outcropping lake sediments are mainly clays and loams, with narrow bands of fine sand where the old beaches occur. The logs of the drilled wells show similar materials in large part. Fortunately, however, in some places there occur water-bearing sands and even gravels with pebbles up to one-half inch in maximum dimension. The water-bearing sands and gravels are probably deltaic deposits formed by streams draining the adjacent highlands and emptying into the glacial lakes. Fluvio-glacial deposits in the ground moraine immediately overlying the bedrock constitute another possible source of ground-water supply.

Within the city limits of Plymouth eight lines were run with the resistivity apparatus. The location of the stations for them is shown in Figure 1 (P1-P8), and the descriptions are given in the table on page 346. One of these (P1) was at a test well, and two (P1 and P7) were about 600 feet from test wells, so that it was possible to calibrate the resistivity measurements with actual well logs. In addition, three stations were occupied in Canton Township to the southeast. These are designated C1 to C3 on Figure 1. Stations C1 and C3 were also at test wells.

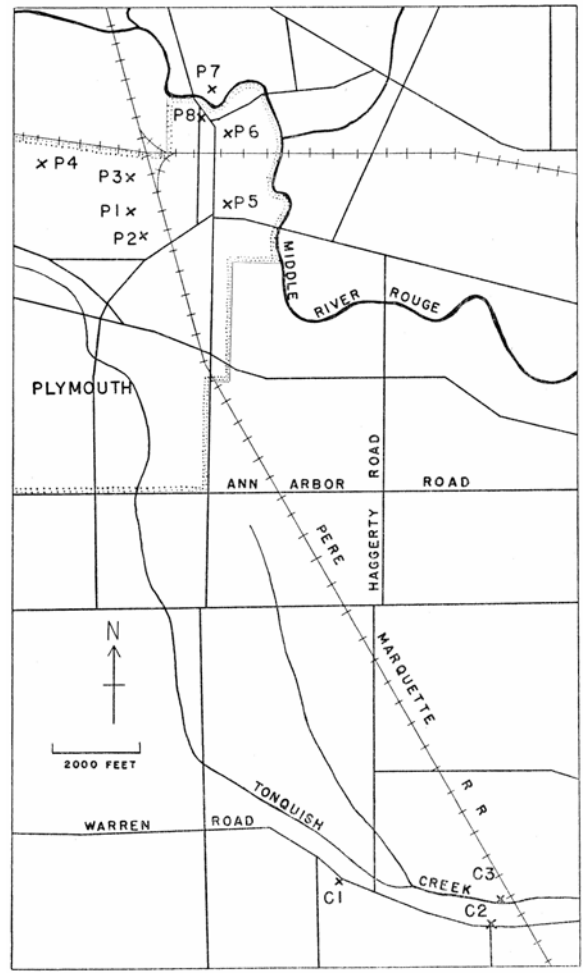


FIG. 1. Plymouth area, showing location of resistivity measurement stations

EQUIPMENT

The procedure in the earth-resistivity method is simple. An electric current is passed through the ground between two electrodes, and the resulting potential at the surface is measured between two other electrodes. For all the measurements presented here the electrodes were equally spaced along a straight line, with the outer two being the current electrodes. The arrangement is shown in Figure 2.

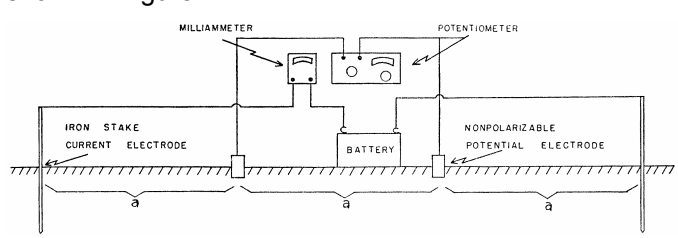


FIG. 2. Wiring diagram of resistivity apparatus

If the spacing is *a* and the ground homogeneous, the resistivity is given by the simple formula:

$$p = 2\pi a \frac{V}{I}$$

where p is the resistivity and V and I are the measured potential and current. This formula is generally used even where the ground is not homogeneous. In case the ground is not homogeneous the computed value of p is usually regarded as a rough measure of the resistivity to a depth a. Jakosky[3] notes, however, that in actual practice considerable variation exists. He has found that the vertical penetration ranges from about one fourth to one ninth of the total electrode spacing (3a). Many factors are involved in producing the potential measurements at the surface, of which electrode spacing is only one. Therefore this method should be used only where some wells are present for control.

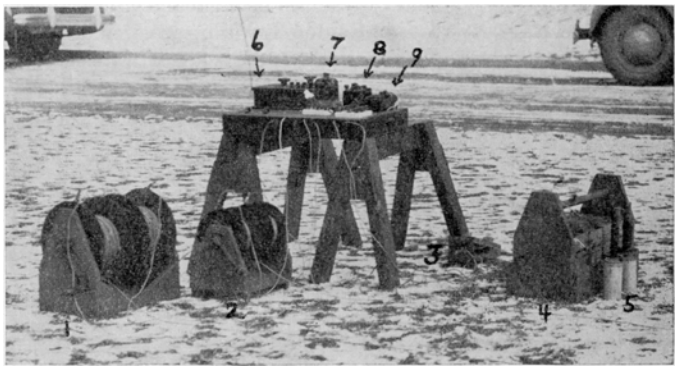


FIG. 3. The measurement apparatus
Explanations of numbers: 1, reels for current leads; 2, reels for potential leads; 3, battery foot switch; 4, battery; 5, spare nonpolarizing electrodes; 6, potentiometer; 7, standard cell; 8, potentiometer galvanometer; 9, milliammeter

A picture of the equipment used is shown in Figure 3. Nos. 1 and 2 on it are the reels for the current and potential leads, respectively. No. 3 is a battery foot switch which enables the operator to have his hands free for adjusting the apparatus on the board. No. 4 is the battery, and spare nonpolarizing electrodes are shown by No. 5. Mounted on a board set on trestles are the potentiometer (6), standard cell (7), potentiometer galvanometer (8), and milliammeter (9).

INTERPRETATION

Figures 4-7 show the resistivity graphs obtained in the Plymouth area plotted beside the logs of wells at or near the station occupied. In general, changes in the Ethology of the buried sediments produce breaks in the resistivity curves at the calculated depth a. Inconsistencies between the resistivity curves and the well logs are due to two causes: (1) Although the aquifers (water-bearing sands and gravels) have lower resistivities than the finer non-water-bearing sediments, a saturated clay may have even lower resistivity; and (2) The use of distance a as the depth figure is at best only an approximation.

Figure 4 gives the results of readings taken at the intersection of Warren and Haggerty roads in Canton Township. A well drilled at this point encountered 83 feet of clay and below it water-bearing gravel down to 105 feet. A marked break in the resistivity curve took place at electrode spacings between 60 and 80 feet. In this well the estimated depths to the top and bottom of the aquifer, based on electrode spacings, are about 20 feet less than actual depths. Obviously, in surveying outward from this well a calibration factor should be applied in calculating depths.

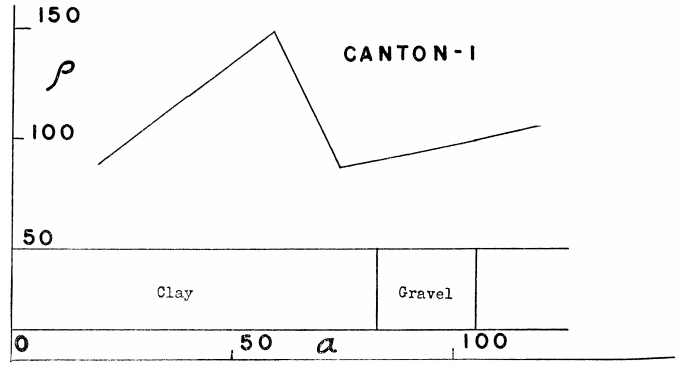


FIG. 4. Resistivity readings at Canton No. 1 plotted against log of test well

The curve obtained at Canton No. 3 station, shown by the dashed line in Figure 5, indicates increasing resistivity with depth, but with a lessening of the increase at electrode spacings between 60 and 75 feet. The main gravel bed (presumably the principal aquifer) lies between depths of 69 and 88 feet in a well drilled at this point. Again the calculated depth falls short of the real depth.

The resistivity readings obtained at the Canton No. 2 station, 500 feet distant from station No. 3, produce a more complicated curve. The resistivity shows a net increase downward, but levels off at two places, with a zone of lower resistivity between. This station was at an elevation 11 feet higher than Canton No. 3. The difference in elevation practically cancels the calibration of the depth distance suggested by the curve at station No. 3. It would seem that here the upper gravel (as well as the lower part of the overlying clay) is water-bearing, which causes the lower resistivity obtained with an electrode spacing of 60 feet. The lower gravel bed brought about the second leveling off of the curve. The spacing between this part of the curve and the higher zone of low resistivity suggests that the second gravel lies at a lower level than at Canton No. 3, probably owing to thickening of the “hardpan” layer in the intervening 500 feet.

The curve obtained at Plymouth station No. 1 coincides remarkably well with the log of the well drilled at that point (Fig. 6). At an electrode spacing of 150 feet lower resistivities were encountered. This distance coincides in the log with the top of a fine water sand. The same break was found at station No. 2, 650 feet away, and also at station No. 3, 800 feet distant. Plymouth No. 2 is southeast, and Plymouth No. 3, north, of Plymouth No. 1. However, the downward break of the curve lies at an estimated depth of 120 feet (instead of 150) at Plymouth No. 3, and at 97 feet at Plymouth No. 2. Several interpretations of this are possible. One is that the top of

the fine water sand rises to both the north and the south. Another is that the overlying quicksand and clay are saturated with water, in the lower parts at least, at Plymouth Nos. 2 and 3.

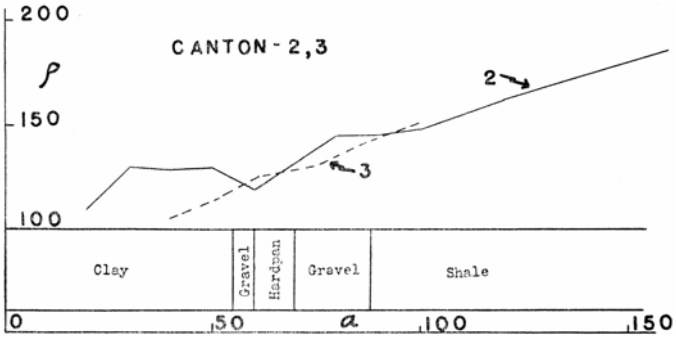
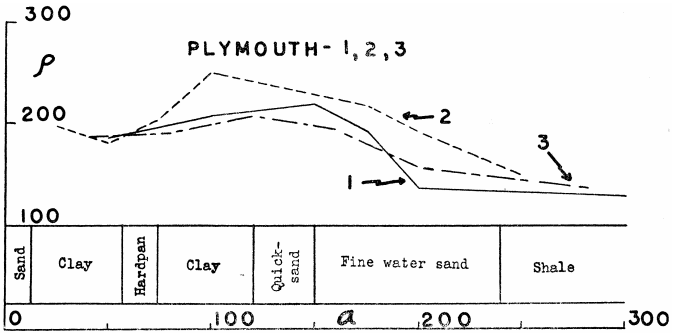


FIG. 5. Resistivity readings at Canton Nos. 2 and 3 plotted against log of well drilled at Canton No. 3



FIG, 6. Resistivity readings at Plymouth Nos. 1-3 plotted against log of test well drilled at Plymouth No. 1

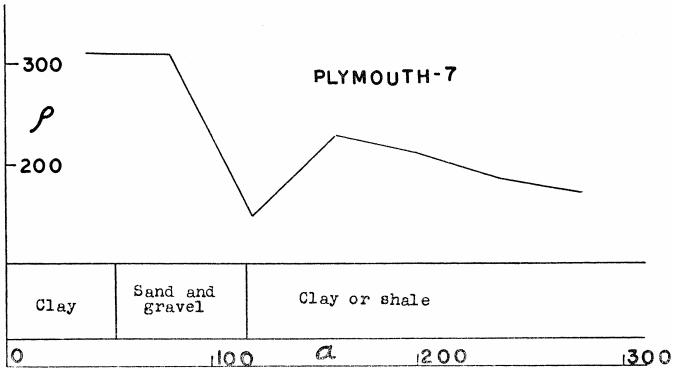


FIG. 7. Resistivity at Plymouth No. 7 plotted against log of well drilled 600 feet to south at Plymouth booster station

The most marked differences in resistivity were obtained at Plymouth No. 7 (Fig. 7). This curve breaks abruptly from exceptionally high resistivity to very low resistivity and then climbs part way back. Evidently a distinct lithologic break occurs underneath the surface in this neighborhood. The very low resistivities encountered suggest the existence of a good aquifer. Subsequent to the taking of these readings a well was drilled about 600 feet distant on the south side of Middle Rouge River on the grounds of the booster station of the Plymouth Water Works. The elevation at the well is approximately the same as that at Plymouth No. 7. The first fifty-one feet of rock was mostly clay. From there to a depth of 116 feet the sediment consists of sand and gravel, much of it coarse, which contains a large supply of water. The aquifer showed such promise that a well has been dug at the site. The capacity of this well is sufficient to make up the present deficiency in the Plymouth water supply.

RESISTIVITY DATA

Plymouth 1

a feet	*ohm/feet*
50	186
100	207
150	219
175	193
200	137
250	133
300	128

Plymouth 2

a feet	*ohm/feet*
25	199
50	182
75	204
100	250
150	227
175	219
200	193
250	151

Plymouth 3

a feet	*ohm/feet*
40	189
80	193
120	206
160	194
200	157
240	147
280	137

Plymouth 4

a feet	*ohm/feet*
40	136
80	166
120	111
160	49
200	69
240	66

Plymouth 5

a feet	*ohm/feet*
40	248
80	71
120	73
160	60
200	43
240	43
280	37

Plymouth 6

a feet	*ohm/feet*
40	111
80	121
120	107
160	87
200	47
240	81
280	89

Plymouth 7

a feet	*ohm/feet*
40	311
80	310
120	148
160	227
200	210
240	187
280	168

Plymouth 8

a feet	*ohm/feet*
40	87
80	55
120	46
160	49

Canton 1

a feet	*ohm/feet*
20	88
40	118
60	149
75	84
90	93
105	99
120	106

Canton 2

a feet	*ohm/feet*
20	159
30	179
40	177
50	179
60	166
70	181
80	194
90	195
100	198
120	212
160	236

Canton 3

a feet	*ohm/feet*
40	155
52	165
64	176
76	181
88	192
100	200

CONCLUSIONS

The writers believe that electrical-resistivity methods should be used in conjunction with the drilling of test wells in the search for ground-water supplies in the glacial drift of Michigan and elsewhere. It should be remembered at all times that this method is capable only of detecting changes in the resistivity in the buried sediments. It does not find water as such, but it can find low-resistivity layers which will bear checking with the drill. It is also possible to obtain an approximation of the depth of these rock layers of low resistivity.

The cost of a resistivity survey is relatively small. All essential apparatus can be assembled for about $250. The only additional equipment needed is a light pickup truck, but a skilled man is required to read the instruments and interpret the results. Two unskilled assistants complete the party. One such party can run from five to eight lines during the course of a day.

By the use of the resistivity method both time and money can be saved in appreciable amounts. The drill is still necessary, but in an average project the number of holes which it would be necessary to drill could be cut in half. The total cost of an average resistivity survey would not equal the cost of one drilled well.

UNIVERSITY OF MICHIGAN

[1] Jakosky, J. J., *Exploration Geophysics* (Los Angeles, California, 1940), pp. 366-370.

[2] Sherzer, W. H., *Detroit, Michigan, Folio No. 205*, U. S. Geological Survey, 1917.

[3] *Op. cit*., p. 317.

THE IROQUOIS IN AMERICAN PREHISTORY*

JAMES B. GRIFFIN

THERE are a number of approaches which can be used in determining the origin and former homeland of a given group of people. The most nearly correct reconstruction will be the one which does least violence to the data known from all of these approaches. All factors must be considered; by constant examination and testing of the various hypotheses which are put forward the less tenable ones will be eliminated and gradually a sound foundation will remain upon which to erect the most reasonable theory of the history of a people and of their culture.

The mythology, folklore, and traditions of a group such as the Iroquois may offer valuable leads, and this approach has been employed by various students of their history. These data, however, should be subjected to the most rigorous examination in order to ascertain the plausibility of origin accounts or migration legends in the light of other known data. Parker, for example, made use of material of this nature in his reconstruction of the origin of the Iroquois.[1] If there are significant references in the unwritten literature of a group to a habitat and an economy differing from those in their historical environment, clues are furnished pointing to areas where such an environment and economy are found.

A study of the ethnology of the cultural group in question will indicate that portion of their workaday life which was well adapted to their habitat and that part which offered but a poor adjustment to the necessity of obtaining a livelihood in their home area. If the tools and the everyday pursuits of a people differ fundamentally from those of neighboring groups, we are justified in seeking a reason. If it can be shown that the economy of a group like that of the Iroquois differed radically from that of their neighbors and more closely resembled the type of life practiced in another area, we are warranted in suspecting a genetic connection between the two related methods of making a living. Outstanding features of material culture such as the difference between the utility of the elm-bark canoe of the Iroquois as contrasted with the birch-bark canoe, or the presence of the blowgun among Iroquois, require an explanation in the light of distribution and probable diffusion. On the other hand, how much of the material culture of the Iroquois was shared by the non-Iroquoian tribes around them? Speaking roughly, the degree of cultural homogeneity would reflect the length of contact between two divergent linguistic groups.

In the same way that one can examine the material culture of a group, so can one study the social organization and religion, for example, and determine the degree of resemblance of the Iroquois to the neighboring Algonquian groups, in the social patterns that each tribe followed in its way of life. If there are significant differences, we are justified in seeking reasons for them.

Another method which can be utilized in studying the prehistory of a given group and its relationship to its neighbors is that of linguistics. If a group under consideration speaks a language which is markedly distinct from that of contiguous tribes, we at once look for an area where more closely related dialects are spoken and we seek to determine the degree of likeness of the geographically separated but linguistically related tongues in an effort to obtain some idea of the time in which such a divergence may have been produced. Another linguistic method analyzes the vocabulary of a given group in order to ascertain those words which indicate borrowing from surrounding tribes and, conversely, to identify the foreign words introduced to the native groups by the most recent migrants into the area. Not only may new techniques, tools, or ideas diffuse themselves but the words applied to such instruments or concepts will sometimes be adopted and reveal thereby the parent group from which the new concept was derived.

Still another approach to the understanding of the historical position of a group of people is by the study of their physical type. If they are essentially the same as their neighbors and the same as the physical remains of the precedent archaeological cultures in the area, there is no need to look elsewhere for their origin, although this does not deny that they could have come into the area from a region where the same type is also found. Minor variations from one time period to another may sometimes be explained by a knowledge of the cultural history of the group. Wholesale amalgamations and intermarriage are likely to cause definite shifts in type, especially if these practices have been of long duration.

Historical documents which have been carefully checked for their accuracy and which are substantiated by internal evidence or by complementary data offer most valuable leads toward the discernment of tribal movements during the earliest contact periods, and these in turn may provide clues to the direction of movement of the group during prehistoric times.

The primary historical method to be employed in a reconstruction of the past life of an ethnological unit is that of archaeology. Such a study must begin with the

accurate identification of the artifacts and village organization of known tribal units at specific sites. When this has been done comparative studies may be made of contemporaneous and linguistically related or unrelated groups in an effort to determine the degree of homogeneity of the material remains. If at an early historic period the group under consideration possesses an archaeological culture which is completely at variance with that of the surrounding groups in the area, we shall need explanations for these differences. If, on the other hand, there is a relatively small number of divergent elements, our task is not so difficult.

After the culture content of our test group has been ascertained for the earliest historic period, the next step is to search for sites with material of similar type but belonging to the period immediately preceding white contact in the area. Once the artifacts from such sites are studied, it is possible to correlate the early historic with the late prehistoric and to identify the new types of artifacts which were being introduced and something of the direction of the cultural drift which was interrupted by European contact. Such a careful comparative method will ultimately enable archaeologists to reconstruct the prehistoric culture of the ancestors of the group under consideration. This method must be used with caution, however, because tracing the development of a culture element or of a group of elements is not the same as tracing the genetic history of the people who had those traits at any particular moment.

