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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

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VOLUME XXIII

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

Ann Arbor

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RIZALITES — PHILIPPINE TEKTITES — WITH A DESCRIPTION OF THE PUGAD BABUY SITE

RALPH BUSICK

HISTORY OF THE DISCOVERY OF RIZALITES

DURING 1926 the first rizalite that attracted the attention of Manila scientists was found in an archaeological site at Novaliches, Rizal Province, where the government was making extensive excavations for the construction of the dam and reservoir which now supply the city of Manila with water.

Because of the fact that, in the main, this strange body seemed to resemble ordinary "natural" glass, yet varied in composition and properties sufficiently to arouse interest, there was considerable doubt and some disagreement among local scientists in regard to its source. Generally, however, it was thought to be of volcanic origin.

For two years, according to Beyer,[1] matters stood thus — until Overbeck[2] visited the Philippines, saw this tektite and others found in the same region, and suggested that they were very similar to billitonites, tektites found on the island of Billiton in the Netherlands East Indies. This observation redoubled Beyer's interest in the tektites, and led them to conduct an intensive search for specimens throughout that immediate region, with most fruitful results on what came to be known as the Pugad Babuy site. It was in connection with the research on this site that the writer worked with Beyer during the later months of 1933, all of 1934, and January and February of 1935.

It happened that, shortly after the first discoveries, an American by the name of Lake, who lived in the neighborhood of the barrio of Pugad Babuy,[3] became interested in collecting the tektites and, in the course of some months, gathered approximately four thousand specimens, a large number of which he turned over to the Bureau of Science in Manila for its museum. The obvious plenitude of the tektites led Beyer to conclude that here was one of the richest fields of these bodies on earth. Assuming that, inasmuch as there had probably been no really scientific approach to the task of

collecting them, a cursory examination of the ground in the Pugad Babuy region actually had unearthed comparatively few, and believing that there must be great numbers of them remaining, he undertook the work of gathering the specimens.

BEYER'S METHOD OF COLLECTING

At the outset Beyer decided to name the Philippine tektites "rizalites" because — to use his own words — "the first specimens were found in Rizal Province — and this name has now been quite generally accepted."

Through years of experience in collecting archaeological specimens in the Philippines, while he was at the same time engaged in a multiplicity of other pursuits, Beyer had developed a specialized technique for this kind of research. He first visited a prospective site to determine its characteristics and potentialities; then he aroused the curiosity of the inhabitants by showing them specimens of the tektites and asking if they had any. Great numbers were being picked up, of course, during Lake's activities, and the natives were familiar with the "stones." It now remained only for Beyer to gain the people's confidence, to establish a set of reasonable prices for specimens collected, and to become thoroughly acquainted with the residents of the barrio and the location of their homes and farms, or the extent of the region over which the individuals might have the privilege of searching.

When he had accomplished these things, he drew a small map showing the location of the richest deposits and the general topography of the site. Thus he was able to record the concentration or the diffusion, as the case might be, of his collections.

His practice was to visit the barrio quite frequently, almost invariably once a week during the rainy season (June to November), but missing a week occasionally during the dry season (December to May). Centrally located in the barrio was a tienda ("small store"), where the proprietor graciously permitted him to conduct the business of buying the specimens from the collectors.

Before long the children of the entire neighborhood were searching for tektites to sell, and it was unusual indeed, after the first few weeks, for an outsider to find one of the objects on the ground.

Beyer paid the children according to the number and the rarity of specimens in their finds, augmenting his payment with candy and fruits from time to time. Upon receiving a week's collection from a child he would write its name on a slip of paper, together with the amount paid for the lot, and place them together in a small sack. Frequently, too, if the collection happened to be extraordinary for some reason or other, he would question the finder closely to make certain of the approximate spot where the specimen or specimens had been found. Under this system he could determine within a few yards where every lot of specimens had lain.

Not content with this manner of collecting the majority of the tektites found in one week Beyer nearly always made a trip to the outlying homes on either side of the dirt road that bisected the site.

When he had finished this part of his work he returned to Manila and there in his office wrote an account of the trip. Later he would carefully clean the specimens and catalogue them.

CHARACTERISTICS OF RIZALITES

Bodies classified by geologists and archaeologists as tektites have been found in various parts of the world, and have been named after the regions where they were found. The best known of these include moldavites, found in the Moldau district of Bohemia and in Moravia and supposed to be associated with the late Tertiary or Recent period; billitonites, found on the island of Billiton in the East Indies; australites and the so-called obsidianites, found in Australia; Darwin glass, sometimes called queenstownite, found in Tasmania; and the pseudotektitic amerikanites found in Colombia and Peru, South America.

These bodies are of various forms described as ellipsoidal, pear-shaped, button-shaped with overhanging edge, cylindrical (slender), and cone-shaped. Beyer says that "they occur chiefly in certain regular forms such as small spheres, ovals, cylinders, dumbbell-shapes, and pointed drops (often, in rare perfect forms, with a slender tail)." Usually a fragment gives some suggestion of the shape of the tektite from which it was broken. Beyer continues:

> Such regular shapes could only be formed in nature by the revolution of a liquid or semiliquid substance in the atmosphere. These objects have also been proved to be of prehistoric origin in the places where found. The only possibility for the natural formation of such bodies upon the earth was formerly thought to be the violent ejection of liquid lava from large volcanoes. However, the chemical composition of the tektites does not correspond to the known products of any earthly volcano — and, recently, a new theory has been suggested that accounts for them on the basis of their resulting from the fusing of a portion of the earth's crust through the impact of a huge meteorite which splashed molten sand and rock high into the air. This theory has met with many objections and has been accepted only by a few scientists. The cosmic theory still remains, at the beginning of 1935, the only one which explains all of the observed facts.[4]

Rizalites have the same chemical composition that other tektites have; that is, in general, they possess the natural content of obsidian — 70 per cent to 90 per cent SiO_2 — with a higher percentage of iron and magnesium, and an excess of calcium and potassium over sodium. In the main, however, according to the *Encyclopaedia Britannica*, tektites do not show the incipient crystallization characteristic of all obsidians.

Nearly all rizalites are distinguishable from other tektites in that they have a pitted surface similar to that of an orange skin, whereas the billitonites, for example, have a deeply grooved surface of "gutters" that often resemble

worm tracks. Rizalites are opaque and, to the casual observer, appear to be black, but when held between the eyes and the light reveal a deep olive green verging on black.

The sizes of the rizalites found before 1935 range from that of a small pea up to that of a lime or small lemon. The largest does not weigh more than 250 grams.

Fragments of rizalites which obviously have long lain exposed show, on the broken surface, patination or "surface sculpture" quite similar to that typical of obsidian fragments, but there is no sign of the layerlike, or laminated, structure of Philippine obsidian.

Native peoples have made use of tektites in past ages wherever the bodies have been found, and the Filipinos are no exception. Though the majority of the larger rizalites remain comparatively untouched by human utensils, a great number of the smaller, odd-shaped ones do show evidences of having been artifacts — drills, scrapers, and the like. Moreover, the natives have names for the bodies. Concerning this matter Beyer writes:

> Scientists are not the only proponents of the meteoritic theory of tektite origin. Long ago, native peoples, seeing these round black spheres and cylinders scattered over their fields after a heavy thunder shower, came to the conclusion that they had fallen from the sky. In the Philippines, the tektites are variously known as *taeñg kulog* (thunder dung), *taeñg bituin* (star dung), and in one province *batong arao* (sun stones).
>
> Outside the Philippines, cosmic or at least heavenly explanations are equally common among native peoples . . . .
>
> The utility of the tektite glass for manufacturing flaked implements was also recognized by early man. European Moldavites have been found among the flaked implements of the old Stone Age; while practically all the Philippine and Malaysian peoples of Middle and New Stone Age times manufactured arrowheads and flaked tools from tektite glass wherever it could be found. This was true also in Australia — although many more were there carried about by the natives as valued charms.
>
> In Philippine graves dating from the Prehistoric Iron Age, tektites have also been found, showing the characteristic "carry-polish," which indicates that they were used as charms or amulets by the people of that time. In Indo-China tektites were also venerated to some degree by the late Bronze Age people, and stone images dating from the early centuries of the Christian Era have been found with polished tektites set into the eyes of the gods.[5]

THE PUGAD BABUY SITE

Although the barrio of Pugad Babuy is hardly fifteen kilometers from the heart of Manila, off what is known as the Manila North Road, it actually lies within the province of Bulacan, adjacent to the Novaliches district in the province of Rizal, where were found the first tektites that caught the scientific attention of the outside world.

The most productive section of the site is on a slight knoll which rises gently above the surrounding terrain to a height of not more than thirty or forty feet. It forms a part of the Marikina River Valley and is not more than a hundred feet above sea level. It is roughly circular and covers an area of perhaps five square kilometers. Over this area grow a scattering of bamboo and trees, most of the latter fruit trees. Farm produce consists chiefly of rice, for which a number of terraces have been built. Sugar cane and some vegetables, too, are grown, but not in abundance.

The soil is what is known as red laterite, a thin layer of which covers the tuff or tufa, or adobe, as it is generally called in the Philippines. Outcroppings of the tufa in various spots over the site suggest that the topsoil is not more than a few feet thick anywhere in the region. Inasmuch as most of the rizalites were found after a rainfall or on a freshly plowed field, it is obvious that they lay close to the surface, not within the tufa.