So far as I am aware, Iroquois folklore and tradition have not been exhaustively studied to determine the likeness and the dissimilarity between the different Iroquoian tribal groups, and the resemblance of the Iroquois folklore and mythology to that of their neighbors. The apparent lack of any tradition among the various Iroquois units which explains their presence in the northeast as the result of group movement into the area is certainly significant with regard to the time of arrival of this linguistic stock. As Fenton has pointed out, several elements of Iroquois shamanistic society bespeak intimate acquaintance with their historic habitat, whereas that portion of their religious life which deals with the maize cycle is southern.[2]

The semisedentary villages of the Iroquois based on a maize economy certainly present a subsistence picture different from that of their Algonquian neighbors on the west, the north, and the northeast. The Iroquois agricultural-hunting economy included relatively permanent large villages, with a social structure highlighted by the matrilineal household unit within the clan and by the possession of two moieties. The Iroquois tribal organization was of a high order, and the conceptual framework of the “League" was a still further advance. Much of this sociopolitical organization is at marked variance with the Algonquian tribes to the north and west and, to a somewhat less degree, with the bordering Algonquian groups to the east and south.[3] The southern New England groups had fairly permanent villages with elaborate stockades and rectangular houses, as well as wigwams.[4] The Iroquois village life and house structures also resemble those of the tribes in the Middle Atlantic states.[5]

The recent picture presented by Butler of the aboriginal village pattern in southwestern Pennsylvania at approximately the 1550-1650 period[6] and that of the Fort Ancient group in southern Ohio are also similar.[7] The type of food production among all these groups was very much the same. The presence, however, of the Iroquois as the northernmost dominantly agricultural groups brings up an interesting point concerning the time period at which either the Iroquois brought the corn to the north or the corn was brought to the Iroquois, who successfully cultivated it. According to some of our best authorities, it must have taken several centuries to produce a corn strain which would mature sufficiently rapidly to make possible its cultivation as far north as Lake Simcoe and Quebec.[8] If, then, the Huron and related Iroquois were growing corn in the sixteenth century near the border of the Laurentian Upland, a reasonably long period must have elapsed during its adaptation to the shorter growing season. We may also assume that the Iroquoian tribes had known the use of corn for some time, owing to its importance as a basic food supply and to its intimate position in their material culture and their social and religious life.

In a recent analytical study of the Coastal Algonquian groups from northern New England to Virginia Dr. Regina Flannery points out that the tribes of the Middle Atlantic area particularly have a distinctive number of traits which can be attributed to the southeast,[9] and that, though some of them are shared with the Iroquois, there is no reason to believe they were derived from the Iroquois. On the other hand, there are definite traits among the Coastal Algonquian dealing with political organization and warfare which may properly be attributed to Iroquois influence. She notes that this trait-trading was by no means a one-way transaction. Her data present a picture somewhat different from the one now current, since it does not indicate that the Iroquois were as distinctive culturally in the northeast as they are thought to have been. Dr. Flannery's paper was written, however, with particular emphasis on the Algonquian, and a sound comparative historical treatment of Iroquoian ethno-history would be a distinct aid in an understanding of northeastern Indian cultures.

The political and martial strength of the Iroquois, together with their fortunate but accidental position as a buffer group and a trading front for the Dutch and English, enabled them to maintain their solidarity while other aboriginal tribes were being broken and having their society destroyed by settlers, soldiers, and epidemics. For a time they were a favored nation of British diplomacy, and they occupied this relatively desirable position until the Revolutionary War, when they bore the brunt of such forays into central New York as that of General Sullivan. Their tribes and their culture thus received more sympathetic treatment at the hands of contemporary English observers, and by the time the

people of the new American nation had ceased hostilities there were a sufficient number of Iroquois available in the United States and Canada to preserve a considerable number of the concepts and part of the content of their life. Some of our outstanding students of American anthropology have devoted much of their time to Iroquoian research,[10] and their work has furnished us with valuable material; but at the same time it emphasizes too much, in my opinion, the superiority of the Iroquois over some of the other groups in the northeast and even over the tribes in the Ohio and upper Mississippi valleys. In a European's eyes, the character of the Indian tribes during the eighteenth century depended on whose side they were fighting. The Iroquois are none too well thought of historically in the Middle West.[11]

I have already mentioned the political and martial strength of the Iroquois, but this seems historically to have been limited to the Five Nations at a particular moment of time and was strongly aided by international developments. On the other hand, there can be little doubt of the uniqueness in the northeast of the Iroquois social structure which was held more or less in common among all the northern Iroquois tribes. This fact alone, without the supporting historical evidence, would suggest a greater age for the social organization as contrasted with the political structure of the Five Nations.

So far as I know, no thorough study of the various Iroquois dialects has been produced with the view of reconstructing a primitive Iroquois tongue which could be compared with Cherokee to arrive at a proto-Cherokee-Iroquois language. It is sufficient to recall here that the Iroquois in the New York-Canadian area had differentiated into a number of distinct dialects, and that the Cherokee in the south had diverged into three. This would not only argue for a reasonably long period for such divergences in the north, but would also ask for a much longer time for the separation of the northern Iroquois from the Cherokee. As for the linguistic relationship between Iroquois and Caddoan, it can only be said here that it is so remote as to be of little or no significance in a reconstruction of the relatively recent migrations and cultural connections of the Iroquoian peoples.[12] It is quite evident, however, that the Iroquois language has no genetic connection with the Algonquian language, and the position of this Iroquois island in a sea of Algonquian requires a historical explanation.

The physical anthropologists have yet to propose a consistent and well-rounded interpretation of the significance of the physical types in the northeast with regard to known chronological and cultural differences. A beginning in this direction has been made by Georg Neumann of Indiana University, who has adopted the nonlinguistic and noncultural term “Sylvid” to apply to the physical type Hrdlička called “Algonkin” and to Dixon's “Proto-Negroid” and “Proto-Australoid.” In New York and in New England there is a definite tendency among the long-headed Sylvid groups, which includes both Iroquois and some Algonquians, toward a lower cranial vault, a lower face, and a broader nose. The Hurons and the Younge site people in eastern Michigan have this same physical type, which has been called the “Younge type.” The Sylvid subtype in the northern Mississippi Valley area, called the “Gooden type,” has a slightly shorter cranial length. The vault is much higher, the face is longer, and it has a narrow nose. The third subtype of the Sylvid race is the shell-midden people, called the “Indian Knoll type,” whose vault proportions have a tendency to approximate those of the western Sylvids, but whose facial proportions more closely approach those of the eastern group. These people differ from both of the other subtypes since they have smaller absolute dimensions.

The evidence for the physical type of the Lamoka Focus, on the basis of published data, is by no means clear. It may be rather closely related to the western Sylvids, such as the Delaware and the people from the Maine shell heaps, and does not offer a progenitor for the eastern Sylvids, to whom the Iroquois and many New England Algonquians belong. On the basis of published evidence, the Vine Valley and Laurentian sites apparently have a continuance of the earlier population, with normal variation or group intrusion represented by a round-headed element which also appears as far north as Newfoundland.[13] In other words, the Iroquois, as well as a strong element of New England Indians, represent a physical type somewhat different from that of their known predecessors in the northeast, and there is little evidence available for wider comparisons. There is also no physical group in the southeast which compares closely with the eastern Sylvid subtype to which the Iroquois belong. That such a group may turn up is, of course, not beyond the realm of possibility.

It is highly important to realize that the Iroquois cannot be derived physically from the Indian stock which is most closely connected with the development and spread of the Middle Mississippi Phase. If the Iroquois were in the southeast or the Mississippi Valley, they must have left before the Middle Mississippi period began. In the Fort Ancient Aspect there is a very small proportion of the eastern Sylvid type, but the dominant types belong with the western Sylvids and the Centralids. The latter are usually associated with the Middle Mississippi cultures. Thus on the basis of physical type alone we can hardly look to Fort Ancient to furnish the ancestors of the Iroquois.

We are truly fortunate in having a large body of historical data dealing with the location of the Iroquois in the early historic period.[14] Our earliest records point to the presence of Iroquois parties in 1534 at the mouth of the St. Lawrence, and slightly subsequent ones indicate their strong position around Montreal and Quebec. Our next accurate information is at the beginning of the seventeenth century, when we find that, though the Iroquois in the lower and middle St. Lawrence Valley have evacuated the area and presumably moved south, the Huron, Tobacco, and Neutral nations were occupying their historic seats and were populous and

prosperous groups. The Hurons, indeed, referred to their former villages dating back to about 1400.[15] By 1600 the Susquehannock were firmly established in the Susquehanna Valley in Pennsylvania and the Cherokee were, of course, already differentiated in the southern Appalachians. The primary fact ascertainable from this early period is the extent of the Iroquoian occupation, so that a reasonable length of time must be allowed for it to have taken place. The stories related by Perrot[16] telling of the Iroquois having been driven by the Algonquian from their middle St. Lawrence Valley home into New York, which were copied by Colden[17] without giving credit, are substantiated by archaeological findings, as are the historic documents relating to the presence of Iroquois at the mouth of the St. Lawrence. In this regard history, legend, and archaeology coincide.

For many years archaeological excavations in the northeast have indicated that the Iroquois possessed certain distinctive material culture traits which served to differentiate them not only from their contemporary Algonquian neighbors but also from a number of prehistoric culture groups which are found in the same area. In an effort to explain the known data on Iroquois culture, particularly those with reference to archaeology, Parker[18] formulated a hypothesis, published in 1916, suggesting a route by which the Iroquois might have migrated into the northeast. In this paper he took issue with a prevalent concept of a northern origin of all Iroquoian tribes. He advocated the theory that the former home of all the Iroquoian-speaking peoples was in the middle Mississippi Valley, where they were in contact with the Caddoan and Siouan peoples. The Cherokee were the first to start east up the Ohio, where they found the “Mound Builders.” These native Ohioans, said Parker, were eventually conquered, and some of their objects were ceremonially destroyed. In this he was following Mills' attempt to explain certain Hopewellian mutilated objects and ceremonial caches which contained intentionally destroyed artifacts.[19] Here Parker evidently meant to call the Fort Ancient people of Mills prehistoric Cherokee. After the assumed Cherokee movement the northern Iroquois arrived in the middle Ohio Valley from its mouth, and a conflict arose between the Cherokee and the proto-Iroquois. The two linguistic relatives then diverged, with the Cherokee going south and the proto-Iroquois going north, where they split into two groups. One of these traveled north around Lake Erie and became the Huron-Mohawk; those who moved east along the south shore of Lake Erie became the Seneca-Erie and Susquehannock. Parker published substantially this same argument in “The Archaeological History of New York.”[20]

In 1926 Parker modified his migration hypothesis to take into account additional information which seemed to bear on the problem of the archaeological connections of the Iroquois.[21] In this statement he moved some of the Iroquois up the Mississippi and thence overland toward Lake Erie. In *The Fort Ancient Aspect* I have discussed this hypothesis at some length and suggested that the new interpretation given Parker's data calls for a different formulation.[22]

It must be emphasized that Parker's hypotheses were the result of an endeavor to explain the known data in terms of a consistent and unified migration story and as such have offered a firm foundation upon which to conduct further research. It is the only intelligible attempt to offer an explanation for the anomalous position of the Iroquois in the northeast, although others have had the same feeling for a southern origin of the Iroquois.[23]

Leaving the theoretical discussion for a moment, we can examine the archaeological materials from the Iroquoian sites and areas to determine the homogeneity of Iroquoian artifacts, first within the confines of known tribal sites, then between closely related tribes, and finally between historic tribal sites and those which go back into the protohistoric and prehistoric periods. When this has been done — and only when it has been done — can we speak with any assurance of the archaeological groupings into which the various Iroquois tribal units will fall. It will, indeed, be somewhat surprising if Ritchie's present alignment of one tribe per focus stands the test of comparative analysis.[24] Such an analysis needs to be made before we can accurately compare Iroquoian units, and Iroquoian archaeological culture as a whole, with contemporary contiguous nations or earlier cultures in the New York-Ontario and surrounding areas. In the discussion on the relationship of Fort Ancient to Iroquois, which I have mentioned earlier, I made a rough beginning in this direction and attempted to specify some of the resemblances and differences between those two distinctive cultural groups.

Parker, Wintemberg, Skinner, and Harrington have all recognized an archaeological cleavage between the Mohawk-Oneida-Onondaga on the east and north and the Seneca-Erie on the west. This separation, although relatively insignificant when one is viewing northeastern archaeology as a whole, is very important in studying the interrelationships of the Iroquoian units and the connection between those units and surrounding groups. It will be possible to characterize clearly the different focal groupings of the Iroquois and isolate those traits which the Iroquois exclusively possessed. It is my impression that this list of so-called diagnostic traits will be relatively small. In my own opinion such traits, though interesting and valuable, are in some ways rather a side issue in archaeological research, for our proper aim is the recovery of the total complex of the group to be studied, and this total complex must be compared with other artifact assemblages equally complete in order to determine the true connection between groups. The diagnostic trait of today turns out to be the link trait of tomorrow.

A comparison of the available archaeological data indicates that there are indeed many similarities between Fort Ancient and the Iroquois, but there are also important differences which make it impossible to

confuse a representative assemblage from sites of both cultures.[25] This is true of all types of the artifacts recovered. Many of the resemblances are of such a general nature that they are of little use in separating Fort Ancient and Iroquois from contemporary contiguous groups, and there are very few, if any, traits which can be said to have been possessed by Fort Ancient and Iroquois alone. Wherever specific Fort Ancient and Mississippi-Ohio Valley traits are found in the Iroquois country they are almost invariably from protohistoric or historic sites. In a number of elements there is as much connection between the Iroquois and their Algonquian neighbors as there is between Fort Ancient and Iroquois. All the archaeological evidence as it is interpreted at present indicates that Fort Ancient was contemporaneous with the Iroquois occupation of between, say, 1500 and 1700. There is a strong probability that the Fort Ancient culture was interrupted by those forces which sent the Iroquois raiding into the Ohio Valley and which concentrated the tribes of that area around either the French trading posts in the Illinois country or the English posts across the Appalachians.

We know from the archaeological evidence that Iroquoian type material is restricted to the area in which the historic Iroquois groups were located, and there is thus no area of which we can say: "Here is the prehistoric material that represents the culture that developed into Iroquois." Those archaeological assemblages formerly interpreted as offering a possible prehistoric Iroquois culture are now believed to be contemporaneous with the Iroquois occupation of the lower Great Lakes.

Many of the Iroquois traits were derived from the southeast,[26] but they did not come *en masse*. A number of them were obtained after the contact period. This does not apply to corn, which is certainly as old as the Hopewellian period and perhaps goes back into the Adena-Vine Valley period. Are there no indications in New York in the artifacts and the pottery of the late Laurentian and Vine Valley cultures that would point toward the traits found in Iroquoian? Must we look entirely in the southern Ontario area for the developmental phases of Iroquois? Is there any suggestion in the physical type associated with the New York cultures of the middle period which would help in the recognition of early Iroquois? Is the Owasco material earlier than or contemporary with Iroquois? If it is earlier, we should find definite examples of stratigraphy; and if contemporary, we should find definite examples of trade objects and not merely speak of "influences" from one group to the other when they must have been in close geographical proximity.

Let us now examine some of the material and sites which furnish suggestions of Iroquoian origins.

At the Reeve site the dominant surface finish is cord-marked.[27] Some of this continues up to the lip, but the area where decoration was placed on the outer rim was usually smoothed. The most common tempering material is crushed rock, but a minor percentage is crushed shell. This site has a minimum of the Woodland elements in pottery and other artifacts to be found in the Whittlesey Focus. The same thing is true of the Fairport Harbor site and, as indicated by Morgan and Ellis, these two sites have a great deal in common.[28] In them the Woodland tradition is most strongly represented in the pottery of the Fairport Harbor site, even though trade material was found there and was absent at Reeve.

The Tuttle Hill and South Park sites have a high degree of cohesion within the Whittlesey Focus which sets them apart from Reeve and Fairport Harbor.[29] This difference in culture content is entirely in the direction of Woodland, with a significant use of dentate-stamp decoration on the rim. The same situation holds true for the Taylor site in the same area; in a forthcoming report on the pottery from it a more detailed statement will be made regarding these ceramic affiliations.[30] It is suggested that there is discernible in the northern Ohio area a gradual transition from a Woodland pottery complex into an Iroquoian complex and that the transition took place near the close of the Hopewellian chronological period.

In the eastern Mohawk-Onondaga sites the pottery still carries the Woodland traits of check-stamp surface finish and dentate-stamp rim decoration. This is particularly significant, for the center of check-stamp concentration is in the Atlantic drainage of the southeast and the adjacent Gulf coast area. It is also an early surface finish in the area and is associated with the early Woodland cultures of the southeast.

Though Wintemberg noted the resemblance of the culture of the Uren site in southern Ontario to Woodland, he inclined to the view that it was attributable to contact with neighboring Algonquian groups. He considered that the Uren site represented an early prehistoric Neutral group,[31] in which he was probably correct. It is also possible to regard the Uren pottery as a transitional stage between Woodland and Iroquoian. The shape, temper, overall surface treatment by brushing, cord-wrapped paddle, and check stamp, and many elements of the decoration are Woodland in type. The decoration is confined to the rim area, and cord-wrapped stick impressions are found on both the inner and the outer rim surfaces. Linear-punctate lines (called "interrupted lines" by Wintemberg[32]), cord-impressed designs, and rim bosses are other significant Woodland features. On the other hand, a strong proportion of the Uren pottery suggests Iroquoian treatment, and though some of the results resemble patterns occurring in the Whittlesey Focus,[33] others are identical with a grit-tempered pottery type from southwestern New York.

Another site of the focus to which Uren belongs was excavated in 1938 by Philleo Nash. In a brief preliminary report he has emphasized some of the Woodland features.[34]

The dominant pottery type at Uren is almost duplicated at a site in southwestern New York near the Pennsylvania line which was excavated by Ross Pier Wright of Erie.[35] This Westfield site also had a pottery

type derived from the Keyser Cord-marked type of the Monongahela Woodland division.[36] It is a shell-tempered ware whose basic jar shape is not essentially different from the Uren and can be regarded as having been derived from Woodland jars. The Westfield shell-tempered pottery is predominantly cord-marked on the body and, when decorated, has an incised rectilinear pattern on the outer rim. The style of decoration is not only related to Iroquoian but is also connected with the Feurt Incised type of the Fort Ancient Aspect.[37] Though there is some evidence of contemporaneity of these two types at Westfield, I believe that the Uren-like type was in use before the shell-tempered ware appeared and that it was not made during the later years of the occupation of the Westfield site. Neither of the Westfield pottery types is typical of the Whittlesey Focus to the west or of the pottery of Ritchie's suggested Seneca Focus.[38]

Quimby has briefly discussed the appearance of Hopewellian pottery in the Saginaw Bay area of eastern Michigan.[39] It is of the Ogden-Fettie-Goodall style of dentate stamping, which is not characteristic of the Ohio Hopewellian pottery. The dentate-stamped designs on the exterior of Iroquoian pottery rims is closely related to this western Hopewell style. Still another possible connection between Iroquoian pottery and that of the earlier Hopewellian horizon can be seen in the small specialized, highly ornamented jars sometimes called "typical Hopewell vessels." The basic shape of many of these jars[40] is not only related to a widespread Woodland cord-marked shape, but is also very much the same as the basic Iroquois shape.[41] One of the essential features of the better Hopewell pottery is the rim area, which is marked by a short vertical upper rim rising from the flaring lower rim. This concept is identical with that on Iroquois vessels. On the rim in both Hopewell and Iroquois there are incised designs. On the former vessels the incisions are almost always fine lines, closely spaced and usually crosshatched. The Iroquois incisions are generally medium-wide, and though they are predominantly oblique, they are rarely crosshatched. The incised Hopewell rim is almost always accompanied by a horizontal row of hemiconical punctates at its lower margin. These punctates are usually oriented horizontally. Many Iroquois rims also have a lower horizontal border of punctates or gashes, but these impressions are usually vertically placed. The most difficult point in this suggested transition or influence is the almost complete absence of body decoration on Iroquois vessels, but the suggested Hopewell prototype normally has the major decoration on that area.

This ceramic development is analogous to that which apparently took place in the middle Missouri Valley in the shift from Woodland to Upper Republican. I have elsewhere suggested that the developed rim of Upper Republican was derived from concepts present in the eastern Plains area during the Hopewell-Woodland period.[42] Thus the similarities noted between Upper Republican and Iroquoian may be explained on the basis of both having developed in their respective areas from similar influences which preceded them. This alternative is offered to the explanation that those resemblances are the result of a migration of Caddoan and Iroquoian groups from an unnamed cultural unit somewhere in the middle Mississippi Valley.[43]

Some sixty years ago L. H. Morgan attempted to explain a number of the earthworks of the Hopewell sites in Ohio as substructures for long communal dwellings of the general type prevalent among the Iroquois and eastern Algonquian tribes.[44] He observed that the height and shape of the geometric earthwork enclosures, together with the height of the dwelling, would make of it an admirable defensive structure. He further argued that this defensive principle was common to all house types associated with the type of economy and social pattern that must have been in existence among the "Mound Builders." Some of the possible objections to these theories of Morgan have already been given by Fowke.[45] The latter's sensible suggestions regarding the systematic excavation of these earthworks have never been adequately carried out. The closest approach was the partial excavation of the Turner site, which was completed after Morgan's paper was published and which indicated that portions of the earthworks may have covered dwellings erected upon the natural surface of the ground.[46]

In any event the contention that the type of economy and the social pattern implied by these earthworks were analogous to those among the Iroquois is accepted by all students of the eastern United States aborigines. In spite of the fact that American anthropologists in general have been labeled as belonging to a "historical school," very little attempt has been made in the past to provide a historical (archaeological) explanation of the development of the contemporary Indian cultures.

The archaeological stage or cultural period which apparently immediately preceded the development of Iroquois material culture was that which has been known for some time as the Hopewellian Phase. This rather general cultural aggregate was widespread in the Mississippi Valley from the Gulf of Mexico to Minnesota and from the Plains to the Appalachians.[47] It is unlikely that a single tribal group or even a single linguistic stock is responsible for this development and diffusion of the Hopewellian culture complex. Factors contributing to this opinion are the variation in physical type in different areas, the distinctive local foci and even larger groupings which are recognized, and the small size and character of the most distinctive Hopewell artifacts, which make them easy to transport by a few individuals. Indeed, it is probable that the majority of the linguistic stocks in the eastern United States at the period of colonization had ancestors in the area who had participated in the Hopewellian culture.

If the progenitors of the Iroquois did not partake of the Hopewellian complex, they must have been either along the eastern seaboard or already in their historic habitat, where they would have been a northern marginal group. This would help to explain the postulated Hopewellian survivals in some of the Iroquoian material culture traits.

These survivals might also be explained as carry-overs from the period when the Iroquois tribes themselves were Hopewellian. The social and economic organization of the Iroquois and the large amount of territory they occupied suggest, as Parker and others have recognized, that the Iroquois probably moved into their historic habitat from the south. The primary error of the earlier hypotheses has been the failure to correlate the time at which this movement might have occurred with the archaeological culture horizon which was in existence at the time the movement could have occurred.

The archaeological program for the future calls for an intensive search for sites in the eastern Great Lakes and St. Lawrence areas which give evidence of earlier and still earlier Iroquois habitations. With a few happy exceptions sites of this type have not been excavated. If such investigations continue to reveal a culture complex which is basically Woodland with additional Hopewellian characteristics, we can then reexamine with more confidence the various Hopewellian centers in an effort to determine with some exactitude whether any of them provides a possible ancestral area for the Iroquois in that archaeological period or whether we must conclude that the Iroquois were already far to the north by approximately 1200 A.D.

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* The bulk of this paper was read in May, 1941, at the annual meeting of the New York Archaeological Society in Rochester, New York.

[1] Parker, 1916, pp. 482-483. Even if the "tree with the long sword-like leaves" is the "palm tree," it would not suggest a former Iroquoian homeland in the Middle Mississippi area but would point toward Florida.

[2] Fenton, 1940, p. 165.

[3] Speck, 1920, p. 66.

[4] Willoughby, 1935, pp. 228-301.

[5] Morgan, 1881, pp. 67, 115-119.

[6] Butler, 1939.

[7] Griffin, 1943.

[8] Jones, Volney H., personal communication.

[9] Flannery, 1939.

[10] Fenton, 1940, pp. 160-164.

[11] Kellogg, 1925.

[12] Griffin, 1943, p. 228.

[13] Ritchie, 1943, p. 314.

[14] Fenton, 1940.

[15] Kinietz, 1940, p. 59.

[16] Blair, 1911, 1: 42-47.

[17] Colden, 1904, pp. 4-6.

[18] Parker, 1916, pp. 483-484.

[19] Griffin, 1943, pp. 220-221.

[20] Parker, 1922.

[21] Parker, 1926, pp. 17-19.

[22] Griffin, 1943, pp. 223-239.

[23] Boas, 1910; Speck, 1920, p. 66, n. 23.

[24] Ritchie, 1936, p. 4.

[25] Griffin, *op. cit*., 1943.

[26] W. R. Wedel is the authority for the statement that the Iroquois style pottery, mentioned by Holmes (1903, p. 105) as from southwestern Alabama, is actually from New York State.

[27] Greenman, 1935, p. 25.

[28] Morgan and Ellis, 1943, p. 52.

[29] *Ibid*., p. 51.

[30] Excavation by E. F. Greenman for the Ohio State Museum. This pottery is being studied in the Ceramic Repository at the University of Michigan.

[31] Wintemberg, 1928, p. 50.

[32] *Op. cit.*, p. 20,

[33] Greenman, 1937, p. 350.

[34] Nash, 1939, p. 74-75.

[35] Personal examination of the collection at Mr. Wright's home in Erie and of a large collection of sherds presented by him to the Ceramic Repository for the Eastern United States.

[36] Manson, MacCord, and Griffin, pp. 375-418 in this volume.

[37] Griffin, 1943, pp. 78-80.

[38] Ritchie, 1936, p. 4.

[39] Quimby, 1941, pp. 132-135.

[40] For examples of these shapes see Quimby, 1941; Griffin and Morgan, 1941.

[41] Parker, 1907 and 1922; Bailey, 1938.

[42] Griffin, item 12 in Bibliography.

[43] Parker, 1922.

[44] Morgan, 1881, pp. 199-221.

[45] Fowke, 1902, pp. 154-155.

[46] Willoughby and Hooton, 1922, p. 10.

[47] Griffin, item 12 in Bibliography.

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THE CULTURE OF THE KEYSER FARM SITE

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INTRODUCTION

IN 1890 Gerard Fowke conducted archaeological investigations in the Shenandoah Valley for the United States National Museum, and in his report[1] he mentioned the existence of several burial caves and mounds in the valley of the South Fork of the Shenandoah River. This early work prompted Manson and MacCord to relocate and further identify these sites, and to search for new ones. They succeeded in finding a heretofore unrecorded burial cave, which was excavated. While trying to correlate this cave with adjacent cultures, they discovered a large village site about one-half mile distant, on the South Fork of the Shenandoah River between Luray and Front Royal, at the foot of Massanutten Mountain (Fig. 1).

TOPOGRAPHIC FEATURES

The Shenandoah River, entering the Potomac at Harper's Ferry, West Virginia, drains a large area in western Virginia and eastern West Virginia. About thirty-five miles from its mouth the river divides into the North and South forks. The North Fork runs between the Massanutten and Shenandoah Mountains from Harrisonburg northward to the junction of the forks at Riverton, just north of Front Royal. The South Fork drains the area between Waynesboro and Front Royal, meandering between the Massanutten and Blue Ridge Mountains and forming the famous Page Valley.

On practically every stretch of bottom land not silted or entirely eroded away traces of aboriginal occupation may be found. On hillsides there are numerous caves and rock shelters, almost all of which show use by the Indians as either shelters or burial places, while on hilltops and spurs of the mountains there are occasional

mounds and rock graves (cairns), most of which have been destroyed by casual investigation.

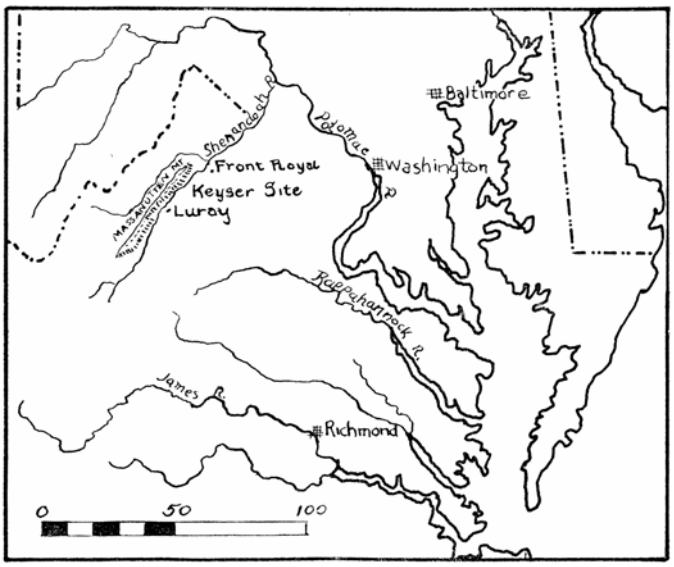

FIG. 1. Location of the Keyser farm site

The Keyser site, which, incidentally, derives its name from the. original settler, is located on one of the higher reaches of bottom land on the right (or west) bank, which is subject to flooding only at extremely high water (Pl. I, Figs. 1-2). It is well back from the river, and is separated from it by a ravine and a high sandy ridge. During the unusually high water of 1924 the site was completely buried Fig. 2. Horizontal placement diagrams of Keyser farm site under from four to six feet of silt, which entirely hid every vestige of occupancy. In 1936 the river undid its concealing work of 1924 and left the site in its original condition. In the three years following the latter flood, plowing and the erosive action of the wind and rain further lowered the surface, exposing many pits and burials. It was the profusion of village refuse thereby uncovered that convinced the writers of the value of the site.[2]

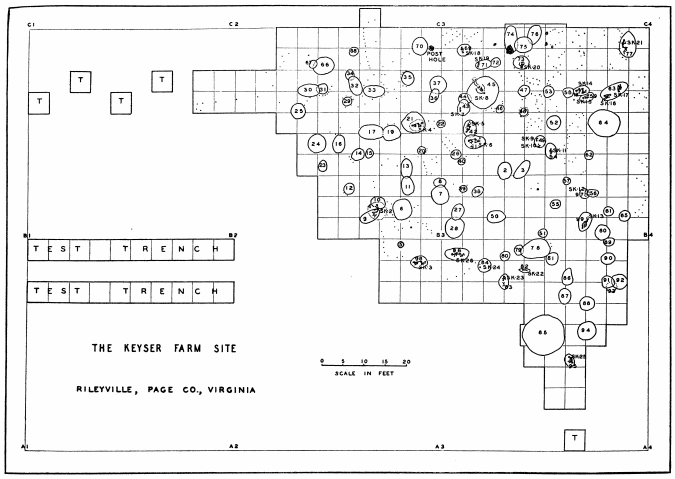

FIG. 2. Horizontal placement diagrams of Keyser farm site

At present the site is about 550 feet from the river's edge and is between 13 and 15 feet above normal river level. In the direction opposite the river is a low range of precipitous hills, at the foot of which lies an extremely marshy area, fed by many springs, which issue from the hills at their bases. These springs were undoubtedly the nearest source of potable water for the Indians, and are still in use locally.

EXCAVATION TECHNIQUE

After having secured permission to excavate the writers proceeded to establish a bench mark and a datum plane, and the area to be explored in one season was divided into fifty-foot squares. These squares, or sections, were subdivided into five-foot squares to facilitate digging (Fig. 2).

At the southern and eastern extremities of the occupied area staggered alternate test trenches were run until pits or post molds were encountered. At this point stripping of every five-foot square began. Topsoil was removed by shoveling to the depth of the plow-line. Material found in the topsoil was labeled “surface.” The subsoil at the plowline was light yellow sand, and in most places clearly revealed the darker outlines of pits and post molds. Where these features were not met at the plowline, the subsoil was removed to a depth of two feet. Several pits were under a foot or more of sterile sand, but as a rule the outlines emerged very close to the plowline.

Stripping was done in five-foot units except when it was necessary to remove additional squares to expose completely some particular feature. Each pit or other disturbance was entirely uncovered horizontally and triangulated from corner stakes for permanent records before being further developed so as to extract all possible meanings and relationships (Pl. I, Fig. 3). The pits were then cut into from one side to ascertain the shape for a vertical section, and to show stratification, if any was present. Wherever possible, the vertical section was made along the east-west line, the pit being entered from the south to ensure proper light for photographing. The data determined were recorded in the field notes, and sketches and photographs were made whenever they were deemed necessary for the record.[3]

ARCHAEOLOGICAL FEATURES

In ten or more instances layers of refuse from three to eight inches thick were found immediately under the plowline and directly over one or more pits. These layers, although usually found in the subsoil beneath the stratum, were distinguishable by the blackness of the soil, their lenslike character, the presence of artifacts and refuse, and the absence of post molds or outlines of pits. Since no definite outlines could be determined, each layer was carefully troweled through, and the material was kept separate from the underlying pit or pits. The layers showed no line of demarcation between themselves and the pits underneath. The first of these phenomena discovered was not recognized immediately and was thought to be a shallow pit with indistinct

outlines, and for this reason was given a number ("Pit 4"). This layer was lenslike and contained a burial, skeleton 2. Later it was found that beneath the layer were the outlines of two very clear-cut pits, numbered 9 and 10 on the plan. In all other examples material recovered from the layers was given a number made up of the numbers of the two underlying pits, e.g. $\frac{\text{P 41–42}}{\text{B 2}}$. In several places there were no pits under the layers, in which case the material was numbered for the square and section in which it occurred, e.g. $\frac{70}{\text{B 3}}$. There are no apparent differences between the material from the refuse layers and the pits under the layers. The exact origin of these layers is not known, but it is surmised that they represent the accumulation of debris and refuse in the depressions and cavities that follow the settling of the organic material of previously filled pits.

The predominant horizontal shape of the pits was circular, and they ranged from 2 to 9 feet in diameter, with the average close to 3 feet. These constituted 64 per cent of the total, whereas elliptical pits comprised 30 per cent. The remaining 6 per cent were pear-shaped or irregular. Considerable variation existed in the shape of the pits as seen in vertical section. They ranged from (1) hemispherical to (2) straight-sided and straight-bottomed to (3) bell-shaped, with every possible combination of the three. The depth varied from 0.4 foot to 5.2 feet; the average was about 3.5 feet. A summary of the pits is given in Table I (pages 380-385).

In many places pits were found which overlapped, a superposition which was very nearly akin to stratification, since it indicated a lapse of time between the periods when the pits were open and being used. It is self-evident that two pits could not occupy the same piece of ground at the same time, so that it is equally self-evident that one pit was dug after an earlier one had been filled. This was further confirmed by the outlines of several of the later pits that were found complete, but the earlier outlines were broken by the excavation for a second pit. Comparison of material from one of these pairs of pits showed no noticeable differences. (For pottery analysis of Pits 11 and 13 see page 402.)

In addition to the feature noted above, there were a number of pits entirely or partly surrounded by post molds. Whether these represented a rooflike structure over the pit or a fencelike row of pickets around it to keep out scavenging animals was not determinable. Similar vertical post molds were found at the Montague site, Somerset County, Pennsylvania,[4] and at Fort Hill, Somerset County, Pennsylvania.[5] This concentric arc of postholes partially surrounded Pits 29, 31, 33, 35, 73, and 77. Pit 48 was entirely surrounded by 15 postholes regularly spaced at intervals of 0.6 foot. This pit was 2 feet in diameter, 2.4 feet in depth, and had a rounded bottom and sloping sides. It contained refuse bone, 35 sherds, several fragments of bone artifacts, and a pipestem fragment. At the bottom was a layer of irregular waterworn pebbles 0.3 foot thick.

In Pit 85, the only one with definite stratification, two distinct layers of cultural material were separated by nearly two feet of sterile sand. This pit was 9 feet in diameter, 4.9 feet deep, and had a straight bottom with sides sloping inward from top to bottom. Immediately below the topsoil was a saucer-shaped layer of heavy black soil with a thick bark layer separating it from the remainder of the pit (Pl. II, Fig. 1). This stratum contained refuse bone, shells, 1.67 sherds, one broken arrowhead, two fragments of beamers and many chips and spalls, besides much organic material. Below this deposit was a two-foot layer of sand, containing a few flint and jasper chips. The layer was banded, probably indicating a lapse of some time after the deposition of each band. At 3.6 feet below the top of the pit was a 0.3-inch layer of cultural material extending 1.5 feet up the sides of the pit. This stratum contained bone fragments intermingled with 149 sherds, one bone awl, one beamer, and several fragments of other bone artifacts, including parts of an antler celt and a bone chisel. The percentage of grit-tempered pottery was greater from the bottom layer of Pit 85 than from the site as a whole, indicating that possibly the grit-tempered ware was older than the predominant shell-tempered ware.

TABLE I

THE PITS AT THE KEYSER FARM SITES

Pit No.	Diameter in feet	Horizontal shape	Depth in feet	Vertical shape	Probable use	Remarks
1	3.0 × 3.0	Round	2.6	Rounded sides and bottom	Undetermined	
2	4.0 × 4.0	Round	3.1	Rounded sides and bottom	Undetermined	
3	5.0 × 3.1	Oval	3.2	Rounded sides and flat bottom	Undetermined	
4	Undetermined	Undetermined	0.4	Lens	Shallow pit or refuse layer that intrudes slightly into Pits 9 and 10	Skeleton 2
5	2.8 × 2.7	Round	1.2	Rounded sides and bottom	Fire	Contained numerous ash lenses and charcoal
6	4.5 × 4.5	Round	2.9	Rounded sides and bottom	Fire	Numerous ash deposits and large amount of fire-burned red sand
7	4.6 × 4.6	Round	3.0	Bell	Storage	Carbonized bark around sides and on bottom
8	2.5 × 3.4	Oval	2.4	Rounded sides and bottom	Undetermined	
9	4.0 × 5.1	Oval	2.0	Rounded sides and flat bottom	Fire	Many ash deposits and charcoal
10	3.1 × 3.1	Round	1.7	Bell; flat bottom	Storage	Bark around edges
11	4.1 × 5.2	Pear	3.7	Rounded sides, narrowing to point at bottom	Storage	Layer of carbonized bark around edges and on bottom of pit
12	3.1 × 3.1	Round	2.8	Rounded sides and bottom	Undetermined	
13	3.2 × 5.0	Oval	3.1	Rounded sides and bottom	Refuse	Abundance of village refuse and ash
14	4.1 × 4.2	Round	2.1	Rounded sides and bottom	Undetermined	
15	2.2 × 3.2	Oval	2.8	Rounded sides and bottom	Undetermined	
16	3.1 × 4.0	Oval	3.1	Bell	Storage	Carbonized bark scattered through pit
17	3.5 × 5.4	Oval	2.9	Rounded sides and bottom	Fire	Much ash and charcoal lenses
18	2.5 × 4.5	Oval	1.8	Rounded sides and flat bottom	Inhumation	Skeleton 14
19	4.1 × 4.2	Round	2.3	Rounded sides and bottom	Fire	Lenses of ash and charcoal
20	2.0 × 2.2	Round	1.7	Rounded sides and bottom	Undetermined	
21	5.0 × 5.5	Round	4.0	Straight sides with pointed bottom	Storage and inhumation	Skeleton 4. Used for storage first (bark layers on bottom); later for burial
22	2.0 × 2.0	Round	2.1	Bell	Storage	Carbonized bark on floor
23	2.5 × 3.0	Oval	1.8	Rounded sides and bottom	Undetermined	
24	4.0 × 4.4	Oval	3.2	Rounded sides and bottom	Storage	Carbonized bark lining
25	4.0 × 4.5	Oval	4.0	Rounded sides and bottom	Fire and storage	Red fire-burned sand on bottom, carbonized bark on sides
26	2.5 × 2.5	Round	1.3	Straight sloping sides with straight bottom	Undetermined	
27	2.5 × 3.0	Oval	2.1	One side straight, other bell-shaped; flat bottom	Storage	Carbonized bark on bottom
28	5.0 × 3.5	Oval	2.7	Straight sides, sloping to rounded bottom	Fire	Much ash and charcoal
29	2.0 × 2.1	Round	0.4	Lens	Undetermined	

TABLE I (*Continued*)