During the dry season the size of the weekly collections of rizalites decreased remarkably in number; but immediately the annual rains began to fall, the collections increased. A trip which did not produce at least a hundred specimens was a disappointing one, and there were occasions when Beyer took as many as seven hundred or a thousand back to Manila with him. The result of this fruitful collecting was that by the end of 1934 his collection numbered somewhere between 25,000 and 30,000 specimens. Among these the rarest were cylindrical, dumbbell-shaped, drop-shaped, and those weighing above 150 grams, of whatever shape.

Of things important to archaeologists or geologists, other than rizalites and obsidian flakes (some artifacts and some not), the Pugad Babuy site was not particularly productive. Beyer did not reject the obsidian, specimens of which invariably accompanied the tektites, though he was not particularly interested in it.

DISCOVERIES SINCE 1934

Important discoveries of other similar bodies in the Philippines were made in 1935, after the writer left Manila. Concerning these Beyer says:

> Near the end of September of this year, a very remarkable new tektite site was located at the very edge of Manila, in the Santa Mesa district. In addition to a plentiful supply of true Rizalites, three other strange forms of tektite-like bodies turned up. The first of these is a grey obsidian-like glass which tends to show the same sort of internal structure as ordinary volcanic obsidian — but which here appears in strangely rounded and sculptured small bodies of a distinctly tektite-like appearance. The second of the new classes of material shows a much more uniform glassy consistency — without the laminated body common in most Philippine obsidian — and although quite translucent, is of a color varying from a brownish-violet to almost a rose-pink. The outside appearance of these bodies is so nearly like that of true Rizalites that they can usually be distinguished from them only by transmitted light, showing the difference in color. Still a third class of new material found in the Santa Mesa site is greenish-yellow in color, but otherwise has the same glassy consistency and pitted surface as the true Rizalites.[6]

The bodies here described he calls "Philippine Amerikanites" because of their close resemblance to the tektites found in Colombia and Peru, as mentioned above. More recently, in a letter to the writer,[7] he specifies the confines of the district and adds:

The part of this new area nearest Manila is simply an extension of the Santa Mesa site, and shows Amerikanites as well as Rizalites. But the new Kubau site proper occupies the higher parts of the ridge and contains only the Pugad-Babuy type of material — but with a much more brilliant luster and deeper surface sculpture. The quantity is not as great as at Pugad Babuy, although the site is sufficiently rich. The most important part of these new finds is due to the fact that extensive new road-work and street-building in that district has given us a great number of excellent cross-sections through the entire group of soil layers down into the solid adobe. This quickly enabled us to determine exactly where the tektites lie — and we were able to prove definitely that they all come from a peculiar stratum only six to eight inches thick in most places.

This tektite-bearing layer lies just above a fairly thick layer of reddish material chiefly made up of decomposed adobe but below other soil layers of varying thickness and color. It is characterized by the presence of thousands of little nodules (called pisolites by geologists) composed mainly of iron and manganese. What connection there is between these pisolites and the tektites, if any, still remains to be determined. It has been possible in this district to get a much clearer idea of the original distribution and characteristics of the tektite material. I think that what we are finding here now may add a great deal to an understanding of the tektite question, and narrow the field of future research considerably beyond the point to which all previous research could carry us. . . .

I wish to add that the Kubao district produced the largest tektite yet found in the Philippine Islands, now 275 grams, and a very fine-looking specimen.

Certainly the great numbers of bodies discovered on the Pugad Babuy site and in regions near by ought eventually to yield considerable information concerning the origin of tektites and the reasons for variations in form, size, and color, and for their irregular distribution. Though it is generally agreed that the bodies are not of volcanic origin, there still remains the fact that an abundance of them, comparatively speaking, has been discovered in volcanic regions.

Again, what is to account for the strange circumstance that the bodies are found in a definite "belt" around the earth? Can it be that this is merely an accident? Or are there many others not in this belt yet to be discovered?

Finally, is Spencer's "splash" theory that the bodies are all merely fragments from one great meteor the answer to the question, or is each tektite an individual meteorite which has struck the earth independently of the others?

WAYNE UNIVERSITY
DETROIT, MICHIGAN

[1] H. Otley Beyer, professor of anthropology and archaeology and head of the department of anthropology and sociology, University of the Philippines.

[2] Hans Overbeck, of the colonial service in the Netherlands East Indies.

[3] *Pugad babuy*, a Tagalog phrase, literally translated means "hog nest." The natives recently changed the name of the barrio to "Torres Bugallon," the name of a prominent resident they wished to honor.

[4] Beyer, H. Otley, "Philippine Tektites," *Philippine Magazine*, 32:542. 1935.

[5] Beyer, *op. cit*., pp. 581-582.

[6] Beyer, *op. cit*., p. 543.

[7] Dated May 27, 1936.

DATED INDIAN BURIALS IN MICHIGAN

GEORGE I. QUIMBY, JR.

THIS paper encompasses those facts which are pertinent to the significance of Indian burials of the historic period in Michigan and to their dating by means of trade objects associated with them. Unfortunately, little attention has been paid to this subject, which may provide links between history and prehistory, and the documentation accompanying museum collections is extremely meager. In addition to establishing such links, this study may offer social implications of an accultural nature.

I

In 1921 an extended skeleton of a young adult male(?) was excavated in a gravel pit one mile west of Tecumseh, in Lenawee County.[1] The lower quarter of the left ear has been preserved by the silver sulphide precipitated from two silver earbobs suspended from the pierced ear lobe. Associated with the skeleton were eight silver ornaments and a small ovoid glass mirror.[2] One of these silver ornaments is illustrated in Figure 9.

Artifacts of native manufacture are a medium-sized ovate, narrow, straight-base, chert projectile point with a straight to slightly contracting stem and a receding shoulder[3] (Fig. 8), found within the left chest of the skeleton, and small tubular shell beads among which, irregularly spaced, were the pierced metapodials, astraguli, and calcaneum of a cottontail rabbit (*Sylvilagus floridanus mearnsii*). Some of these bones are covered with red ocher (Fig. 11).

On the basis of datable trade-silver artifacts the earliest possible date for this particular burial is between 1784 and 1810. The silver is probably all of British origin.[4] The projectile point, which may possibly have been the cause of death, was doubtless only secondarily associated with the skeleton. The only artifact of native manufacture which could be attributed to this particular Indian is a shell and bone necklace with the red ocher.

II

Near the center of Section 4, Clinton Township, Lenawee County, the burial of a young adult female was found in 1923 by the highway department in the course

of road construction.[5] Unfortunately no information is available concerning the position of the skeleton. Accompanying the burial were a pewter teaspoon and two silver armbands in a fragmentary condition. The latter were stamped with the Roman letters 'AS' in a rectangular cartouche.

This touchmark is not identified, but thus far there have been found in Michigan no silver objects manufactured before 1780.[6] Furthermore, the earliest documentary evidence dealing with the manufacture of Indian silver ornaments is dated 1750.[7] It is quite unlikely that this Indian was buried before 1780.

III

At the Furton site in St. Clair County, about five miles south of New Baltimore, erosional forces recently exposed a burial in the sandy bank along Lake St. Clair.[8] Information concerning the skeletal material is lacking, but associated with the burial were the following objects: a brass tomahawk pipe, an iron strike-a-light, an iron knife blade, a white clay trade pipe with 'TD' stamped upon the stem side of the bowl (Fig. 1), a silver crown, sixteen miniature round silver brooches, and a medium-sized, double-barred silver cross made by Robert Cruickshanks of Montreal (Fig. 6). Also one potsherd, grit-tempered and with a cord-wrapped paddle impression, and a fragment of deer mandible (*Odocoileus virginianus borealis*) were found, but these probably were included in the fill of the grave and may be manifestations of an earlier occupation.

To judge from the identification of the mark upon the silver cross, the earliest possible date for this burial is between the years 1781 and 1809.

IV

In 1923 workmen excavating for a cellar on the Captain Smith on Harsen's Island in Lake St. Clair exposed several Indian burials in a gravelly knoll. No data on the position of skeletons in the graves are available. With one of these burials were associated the following objects:[9] two badly patinated basal parts of pewter vases, two small brass pots, two gunflints, a bell-shaped brass nozzle, threaded at the base and filled with wood, a double-barred silver cross, a brass bracelet (Fig. 10), and a Stiegal glass bottle with decorations painted in white, black, green, yellow, red, and blue enamel (Fig. 14).[10] With this burial were included an ovoid implement of reddish chert and a wooden spoon with a bird carved on the handle.

Heinrich Stiegal of Manheim, Pennsylvania, the first to produce in America glass so decorated, made his enameled glass between the years 1772 and 1785.[11] Therefore the earliest possible date for this burial falls sometime between these years. Supplementary evidence for this date is the presence of the silver cross.

The only artifacts of native manufacture associated with this burial are the wooden spoon carved on the handle and the chipped reddish chert implement. It is possible that the implement represents an older occupation and was accidentally included in the grave fill instead of having been intentionally placed there, like the other artifacts.

V

In a sandy beach ridge along the shore of Lake Michigan between Cross Village and Goodheart in Emmet County Mr. L. P. Rowland between the years 1875 and 1900 excavated several Indian burials.[12] Unfortunately he kept only a general record of his findings and, consequently, a number of his burials must be treated as one unit. Further, because of lack of documentation only a proportionately small number of objects represented in his large collection may be definitely attributed to these burials. From one of these graves came the skeleton of a woman.

Associated with the various burials were sixty-three marked silver ornaments, at least fifty of which were made in Montreal, one in England, and two in the United States. These ornaments were manufactured between the years 1780 and 1810. Therefore, on the basis of the silver, these particular burials would have an earliest possible date between 1781 and 1810.