Pit No.	Diameter in feet	Horizontal shape	Depth in feet	Vertical shape	Probable use	Remarks
30	4.5 × 4.0	Oval	3.3	Rounded sides and straight bottom	Fire and storage	Used first as storage pit (carbonized bark on bottom); later as fire pit (red sand over bark)
31	2.4 × 2.6	Round	2.4	Rounded sides and bottom	Undetermined	
32	5.1 × 3.0	Oval	3.0	Rounded sides and bottom	Fire	Much ash and a charcoal layer
33	6.2 × 4.1	Oval	2.7	Rounded sides and bottom	Fire	Red sand (burned) layer and ash
34	2.5 × 2.3	Round	1.1	Lens	Fire	Ash lens and red fire-burned sand
35	3.5 × 3.6	Round	2.3	One side rounded, one side bell-shaped; rounded bottom	Storage	Carbonized bark layers
36	2.5 × 3.5	Oval	1.1	Sides concave and tapering to flat bottom	Fire	Red fire-burned sand on bottom
37	4.5 × 4.5	Round	1.5	Straight sides, sloping to straight bottom	Refuse	Abundant sherds, bone, etc.
38	4.0 × 4.0	Round	0.7	Rounded sides and bottom	Undetermined	
39	3.0 × 3.0	Round	1.6	Rounded sides and bottom	Storage	Bark layer on bottom and sides
40	2.0 × 2.0	Round	1.2	Rounded sides and bottom	Fire	Red fire-burned sand on bottom and much ash
41	3.0 × 4.6	Oval	1.6	Rounded sides and bottom	Undetermined	
42	3.5 × 4.5	Oval	3.2	Rounded sides and bottom	Inhumation	Skeleton 5
43	2.5 × 4.0	Oval	3.0	Rounded sides and bottom	Inhumation	Skeleton 7. Bark layer above burial
44	2.5 × 2.5	Round	2.1	Lens	Undetermined	
45	7.5 × 7.5	Round	3.4	Bell	Inhumation and storage	Skeleton 8. Bark layer on bottom and sides
46	2.0 × 2.0	Round	1.1	Lens	Undetermined	
47	2.5 × 2.5	Round	0.9	One side bell-shaped, other straight; flat bottom	Undetermined	
48	2.0 × 2.0	Round	2.4	Straight sloping sides with rounded bottom	Undetermined	No ashes or evidence of fire; fire-cracked stones on bottom
49	3.5 × 3.5	Round	2.6	Rounded sides and bottom	Inhumation	Skeletons 9–10
50	3.5 × 4.0	Oval	2.6	Bell	Storage	Bark layer on bottom and sides
51	2.5 × 2.5	Round	1.4	Bell	Storage	Bark layer on bottom
52	3.5 × 3.5	Round	0.6	Lens	Undetermined	
53	3.5 × 3.5	Round	2.1	Rounded sides and bottom	Undetermined	
54	3.0 × 4.0	Oval	2.8	Rounded sides and bottom	Inhumation	Skeleton 11
55	2.5 × 2.5	Round	0.6	Lens	Undetermined	
56	2.4 × 2.4	Round	2.5	Rounded sides and bottom	Refuse	Unusual amount of animal bones and village refuse
57	2.0 × 2.0	Round	1.2	Rounded sides and bottom	Undetermined	
58	2.5 × 2.5	Round	1.3	Bell	Storage	Bark layer on bottom
59	2.5 × 3.0	Oval	3.0	One side rounded, other straight; rounded bottom	Inhumation	Skeleton 15
60	3.5 × 3.5	Round	1.3	Lens	Fire	Red fire-burned sand and much ash
61	2.5 × 2.5	Round	1.2	Lens	Undetermined	
62	2.4 × 2.3	Round	2.9	Sides straight and sloping to straight bottom	Refuse	Large amount of animal bones and village refuse
63	3.1 × 6.5	Oval	2.5	Rounded sides and bottom	Inhumation	Skeletons 16–17
64	7.0 × 7.1	Round	5.2	Rounded sides and bottom	Refuse	Unusual amount of refuse

TABLE I (*Concluded*)

Pit No.	Diameter in feet	Horizontal shape	Depth in feet	Vertical shape	Probable use	Remarks
65	2.4 × 2.5	Round	2.7	Rounded sides and bottom	Fire	Fire-burned sand and much ash
66	4.0 × 5.0	Oval	3.1	One side straight, other rounded; flat bottom	Undetermined	
67	2.1 × 2.1	Round	1.7	One side rounded, other straight; rounded bottom	Undetermined	
68	2.5 × 2.5	Round	2.1	Rounded sides and bottom	Undetermined	
69	2.4 × 2.4	Round	3.6	Rounded sides and bottom	Inhumation	Skeleton 18
70	3.5 × 3.4	Round	2.3	One side rounded, other bell-shaped; flat bottom	Storage	Bark layer on bottom and side
71	2.0 × 2.0	Round	2.4	Sides straight and sloping to rounded bottom	Inhumation	Skeleton 19
72	2.2 × 2.2	Round	1.9	Sides straight and sloping to rounded bottom	Refuse	Unusual amount of village refuse
73	3.0 × 3.3	Round	2.7	One side bell-shaped, other rounded; rounded bottom	Refuse and inhumation	Unusual amount of village refuse. Skeleton 20
74	3.1 × 6.8	Oval	4.8	Rounded sides; flat bottom	Undetermined	Rock layer on bottom
75	3.4 × 3.1	Egg	4.0	Rounded sides sloping to flat bottom	Fire	Ash layer at 1.3 level; nest of six perfect beamers in ash layer
76	3.6 × 2.9	Oval	1.1	Lens	Undetermined	Disturbed, but no artifacts
77	5.2 × 3.7	Oval	2.1	Rounded sides and bottom	Inhumation	Skeleton 21
78	6.6 × 5.1	Oval	3.9	Straight sides sloping to rounded bottom	Fire	Ash layer, and large pieces of charcoal
79	2.5 × 2.4	Round	2.3	Rounded sides, flat bottom	Undetermined	
80	2.3 × 2.5	Round	1.8	Rounded sides and bottom	Undetermined	
81	3.1 × 3.2	Round	0.5	Lens	Undetermined	
82	2.8 × 0.9	Irregular	0.4	Lens	Inhumation	Skeleton 22. Shallow layer of stones covering infant burial
83	5.1 × 2.3	Oval	2.9	Sides straight and sloping to flat bottom	Inhumation	Skeleton 23
84	4.1 × 4.2	Round	2.4	Straight sides and bottom	Inhumation	Skeleton 24
85	9.2 × 9.1	Round	3.9	Slightly rounded sides and bottom	Undetermined	
86	4.4 × 4.0	Pear	0.4	Lens	Fire	Ash, charcoal, and red fire-burned sand
87	3.0 × 2.5	Oval	1.2	One side straight and sloping to rounded bottom, other rounded	Fire	Charcoal and fire-burned sand with ash layers
88	3.0 × 2.8	Round	1.1	Lens	Undetermined	
89	2.0 × 2.0	Round	0.7	Lens	Undetermined	
90	3.0 × 3.2	Round	2.0	Both sides straight and sloping to flat bottom	Storage	Heavy layer of bark on bottom and also much organic material
91	3.0 × 2.6	Oval	1.4	Rounded sides and bottom	Undetermined	
92	4.0 × 4.2	Round	2.0	Bell	Storage	Bark and organic material
93	2.1 × 2.1	Round	1.0	Lens	Undetermined	Destroyed by Pit 92
94	4.2 × 4.3	Round	1.8	Rounded sides and bottom	Undetermined	
95	2.0 × 3.1	Oval	0.6	Lens	Inhumation	Shallow burial of skeleton 25
96	5.0 × 3.8	Oval	0.9	Lens	Inhumation	Shallow burial of skeleton 26
97	4.0 × 3.6	Oval	0.9	Lens	Inhumation	Shallow burial of skeleton 3

Where burials occurred in refuse or storage pits they were placed at various depths and orientations, and as a rule were not accompanied by any form of grave goods. Unceremonial disposal of the bodies is evidenced by several finds of skeletons in what would otherwise be typical refuse pits. Where pits were expressly dug for funeral purposes, the bodies were carefully placed on the bottom, accompanied by greater or smaller quantities of grave goods, but with practically no refuse in the fill over the body.

Positive evidence of fire was found in pits, although it was meager. At the most it consisted of a layer of red sand or a layer of ash and charcoal, with calcined bones bedded at intervals. The majority of the pits must have served as storage places for food or other valuables; when they were no longer needed, they were filled with refuse or were allowed to fill up naturally with blown sand and accidental enclosures of cultural objects. This would account for the sparsity of remains in many of the pits.

Hundreds of post molds were scattered over the entire explored area, but in no case could they be interpreted as definite house or stockade outlines, although these features were assiduously looked for. The molds ranged from two to four inches in diameter, although several had a diameter of over one foot. The largest of these was pitlike in character and was two feet in diameter, with nearly parallel sides extending to a depth of over four feet, tapering to a point at six feet six inches. The mold contained the charred remnants of the wood, but no village refuse. No special significance could be attached to this unusually large post mold.

Several groups of postholes forming arcs might be construed as part of a house outline; if they were, the size of the houses was approximately ten by twenty feet, and they were elliptical. There was no evidence to connect the partial outline of these arcs with any other feature, and no trace of a prepared floor was discovered.

Burials

Skeleton 1 was on the surface, where the plow had deposited it. An unsuccessful attempt was made to locate the burial pit, and so the topsoil was sifted. This operation recovered many of the bones of a child, the parietals of which were copper-stained. The only artifacts were numerous shell beads and ten small copper ones.

Skeleton 2, of an adult male, was in a refuse layer over Pits 9 and 10. It was loosely flexed on its right side, head to the west with the forearms together, and with the hands in front of and touching the face. No artifacts were found.

Skeleton 3, of an adult female, was taken from Pit 97, one of the few burial pits. It was loosely flexed on the right side, with the left hand in an unnatural position. The left elbow was placed immediately below the mandible, and the left hand was forced back against the sternum. The complete absence of refuse in the pit and

its oval shape indicate that it was dug especially for a burial.

Skeleton 4, in Pit 21, was that of an adult male, buried closely flexed at a depth of 2.0 feet. That this pit was used for refuse is borne out by the haphazard placement of the burial and by the abundance of refuse bones and artifacts under, over, and around the skeleton. The position of the skeleton was as follows: on the right side, knees and elbows touching in front of lumbar vertebrae, the right hand in front of face, left hand touching left knee; feet drawn up very close to sacrum.

Skeleton 5, of an adult male, was in Pit 42, at a depth of 3.2 feet. Orientation was to the east, with the skeleton closely flexed on the left side (Pl. II, Fig. 2). The right hand rested under the chin; the left reposed on top of the right femur.

Skeleton 6, of a young adult female, 18-20 years of age, was loosely flexed on the right side at a depth of 3.2 feet. Orientation was to the southeast. The hands were clasped directly in front of the face, and rested on the floor of the pit (Pl. II, Fig. 2).

Skeleton 7 was that of a two-year-old infant, the bones of which were very fragile and fragmentary. It was closely flexed on its right side, with the head to the east, at a depth of 3.0 feet. The feet were drawn up close against the sacrum, and the arms were folded tightly against the chest. Four *Marginella* beads lay near the neck and inside the mandible; in the dirt over the burial was a small piece of polished chlorite, probably part of a stone tube or ornament.

Skeleton 8, at a depth of 2.7 feet, was that of an adult female (young), who had been interred in an extended position, face up, with arms alongside, and both knees slightly bent to the left. Orientation was to the north.

Skeleton 9 comprised parts of a skull and skeleton of a five-year-old child buried at a depth of 2.6 feet. Orientation was indeterminate owing to the fragmentary condition of the remains. Adjacent to the skull was a crushed but restorable pottery vessel, four inches in diameter and four inches high (Pl. II, Fig. 3).

Skeleton 10 was represented only by a fragmentary skull, that of an infant under two years of age. It was in the same pit with skeleton 9, beside which it lay, but the lack of body bones precluded any determination of position or orientation.

Skeleton 11 (so called) represents the unusual burial of most of the body bones, without head or limbs, of a male subadult, along with several bones of a young child. The only semblance of articulation was in the vertebral column, which was almost complete. All the other bones were jumbled indiscriminately. Scattered among the body bones were several ankle and wrist bones and a number of phalanges. No artifacts accompanied this burial, nor was there anything to indicate the reason for its fragmentary condition. It is possible that the skeleton had lain on the surface long enough for animals to carry off the detached parts of the body. It was found at a depth of 2.5 feet. No orientation, of course, could be determined.

Skeleton 12 was that of a child nearly five years of age, buried at a depth of 1.8 feet. The body had been placed on its back, head to the southwest, legs bowed, with feet touching. The pit, number 97, had been cut into by Pit 56, which had slightly disturbed the burial. The skull was crushed, and the rest of the bones were in a very fragile condition. In the fill directly over the skull were two tubular copper beads, and directly under and in contact with the skull were seven additional specimens. Between the legs and touching the left femur lay four shell pendants derived from the columella of the *Busycon carica*. Also touching the left femur was a shattered but restorable clay pipe.

Skeleton 13, that of an adult male, was buried at a depth of 0.8 foot. The body had been closely flexed on its right side, with head to the east. The knees and feet were together, hands in front of the abdomen. The shallowness of the burial resulted in the crushing of the skull and pelvis by external pressure.

Skeleton 14 was at a depth of 1.8 feet. The body, that of an adult female, had been closely flexed on its right side, with the head to the southeast. The feet and knees were together; the left arm was between the legs, and the right arm was placed across the body.

Skeleton 15 was at a depth of 2.3 feet. The body had been closely flexed on the right side, head to the southeast. The skeleton, that of an adult female, lay almost on its face, with the knees at a lower level than the remainder of the skeleton.

Skeleton 16, that of an adult female, was at a depth of 1.7 feet. The body had been placed on its left side, with the head to the northwest (Pl. III, Fig. 3). The knees were drawn up in front of the sternum, with the heels about six inches from the pelvis. The left hand covered the upper part of the facial region; the right hand lay just below the right knee.

Skeleton 17 was in the same pit with skeleton 16, but at a depth of 2.5 feet. This burial, that of an adult male, was closely flexed on its right side, with the head to the northeast. The pelvis was about 0.6 foot deeper than the skull; the knees and feet were still deeper, at a total depth of 3.5 feet.

Skeleton 18, that of a newborn infant, was buried on its back, with its head to the southwest at a depth of 3 feet.

Skeleton 19, that of a six-year-old child, had been buried with the body loosely flexed on its right side and with the head to the east at a depth of 2.4 feet. Under the head and neck lay a rectangular slab of limestone, 6 by 10 by 2 inches. Directly in front of the face was a large lump of charred wood, 0.4 foot in diameter and about 0.8 foot in length, that was roughly round. It had not formed part of a post, since it lay on its longer side. At the feet of the burial was a roughly elliptical layer of waterworn boulders. The dimensions were 2 by 4.5 feet.

Skeleton 20 (incomplete), at a depth of 2.6 feet, was that of an adult female (Pl. III, Fig. 1). The body, without legs, had been buried on its back, with the face uppermost and the head to the northwest. The right hand lay directly on the right pelvic bone; the left arm was fully flexed, so that the head rested on the left shoulder. There was no trace of the lower limbs, and the sockets of the pelvis were empty. Scattered through the fill, however, were the small bones of the legs — patella, phalanges, tarsals, and metatarsals. None of these were articulated, so that their significance is only conjectural. Accompanying the burial and resting right side up at the right elbow was a fine small pottery jar containing a perfect turtle-shell cup. The left parietals were copper-stained, but no other trace of the metal could be found. A number of perfect bone artifacts in the pit may or may not have had some relation to the burial, but direct association was lacking. There was absolutely no secondary disturbance which might have accounted for the incompleteness of the skeleton.

Skeleton 21, that of an adult male, was loosely flexed at a depth of 2.8 feet in Pit 77 (Pl. III, Fig. 2). The body had been placed with the head to the west, lying on the left side. The hand bones were together in front of and slightly deeper than the face. The clayey nature of the soil at this particular point led to the poor condition of the bones as compared with others in sandy soil as close as ten feet. An arc of postholes adjacent to the pit edge was an unusual feature of this burial.

Skeleton 22, that of a newborn infant, lay at a depth of 0.4 foot. It had been disturbed by the plow, and orientation and position could not be ascertained owing to the fragmentary condition of the bones. Associated with the burial were two stone arrowpoints, and one of antler, one piece of “cut” turkey tibiotarsus, and one gorgetlike but unperforated piece of felsite.

Skeleton 23, that of an adult female, was in a fragmentary condition in the topsoil, where the plow had thrust it after disturbing Pit 83. No indication of placement or orientation was discernible.

Skeleton 24 was at a depth of 2.3 feet. The bones, those of a small child, were against the edge of the pit, with the head to the east. Lying around the head and face were twenty-four cylindrical shell beads (of *Busycon carica*) and small shell-disk beads (remains of a string of beads about four feet long). Directly under and in front of the face was a piece of clay pipestem, one and one-half inches long, probably an accidental enclosure.

Skeleton 25, that of an adult male, was at a depth of 0.6 foot. The body had been placed loosely flexed on its right side, with the head to the southwest. It had been disturbed by the plow.

Skeleton 26, that of a male subadult, lay in the top of Pit 96, where the plow had removed the uppermost sections of the skull, pelvis, and feet. Enough remained to show the position of the body, which had been placed closely flexed on its right side, with the head to the southeast. At the head was half of a cylindrical awl or pin. Only the pointed half was found, since the remainder had been carried away by the plow.

The following statement by Dr. T. D. Stewart, Division of Physical Anthropology, United States National Museum, outlines some of the physical relationships of the skeletal material.

The skeletal remains from the Keyser site represent a fairly typical sample of an Indian village population, because they include about 46 per pent sub-adults — newborns, infants, and adolescents. This high percentage of immature individuals limits the number of adults that can be used for comparative purposes to the remaining 54 per cent of the series — 14 individuals in varying degrees of completeness.

Comparative material from this region is limited at present mainly to that from sites in Fayette and Somerset counties, Pennsylvania, and in Rockbridge County, Virginia. I am in the course of studying the Pennsylvania material, whereas the Virginia material (Hayes' Creek Mound) is known to me only from Hrdlicka's measurements.[6] For this reason I can indicate at this time only the general relationships of these series as I see them.

Occipital flattening of moderate grade is apparent in at least two skulls from the Keyser site, and it is impossible to rule out slight occipital flattening as the cause of the roundness of other skulls. I have encountered the same problem m the collections from Pennsylvania. The cranial indices of these two lots compare as follows:

Classes	*Keyser site*	*Pennsylvania*
70–74.9 (dolichocrany)	..	7
75–79.9 (mesocrany)	1	1
80–84.9 (brachycrany)	8	3
85–89.9 (hyperbrachycrany)	4	1
90–94.9 (ultrabrachycrany)	1	1

The Pennsylvania material thus tends more to dolichocrany. The skulls from the Hayes' Creek Mound have an average cranial index of 76.0 (36), and all but two fall within the dolicho- and mesocranic classes. They are thus even more long-headed.

The three series here compared all agree in being very high-headed, the average mean height index in each case being around 87.

Although the samples are inadequate and as yet incompletely studied, it is my impression that the Keyser remains are closest in type to those from Pennsylvania.

ARTIFACTS

Artifacts were obtained throughout the excavated area, not only in pits, but in the topsoil and on the surface. In some pits none were located, but in the vast majority such remains were common. The materials represented consisted of antler, bone, shell, stone, ceramics, and copper. Practically every article of raw material employed by the Indians was native to the immediate locale, with the exception of the marine shells and possibly the copper. The antler and bone were secured from the local fauna; the majority of the shell material came from the adjacent river beds. All the lithic artifacts were derived from the local igneous and metamorphic deposits characteristic in the two mountain ranges between which Page Valley nestles. The pottery was

made almost entirely of the local clays tempered with pulverized mussel shells or comminuted pieces of limestone or quartz. No objects were recovered which indicated white contact.

ANTLER

With a few exceptions the artifacts of antler were not dissimilar to those found on many sites throughout the eastern and northeastern areas. Probably the most unusual feature was the presence of several antler headdresses not previously recorded or described for the area under consideration (Fig. 3).

Four examples of this unique ornament were discovered in the course of the digging. Of these, one was practically complete, and the others were fragmentary. The most nearly perfect specimen consisted of the two antlers and a triangular piece of the frontal portion of the skull of a Virginia deer, cut and modified so as to fit closely the forehead of the wearer. It was probably held in place by a band similar to a carrying strap, which passed around the head; the parietal vascular foramen provides an opening through which a cord could have been passed and tied behind the head. (One specimen is worn around the interior edges of the foramen and supports this hypothesis.) The antler branches were carefully hollowed out and cut away lengthwise to lighten the burden without loss of shape or beauty. The anterior view of the headdress showed the natural surface of the antler since the "channeling" was entirely on the posterior side of the antler beam. On the better specimen the marks of the chisel throughout the length of the channeling disclose the technique by which the hollowing was effected. That this ornament was further embellished is indicated by the traces of red pigment remaining on the less exposed portions along the sides, which suggest that the skin was not worn with the headdress. Two holes drilled near the tip of one antler may have served to repair the broken tip or could have been the means of attaching feathers, pendants, or other decorations to the ends of the individual antlers to make them more imposing. This cannot be ascertained, since the tip of the other antler is missing.

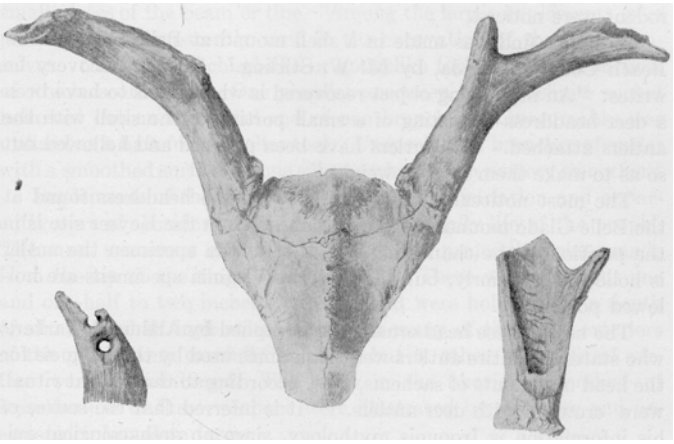

FIG. 3. Antler headdress artifacts (drawing by Dr. Doris Cochran)

In the next best-preserved headdress the skull portion was in excellent condition, although all of one antler and half of the other were missing. The half recovered showed the chisel marks along the interior of the channeling, but any further decoration had been obliterated by weathering.