Since the area including Cross Village and Goodheart has been continuously occupied by the Algonquian-speaking Ottawa and Chippewa or Ojibwa tribes since 1741, it is quite probable that these burials may be attributed to them.[13] That they were allies of the British is certainly reaffirmed by the amount of British silver present.

Native artifacts associated with these burials are as follows: five square thin catlinite beads, a small skin bundle filled with vermilion paint (Fig. 7), a plain and rather crudely carved wooden spoon, a small ovoid wooden bowl (Fig. 2), and a fragment of a shell gorget with a countersunk perforation (Fig. 4).

Trade objects other than silver associated with the Cross Village-Goodheart burials are three copper or brass pots, two of which have iron bails, large quantities of colored glass beads, and several fragments of cloth. Identification of materials and weaves 14 showed three types: (1) a brown woolen broadcloth of plain plaiting somewhat felted; (2) a dark wool cloth of twilled weaving (two strands over and two under); and (3) blue material with a weft of linen and a woof of silk. The third type of weave is now called "grosgrain" and is used in making ribbons.

VI

In 1900 a burial was excavated by graders at the site of the present post office in the village of Franklin, Southfield Township, Oakland County.[15] The skeleton was in a flexed position, and the following articles were associated with it: a bone-handled jackknife with a single blade, an iron tomahawk pipe, a silver armband

with the stamped Roman letters 'CG' in a square cartouche, a silver armband with a snake engraved upon the face, manufactured by Robert Cruickshanks of Montreal, and two silver hair plates made by the firm of George Heming and William Chawner of London, England, 1781-82.[16]

Additional artifacts found with this burial were a shell gorget, a polished stone celt, and three medium-sized chert projectile points. The shell gorget is ovate; it is curvate in cross section. In the upper third of the gorget at each side are perforations which are countersunk.

The shapes of the projectile points vary. One is narrow and triangular, with a straight base and a contracting stem (or corner notch); the second, broadly ovate, with a convex base and a contracting stem (or corner notch); the third, narrow and triangular, with a straight base and a slightly contracting to straight stem.

Identification of the manufacturers of the accompanying trade silver places the earliest date for this burial between the years 1781 and 1809. The presence of the native artifacts is of particular interest.

VII

On the farm of Miner L. Cook, near Cook's Bridge in Cascade Township, Kent County, the skeleton of a young adult female (?) was excavated from a gravel pit some years ago.[17] Beside the skeleton were a small copper kettle, a badly patinated iron strike-a-light, small white glass beads, a pair of iron scissors, heavily encrusted, four wooden button molds, miniature round silver brooches, and a medium-sized double-barred silver cross, stamped with the Roman letters ‘CG’ in a square cartouche.

Artifacts of native manufacture are a long, flat, curved bone needle, and the bone handle of an iron awl. The bone needle is about nine inches long, a half inch wide, and an eighth of an inch thick. Near its middle is a drilled hole, countersunk from both sides. One edge of the proximal end has three closely spaced shallow crenulations. The bone handle bears a decoration of incised straight lines obliquely placed, right to left and left to right, joining at each extremity.

Because of the presence of trade silver ornaments it is reasonable to assume that the earliest date for this burial falls between 1780 and 1815.[18]

VIII

On the north side of Dowagiac Creek, about one mile east of it’s junction with the St. Joseph River (near Niles, Berrien County), a historic burial was exposed in a sand ridge during the excavation of a cellar in 1935.[19] Three skeletons came from this ridge. One of an adult female (?) lay in a flexed position. At its feet was a large brass kettle with an iron bail, and in its left hand was a polished stone pipe. Associated with this skeleton and to the east was that of a child with which were buried a number of miniature round silver brooches, two small brass "jingle bells" (Fig. 3), and a large iron spoon. Information about the position of the child's skeleton is lacking. About seven feet southwest of it was the extended skeleton of an adult female (?). Laboratory examination revealed fragments of trade cloth adhering to the bones.

The polished stone pipe with the female (?) skeleton is typolog-ically related to the white clay trade pipes. The bowl extends obliquely from the stem, and at the bottom of the bowl is a spur (Fig. 5). It is interesting to note the retention of a native technique and its application to an introduced form.[20]

Although European forms of pipes to which the stone pipe is related typologically may have been seen in this region at a much earlier time, the presence of the miniature round silver brooches suggests that the earliest possible date for this burial is between 1780 and 1815.

IX

During landscaping operations in the State Park, West Allis Township, in Presque Isle County north of Onaway (southeast shore of Black Lake), a number of historic burials were excavated in 1934.[21] Because of insufficient data these burials must be taken as one unit. Skeletal material includes bones of males and females, young and middle-aged adult. Associated with these burials were nine silver ornaments, fragments of copper kettles, a badly encrusted jackknife, three heavily patinated iron knives with wooden handles, one gun-flint, two fragments of strike-a-lights, colored glass beads of various shapes, sizes, and colors, one white clay trade pipe with bowl extending obliquely from stem and spur at bottom, fragments of plain-plaited (somewhat felted) brown woolen broadcloth and green-blue plaited silk, and a small rectangular mirror. There were no artifacts of native manufacture associated with these burials.

Again, on the basis of the trade silver ornaments, the earliest possible date for this burial is probably between 1780 and 1815.

X

In 1922 a very poorly documented burial or burials collected from an unknown site in Leelanau County revealed the following trade artifacts:[22] two iron knife blades, badly encrusted, three fragments of white clay pipe stems of European form, one of which has a green glaze, one iron needle, a fragment of a medium-sized brass sleigh bell, one fragment of green pressed glass (Fig. 16), one fragment of blue and gold lusterware china (Fig. 13), the basal part of a glass bottle which has a rough pontil mark (Fig. 15), a large fragment of a mulberry-colored Staffordshire teapot (?) (Fig. 12), and a number of blue glass beads.

Artifacts of native manufacture are one deer antler projectile point, a fragment of charred bone with an incised crosshatched design upon it, a large piece of

worked antler, and a fragment of a stone pipe bowl. Possibly these artifacts are camp or village refuse from a previous occupation which was accidentally included in the grave fill. Since there are no data concerning skeletons or positions of skeletons, or relationship of artifacts to the burials, very little trustworthy information can be secured in this case.

Using for a chronological aid the mulberry-colored fragment of Staffordshire-like china which has an oriental motif for decoration, one finds that the earliest possible date for this burial would be c. 1830, for it was not until then that the English potters had access to the lithographing process which enabled them to print cheaply colors other than blue.[23]

XI

In 1935 excavations by a farmer on his land west of Port Austin in Huron County revealed several burials of the late historic period.[24] Accurate information concerning the skeleton is lacking, but associated with this burial were the following trade artifacts: eleven gun-flints, the fragments of a flintlock gun, including lock, barrel, and German silver fittings, two lead balls (shot), a number of small glass beads, and fragments of brown, plain-plaited, woolen broadcloth, somewhat felted.

None of the trade artifacts give any clue to the date of this burial, but in a letter to the Museum a very old lady who was an early settler in the region claims that this was the burial of the "Cheaf," and that he died in 1862. She claims, further, that her mother, the local missionary at that time, preached the funeral sermon, and the "Cheaf's" first gun, a flintlock, was buried with him.[25]

The skulls from these Indian burials of the historic period, taken as a group, are round. The range of the cephalic indices is from 78.15 to 88.64, and the mean cephalic index for the group is 82.19. The skulls as a group are hypsicranial (high-vaulted), and the eye orbits are of medium proportions (mesoconch). The nasal proportions are variable, some mesorrhine, one chamaerrhine, and some hypochamaerrhine. All the skulls are undeformed.[26]

SUMMARY AND CONCLUSIONS

The dates of manufacture of the various kinds of trade objects found in Indian burials of the historic period in Michigan give a reasonably accurate clue to the earliest possible dates for these burials. Use of this method reveals that such dates for most of the burials studied are between the years c. 1780 and 1815, although it is possible that any one of the burials occurred at a much later time. Some burials seem to have been made at least after 1830.

Identification of the place of manufacture indicates that most of the trade objects were of British origin, and probably belonged to Indians who were friendly toward the British. This is apparent from the silver ornaments alone, since both Americans and British used silver for gifts and for trade. There is the possibility that the silver may have been captured from the British by Indians friendly to the American colonists, but if this is so, one would expect to find in the burials a reasonable proportion of silver ornaments manufactured in the United States. Therefore it seems that most of the burials reported upon in this paper belong to Indians who were well disposed toward the British throughout the period from 1780 to 1815. The tribes in Michigan which fit into this category are the Ottawa, the Chippewa, and the Potawatomi.[27] Documentary evidence indicates that the Ottawa and the Chippewa occupied the Emmet County site previously mentioned.

Some of the burials of this period contained artifacts showing prehistoric technique and form, and one burial had an artifact which illustrates prehistoric technique applied to a historic European form. All the burials had trade objects, although the cultural pattern of the burial itself was prehistoric. This culture pattern was so widespread and its manifestation so general during prehistoric times that there is little chance of identifying the tribe by means of the position of the skeleton and the relationships of artifacts within the historic burials.[28]

Ethnological studies of primitive peoples in the process of culture change and archaeological investigations of historic sites in other regions have shown that, with the type of contact which occurred between Indians and white groups, the aboriginal technological culture changed before the social culture. The facts presented in this study, namely, that grave furniture of white manufacture was substituted for native grave furniture, although the cultural concept of placing objects within the grave remained the same, agree with or conform to the results of studies made in other areas. Further, there is the possibility that old techniques were employed in producing new forms (in the technological culture) when these forms, once having been observed, were not available to an individual.

Considerable work in this subject remains to be done in the laboratory as well as in the field. In addition, there exists the strong probability that links between history and prehistory will be discovered through such a study. There is also the possibility of revealing facts of interest in the study of continuous first-hand contact between groups possessing different cultures.

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[1] Cat. Nos. 158-166, 5427-5428, Museum of Anthropology, University of Michigan. Other articles in this museum will be cited by catalogue numbers only.

[2] Other ornaments have been described and discussed in another paper by George I. Quimby, Jr., "Notes on Indian Trade Silver in Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 22(1936): 15-24. 1937.

[3] Coe, Joffre L., University of North Carolina, "Classification of Chipped Stone Projectile Points." (*In manuscript*.)

[4] Quimby, *op. cit*.

[5] Cat. No. 898.

[6] Quimby, *op. cit*.

[7] Gillingham, Harrold E., "Indian Silver Ornaments," *Penna. Mag. of History and Biography,* 58: 97-126. 1934.

[8] Field Cat. Nos. F9-F20.

[9] Cat. Nos. 740-752.

[10] This bottle is 15.2 cm. in height, 13.1 cm. base to shoulder, 6 cm. face to face, and 7.4 cm. side to side. It is octagonal in cross section, owing to four bevel-like areas connecting the two sides and faces. Enclosed within an egg-shaped outline in yellow, on either face, is a white dove surmounting a yellow cross-shaped twig rising from olive-green foliage. On each outside edge of this border are white frills. At the top is a solid green circle from which radiate leaves of red and white, yellow, blue and white, and red. A similar design is at the bottom of the oval frame. On either side is a floral motif consisting of a vertical white stem with leaves of red and white, red, yellow, and blue and white arranged symmetrically on both sides of the stem. Surmounting the stem is a three-petaled olive-green flower. The same design, white frills and yellow leaves, appears on all four of the short interfacial side areas. Encircling the shoulder area is a band of blue relieved by white dots and curved lines. Occasional parts of all the design motifs are sharpened by black lines. The pontil mark is elliptical and surrounded by units of parallel curvilinear grooves, the whole having been somewhat smoothed over.

The bottle top is of lead or pewter and may have been gilded. It screws on a fitting of similar material fastened to the upper rim and lip of the bottle.

[11] Knittle, Rhea Mansfield, Early American Glass. New York, 1927.

[12] Cat. Nos. 989, 1033, 1035, 1039, 1054, 1055, 1057, 1058, 1060, 1063, 1067, 1071, 1083, 1087, 1116, 1130, 1139.

[13] Greenman, E. F., "History of the Indians of Michigan." (*In manuscript*.)

[14] Identification by Volney H. Jones, Ethnobotanical Laboratory, University of Michigan.

[15] Artifacts associated with this burial are in the Detroit Historical Society Museum.

[16] The touchmark, 'GH' over 'WC' in a square cartouche, was tentatively identified by John Marshall Phillips, Gallery of Fine Arts, Yale University. This identification was tentatively suggested by Mr. Harrold E. Gillingham of Germantown, Pa. Sketches and a written description of this mark were sent by letter to these two men.

[17] Cat. Nos. 112665-112674 in the Grand Rapids Public Museum (formerly Kent Scientific Institute).

[18] See note 6.

[19] Cat. Nos. 4590-4599.

[20] Mr. Peter Brannon, of Montgomery, Alabama, has noted similar examples from historic burials in the South (e.g. pottery kettles so faithfully executed after the European form that they have even the reinforcements with nonfunctional rivets where the bails are fastened).

[21] Cat. Nos. 4601-4603, 4722-4724, 4734-4736, 5411-5426.

[22] Cat. Nos. 124-127, 1369.

[23] Camehl, Ada Walker, *The Blue China Book*. New York, 1916.

[24] Cat. Nos. 4726-4733.

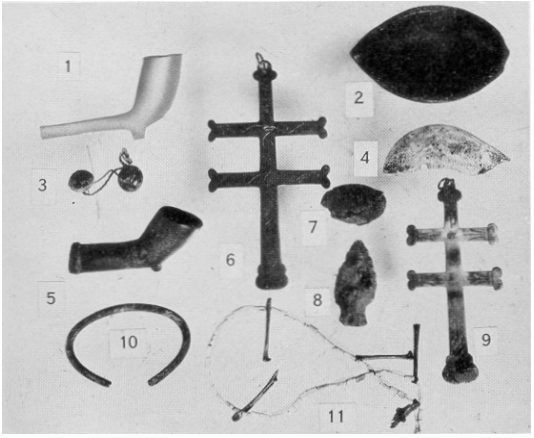
[25] Her claim is not beyond the realm of possibility, and I include it for what it may be worth.

[26] On the basis of limited cranial measurements and observations made by Mr. Georg Neumann upon skulls Nos. 159, 591, 754, 898, 1268, and 4722-4724. Mr. Neumann pointed out that skulls associated with trade materials in the upper levels of the Fisher Site, Will County, Illinois, also conformed to this type, and had tentatively been identified as Potawatomi by means of the direct historical method. All the trade silver from this site that I have examined at the Department of Anthropology, University of Chicago, was made between 1780 and 1810.

[27] Encyclopaedia Britannica, Eleventh Edition, XII: 553a.

[28] Griffin, James B., "Aboriginal Mortuary Customs in the Western Half of the Northeastern Woodlands Area." (*In manuscript*.)

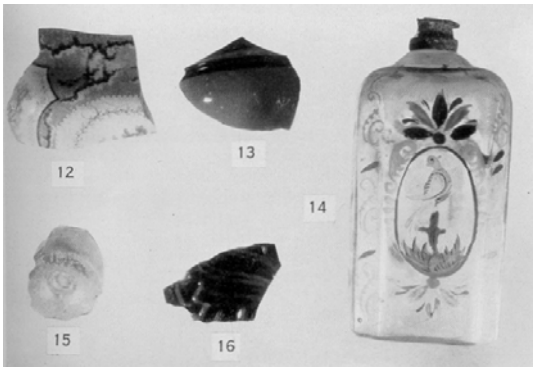
QUIMBY PLATE I



ARTIFACTS WITH HISTORIC INDIAN BURIALS

1. Clay trade pipe from Furton site
2. Carved wooden bowl from Cross Village, Goodhart burials
3. Brass jingle bells from burial near Niles
4. Fragment of perforated shell gorget from Cross Village, Goodhart burials
5. Stone imitation of white man's clay pipe, from burial near Niles
6. Double-barred silver cross found with burial at Furton site. Manufactured by Cruickshanks
7. Skin-covered packet of vermilion from Cross Village, Goodhart burials
8. Chert projectile point from burial near Tecumseh
9. Double-barred silver cross from burial near Tecumseh. Manufactured by Arnoldi
10. Brass bracelet found with burial on Harsen's Island
11. Necklace of shell beads and rabbit metapodials from burial near Tecumseh

QUIMBY PLATE II



ARTIFACTS WITH HISTORIC INDIAN BURIALS

12. Fragment of china of Staffordshire type from burial in Leelanau County
13. Fragment of lusterware china from burial in Leelanau County
14. Stiegel glass bottle from burial on Harsen's Island
15. Basal fragment of glass bottle found with burial in Leelanau County
16. Fragment of pressed glass found with burial in Leelanau County

PALEOBOTANICAL STUDIES IN MICHIGAN

CHESTER A. ARNOLD

THE existence of fossil plants in Michigan has been known for a long time. Among the collections in the Museum of Paleontology of the University of Michigan are specimens obtained many years ago by Bela Hubbard and Alexander Winchell from coal mines or quarries in the vicinity of Jackson. Though the greater number of them are indeterminate, they represent for the most part medullary casts of *Cordaites* and *Calamites*. In 1874 Leo Lesquereux described as land plants some objects from the Silurian near Monroe, but the remains are fragmentary and indefinite and are not accepted as constituting satisfactory evidence of the existence of terrestrial vegetation during that period. In his *Coal Flora*, published in 1880 and 1884, Lesquereux makes no reference to fossil plants from Michigan, although this work was intended to be a comprehensive treatment of the Carboniferous floras of the United States as they were then known. In 1876 Rominger reported silicified wood from the Antrim shale.

If we disregard the supposed bacterial and algal remains described by Walcott from the pre-Cambrian of the Lake Superior region, and the more recently noted but highly problematic vegetable life in the Upper Peninsula, recognizable plant fossils are confined mostly to the Squaw Bay limestone, the Antrim shale, the Saginaw formation, and the Woodville sandstone.

Very few plant types are known from the Antrim shale. *Callixylon* is the only positively identifiable form with known affinities, although a specimen probably belonging to *Bothrodendron* was described by Miss Inez M. Clark in 1934.[1] *Callixylon* occurs in the shale as sections of large silicified trunks, some of which must have attained a diameter of two or three feet. Several such specimens have been recovered from the quarry at Paxton, west of Alpena. Preservation of the cell structure is excellent, and splitting reveals, even to the unaided eye, an appearance which, except for the brownish black color, is characteristic of that of recent wood. Fragments of *Callixylon* from the Antrim of Michigan or Ontario occasionally occur in the glacial drift in the southeastern part of the state.