The third specimen consisted of six pieces of a hollowed antler branch, worked to a fine polish. Five of the pieces joined, but because of warping their union could not be effected. To judge from the size of the pieces, this headdress was fashioned from elk antler, whereas the other specimens were made from Virginia deer. The chisel marks in the interior of this specimen had been rubbed smooth, but the outside bore a high polish. Two perforations, equidistant from the edge of a fracture, indicated that an attempt had been made to repair the artifact before it was finally discarded. At several points on the edge of the fragments the tooth marks of a small rodent were noticed.

A similar find was made in a shell mound at Belle Glade, Palm Beach County, Florida, by M. W. Stirling.[7] Of this discovery he writes: "An interesting object recovered is what seems to have been a deer headdress consisting of a small portion of the skull with the antlers attached. The antlers have been polished and hollowed out so as to make them light in weight."

The most noticeable difference between the headdress found at the Belle Glade mound and the specimens from the Keyser site is in the position of the channeling. In the Florida specimen the antler is hollowed anteriorly, but those of the Virginia specimens are hollowed posteriorly.

The use of these head ornaments is implied by Arthur C. Parker,[8] who states: "Entire antlers were sometimes used by the Iroquois for the head ornaments of sachems, who, according to the ancient ritual, were 'crowned with deer antlers.'" It is inferred that the source of his information is Iroquois mythology, since no archaeological evidence in New York is known to support it.[9] M. R. Harrington[10] believes that headdresses were undoubtedly used as part of the war or hunting regalia of the Cherokee. But again no substantiating archaeological evidence is adduced. Dr. Frank G. Speck[11] illustrates a similar ornament in actual use by the Penobscots of Maine in their Clown dance. Speaking of the costume worn, he says (p. 297): "A mask made of the headskin and antlers of a deer is also mentioned." Other than the Florida find, the only archaeological specimens of this nature were those excavated by Moorehead in the Hopewell mound, where a burial was discovered crowned with a headdress made of copper in imitation of deer antlers.[12]

Altogether, enough of these unique artifacts are known to indicate that they were of considerable importance to the aboriginal owners, since so much labor was expended on them and since at least one discloses an attempt to repair a break.

Fragments of antler were recovered from almost every pit either as artifacts or as refuse. Two classes of artifacts could be distinguished: those made from the entire antler beam and those made of small pieces of the beam or tine. Among the larger implements were picklike tools, apparently used in the excavation of the pits themselves. Others were chisel-like or gougelike tools, the exact purpose of which is unknown. One peculiar specimen had a definite socket hollowed out on the distal end of one branch, and presumably was utilized as a haft for a smaller tool. Unspecialized branches of antler with a smoothed surface on one side may have been pottery smoothers.

Implements of the second class have much variation and apparently were of considerable importance in the daily life of the people. The most numerous group consisted of the projectile points made from the tip of the tine (Pl. IV, Fig. 1). These were all about one and one-half to two inches in length and were hollowed to a depth of about one-half inch at the base. In many of them the exteriors of the points were carefully polished, but in others the natural surface was left unaltered. The steps in the aboriginal method of manufacture of these weapons were illustrated by rejectage and occasional incomplete forms.

A second important group comprised the chippers or drifts, two-inch long, cylindrical pieces of hard antler, sometimes rubbed to a fine polish, but with occasional rougher examples represented (Pl. IV, Fig. 2).

Fragmentary remains of antler celts, or of some similar implement, suggest that antler was used for purposes other than those mentioned.

The refuse antler reflects the primitive methods employed by the Indians in detaching the antler and reducing it to a workable size. Sometimes it was broken forcibly from the skull of the deer, and at other times it was removed by burning the beam partly through and then breaking it along the charred area. Incising preliminary to breakage was noticed in only two minor instances. This was the method followed in detaching the tines from the main branches, but not in separating the beams from the skull. The majority of antler pieces were from the Virginia deer, although some were definitely identified as of elk.

BONE

Extensive utilization was made of animal and bird bones in the manufacture of artifacts. Deer bones were the main source of raw material, and for this reason most of the artifacts were of this animal's bones.

The most common bone artifact was the bone beamer or currier, made from the cannon bone of the deer and usually found in fragmentary condition. Fourteen perfect specimens were obtained, however, including a cache of six slightly worn tools. The cache was found under a large sherd of pottery in Pit 75. Most of the seventy-odd broken specimens recovered showed that continuous use had worn down the cutting edge until the bone was no longer thick enough to withstand further strain. Occasionally both halves of a broken tool were thrown into the same pit, in which case they were restorable, but as a rule only one half was found in a pit, and usually even the halves were further fragmented. The beamer has a wide distribution over most of the eastern United States, but it is found in unusual numbers at this site.

Bone awls, the next most common bone artifact, had a great deal of variety in shape and origin (Pl. V, Fig. 4). The sources of the raw material for these tools were as follows:

Turkey joint	10
Turkey splinter	3
Deer joint	3
Deer scapula	3
Deer splinter	6
Cylindrical bones, indeterminate	3
Total	28

Two specimens made from the turkey tibiotarsal bone have notches or tally marks on one side (Pl. V, Fig. 5). Similar marks were also present on one of the deer-scapula awls. No perforated awls were found, although one tibiotarsal with a natural perforation was recovered.

The artifacts listed as cylindrical awls may possibly have been broken hairpins like those illustrated from the Castle Creek site.[13]

Bone bodkins (Pl. V, Figs. 1-2) were represented by two complete and four broken specimens. The source of the material is not known, but the curvature of the implements suggests the rib of a large animal. The length of each of the perfect specimens is seven inches.

Seventeen bone-chipping tools (Pl. V, Figs. 3, 8-15) may be classified by types:

Perforated	7
Perforated by scoring hollow bone	1
Grooved	4
Notched	2
Splinter (unspecialized)	3
Total	17

The length of these chippers ranged from one and one-half to four inches. The working ends are rounded and show the effects of much wear.

The only fishhook found was incomplete; it had been fashioned from a semicylindrical blank formed by scoring and breaking a hollow bone. The lack of fishhooks is not surprising since fishing in the river is better suited to the use of nets or weirs.

One tube, three inches in length (Pl. V, Fig. 6), one bead, and one broken whistle with three openings (Pl. V, Fig. 7) were the only artifacts made from hollow bird bones. The presence of twenty-five pieces of “cut” bone implies, however, a much greater use of this material than was represented.

The carapace of the box tortoise was extensively employed in the manufacture of scoops, cups, and other receptacles. Several examples have perforations near the rim, either for suspension or for the attachment of a

handle. The use of these shells as rattles is not indicated by the examples recovered.

Among the rarer bone artifacts were the following: one complete and one fragmentary chisel of deer bone; one perforated bone handle suitable for the insertion of a blade; one fragmentary bone tube, four inches long, split longitudinally; one perforated and worked raccoon baculum; and one worked beaver incisor.

It is of interest to note that the canine teeth of the bear and the dog had no utilitarian or decorative purposes. Many jaws of these animals were found with all teeth intact, and no attempt had been made to modify or decorate the teeth that did occur separately. Well over one hundred unworked canine teeth were recovered from the excavations.

SHELL

An unusually small number of shell artifacts were found, and they represented but few types. The most common use of shell was in the manufacture of small disk beads, of which there were several hundred (Pl. VI, Fig. 6), recovered mainly in the backfill of burial pits.

Twenty-four tubular beads, one-quarter to three-quarters inch long, were made from the central column of the conch shell (Pl. VI, Fig. 5). Four pendants of the same material, two and three-quarters inches long and having perforations at one end, accompanied skeleton 12 (Pl. VI, Figs. 1-2). This conch was the *Busycon carica*, the nearest source of which was the Atlantic Ocean at the capes of the Chesapeake. Contrast may here be made between these shell pendants and some identical specimens described by Fowke,[14] from the Brumback mound, eight miles to the south, where the pendants had been formed from the *Busycon perversum* of the Gulf of Mexico. One flat pendant, shaped like a bear's claw, was taken on the surface, and a similar broken specimen was obtained in Pit 35 (Pl. VI, Figs. 3-4).

Mussel and snail shells were fairly well preserved, which suggests that the character of the soil was not likely to have been the reason for the paucity of shell artifacts. One fragmentary shell “spoon,” four scrapers, and one perforated shell of unknown use were the only artifacts made from the river mussel.

CHIPPED STONE

The most important chipped stone artifacts were projectile points, of which some 120 were recovered (Pl. VII). They range from very crude to medium-fine in workmanship, with a preponderance of the cruder forms. They vary in shape and material as the following list shows:

Material	*Total*	*Percentage*
Quartz	48	40
Quartzite	19	16
Flint	16	13
Jasper	28	23
Rhyolite	5	4
Chalcedony	2	2
Shale (?)	1	1
Chert	1	1
Total	120	100

Shapes	*Total*	*Percentage*
Triangular	104	87
Stemmed	6	5
Unspecialized (crude)	6	5
Drill-like	4	3
Total	120	100

The predominant form is the isosceles triangle, ranging from one-half to two inches from tip to base. All the materials are native to the valley and adjacent mountain ranges.

POLISHED STONE

There were very few complete polished stone artifacts, but celts or fragments of them were fairly common. From the great amount of felsite scattered over the surface and in the general digging it is apparent that considerable celt manufacture was carried on in the area. Since the site was that of a village, the evidence was not so plentiful as one expects to find at a true celt workshop, such as that visited and described by Holmes[15] at the mouth of Pass Creek, three miles west of Luray. Altogether, three perfect celts were collected in addition to several dozen crude and fragmentary specimens.

Stone was used in the manufacture of pipes also (Pl. IX, Fig. 2D). A portion of the flat stem of a monitor pipe was picked up on the surface. Part of the bowl of another was also a surface find. This is a truncated egg-shaped bowl having a conical cavity that meets the socket for the stem at a right angle. The material is chlorite, and the exterior is decorated with a line of minute incised dots running around the bowl parallel to the lip (Pl. IX, Fig. 2E). One other small piece of polished chlorite is either part of a pipe bowl or a segment of a stone tube.

The only other articles of polished stone were two fragments of tablet-like objects (Pl. VIII, Figs. 3, 5).

Limonite showing rubbed edges occurred in fragments ranging from one to two and one-half inches square (Pl. VIII, Figs. 1-2). The palette on which the limonite was rubbed is represented by a broken slab of compact sandstone, one side of which still showed the powdered ocher adhering to the rough surface.

Cruder stone implements included hammerstones, both pitted and plain, one net sinker, a cupped stone, three abrasives or sinew stones (Pl. VIII, Fig. 4), and one broken crude discoidal.

COPPER

Copper artifacts were found in two burials only. With skeleton 1 were ten small tubular beads, three sixteenths of an inch in length and one eighth of an inch in diameter (Pl. IX, Fig. 1B). These had been made by rolling a flat piece of copper into a cylinder producing overlapping edges.

With skeleton 12 were nine tubular beads two inches long and one eighth of an inch in diameter. These also had the characteristic overlapping edges (Pl. IX, Fig. 1A).

Professor W. C. Root, Department of Chemistry, Bowdoin College, Maine, kindly made a spectroscopic analysis of the copper artifacts. The specimens with burial 1 (Root's no. 1198) were pure copper; those with burial 12 (Root's no. 1199) were copper, with a trace (0.1 per cent) of silver.

Of the copper Professor Root states: "Neither one of these samples had any detectable gold, lead, tin, arsenic, antimony, bismuth, cadmium, zinc, or mercury. I think there can be little doubt the beads were of native American metal."

TRAIT LIST OF THE KEYSER FARM SITE

This trait list is intended to facilitate comparison with similar lists from related sites.

Objects found	*No.*
1. Round pits (top view)	64
2. Overlapping pits	34
3. Refuse layers over pits	10
4. Pits surrounded by post molds	6
5. Burial in refuse pit	1
6. Burials in storage pits	2
7. Burial in refuse layers	1
8. Artifacts with burials	6
9. Pottery as grave goods	2
10. Stone slab for pillow of skeleton	1
11. Flexed burials	15
12. Double burials	2
13. Extended burial, knees bent	1
14. Fragmentary skeletons in grave	2
15. Beads, copper, rolled	2
16. Bead made from a shell of a snail of the genus *Marginella*	1
17. Bead, shell, large tubular	1
18. Bead, shell, small tubular	1
19. Beads, shell, small disk	7
20. Pendant, columella	1
21. Pendants, shell, imitation bear claw	2
22. Pendant, shell, bipointed	1
23. Spoon, shell, notched edges	1
24. Spoon, shell, plain	1
25. Scrapers, mussel-shell	4
26. Headdresses, antler	4
27. Picklike tools, antler	3
28. Celts, antler	3
29. Chisels, antler	2
30. Drifts, antler	13
31. Arrowpoints, antler	37
32. Arrowpoint, antler, tanged	1
33. Spear points, antler	2
34. Pottery smoothers, antler	3
35. Bead, bone, decorated	1
36. Handle, socketed, bone	1
37. Fishhook, bone, center cut out	1
38. Whistle, bone, three holes	1
39. Chipping tools, bone	9
40. Chipping tools, perforated	8
41. Chipping tool, grooved	1
42. Hairpins, bone	2
43. Pins, bone, double-pointed	2
44. Chisels, bone	2
45. Tubes, bone	2
46. Bodkins, bone	8
47. Beamers, deer, metatarsal	84
48. Baculum (penis bone of raccoon) perforated,	1
49. Chisel, beaver incisor	1
50. Scoops, turtle-shell, perforated near rim	33
51. Scoops, turtle-shell, plain	46
52. Awls, whole bone	3
53. Awls, splintered bone	9
54. Awl, bone, perforated	1
55. Awls, deer scapula	3
56. Awls, turkey metatarsal, notched	2
57. Pipe, clay, obtuse-angled, decorated	1
58. Pipe, clay, elbow, short stem	1
59. Pipes, clay, all types	4
60. Pipes, clay, with flanged mouthpiece	3
61. Pipes, stone, all types	3
62. Pipe, ovoid stone, decorated	1
63. Pipe, stone, monitor.	1
64. Net sinkers, stone, notched	2
65. Limonite, lumps showing rubbing	18
66. Palette, stone slab for rubbing paint	1
67. Whetstone	1
68. Sinew stones	3
69. Smoothing stones	2
70. Discoidal, plain	1
71. Hammerstones, centrally depressed	4
72. Celts, stone, narrow-polled	10
73. Celt, stone, chipped	1
74. Blade found in cache	1
75. Pendant, stone	1
76. Choppers, chipped stone	2
77. Drills, unstemmed	4
78. Knives, stone, oval	6
79. Arrowpoints, stemmed	6
80. Arrowpoints, triangular	104
81. Potter's clay, in lump	1

THE CERAMIC COMPLEX

The clay pipes are of the obtuse-angle style, which Holmes demonstrated was the dominant type along the Middle Atlantic area at the time of the English colonization.[16] A complete specimen (Pl. IX, Fig. 2A) is an excellent example. The bowl section (Pl. IX, Fig. 2B) has a fine dentate-stamped decoration. Comparable pipes from western Pennsylvania are described and illustrated. The northern and southern limits of pipes of this shape are not clear, although a connection with the shape of late Woodland and Iroquois pipes is obvious, and also with the decoration of the late Woodland pipes of the North Atlantic drainage. The flaring bit on the obtuse-angled elbow pipes is reminiscent of the mouthpiece of some tubular pipes of the Adena-Tchefuncte cultures (Pl. IX, Fig. 2C).

The pottery submitted for analysis from the Keyser site is an interesting mixture of three separate ceramic complexes, which can be recognized immediately because of significant differences in the kind of temper used in their manufacture.

Cord-marked Body Sherds from Various Localities Separated by Type of Temper

	Shell	*Grit*	*Limestone*
Pit 11	107	15	..
Pit 13	109	17	8
Pit 85, deep level	57	31	5
Miscellaneous	89	21	5
Total	362	84	18
Grand total			464

The dominant pottery type is clearly indicative of a close relationship with a late prehistoric occupation in southwestern Pennsylvania. The minority types, on the other hand, just as definitely indicate a close connection with the pottery styles found in the Coastal Plain and the Piedmont area of the Middle Atlantic states. Though the evidence obtainable from the pottery itself and from the notes of the excavators is by no means conclusive, there is a suggestion that the minority types were the earlier.

KEYSER CORD-MARKED

The paste of the majority type is composed of a local clay mixed with ground portions of mussel shell. The shell fragments vary considerably in size, from minute flakes of less than half a millimeter to large pieces up to eight millimeters in length. The particles are flaky, and most of them are oriented parallel with the vessel walls. This orientation was probably accomplished during the surface manipulation. The proportion of shell varies considerably, and ranges from approximately 10 per cent up to 30 per cent. The texture of the cross section is almost entirely medium-fine, and in many respects is identical with that of the sherds in the southern foci of the Fort Ancient Aspect. It is also identical with that of the shell-tempered complex in southwest Pennsylvania. The majority of the sherds have an exterior surface hardness of 2.5 and 3. The exterior surface is predominantly dull grayish brown, with a minority of the sherds having a buff to reddish-brown exterior. The interior surface of practically all the sherds is dark gray

to black. The core ranges from dark gray to red or buff. Red and buff cores are found principally but not always on sherds with a similarly colored exterior surface.

Surface Finish

The exterior surfaces are all malleated with a cord-wrapped paddle, extending from the lip down the entire body and onto the base of the vessel. On approximately 90 per cent of the rims the cord markings are applied vertically (Pl. X, Fig. 2), but on the remaining sherds the cord impressions are oblique from left to right (Pl. X, Fig. 1). The individual cord impressions are rather indistinct. This is probably the result of a short sliding stroke of the paddle. There was very little subsequent attempt to smooth the exterior surface. The interior surfaces are roughly smoothed.

Decoration

The lip and the immediately adjacent outer rim area received the only decorative modifications, which are as follows:

Keyser Cord-marked Rims Divided according to Lip Treatment and Decoration

Lips with smoothed surface	23
Lips with cord-marked surface	104
Transverse incised grooves on smoothed lip	42
Transverse or oblique cord-wrapped stick impressions	130
Smoothed lips with circular punctates	9
Rims with small lugs	22
Small loop handle	1
Rims with rectilinear narrow line incising and punctates	16
Total	347

Almost one third of the lips bear impressions of a cord-wrapped paddle made either parallel with or transverse to the lip edges (Pl. XI, Fig. 4). Such lips are flat but have the cord-roughened surface. At least half of them project slightly outward owing to the lip treatment. Over a third of the lips have transverse impressions of either the cord-wrapped stick or the narrow edge of the cord-wrapped paddle which was used to work the surface (Pl. XI, Fig. 9). There is considerable variation in the width, depth, and spacing of these indentations. Instead of - being transverse a few of these impressions have been placed obliquely. The lip was probably flattened before it was decorated. Less than 10 per cent of the lips have a smoothed surface, which is flattened to rounded. About 12 per cent have a smoothed or cord-marked lip with transverse notches made by a smooth implement. These also vary in size, shape, and spacing from narrow V-shaped cuts to wide U-shaped impressions. There are nine sherds which have a horizontal row of closely spaced circular punctates on the lip surface (Pl. XI, Fig. 7).

About 8 per cent of the Keyser Cord-marked rims have small irregularly shaped solid lugs attached on the outer rim contiguous with the lip (Pl. XI, Fig. 1). The cord-wrapped stick or paddle edge was used to impress the outer surface of the majority of these lugs (Pl. XI, Figs. 5, 8). One such specimen has a deep vertical incised gash (Pl. XI, Fig. 2). Two of the small lugs have each a small horizontal cylindrical hole, which runs underneath the lug at the level of the outer surface of the vessel (Pl. XI, Fig. 6). It is too small to have been of any service in supporting the vessel. The size of the lugs indicates that they were for decorative and not utilitarian purposes. One rim has a small strap or loop handle that is attached at the lip area and extends three centimeters below the lip (Pl. XI, Fig. 3). The lip surface of this sherd has shallow U-shaped transverse notches.

Only a very few sherds have incised lines, and on none of these is the design apparent. The lines, which are rectilinear, are placed obliquely on the outer rim, most often in groups of three. The incisions are narrow, being but two millimeters wide, and are medium-deep to deep. On three sherds irregularly spaced circular punctates were used in connection with incised lines. The lips of these sherds are smooth, and they have plain transverse notches.

Shape

The rim is either vertical and straight or slightly flaring. The lip shape and treatment have been discussed under the head of “decoration.” These vessels were wide-mouthed jars with slightly constricted lower rims, slightly expanded bodies, and rounded bases.