It should be noted in this connection that *Callixylon* is characteristic of this middle Paleozoic black shale wherever it is exposed. It occurs in the Antrim at Kettle Point, Ontario, in the Huron shales of northern Ohio, in the Ohio and New Albany shales wherever they are exposed in Indiana, Ohio, and Kentucky, and in the Chattanooga shale of Tennessee. Microscopic examination of the silicified wood shows that *C. Newberryi*, the common species in Indiana, exists in the Antrim also. The vertical range of *Callixylon* is undetermined, but with the exception of its presence in such shales as the Antrim, New Albany, and others, the age of which has been the subject of considerable dispute, the genus has never been found beyond the limits of the Upper Devonian. In central and western New York it ranges from the top of the Genesee shale to the Cattaraugus, but never as high as beds of undisputed Mississippian age, such as the Pocono or the Kinderhook, or any of the lower Carboniferous horizons of Europe. In New York and Pennsylvania it occurs with Archaeopteris, a fern-like plant characteristic of the Upper Devonian the world over.

The plant fossils in the Antrim most likely to arrest attention are long slender impressions marked with prominent cross lines and covered with a thin layer of finely fractured coal. These impressions are commonly from one to three inches wide, but narrower and wider specimens are frequent. Their length is indeterminate, since they are limited to the diameter of the shale slabs, which is seldom more than three feet. Because of the prominence of the cross lines these curious fossils were originally placed in the genus *Calamites*, but later transferred to *Pseudobornia*. Positive evidence exists that at least some of them belong to *Callixylon Newberryi*. Most of them, however, are indeterminate. Satisfactory proof has recently been secured which shows that, whatever their affinities may be, they are not jointed stems of the bamboo fishing-pole type, as is suggested by the prominence of the cross lines, but, rather, pieces of split and broken driftwood which had become transversely cracked by frequent wetting and drying previous to fossilization. Some of them may represent *Callixylon*, or any other woody plant, since strips of oak bark split in exactly the same manner have been observed.

Passing reference should also be made to the familiar but problemtic fossil *Sporangites huronensis*, a small, almost microscopic, spore-like object of which little more is known than when it was originally described by Sir William Dawson many years ago. At places these small amber-colored bodies exist in such numbers that they impart a brownish gray color to the shale.

The coal flora of Michigan has always been regarded as a meager one and when it is compared with floras of corresponding age in Ohio, Illinois, Pennsylvania, and other states this supposition proves well founded. David White referred to this sparse flora, stating, however, that it is sufficient to indicate a place high in the Pottsville. Two lists of his determinations are included in state geological survey publications of 1902 and 1908. Forty-five forms are listed from eleven localities, but some of the specific names are followed by an interrogation mark and other forms are determined only to genus. Until recently these two lists, which are merely annotated tabulations, were the only published information pertaining to the flora of the Michigan Coal Basin.

This reputed meagerness of the coal flora is in direct relation to the limited vertical and lateral extent of the coal-bearing formation itself, and is not due to any appreciable lack of plant material in the shales interbedded with the coal seams. In direct contrast to the small amount of material that may be collected from various localities near Grand Ledge, St. Charles, and

Saginaw, the relative number of species that may be obtained is often surprisingly large. In the collections of the Museum of Paleontology of the University of Michigan the coal flora is represented by only a few hundred specimens, but from this number, thirty-five typical Pennsylvanian species have been determined and four new ones described.[3] Moreover, this number probably represents only one half or less of the total number of species in the collection. From the number of species represented in it we may gain some notion of the relative productivity of the shales of the Michigan coal series if we compare a collection, recently reported from southwestern Pennsylvania, which contains eighteen thousand specimens but in which only fifty-five species were recognized. Relatively speaking, the flora of the Michigan Coal Basin is not a meager one, but contains a wide range of Pennsylvanian types representing most of the larger plant groups.

Mention of all the plant types of the Michigan coal flora would be out of place here; only those having some special significance will be discussed. It should be noted, however, that there is in the flora an abundance of arborescent forms, such as *Catamites*, *Cordaites*, and *Lepidodendron*. Some of the ironstone nodules belonging to Cycle "A" of W. A. Kelly at Grand Ledge are made up largely of the compacted slender, strap-shaped leaves of *Cordaites*, and pressed between them are broad-winged, platyspermic seeds of the *Samaropsis* type. *Calamites* is represented by foliage, strobili, and pith casts, the latter being especially abundant in the Woodville. Several species of *Lepidodendron* are known. The remains consist of impressions of the trunk surfaces, leafy twigs, spores, and structurally preserved cones of the *Lepidostrobus* type.[4] The cones are rarely observed in the petrified state in North America. Two or three species of *Sigillaria* are present. *S. scutellata* has been observed in the quarry of the Grand Ledge Face Brick Company, and this is the only known occurrence of this common middle Carboniferous European species in America. *Stigmaria*, the rootlike organ of both *Lepidodendron* and *Sigillaria*, occurs in quantity, but merits no comment other than that pieces of it are sometimes found in the glacial drift. Professor Bartlett has described a variety of lepidodendroid spore types from the coal pebbles of the glacial drift.[5]

The pteridosperms and the ferns are represented by several familiar Carboniferous leaf genera as *Neuropteris*, *Alethopteris*, *Mariopteris*, *Sphenopteris*, *Odontopteris*, and *Megalopteris*. The last is known only in North America, where, according to David White, it is characteristic of the Conoquenessing stage of the upper Pottsville. It is also known from Iowa, Illinois, Indiana, Ohio, West Virginia, and New Brunswick.

Megalopteris has large bifurcated fernlike foliar organs, which sometimes reach a length of one foot. Extending lengthwise along each lobe of the lamina is a prominent midvein, from which closely spaced, dichotomously forked veinlets depart at angles ranging from 45 to 90 degrees, depending upon the species. The largest and most spectacular species is *M. Dawsoni*, which is abundant in the ironstone nodules of Cycle "A" at Grand Ledge. Leaf fragments more than two inches broad have been found. Occurring with it is *M. Kellyi*, a species recently described, which may be distinguished from *M. Dawsoni* by its slightly smaller size and by the lateral veins which extend to the margin, at right angles to the midvein.

The rather constant association of *Megalopteris* and broad-winged seeds of the *Samaropsis* type has been observed upon several occasions and although they have never been found in organic connection, there is a certain amount of circumstantial evidence that they belonged to the same plant.[6]

Although the plant remains of the Woodville (or, more specifically, the Eaton) present a different aspect from those of the underlying Saginaw, the apparent differences are due to preservation. The remains are largely sandstone casts of trunks and roots, with very little leaf material except *Cordaites*. Preservation took place under an entirely different set of conditions during the time of deposition of the Woodville, but there is no reason to suppose that a markedly different flora existed then. The species of *Calamites*, *Cordaites*, and *Lepidodendron* appearing in the Woodville are not greatly different from the Saginaw species, and since no typical Permian species have been found, the suggestion from the stratigraphy of the beds that they belong to the Permo-Carboniferous is scarcely supported by the flora. However, the expression of a final opinion must wait for further evidence.

UNIVERSITY OF MICHIGAN

[1] Clark, Inez M., "Two New Paleobotanical Records for the Antrim Shale of Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 19 (1933): 59-64. 1934. Unfortunately the figure of *Bothrodendron antrimense* on Plate III is inverted.

[2] Arnold, C. A., "The So-called Branch Impressions of *Callixylon Newberryi* (Dn.) Elkins & Wieland and the Conditions of Their Preservation," *Journ. Geol*, 42 : 71-76. 1934.

[3] Arnold, C. A., "A Preliminary Study of the Fossil Flora of the Michigan Coal Basin," *Contrib. Mus. Paleontol, Univ. Mich*., 4: 177-204. 1934.

[4] Arnold, C. A., "A Petrified Lepidophyte Cone from the Pennsylvanian of Michigan," *Am. Journ. Bot*., 17: 1028-1032. 1930.

[5] Bartlett, H. H., "Fossils of the Carboniferous Coal Pebbles of the Glacial Drift at Ann Arbor," *Pap. Mich. Acad. Sci., Arts, and Letters*, 9 (1928) : 11-28. 1929.

[6] White, D., "Megalopteris and the Giant Winged Cardiocarps," *Bull. Geol. Soc. Am*., 44:213. 1933.

BATTLE CREEK: A STUDY IN URBAN GEOGRAPHY
PART I. PRESENT-DAY CITY AND FUNDAMENT

H. THOMPSON STRAW

INTRODUCTION

IN THE southernmost part of Michigan there are two lines of cities, each located along what originally were Indian trails and what today are highways radiating from Detroit (Fig. 1). The line farthest south on the map is composed of small market towns, most of them of less than ten thousand population. Here trade is the dominant industry, and what manufacturing exists came late in the history of the city and is still generally of only secondary importance.[1] The second line of cities, immediately north of the first, is composed of somewhat larger urban units, of which Battle Creek is one, and here manufacturing rather than trade is the principal function. Nor did manufacturing come late in the history of these cities. Generally it was the function around which the city was planned.[2]

Perhaps the two most outstanding characteristics of Battle Creek are: first, that it is so well known, which is unusual when its size, less than fifty thousand population, is considered — many cities a great deal larger are much less well known; and second, that its two major industries, the production of cereal preparations and the activities of the sanitarium, are so little related to the surrounding area. Its location in the southern part of the Hay and Dairy Belt[3] places it outside the major areas producing its raw materials, and its proximity to the large urban markets is an advantage shared by many another near-by city. Even more peculiar is the location in this particular city of a health resort. The average American is accustomed to associate health centers with mineral springs, watering places, or seashore and mountain scenery. Battle Creek has none of these. The explanation will have to be found in the evolution of the city rather than in its environs.