In marked contrast to the cord-marked, shell-tempered pottery type discussed above are two grit-tempered types whose paste, surface finish, decoration, and shape clearly set them apart from the dominant ware at this site. There are a number of similarities that will be discussed in a statement of pottery relationships (pp. 409-413). Within the grit-tempered ware a further division can be made on the basis of the type of tempering employed and also of a number of other distinguishing features.

PAGE CORD-MARKED

The smaller series of sherds of the grit-tempered group has large angular particles of limestone as the tempering material. Many of these individual limestone pieces are three and four millimeters in diameter. In the majority of the sherds the limestone fragments nearest the surface have been leached, but in some all the limestone has been dissolved and angular holes have been left. There is a small proportion of limestone. The texture of the cross section is medium-fine to medium-coarse, depending on the degree of prominence of the temper. Otherwise the paste is rather fine grained and relatively compact. The exterior surface has a hardness of 2-2.5 to 2.5, and thus is somewhat softer than the preceding group. At least three fourths of these sherds have buff to reddish-tan exterior surfaces, whereas the rest are dull grayish brown. The interior surfaces are grayish tan to black. The color of the core is predominantly buff to light reddish tan or is gray.

Surface Finish

The exterior surfaces were malleated with a cord-wrapped paddle, but the impressions so made have been partly obliterated. The obliteration is particularly noticeable in the rim area. The interior surface is smooth.

Decoration

Five of the rims have a plain, unmodified exterior; on nineteen there is an added outer rim strip which gives a slightly collared appearance (Pl. XII, Fig. 7). The rim strips vary somewhat in size, conforming in some degree to the size of the vessel. The normal range is from two to three centimeters. Only three of these strips bear no additional decoration beyond the partially obliterated cord-wrapped paddle marks. One sherd is vertically incised at the base of the thickened rim (Pl. XII, Fig. 4); a second has oblique punch marks at the lower edge of the added rim strip. Between the lip of this last sherd and the row of punch marks there are two closely spaced medium-wide and medium-deep U-shaped horizontal incised lines (Pl. XII, Fig. 1). Six of the added rim strips have obliquely placed impressions of a cord-wrapped string, or cylinder, across the lower segment of the rim strip. Four rims show horizontal impressions of cord-wrapped string between the lip and similar impressions that were made vertically or obliquely across the projecting edge of the rim strip. One vessel is represented by three rim fragments and two upper body pieces (Pl. XII, Figs. 2, 5-6). In this vessel there are two parallel rows of cord-wrapped string impressions on the added rim strip and six to seven roughly horizontal rows on the lower rim. The lower edge of the rim strip is cut by short, deep vertical incised gashes. One rim sherd of this type has irregularly placed shallow individual cord impressions on the upper rim and a horizontal row of deep thumbnail gouges 1.5 centimeters below the lip (Pl. XII, Fig. 3). Three of the sherds have cord-wrapped stick impressions vertically or obliquely placed on the inner rim surface.

Shape

The rims are vertical to slightly flaring, with the body somewhat wider than the orifice. No basal sherds were examined.

POTOMAC CREEK CORD-IMPRESSED

The pottery belonging to the most numerous group of the granular tempered sherds has crushed particles of rock for tempering material. The fragments are of various sizes, ranging from less than a millimeter in diameter to three and four millimeters. There is approximately 20 to 30 per cent of grit. Though the exact nature of the rock employed has not been determined, most of it is apparently granitic. The cross-sectional texture is usually medium to medium-coarse. The hardness ranges from 2.5 to 3.5, and the majority of the sherds have a surface hardness of 3. As a rule the exteriors are a grayish black color; a small number of sherds are light tan to buff. There is very little reddish tinge. The interiors are almost all grayish black; the core is dark gray, except on a few of the buff-colored sherds, where the core is also buff.

Surface Finish

Using as evidence not only the decorated rims, but also the underrated rims and body sherds, one can see that these vessels were originally malleated with a cord-wrapped paddle over the entire exterior surface. On a majority of those sherds that have a rim decoration the rim and the upper body had been well smoothed before the decoration was applied. The cords used in this group for surfacing are rather small and closely braided, and the majority have a clockwise twist. The interior surfaces are roughly smoothed, with fine finger striations showing on the inner rim area. This inner smoothing was not always sufficient to cover the projecting edges of the grit particles completely. There are nine plain cord-marked rims, on six of which the cord impressions were applied obliquely and slant from left to right. The lips of the nine rims are cord-marked and are rounded to flattened.

Decoration

About 90 per cent of the rims on this distinctive pottery type have a decoration on the outer-rim area. It was made either with a single cord, placed against the plastic clay and impressed to form a decorative pattern, or by a technique that is here called “pseudo-cord.” The majority of the rims were decorated by the latter technique, and on these sherds the impressions were probably made by a cord wrapped around a flexible element that was either a fiber of some type or another material of similar nature. A numerical listing of the several styles showing variations that may be important in future comparative distributional studies is given below.

Potomac Creek Cord-impressed Rims Divided according to Decoration

Plain cord-marked rims	9
Plain rims with horizontal pseudo-cord impressions	13
Horizontal pseudo-cord impressions, lip notched	8
Lipless rims with horizontal pseudo-cord impressions	19
Plain rims with oblique pseudo-cord impressions	7
Lipless rims with oblique pseudo-cord impressions	2
Patterned arrangement of pseudo-cord impressions	10
Added rim strip with lower edge notched obliquely	3
Added rim strip bearing horizontal pseudo-cord impressions	3
Rims with cord-impressed rim decoration	11
Total	85

By far the most common style was the arrangement of the pseudo-cord impressions in closely spaced, parallel horizontal rows on the outer rim (Pl. XIII, Figs. 2, 4). Depending somewhat on the size of the vessel, this decorated zone extends from two to five millimeters beneath the lip. The notched lips were impressed on the outer lip edge in four examples and transversely across the lip on the remaining four. In three, notching of the latter type is so wide and deep as to present a scalloped appearance (Pl. XIII, Fig. 3). The scalloping was done

either with a rather large cord-wrapped dowel or with the edge of the cord-wrapped paddle. One interesting rim with such horizontal pseudo-cord impressions has a small added lug, which was vertically applied on the lip surface and forms a small semicircle projecting above the lip. This has been transversely notched. It resembles in concept the small horizontally projecting lugs on Keyser Cord-marked that were vertically notched.

Seven of the rims have closely spaced parallel oblique pseudo-cord impressions. Five slant from right to left, and the other two from left to right. The lips on two are slightly notched transversely; the others are flattened and cord-marked. These oblique cord impressions begin at the lip level and extend downward to a horizontal pseudo-cord impression which sets off the smoothed lower rim from the decorated upper rim area.

There are ten rims that have a patterned arrangement of pseudo-cord impressions (Pl. XIII, Figs. 1, 5). On them the decorated zone is set off from the lip area and the lower rim by horizontal rows of pseudo-cord impressions. Within this zone the decoration was applied at various angles, forming a herringbone or line-filled triangles or rectangles.

There are six rims with an added strip. Three have right oblique incisions or punctates on the lower margin of this strip. The other three bear horizontal pseudo-cord impressions running parallel around the rim.

The decoration of eleven rims is formed by lines of individual cord impressions in either horizontal or oblique rows. Those placed at an angle are usually set off in the decorated zone by a horizontal cord impression. Two of the lips in this group are notched. One was impressed by a smooth implement and the other by a cord-wrapped stick or the edge of the cord-wrapped paddle. Four of the rims were probably parts of one vessel.

Shape

The rim is either vertical or slightly flaring. The lip is usually approximately the same width as that of the rim and is flattened or rounded, depending upon the amount of modification caused by the application of the cord-wrapped paddle. Most of the lips either are cord-marked or were impressed by the edge of the cord-wrapped paddle, or by the implement used to decorate the rim. Only one good-sized lower body fragment is present in the collection, and it indicates that the vessel base was almost conical. Probably the majority of the vessels of this type had such bases.

POTTERY RELATIONSHIPS

As noted in an earlier paragraph (p. 402), there are three well-defined ceramic types in this collection from the Keyser site. The most common ware is the shell-tempered cord-marked wide-mouthed jar called “Keyser Cord-marked,” which has its closest relationships to the northwest and west. A very similar pottery type, from excavations in Fayette and Westmoreland counties in southwestern Pennsylvania, has already been described and illustrated by Engberg.[17] The Ceramic Repository at the University of Michigan has a large collection of sherds from the drainage area of the Monongahela and Youghiogheny rivers. They were collected from various sites by Mr. George Fisher. Some were presented to the University of Michigan by the Pennsylvania Historical Commission, which purchased one of Mr. Fisher's collections; the sherds from documented sites were obtained directly through the courtesy of Mr. Fisher. Subsequent excavation in this same area by the Pennsylvania Historical Commission, under the active direction of Dr. Mary Butler, also uncovered this same ware. Somewhat more distantly related is a shell-tempered type which has been found by Mr. Ross Pier Wright in northwestern Pennsylvania and southwestern New York and by field parties excavating for the Pennsylvania Historical Commission. Another relative of this Keyser Cord-marked type is represented by sherds sent to the Ceramic Repository from numerous sites in the Ohio Valley drainage from northwestern West Virginia by E. W. Fetzer.

There can be little hesitation in assigning the shell-tempered pottery to a group of people who were closely related culturally to what Dr. Butler has called the “Monongahela Woodland Culture.”[18] It is becoming increasingly evident that to the east and northeast of the group of sites which have been grouped together into the Fort Ancient Aspect[19] there is a cultural complex that was contemporary with and related to the Fort Ancient and Iroquois divisions. Its manifestation is contained almost entirely within the upper reaches of the Ohio drainage and can be considered the eastern border zone between those late prehistoric and protohistoric divisions now classified in the Mississippi Pattern and those which can be grouped into the Woodland Pattern. The basic shape of the pottery, the overall cord-marked surface, the lack of variety in shape, the relative simplicity of decoration, and the relative absence of utilitarian or ornamental appendages strongly suggest Woodland pottery as the direct genetic background for this type. On the other hand, the shell tempering, the spare use of rectilinear incised and punctate decoration, together with the use of small solid rim lugs and an occasional strap handle, represent the Mississippi ceramic ideas which have been engrafted upon the older Woodland tradition. These Mississippi influences are not so strongly represented on the pottery from the Keyser site as they are on that from southwestern Pennsylvania. Their modifications are analogous to those on the pottery of the Fort Ancient Aspect.

A connection between the Keyser Cord-marked and the Potomac Creek Cord-impressed types at the Keyser site can be recognized in certain features. The fundamental shape is very much the same, but a rounded bottom is typical for the shell-tempered ware and a conoidal bottom for the grit-tempered. Both types have the exterior surface malleated with a cord-wrapped paddle, although the resultant surfaces are somewhat different.

On both types the lip surface is sometimes cord-marked or notched with a cord-wrapped dowel or the edge of the cord-wrapped paddle. The differences between these types are equally if not more important. The shell-tempered type probably has a higher percentage of rims that gradually flare outward; the small solid lug on the outer rim is an integral part of the decoration, and the incised and punctate sherds find no counterpart in the grit-tempered type. The cord-marked surface extending to the lip and the predominant notched lips provide a distinctive upper rim treatment which is characteristic of Keyser Cord-marked.

The Page Cord-marked type, with its added rim strip, suggests a connection with a limestone-tempered ware found by Fowke at Gala, Botetourt County, Virginia,[20] and by Holmes at a site three and one-half miles north of Luray, Virginia.[21] The ware discovered at these sites is limestone-tempered. The exterior surface of most of it is covered with cord-wrapped paddle, but there is some use of what may have been a plain plaited fabric and a net fabric. The dominant use of an added outer rim strip which has finger notches or incised notches across its lower margin, or a horizontal row of small punctates just below the lip, serves to distinguish this Woodland type from the ones discussed in this paper. The type of rim-strip decoration found at the Keyser site is significantly different, however, from that obtained by Fowke, but that obtained by Holmes is quite similar and also suggests a strong connection with the Potomac Creek Cord-impressed type. The pottery most closely connected with the sherds from Gala is described in Holmes' text as Piedmont Virginia ware, but in the illustration they are called members of the Chesapeake-Potomac Group. Actually both designations would be correct.

The pseudo-cord-impressed and cord-impressed decorated pottery was classed by Holmes as a subdivision of his Middle Atlantic Province. This subdivision extended from the coastal area of the Carolinas as far north as Maine. One of the most important problems of the eastern United States culture history is the classification of the different ceramic types along the seaboard and their arrangement in a chronological sequence in the various subareas. The particular subgroup into which these grit-tempered sherds from the Keyser site can be placed Holmes called “Potomac Creek Ware,” the type site being an Algonquian village called Pottowomeck.

Recently excavated sites in the Washington area will undoubtedly provide a sounder basis for a comparative statement on the ceramic connections of this Potomac Creek Cord-impressed type.[22] As a distinctive entity within the very broad Woodland pottery tradition it can confidently be said that this type does not extend very far south of the Rappahannock or very far north of the Susquehanna. Bushnell[23] presents pottery from Jerrys Flats, Richards Ford, and Forest Hall, and from an unnamed site near “the large island” in the Rappahannock which belongs to the same Potomac Creek type. He also illustrates pottery from the same and adjacent sites that does not belong to the Potomac Creek Cord-impressed type. In another publication Bushnell[24] figures pottery from the site of Pisaseck which bears little resemblance to the grit-tempered sherds from the Keyser site or to the majority of the pottery he illustrated in his earlier publication from the sites above the falls of the Rappahannock. Just what material collected by him from the area formerly occupied by the Virginia Siouan tribes actually belonged to that linguistic stock is still a matter of controversy. The pottery from the sites along the James reproduced by Bushnell[25] does not closely resemble the Potomac Creek Cord-impressed type or the net or plain plaited fabric (not coiled) pottery that occurs farther north on the coastal area. The Woodland pottery found along the Coastal Plain and the Piedmont area of the Carolinas and Georgia does not indicate a close relationship with the Potomac Creek type. There is only a general resemblance between the Potomac Creek type and the cord-marked grit-tempered or clay-tempered Woodland pottery of the Tennessee, Ohio, and central and lower Mississippi Valley drainages. The ceramic connections are rather to the north along the Coastal Plain and the drainage systems flowing into the Atlantic, until in the New York area there is a westward spread of cord- and pseudo-cord-impressed decoration which carries across southern Canada north of the Lakes and across Michigan and Wisconsin into Minnesota.[26] The techniques employed, but not the actual designs, are the same as those which appear on the Owasco Aspect of New York.[27] The same decorative concepts occur on Woodland ware in the vicinity of New York City[28] and on north into New England.[29] The northern limit is apparently in Nova Scotia.[30] Pottery with a similar decorative technique is widespread throughout Michigan[31] and Wisconsin and into Minnesota. There would be little difficulty, however, in separating distinct ceramic types throughout this distribution if sufficient attention were paid to the material.

It should be noted that the pottery of the Potomac Creek Cord-impressed type has been called “Siouan” by Bushnell and “Algonquian” by Holmes and others.[32] It does not occur on known Siouan sites of the early historic period in southern Virginia and the Carolinas, nor has it been found in the upper Ohio drainage. The related types to the north of Virginia have usually been associated with Algonquian-speaking groups. The majority of related sites in Michigan and Wisconsin have been attributed to Algonquian divisions, but there has been a tendency on the part of some to suggest an Iroquoian connection for the Younge site. The related pottery in Minnesota and northwestern Wisconsin has been confidently assigned to the Dakota Sioux.[33]

POTTERY SUMMARY

The pottery from the Keyser site is composed of two major and one minor ceramic types. The dominant type is a shell-tempered cord-marked wide-mouthed jar called “Keyser Cord-marked,” which belongs in the same cultural division as the late prehistoric and protohistoric

cultures of southwestern Pennsylvania. The limestone-tempered subgroup of the grit-tempered ware called "Page Cord-impressed" finds close connections in the immediate area, whereas the cord-impressed and pseudo-cord-impressed grit-tempered sherds were called "Potomac Creek Cord-marked," since they are closely related to if not identical with the Potomac Creek type defined by Holmes. Though the evidence is by no means clear, there is a suggestion that the granular tempered wares may be slightly older on the Keyser site. It is roughly estimated that the site was occupied sometime between 1550 and 1650.

Food Remains

Since practically the entire economy of the Indians revolved around the procurement and preparation of foodstuffs, it is of interest to note the results of their efforts as shown by the food remains pre served in the excavations. These may be divided as floral and faunal.

The floral portions of the diet were undoubtedly of greater importance than is indicated by the scanty remains. The principal articles of such food were corn, squash, and beans, which were cultivated in the garden patches of the village. These were supplemented by the nuts, seeds, berries, and roots that could be gathered from the surrounding forests, along the river banks, and on mountain slopes.

Carbonized remains of the following foods[34] were found:

Corn	*Zea mays*; abundant
Black walnut	*Juglans nigra* L.; abundant
Big shellbark	*Carya laciniosa* Michx. f.
Sweet pignut (a hickory)	*Carya glabra* Mill.
Squash	(Identification not definite); scarce
Papaw	(Identification not definite); scarce

By far the most plentiful of the remains of foodstuffs were the bushels of animal bones and the pecks of mussel shells, which indicate the great dependence placed on the animal kingdom as a source of food. Among the animals most sought after was the Virginia deer, to judge by the fragments of antler and bone refuse in the pits. All the long bones were cracked to extract the marrow contained in them. Apparently every type of animal in the area was consumed. A list of the mammals identified by the osseous remains follows:[35]

Opossum	*Didelphis virginiana marsupialis*
Elk	*Cervus canadensis*
Deer	*Odocoileus virginianus*
Bear	*Euarctos americanus*
Dog	*Canis familiaris*
Raccoon	*Procyon lotor*
Otter	*Lutra canadensis*
Fox	*Urocyon cinereoargenteus*
Wildcat	*Lynx rufus*
Mountain lion (cougar)	*Felis concolor*
Weasel	*Mustela frenata noveboracensis*
Skunk	*Mephitis mephitis*
Squirrel	*Sciurus carolinensis*
Rabbit	*Sylvilagus floridanus*
Muskrat	*Ondatra zibethica*
Groundhog	*Marmota monax*
Beaver	*Castor canadensis*

Bones of birds, especially those of the turkey, were second in abundance to those of the mammals. The amount of splintered and fragmentary bone indicates that birds were an important article of diet. Not many species are represented in the collections, but undoubtedly additional ones were considered "fair game." The species identified by bones are as follows:[36]

Wild turkey	*Meleagris gallopavo*
Turkey buzzard	*Cathartes aura*
Bald eagle	*Haliaeetus leucocephalus*
Whistling swan	*Cygnus columbianus*

The amphibians were well represented by two species. One of these is the fresh-water terrapin, or slider. Many bones and fragments of the carapace and plastron were scattered throughout the digging, but there was no indication that these were utilized for ornaments or implements. The second species is the common box tortoise found plentifully in the woods.[37]

That fish were caught and consumed is shown by the presence of one unfinished fishhook, one net sinker, and one fish scale discovered in a pit. Fish abound in the river adjacent to the site, and include bass, carp, perch, catfish, and many smaller species.

Mollusks of various types were eaten and also furnished raw material for artifacts. The river, alternating between a series of rapids and long stretches of still deep water, offered ideal living conditions for a variety of shellfish. Snails of different kinds were also employed to vary the diet, and both land and water species were recovered. The following species, all of which are still found in the region, were identified from the remains:[38]

MUSSELS

Elliptio complanatus (Dillwyn), mainly from the rapids
Anodonta cataracta Say, mainly from the rapids
Lampsilis cariosa (Say), mainly from the deeper water

FLUVIATILE SNAILS

Campeloma decisum Say, from sandy or muddy bottoms

TERRESTRIAL SNAILS

Mesodon thyroidus Say, from sandy or muddy bottoms
Triodopsis albolabris Say, from sandy or muddy bottoms

Conclusions

It is difficult at this time to reach any satisfactory conclusion regarding the cultural affiliations of the site. The presence of three pottery types as distinctive as those at Keyser farm site indicates a commingling in the Page Valley of three different cultural units. At this time it is uncertain whether these types were contemporary or whether the Page Cord-marked and possibly the Potomac Creek Cord-impressed were slightly earlier than the Keyser Cord-marked type. With the possible exception of the Monongahela Woodland Aspect the related culture groups in the immediate area have not been adequately described or illustrated in the literature. Fortunately this condition can be remedied in the period after the war by the publication of a number of reports already prepared, and by others on sites in the Washington area which have been excavated.

The Page Cord-marked type is most closely connected to the Shenandoah Valley area, and it is probably the end product of a considerable period of local ceramic development. It is a variant of a pottery series of the widespread Woodland ware. Another type of this series was found at Gala.[39] Limestone-tempered sherds of a related type were collected by Manson and MacCord near Alma, Virginia, about twenty-five miles south of the Keyser site, where they were associated with complicated stamped pottery of the South Appalachian area. These sherds most closely resemble the style of stamping of the late prehistoric period, and they mark the most northerly record of the complicated stamp east of the Appalachians.