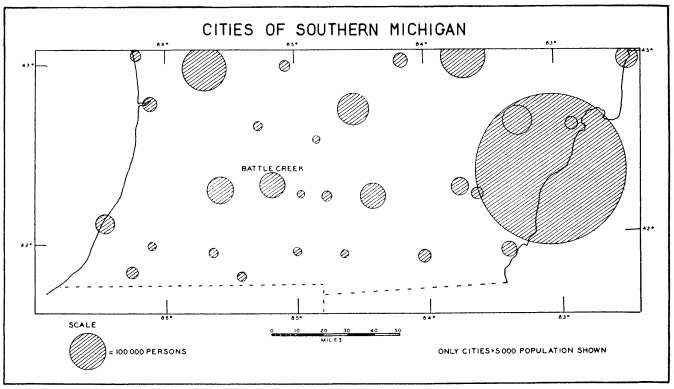


FIG. 1

PRESENT-DAY CITY

Battle Creek occupies a valley about three quarters of a mile wide (Fig. 2).[4] In southern Michigan one is accustomed to a glacial terrain, rough in surface and complex in pattern, and the relatively flat land of the valley bottom, simple in design and bounded by clear-cut limits, serves sharply to differentiate this site from the areas of glacial deposition to the northwest and the southeast.

Two rivers, the Kalamazoo and the Battle Creek, meet here near the center of the city. Both rivers are surprisingly small in relation to the size of the valley, which, though continuing at about the same width, is occupied above the confluence by the smaller of the two streams, the Battle Creek. The Kalamazoo River, on the other hand, above the Upper Mill Pond flows through a valley which is in proportion to the size of the stream. Near the confluence both rivers are confined within the smaller *thalwegs* which they have cut in the larger valley. Upstream the Battle Creek and downstream the Kalamazoo present a different appearance — the flow is less rapid and there are numerous bends and oxbows. Associated with these meanders are large stretches of poorly drained land (Fig. 3).

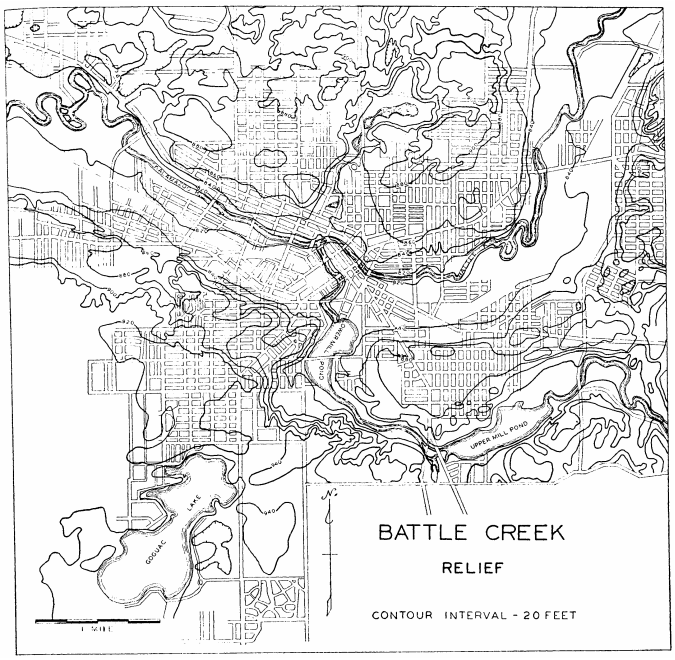


FIG. 2

The valley sides, although in general have much more sharply defined than the surrounding glacial area, have many irregularities along them (Fig. 2). The slope which drains Spring Lake, in the northern part of the city, is an excellent example. The lake itself is about a mile from the edge of the valley side, and yet its drainage basin is but little above the general level of the valley floor. The boundaries of the sides vary in sharpness from place to place. In the eastern part of the city they are fairly clear cut, but on the southern slope of the northwestern part of the valley they are very poorly defined.

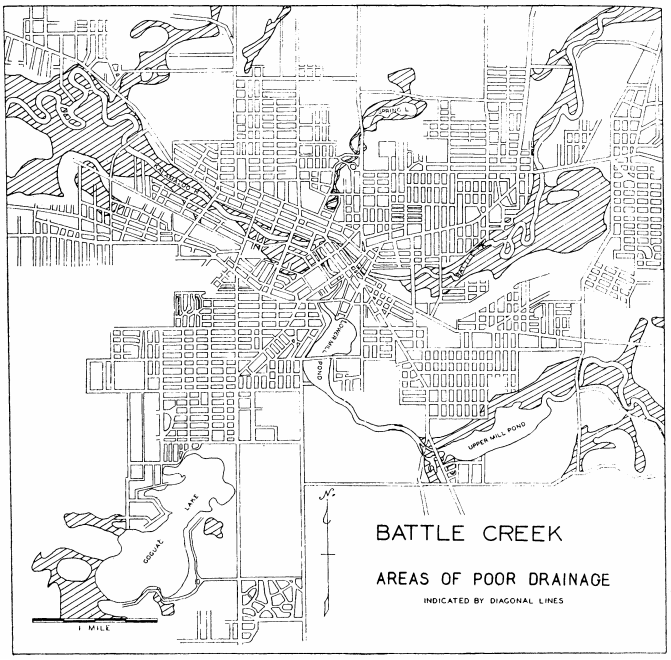


FIG. 3

As the city has outgrown its valley it has expanded upon the higher lands to the north and the south. Here the terrain is distinctly one of glacial origin. Boundaries of any sort are absent, and complexity of surface and of structure is the rule.

STREET PATTERNS

The street pattern of the valley portion of Battle Creek is in harmonious relation to the landforms (Fig. 3). There are five principal streets: two which enter from the northwest, one from the northeast, one from the east, and one from the south. These connect Battle Creek with Kalamazoo, Bellevue, Marshall, and Athens, respectively. There are a convergence and a crossing of these routes; the convergence is the result of following the more easily traversed valley floor and avoiding whenever possible the ascent of the valley sides, and the crossing occurs at the better-drained area in the center of the city.

The streets of the higher glacial section are of the rectangular grid pattern characteristic of urban centers laid out in the nineteenth century.[5] Streets which seem to fit into neither of these two groups are mainly those which serve as connecting links between them.

THE ARRANGEMENT OF FUNCTIONAL AREAS

Industry

As one approaches Battle Creek from the higher land one sees in the valley a bristling of smokestacks and water towers, so common to the American manufacturing scene. This picture is most strikingly developed, however, before an impending storm at times when the wind is in the southeast, for then a pall of smoke drifts over the city and seems from a distance to form an unbroken canopy.

The factories are located almost exclusively upon the valley floor (Fig. 4). Here they are in close proximity to the principal roads of the valley and to the railroads. There is a definite division of factories on the basis of size. Those industries close to the commercial core tend to occupy smaller areas, whereas those at some distance generally cover larger units of ground. A scattering of factories, such as one might find in many cities, produce a variety of goods, but the rest may be divided into two distinct groups, the food factories and those making metal products. The food factories are the Battle Creek Food Company, the W. K. Kellogg Company, the Postum Company, and a branch of the Ralston Purina Company (Pl. I, Figs. 1-2). Among the metal-working factories are a few foundries, but these are small. Most of the metal-working industries produce such machinery as bread-wrapping devices, farm appliances, printing presses, and steam pumps. There are also smaller metal products — lawn sprinklers, registers for heating systems, registering machines, and wire crates and grids. Many of these metal-working factories differ from the food factories in location and in architectural design: their location is usually near the commercial core and the center of the city, and their architectural style is generally less modern (Pl. I, Fig. 3; Pl. II, Fig. 1). Apparently most of them are of earlier origin and existed in the city prior to the growth of the food factories.

Commerce

The commercial core is located near the center of the city, at the chief intersection of routes. There is considerable diversity of form within this core itself (Fig. 5). The principal street and the adjoining areas are occupied by the first-class commercial section (Pl. II, Fig. 2). This section contains most of the apparel, department, furniture, and jewelry stores, and constitutes the shopping area. The second-class commercial district (Pl. II, Fig. 3) extends in a broken ring about the shopping district. It is composed of stores of less pleasing appearance — building-supplies, grocery, and secondhand stores, with small restaurants predominant. The single exception to the generally poor appearance of this area is furnished by the often attractive automobile salesrooms.

There are two types of industry in the commercial core. The first is that, already mentioned, which is usually associated with one or the other of the two rail lines that traverse it. The second consists of a combination of local retail and manufacturing, such as shops selling office supplies and stationery in the front and doing job printing in the rear and bakeries which have small retail shops in the forepart of the buildings. This combination is distributed throughout the second-class commercial area and often at first sight seems to be a part of it (Fig. 5).

Throughout the commercial core there is a scattering of public buildings, and surrounding it is a ring of second- and third-class residence districts. Although not true in

all cases, the third-class residence seems to be generally associated with industrial or rail districts.

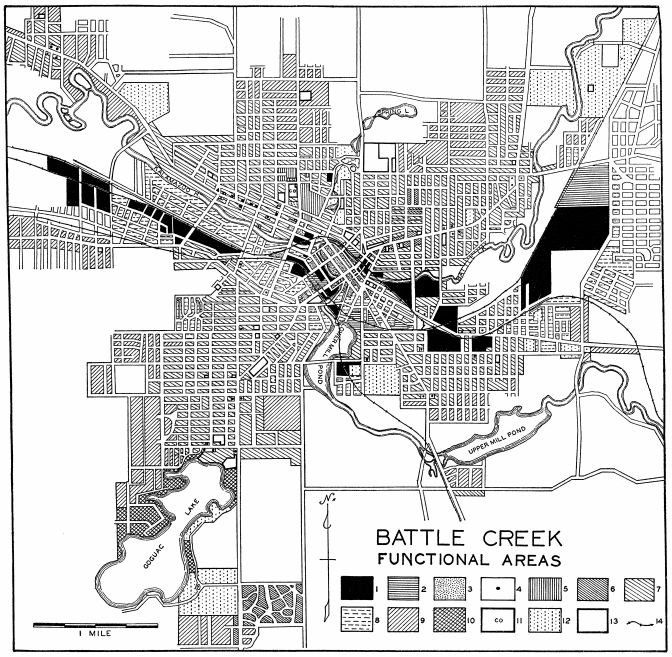


FIG. 4.