The Keyser farm site is not far removed from the Monongahela Woodland sites or some of the Chesapeake area Woodland sites of a late period. The similarity of pipe shapes and decorations between the Monongahela area, the Shenandoah Valley, and the coastal area is evidence of cultural interchange between these areas.

The antler and bone artifacts are not particularly diagnostic. The unusual antler ornaments can be interpreted as local representatives of a rather widespread trait which was present in the eastern United States from at least the Middle Woodland period of Hopewell domination. The notched turkey metatarsal awl is found in considerable numbers in Fort Ancient sites and also in the Dallas Focus of eastern Tennessee.[40] The remainder of the artifacts are at present of relatively little value in indicating closer cultural affiliations. The burial position and the site arrangement can be assigned to the general Woodland culture of the late prehistoric and early historic period along the central Atlantic coast.

* The sections dealing with the excavation and the artifacts were prepared by Carl Manson and Howard A. MacCord. The one on the pottery was prepared by James B. Griffin, who also edited the manuscript and arranged the illustrations. In addition to the individuals referred to in the footnotes the writers are indebted to Frank M. Setzler, Neil Judd, and Waldo Wedel, of the Department of Anthropology of the United States National Museum, for advice and encouragement during the excavation of the site and the writing of the report.

[1] Fowke, 1894.

[2] The fall flood of 1942 severely damaged the site.

[3] The field notes and the majority of the artifacts are now in the collections of the United States National Museum. A representative series of sherds are in the Ceramic Repository for the Eastern United States at the University of Michigan.

[4] Butler, 1939, pp. 12-13.

[5] Augustine, 1940, pp. 51-58.

[6] Hrdlička, 1927.

[7] Stirling, 1935, p. 374.

[8] Parker, 1922, p. 351.

[9] Private correspondence with W. A. Ritchie, May, 1940.

[10] Harrington, 1922, p. 207.

[11] Speck, 1940, fig. 30.

[12] Moorehead, 1922, pp. 107-108, 126-127.

[13] Ritchie, 1934, Pl. XIII.

[14] Fowke, 1894, pp. 49-53.

[15] Holmes, 1897, pp. 100-103.

[16] Holmes, 1903, p. 158.

[17] Engberg, 1930, 1931.

[18] Butler, 1939.

[19] Griffin, 1943.

[20] Fowke, 1894, p. 17.

[21] Holmes, 1903, pl. CXXXIV.

[22] Stewart, 1939 and 1940.

[23] Bushnell, 1935.

[24] Bushnell, 1937.

[25] Bushnell, 1930.

[26] The recent find of pseudo-cord-decorated pottery as part of the culture associated with an "early" Marksville period mound in Louisiana is significant in estimating the antiquity of this style of decoration in the north and the age of the Marksville period in the lower Mississippi Valley. Ford and Willey, 1940, p. 88, fig. 20j-k, fig. 28 c; fig. 34.

[27] Ritchie, 1934 and 1936.

[28] Skinner, 1919.

[29] Willoughby, 1935.

[30] Smith and Wintemberg, 1929.

[31] Greenman, 1937.

[32] Ferguson, 1937.

[33] Wilford, 1941.

[34] Identified by Dr. Paul G. Russell, of the Bureau of Plant Industry.

[35] Identified by Dr. Remington Kellogg, United States National Museum.

[36] Identified by Dr. Herbert Friedmann, United States National Museum.

[37] Identified by Dr. Leonhard Stejneger, United States National Museum.

[38] Identified by Dr. J. P. E. Morrison, United States National Museum.

[39] Fowke, 1894, pp. 17-23; also Griffin, 1943, pp. 193-194, and Pl. CXXVII.

[40] Prepublication data, by courtesy of the Department of Anthropology of the University of Tennessee.

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PLATE I

FIG. 1. The Keyser farm site, looking east from stake C4 (see Fig. 2)

FIG. 2. The Keyser farm site, with Massanutten Mountain in the background

FIG. 3. Pit outlines delineated by stakes after removal of topsoil

PLATE II

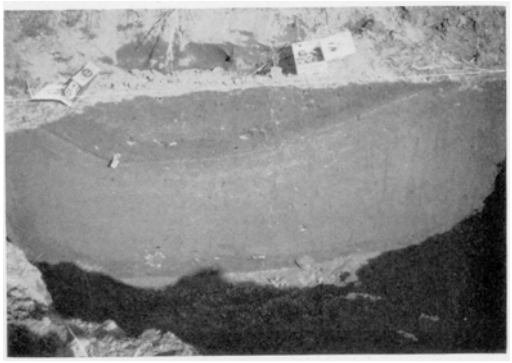


FIG. 1. Profile of Pit 82, with dark upper level clearly differentiated from light lower level

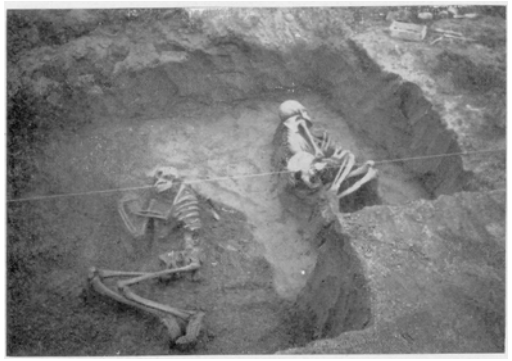


FIG. 2. Burials 5 (right) and 6

FIG. 3. Burials 9 and 10. The pottery vessel beside the skull is illustrated in Plate X, Figure 1

PLATE III

FIG. 1. Burial 20. A female with funerary jar (illustrated in Pl. X, Fig. 2) at right shoulder

FIG. 2. Burial 21, with posthole outlines bordering Pit 77

FIG. 3. Burial 16. An adult female

PLATE IV

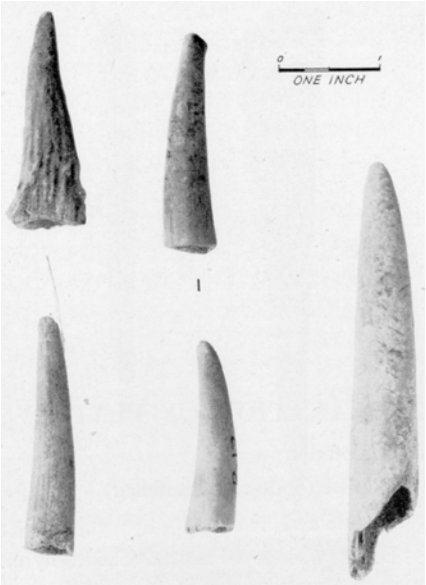


FIG. 1. Antler projectile points

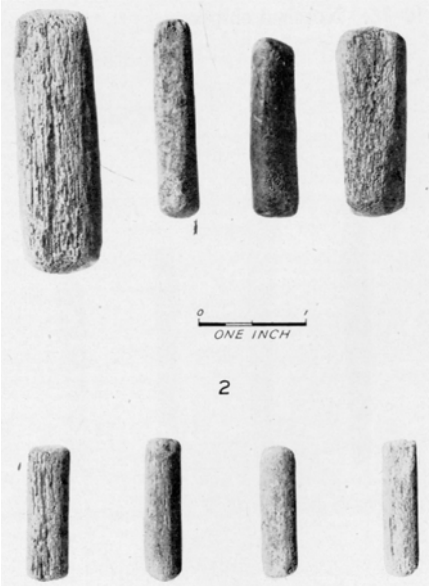
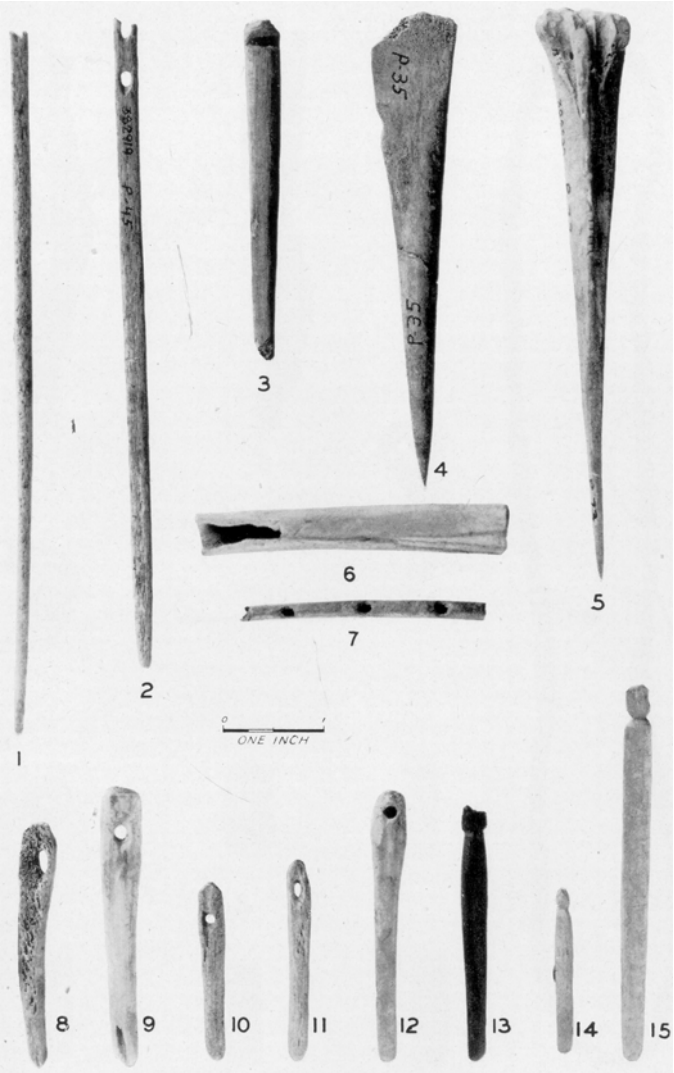


FIG. 2. Antler drifts

United States National Museum negatives 36328-A (Fig 1) and 36328-D (Fig 2)

PLATE V



Bone implements (U. S. N. M. neg. 36328-B)

EXPLANATION OF PLATE V

FIGS. 1-2. Bodkins

FIG. 3. Chipper (hollow and notched)

FIG. 4. Scapula awl

FIG. 5. Turkey tibiotarsal awl (notched tally marks)

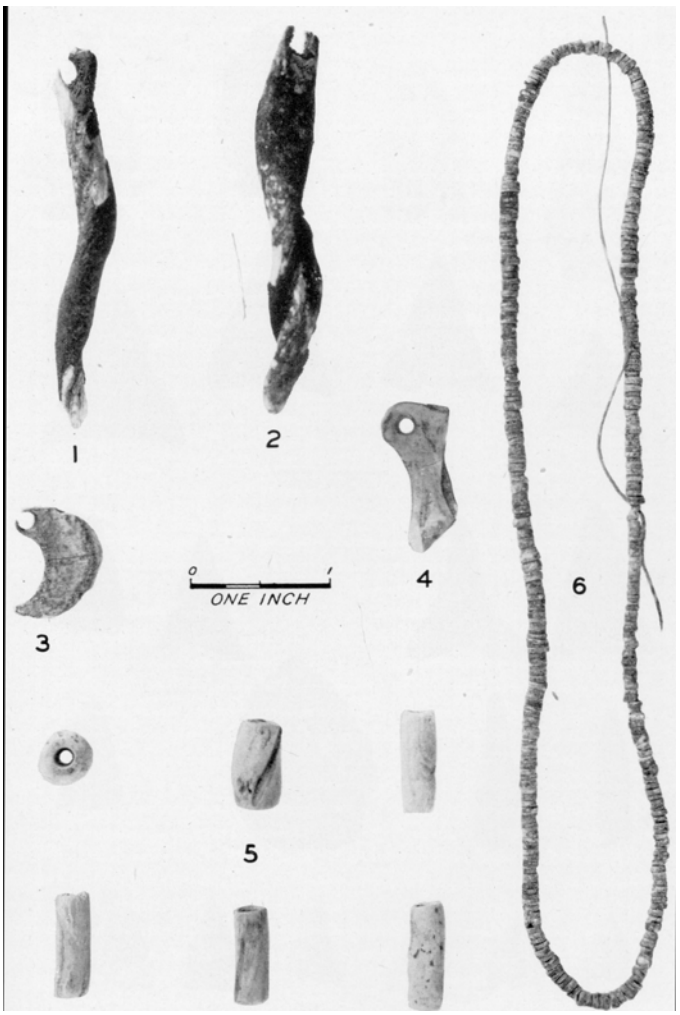
FIG. 6. Bone tube from Pit 73

FIG. 7. Whistle from Pit 28

FIGS. 8-12. Pierced chippers

FIGS. 13-15. Notched chippers

PLATE VI



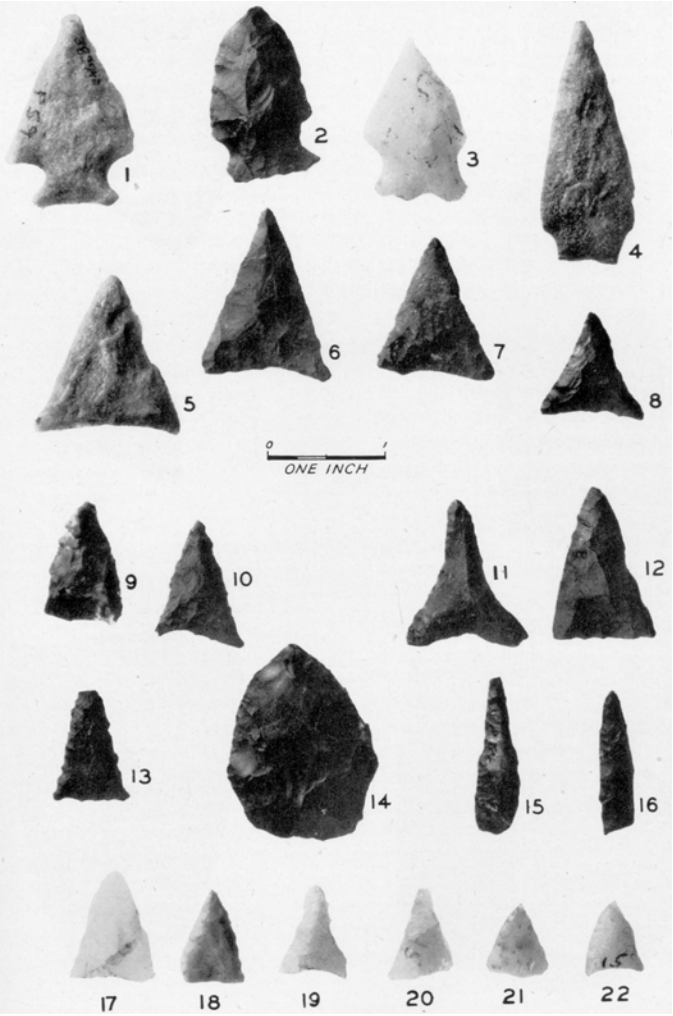
Shell ornaments (U. S. N. M. neg. 36328-H)

FIGS. 1-2. Columella pendants with Burial 12

FIGS. 3-4. Small pendants (surface finds)

FIGS. 5-6. Beads associated with Burial 24

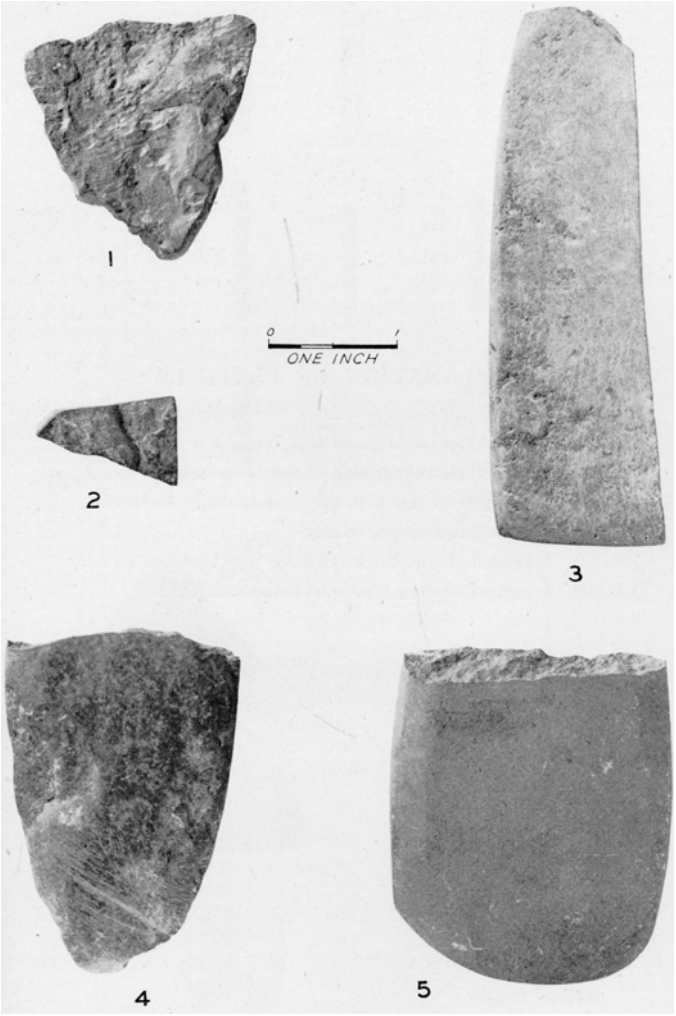
PLATE VII



Chipped stone implements (U. S. N. M. neg. 36328-G)

The materials are as follows: chalcedony, 18; chert, 21; flint, 7-9; red jasper, 13-16; quartz, 3, 17, 19, 20, 22; quartzite, 1, 4, 5; shale (?), 6; yellow jasper, 2, 10-12

PLATE VIII



Worked and polished stones (U. S. N. M. neg. 36328-C)

FIGS. 1-2. Rubbed limonite

FIG. 3. Broken stone tablet found with Burial 22

FIG. 4. Abrading stone found with Pit 45

FIG. 5. Unfinished stone tablet

PLATE IX

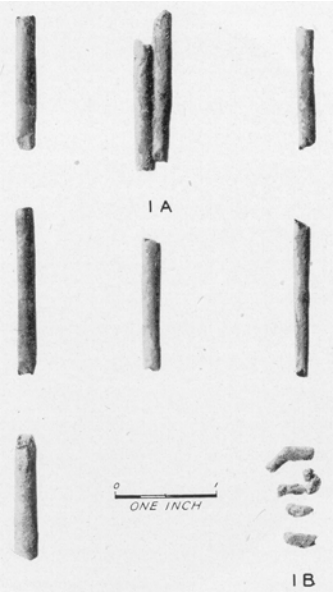


FIG. 1. Copper beads (U. S. N. M. neg. 36328-E)

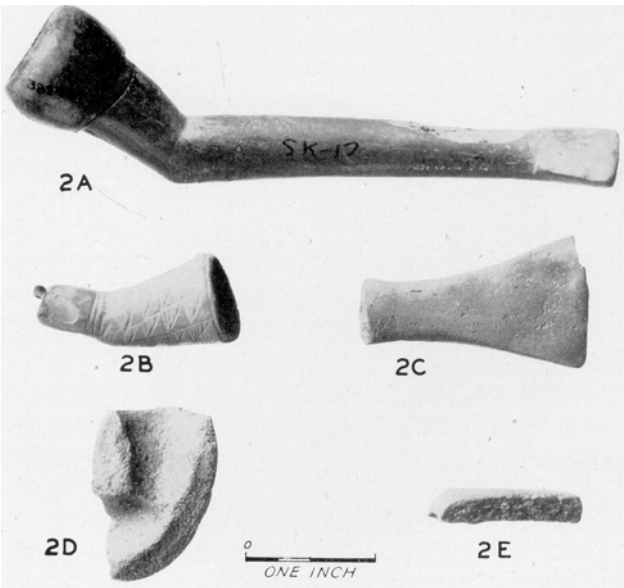


FIG. 2. Pipes and pipe fragments (U. S. N. M. neg. 36328-F)

EXPLANATION OF PLATE IX

FIG. 1A. Large copper beads associated with Burial 12

FIG. 1B. Small copper beads found with Burial 1

FIG. 2A. Obtuse-angled elbow pipe of clay with flattened mouthpiece

FIG. 2B. Elbow pipe of clay with fine dentate design on bowl

FIG. 2C. Flattened mouthpiece of clay

FIG. 2D. Fragment of stemless ovoid stone pipe found on surface

FIG. 2E. Fragment of stone pipe bowl found with Burial 7

PLATE X

FIG. 1 (Burial 10)

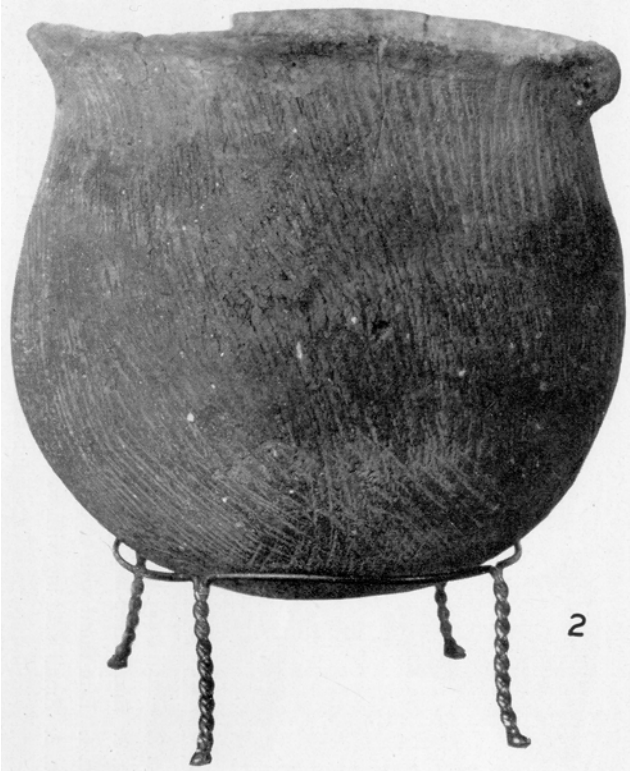
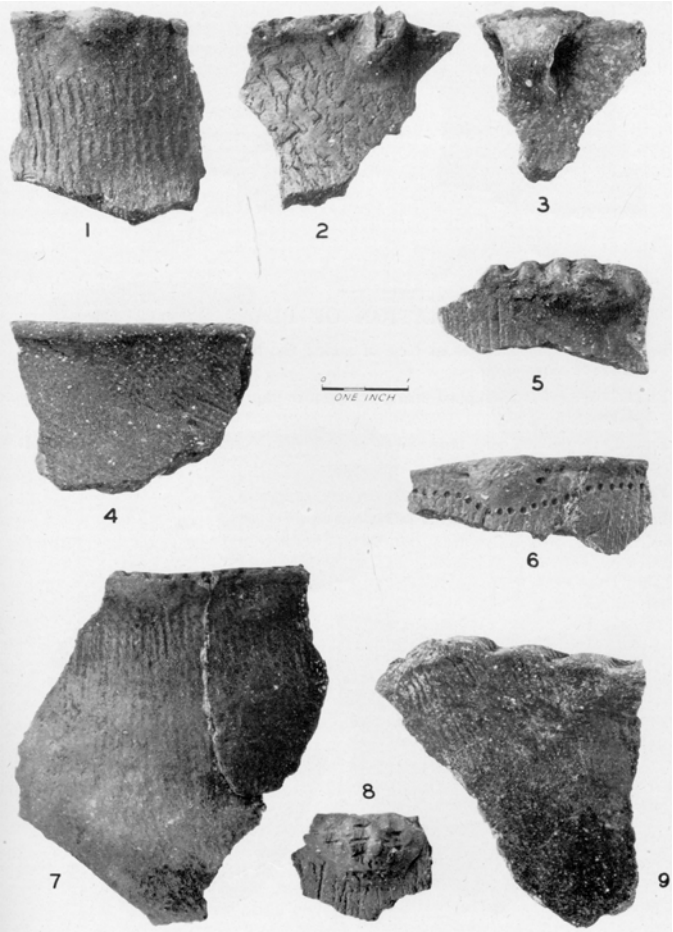


FIG. 2 (Burial 20)

Keyser Cord-marked jars (U. S. N. M. neg, 36328)

PLATE XI



Sherds of Keyser Cord-marked type (U. S. N. M. neg. 36340-B)

EXPLANATION OF PLATE XI

FIG. 1. Small solid lug attached to outer rim at level of lip

FIG. 2. Small solid lug with V-shaped gash

FIG. 3. Small strap handle

FIG. 4. Rim sherd with cord-wrapped paddle impressions on surface of lip

FIG. 5. Small solid lug with cord-wrapped stick impressions

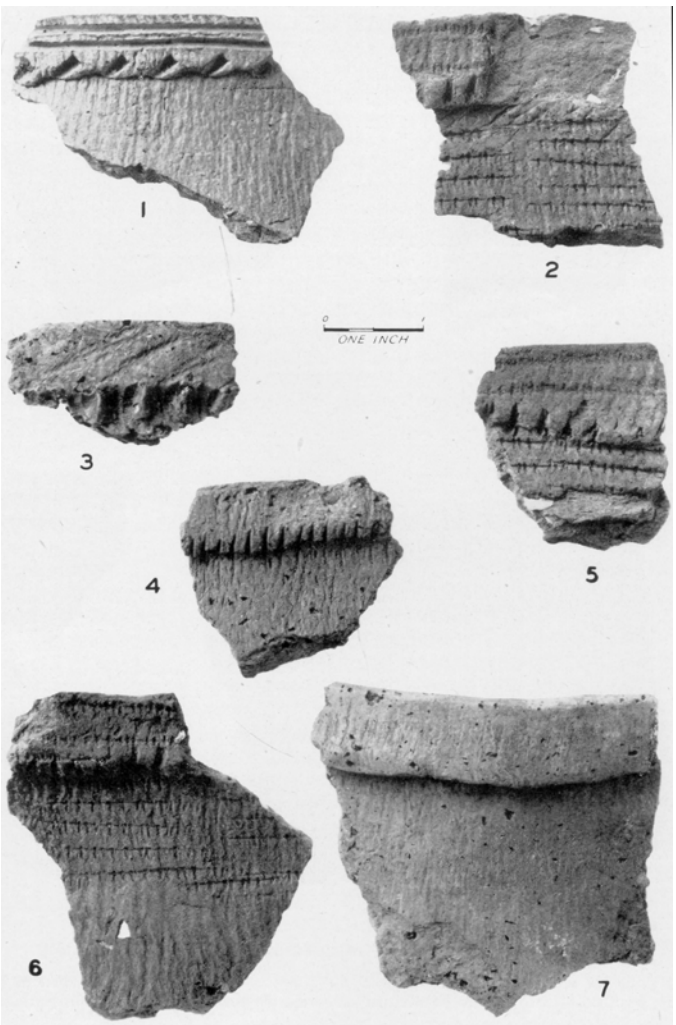
FIG. 6. Small lug with small horizontal perforation and horizontal row of punctates

FIG. 7. Small circular punctates on surface of lip

FIG. 8. Cord-wrapped stick impressions applied vertically on small lug

FIG. 9. Cord-wrapped stick impressions applied transversely on lip surface

PLATE XII



Page Cord-marked sherds (U. S. N. M. neg 36340)

EXPLANATION OF PLATE XII

FIG. 1. Oblique punctates at base of added rim strip, with horizontal incised lines on rim

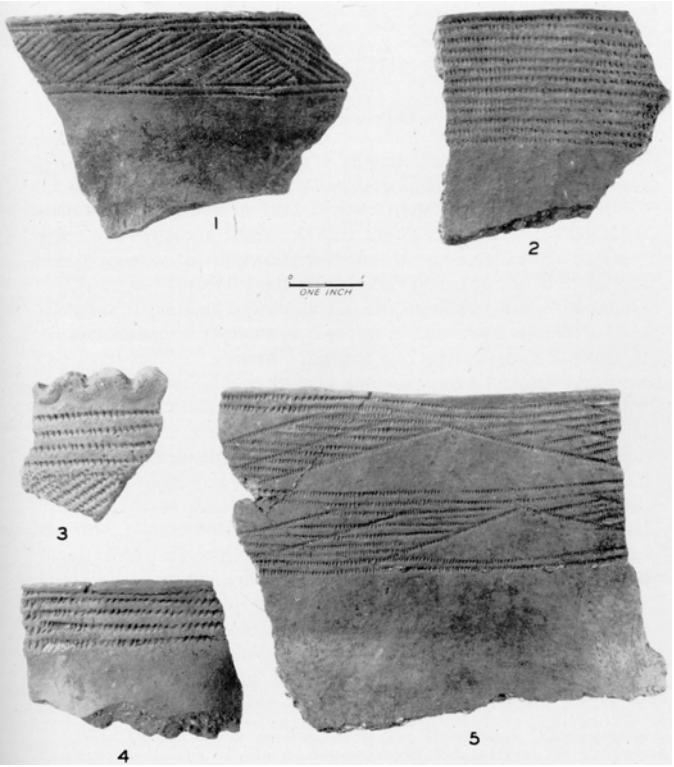
FIGS. 2, 5-6. Cord-wrapped string or cylinder impressions on upper and lower rims

FIG. 3. Individual cord impressions on rim and thumbnail gouges at base of added rim strip

FIG. 4. Short vertical gashes at base of thickened rim

FIG. 7. Undecorated rim with added rim strip

PLATE XIII



Potomac Creek Cord-impressed rims (U. S. N. M. neg. 36340-A)

These five rims have a decoration of the type called pseudo-cord in the text. A cord wrapped around a narrow pliable element was impressed on the plastic prefired rim

SOME NEW DATA ON THE GOODALL FOCUS

GEORGE I. QUIMBY, JR.

SOME additional data on the Hopewellian occupancy of southwestern Michigan and northwestern Indiana have been gathered since the publication in 1941 of my article "The Goodall Focus," which was written in 1938.[1] At that time I was unaware of the existence of most of the new material[2] that is presented in this paper.

The term "Goodall Focus," which is applied to one of many foci belonging to various aspects of the Hopewellian phase,[3] designates the archaeological remains of a group of culturally related Indians who lived in southwestern Michigan and northwestern Indiana in prehistoric times. These Indians probably were farmers who were also dependent upon hunting, fishing, and the gathering of wild foods. For ceremonial purposes they constructed dome-shaped burial mounds of earth and had elaborate funeral rituals in which fine ornaments, tools, and clothing were placed in the graves. Tools and ornaments were made of copper, silver, stone, bone, wood, shell, and mica. Garments were manufactured from animal skins and woven cloth. Several varieties of fired clay pottery were used by these Indians, one of which was possibly imported.[4] Nicely executed stone platform pipes provide evidence of their smoking.

Stratigraphic, typological, and distributional studies of other Hopewellian foci show clearly that the Goodall focus is the product of a cultural movement into southwestern Michigan and northwestern Indiana, probably from Illinois by way of the Kankakee River. The individual sites are distributed along drainage systems in such a way that it looks as if there had been a progressive movement northward from one river valley to another, without, however, any appreciable loss of contact with the main culture center or centers in Illinois.

In another paper[5] I have contended that the south-to-north geographic distribution of river valleys containing sites has temporal significance. The St. Joseph, Grand, and Muskegon rivers, named in order from south to north, all flow in a westerly direction into Lake Michigan. The Goodall focus occupancy of the Muskegon Valley is northernmost and therefore represents the latest known period in Goodall focus history. Similarly, the Grand River occupancy is earlier than that of the Muskegon Valley, and the sites in the St. Joseph Valley are earlier than those in the Grand. The southernmost and oldest occupancy in the series is represented by sites in the area drained by the headwaters of the Kankakee. Of course, there must have been some cultural overlapping from one river valley to another and, therefore, chronological overlapping from one period to another, but, by and large, the settlement of each valley seems to have been temporally distinct. Typological studies of the Goodall focus ceramics tend to strengthen this hypothesis.[6] The cultural outline and the conjectural

chronology, which have been presented in summary fashion, are intended only for purposes of orientation.

The Goodall site is in northwestern Indiana in the region drained by the headwaters of the Kankakee River. The new material from it is in the collections of the Field Museum (see Pl. I). There are seven small to medium-sized copper celts which are ovate-oblong in outline and narrow-rectangular in section (Figs. F-G, L, S-U, W). One has a slightly flaring bitt (Fig. F); three others are also ovate-oblong in outline, but have flaring bitts and are plano-convex in section (Figs. H, K, V). A fragment of twined fabric adheres to the convex surface of one of these three (Fig. H). There are five double-pointed copper awls, three of which are illustrated (Figs. A-C). Four are short, and one is long. The last, which is the best preserved, clearly shows that the point on one end is sharper and tapers more gradually than the other. Possibly the dull point was jammed into a handle of some kind. Three small fragments of copper appear to be broken sections of awls.

Copper ornaments from the Goodall site are one small spheroidal bead (Fig. I), two small tubular beads made from rolled sheets (Fig. I), one fragmentary hemisphere, which probably was the covering for a wooden button (Fig. J), and two earspools (Fig. O). Each earspool consists of a flat disk joined by an axle to a concavo-convex disk.

Woven cloth is represented by one fragment adhering to a copper celt and by three impressions preserved by copper salts on the surfaces of three celts. The weaving is plain twining of several varieties. The cordage, which is probably bast, is made of two strands twisted clockwise.

The Marantette site is located in the St. Joseph River Valley near the town of Mendon in southwestern Michigan. Material from this site comprises one large, thick tubular bead of copper (Fig. D) and two copper earspools nearly identical with those already described for the Goodall site (Fig. P). All these artifacts are in the Field Museum.

It is interesting to note that copper earspools are found only at sites in the Kankakee and St. Joseph drainages. In view of the geographic-temporal relationships previously postulated, it is probable that earspools are to be associated with the early phases of Goodall focus history and were not used in the late phases represented by the occupancies of the Grand and Muskegon valleys. These spools are unique in that one of the disks in each is flat. The usual Hopewellian variety consists of two disks, which are concavo-convex.

Although hundreds of earspools have been excavated from Ohio Hopewell mounds, there is only one published record of the finding of such spools of the Goodall-Marantette type. A pair came from the Tremper site.[7]

Because most of the cultural similarities of the Goodall focus are with Hopewellian sites in Illinois it seems reasonable to assume that the Goodall-Marantette type of earspool should occur in Illinois also. Unfortunately, such an occurrence cannot be demonstrated because these spools are rarely found in Illinois Hopewellian sites, and the published descriptions of those that have been excavated are not adequate for comparative purposes.

It is unlikely that the Goodall-Marantette type of earspool does not indicate a cultural connection of some kind with other Hopewellian groups. If future evidence demonstrates that this type is lacking in Illinois, I should be inclined to assume that there was contact between some parts of the Goodall focus and some Hopewell groups in Ohio. In my opinion such contact would be of less importance, however, than the contacts with Hopewellian groups in Illinois that have been formulated upon a greater number of cultural similarities.

The Converse site is in the Grand River Valley in the city of Grand Rapids, Michigan. Artifacts from it in the Field Museum include two large ovate-oblong copper celts that are narrow-rectangular in section. One is here illustrated (Fig. E). Additional artifacts are one small copper celt, which is ovate-oblong in outline and narrow-rectangular in section (Fig. R); one long copper needle, square in section at the middle and broken halfway across the eye (Fig. Q); and two medium-sized copper awls, round in section, one of which has an end wound with gut or plant fiber (Figs. M-N).

A visit to the Peabody Museum, Cambridge, Massachusetts, enabled me to ascertain that two silver artifacts which I had thought to be historic trade material associated with intrusive burials[8] were actually prehistoric and therefore should have been included in the original list of culture traits for the Converse site. One that is rather fragmentary appears to be a large sheet-silver arm band. The other is a silver band corrugated on one side.[9] Artifacts of this type, which have been called “conjoined tubes,” probably were musical instruments. The complete instrument had reed or bone pipes inserted in the tubes. Such panpipes made of silver, copper, or iron have been found in Michigan, Illinois, Wisconsin, Ohio, Tennessee, Alabama, and Florida.

The Brooks site, located in Newaygo County, Michigan, along the Muskegon River, is the northernmost site in the Goodall focus.

In the Muskegon County Museum there is an additional pottery vessel from this site — a small jar about 13 cm. high and 7 cm. in diameter at the mouth. It has a quadrilobate body, a rounded bottom, a constricted shoulder area or “neck,” and a slightly flaring rim which terminates in a flattened, insloping lip. The upper rim is thickened and cambered.

The paste of which this vessel was constructed is medium to fine in texture, tempered with small particles of granitic rock, has a surface hardness of 2-2.5, and color ranges in buff and gray. The surface is smooth. Decorative techniques, which are rather poorly executed, consist of incising and punctating. The

ornamentation, which covers the exterior from lip to base, is as follows: There is a narrow band of closely spaced crosshatching that is confined to the thickened area of the upper rim. The individual incised lines are narrow, a millimeter or less in width. Beneath this band is a single row of small hemiconical punctates, punched from the left. The remaining smoothed area of the rim and upper shoulder is decorated with two or three rather wide (2 to 3 mm.) shallow incised lines that make a pattern of curvilinear meanders around the vessel. The interlobate areas are smooth and undecorated, but the lobate areas are outlined by narrow shallow incised lines and are filled with short parallel vertical lines of similar type. This vessel appears to be a poor copy of the exceptionally fine Hopewellian ware of the limestone-tempered variety.

In general, the new data do not change the interpretations and conjectures set forth in my first paper, "The Goodall Focus." Traits hitherto unreported for this focus are copper earspools, a copper needle, a silver conjoined tube, and a silver arm band. Other data presented here serve to enrich our knowledge of the culture content of particular sites and also of the frequency of a trait in a given site.

FIELD MUSEUM OF NATURAL HISTORY
CHICAGO, ILLINOIS

[1] "The Goodall Focus, an Analysis of Ten Hopewellian Components in Michigan and Indiana," *Prehistory Research Series*, Vol. 2 (1941), No. 2. Published by the Indiana Historical Society.

[2] Dr. James B. Griffin of the Museum of Anthropology, University of Michigan, has kindly brought to my attention much of the new material presented in this paper.

[3] The terminology and the system of classification have been described by W, C. McKern, "Midwestern Taxonomic Method as an Aid to Archaeological Culture Study," *American Antiquity*, 4 (1939): 301-313.

[4] Quimby, *op. cit*. (see note 1), and "Hopewellian Pottery Types in Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 26 (1940): 489-494. 1941.

[5] *Idem*, "The Ceramic Sequence within the Goodall Focus," *Pap. Mich. Acad. Sci., Arts, and Letters*, 28 (1942): 543-548. 1943.

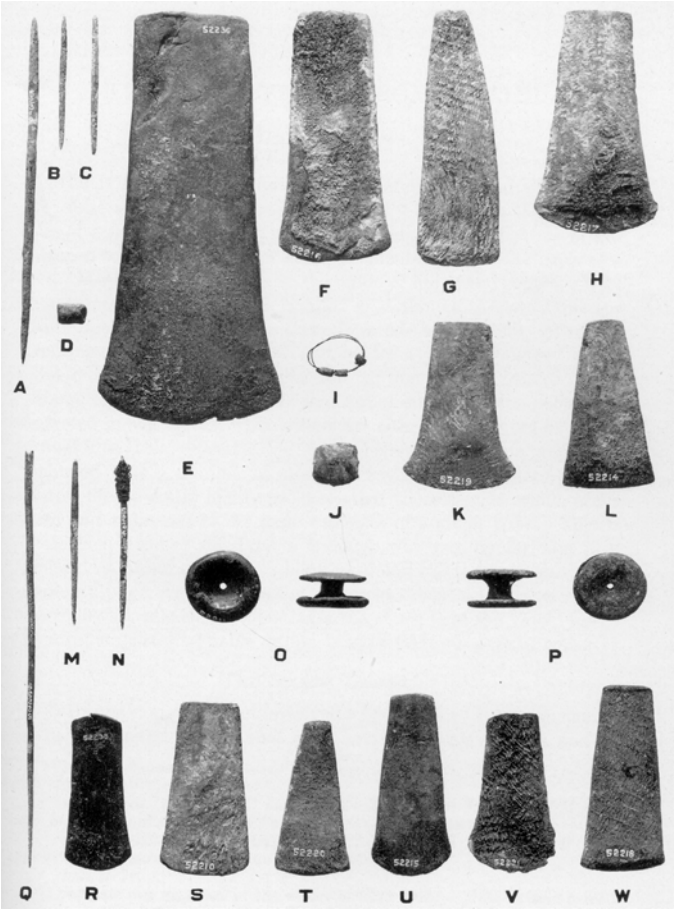
[6] *Op. cit*.

[7] Mills, Wm. C, "Exploration of the Tremper Mound." *Certain Mounds and Village Sites in Ohio*, 2: 216. Columbus, 1917.

[8] "The Goodall Focus," p. 100, note 30 (see note 1 of this article).

[9] This artifact is mentioned by Chas. C. Willoughby, "The Turner Group of Earthworks, Hamilton County, Ohio," *Papers of the Peabody Museum*, 8, No. 3 (1920): 51.

QUIMBY PLATE I



Copper artifacts of the Goodall Focus

Converse mounds: celts, E and R; needle, Q; awls, M and N

Goodall mounds: celts and adzes, F-H, K-L, S-W; awls, A-C; beads, I; covering for button, J; earspools, O

Marantette mound: bead, D; earspools, P