KEY TO SYMBOLS

1. Industries
2. Area devoted to transportation
3. Commercial core
4. Retail outside area 3
5. Sanitarium
6. First-class residence
7. Second-class residence
8. Third-class residence
9. Suburban residence
10. Summer residence
11. College
12. Parks, cemeteries, and playgrounds
13. Public buildings
14. Railroads

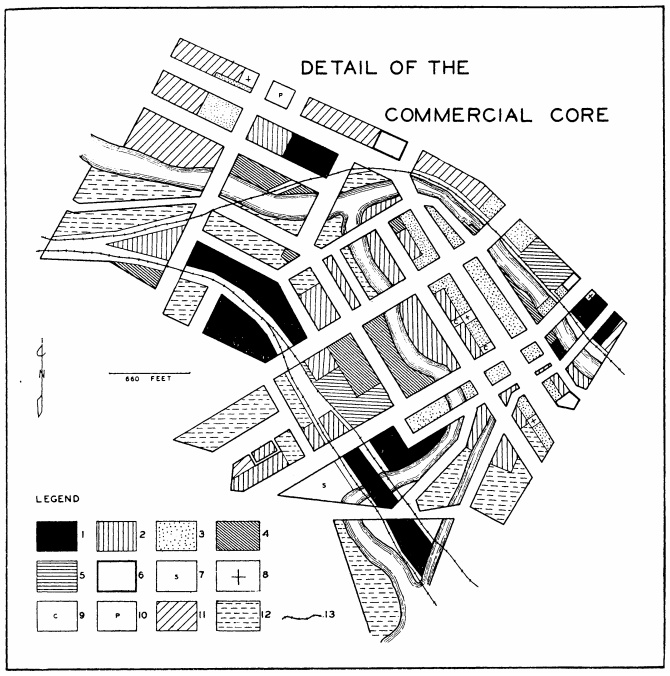


FIG. 5

KEY TO SYMBOLS

1. Industries
2. Second-class commercial core
3. First-class commercial core
4. Local retail and workshop
5. Area devoted to transportation
6. Public buildings
7. Schools
8. Churches
9. City property
10. Parks
11. Second-class residence
12. Third-class residence
13. Railroads

Outside the commercial core and within the residence district there are also small isolated areas devoted to commerce (Fig. 4). The stores of these areas are small and, generally, are food or drug stores or restaurants, the primary purpose of which is to serve the immediately surrounding residence area. There is a definite concentration of these commercial areas along the main traffic arteries leading from the city. This is particularly true of the road to Verona in the northeastern (Pl. III, Fig. 1) and of the road to Marshall in the eastern parts of the city. Such a location enables the merchant to be the first to offer services and goods to those arriving and the last to offer them to those leaving.

Along the northern road to Kalamazoo, in the western part of the city, is a broken string of outlying commercial areas. This is a "string-street"[6] development and may very well mark the direction of greatest future expansion of the commercial core itself.

Sanitarium and College

In the western part of the city, upon the land immediately north of the valley, are the sanitarium and the college. The sanitarium is of considerable size (Pl. III, Fig. 2) and rises above the surrounding neighborhood. It is capable of housing some twelve hundred patients. The college, on the other hand, is small, having an enrollment of only about three hundred and fifty students. A few of the buildings are of recent origin (Pl. III, Fig. 3), but the main ones are of a much older style of architecture. Not only are the buildings of the sanitarium and the college in close proximity, but certain ones are for the joint use of both institutions.

Transportation

Intimately connected with the commercial core and the factories is the area devoted to railroad transportation (Fig. 4). Battle Creek is served by both the Grand Trunk Railroad and the Michigan Central Railroad. The area devoted to transportation is unusually large, owing to the location within the city of engine and repair shops of the Grand Trunk Railroad, of which Battle Creek is the divisional center. The rail lines are laid in the valley section of the city. The Grand Trunk, which enters from the northeast, uses the valley in which the Battle Creek is located. The Michigan Central, which enters from the east, curves northward at the edge of the city, thus avoiding the slight increase of grade which it would have were it to straighten its line (Fig. 2). This same railroad makes another northern bend in the center of the city. West of Battle Creek both railroads occupy the valley. The line which runs south of the city is a branch line and is of relatively small importance.

Besides transportation by rail the city possesses another kind, that by air. The airport is located some distance west of the city. Battle Creek is on the air route from Chicago to Detroit, and planes stop regularly for passengers.

Residence Areas

Occupying for the most part the higher land north arid south of the valley with its factories and commercial core is the residence district (Fig. 4). Residence in the built-up urban area has been divided into three classes, upon the basis of general appearance. The author's field work was done during the years 1934 and 1935. At that time five to six years of the economic depression had passed. This meant that many homes went unpainted and had unkept yards. In some areas the condition presented no trouble in classification, but in others, where the homes were themselves simple frame buildings of unpretentious styles of architecture, there was great difficulty. Many of these homes, if well taken care of, would be called second-class residence. As they were, however, they had the appearance of being third-class. In the end it was decided to classify them as they would probably be under more normal economic conditions. However, there is no assurance that this aim was always attained.

Third-class residence is generally in close proximity to the factories, the railroads, or the commercial core. That portion associated with the commercial core appears, in part at least, to be decadent (see Pl. IV, Figs. 1-2). Other sections of third-class residence immediately southwest of the commercial core contain a large number of the Negro population. Since there are in Battle Creek no zoning ordinances which segregate the races, the homes of whites and Negroes are intermingled.

First-class residence (Pl. IV7 Fig. 3) occupies a very small portion of the residence area. This is explained in part by the location of what will probably develop into first-class residence in the present suburban residence districts (Pl. V, Fig. 1), particularly in the area in the northern part of the city. There is a similar development southeast of Goguac Lake. The first-class residence northeast of the commercial core is the oldest. Although it is still a residence area, that part of it nearest the commercial core is slowly being transformed. The first house at the right in Plate IV, Figure 3, has been turned into an apartment house, the second into a hospital. Farther down the street another is now used as a church. However, the change is slow and not extensive.

Second-class residence occupies most of the residence area (Pl. V, Fig. 2). The suburban residence (area which is less than 50 per cent built up) forms a broken ring about the periphery of the urban residence district.

Scattered throughout these residence areas are public buildings, mostly schools and churches. There are only a few parks, and these are small. In general, the larger parks of the city lie outside the residence area and are of recent development.

One special type of residence, the summer-cottage, occurs on the shore of Goguac Lake. Its extent is small, since much of the lake frontage is given over to a public park and a golf course, and it has contributed little to the growth of the city.

Parks, Subdivisions, and Vacant Land

We have already noted the presence of a few small parks and public grounds scattered throughout the residence areas. Most of these are used either to commemorate some spot of importance in local history or as playgrounds. At the outskirts of the city are larger parks. These appear to be of more recent origin and are designed for recreation.

Surrounding the city, and particularly well developed to the west, are areas of subdivision. Such areas are normal to almost every American city, but here they seem somewhat out of proportion to the size of the city itself. There are approximately three and one-eighth square miles which are practically unused either by the city or for agriculture.

Within the political limits of the city nearly one half of the land is vacant (indicated by white on Fig. 4). In general, two factors explain this: the presence of wasteland associated with the natural drainage of the city and the extension of the city limits to include agricultural land. The wasteland strongly corresponds with the areas of poor drainage (Fig. 3). Although, as can be seen by a comparison with Figure 4, the urban area has in most places pushed toward this undrained section as far as possible, there is much which still remains. The greatest amount of agricultural land within the city limits occurs in the northwestern part. Here it is apparently the result, not of the overambition of the city to acquire territory, but of the natural difficulty of fitting straight lines to the irregular pattern of actual urban use.

FUNDAMENT

That certain parts of the general pattern of Battle Creek are closely related to the underlying landforms and drainage has already been noted. Still other parts represent relict forms of earlier occupance, many of which were also related to the terrain in terms of the then usual mode of settlement. Therefore, to arrive at a complete understanding of the city, it is necessary to study the fundament of both its site and its surroundings.

LANDFORMS AND DRAINAGE

Battle Creek and the area surrounding it lie in that part of the United States affected by the glaciers of the Pleistocene period. The underlying Waverly shale and Marshall sandstone[7] have been so deeply covered by glacial till that they are present at the surface in but few places. Small areas are in evidence where old glacial drainage channels have severely eroded the glacial material (Pl. V, Fig. 3). Otherwise the surface structure is almost entirely a product of glacial deposition.

Although three ice lobes invaded southern Michigan[8] only two, the Lake Michigan and the Saginaw, affected the region about Battle Creek (Fig. 6). The deposits of the third lobe are found farther to the east. Deposition from all lobes occurred during the latter part of the Pleistocene period. A change of climate produced a

condition in which the rate of melting exceeded the slow advance of the sheet, and recession took place. Apparently this change from an ice-age climate to something approximating that of today was not a slow, continuous process, but one of fluctuations, for the moraines about Battle Creek exhibit too much relief to have been deposited while the glacier was receding. Rather it would seem that during the short periods of relatively greater cold and precipitation the glacier advanced slightly, and that at the culmination of each short advance a moraine was laid down.[9] This movement and deposition was repeated again and again. The spaces between moraines were generally filled with outwash or, where the retreat of the glacier was more regular, with ground moraine.

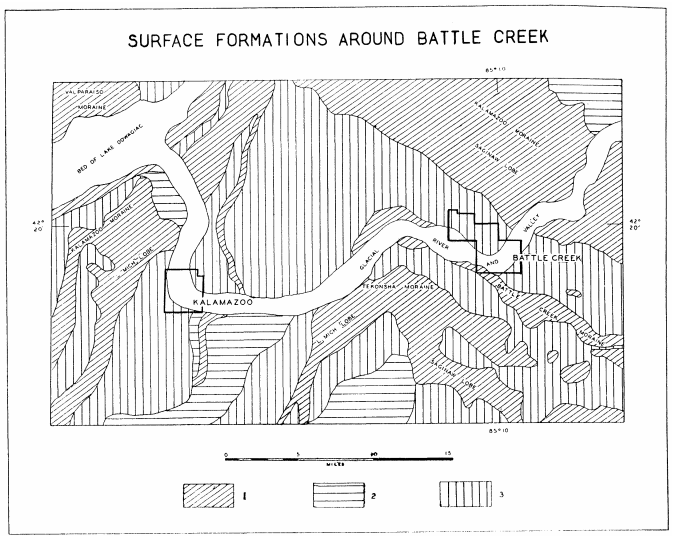


FIG. 6

KEY TO SYMBOLS

1. Moraines 2. Till plains 3. Outwash plains

(After Frank Leverett, "The Country around Camp Custer," U. S. Geol. Surv., Fig. 3. 1918.)

The pattern of the various landforms of today is shown on Figure 6. It cannot be assumed that the outlines of the present-day formations more than approximate the original ones. These formations are a part of an area of unusually complex glacial deposits.[10] Much of the outwash plain is not associated with the moraines immediately to the north or the west but with those farther away. The glacial streams which deposited the outwash have in many places severely eroded moraines which were formed earlier and which lay at some distance in front of the glacier. At other times the outwash was deposited over the moraines and the till plain, so that many areas designated as outwash on the map may be underlain by earlier and differing deposits.

The first morainic system produced within the area shown on the map was the Tekonsha moraine. It takes the form of an inverted V, with the apex just north of the glacial river valley and northwest of Battle Creek. This moraine, the product of the combined deposition of both the Lake Michigan and the Saginaw lobes, has its reentrant angle about five or six miles west of Battle Creek. The portion of the moraine which lies north of the glacial river valley is a part of the interlobate deposits which were formed between the Lake Michigan and the Saginaw lobes during the later stages of ice withdrawal.[11] In land surface it differs somewhat from the rest of the Tekonsha moraine. Its relief is produced largely by depressions and basins, whereas that of the remainder is caused mostly by ridges and knobs. Large parts of the moraine have been greatly modified by outwash deposition which occurred after the moraine had been laid down by the glacial lobes. One can surmise the earlier existence in many places, especially toward the south, of a more extensive moraine. This surmise seems borne out by the boulder deposits in some of the adjacent outwash areas.

The moraine deposited immediately after the Tekonsha was the Battle Creek. It might perhaps be better to consider the Battle Creek a part of the Tekonsha, since it was at the time of its deposition that the previously mentioned interlobate moraine was laid down. The Battle Creek is, however, a distinct moraine and is separated from the Tekonsha by an outwash plain from one to two miles in width, sloping gently to the south. It is cut off at its southeastern end by the outwash deposited later from the Kalamazoo moraine, and the northwestern end has been eroded by the glacial river, the valley of which is now occupied by the Kalamazoo. At this end the out-wash plain is at the same elevation as the moraine and can be differentiated from it only by a less rolling surface and a smaller deposition of boulders. As one travels toward the southeast, however, the difference in elevation of the two deposits becomes more and more apparent. This difference is brought about not by an increase in the elevation of the moraine but by the gentle drop of the general level of the outwash. There is also a gradual change in the type of deposit of the outwash. The larger particles, the gravels and coarse sand, tend to be more abundant in the northern part, whereas finer material is more abundant in the southern.

The moraine deposited next, and separated from the earlier Battle Creek moraine by an outwash plain of considerable size, was the Kalamazoo. The elevation is greatest near the reentrant angle and decreases as one approaches that part eroded by the glacial stream. The general surface is of the knob-and-basin type. The numerous small lakes near the reëntrant angle are replaced by numerous swamps near the channel.

This old glacial channel occupies for the greater part of its course one of the most extensive outwash plains in southern Michigan. The plain has a very definite southward slope; the elevation at the reentrant angle of the two Kalamazoo moraines is about one thousand feet and drops to about eight hundred feet at the Michigan-Indiana border. The larger gravel particles, as has been mentioned before, are deposited in the north, and the finer materials in the south. From both the slope and the size of particles deposited it would seem that the general

trend of glacial drainage on the outwash was southward. Still, the valley occupied by the Kalamazoo River, itself a part of the glacial drainage of this time, travels at right angles to the general trend. Indeed, north of the city of Kalamazoo it turns and continues in a direction exactly opposite to the general trend. Another peculiarity of the valley, as stated before, is the fact that while large parts of it are obviously the result of stream erosion, there are sections of the bluff the outlines of which are so irregular that this general explanation fails to solve the problem of their forms. Examples of this irregularity have been offered within Battle Creek itself.

The only possible solution to this apparent discrepancy seems to be that the old glacial stream followed not a self-made valley but one which, at least in part, had been prepared for it by a series of pits[12] in the outwash. These pits had resulted from the melting of large blocks of ice deposited by the glacier, and they formed the rudiments of a valley which the glacial stream followed and widened. This explains the fact that the direction of the stream differs from the usual one of its time and that its valley sides are so filled with irregularities.

The present Kalamazoo River is a much-underfit stream after reaching the glacial drainage channel and has produced but a narrow, wandering thalweg and a few swamps. It has in scarcely any place modified the valley bluffs of the earlier and larger stream.

Aside from those which occupy former glacial drainage channels, the streams are for the most part consequent ones which have adapted the direction of their flow to the slope of the glacial deposits. The complexity of the slopes of the deposits is reflected in the frequent changes of direction of the rivers. In detail, one finds lakes which drain in two directions and rivers which trace a tortuous pattern across the terrain. On a traverse of the area one meets the same river in many different and unexpected places. In general, however, the tendency of most rivers is to occupy the outwash and to avoid the till plains and, especially, the moraines.

Associated with the streams are numerous small lakes and swamps, also attesting the early youth of the area.[13] The lakes are of several origins, but those near the city of Battle Creek are most frequently of the pit type, as, for example, Goguac Lake, southwest of the city.[14] Many of the swamps are doubtless the relict forms of earlier lakes. With their heavy growth of grasses they were the popularly called "wet prairies" of pioneer days and the frequent, though often unfortunate, sites of early settlement.

The presence of these numerous swamps and lakes has caused a fairly even regimen of stream flow throughout the area, and thus any possibility of heavy seasonal floods is eliminated. This even regimen was of importance in former days, also, when the use of water power in Battle Creek was more extensive. Late summer ordinarily brought no great diminution of water supply, and thus the period within which manufacturing was possible was not curtailed.[15]

VEGETATION

The vegetation which covered the surrounding country at the time the first settlers came to Battle Creek, although in general determined by climate, in detail is closely related to the various surface forms. The climate of the area places it in the Dfa[16] classification and consequently identifies the natural vegetation as a part of the deciduous broadleaf forest of the middle latitudes. The dominant association is oak-hickory. This has been classified as a xerophytic phase of the Appalachian Forest.[17] Such a classification seems borne out by the fact that the oak-hickory association changes to a maple-beech association where the upland soil is heavier and of greater clay content,[18] and where, consequently, the amount of moisture available to the tree is greater. The poorly drained mineral soils support a tree growth principally of the elm-ash-silver-maple type.

There are two dry-prairie areas near Battle Creek: one just southwest of the city, called Goguac Prairie, and the other about ten miles southwest, known as Climax Prairie. These areas were covered principally by tall prairie grasses, with a scattering of bur oaks. The explanation of the presence of these prairies in southwestern Michigan seems to lie in a complicated mixture of natural and cultural conditions. The change of climate which caused the retreat of the glacier apparently continued for some centuries after the Pleistocene period and produced a much more xeric condition than that of the present day. It appears that under these favorable circumstances the prairie, now extant in Illinois and westward, reached far north into Michigan.[19] A second change in climate[20] resulted in a condition fostering the present forest cover, and the prairies such as the Goguac and the Climax are existent as relict forms.

These natural conditions favorable to grass growth were supplemented by certain practices of the Indians who inhabited the area. To judge from the Indian remains, aboriginal occupation of many of the prairies was relatively intensive for Indian standards. It was generally the custom to burn the grasses of the prairies in the fall to drive whatever game existed there into the near-by woods, where it could be more easily hunted.[21] This practice encouraged the continuance of grass rather than the growth of trees and augmented the natural conditions which favored its existence. The probable importance of the custom seems borne out by the fact that certain uncropped prairies or openings became covered by upland forest after the arrival of the white men.[22]

The first settlers, having learned the use and the advantages of prairie land in Illinois and western Indiana, were attracted to these dry prairies. The land was not so difficult to clear as the forest could immediately be plowed, was of rich soil with a high humus content, and was especially suitable for wheat, the important pioneer cash crop.[23]

The remaining form of original vegetation is the so-called "wet prairie" or swamp. These soils were unsuitable for pioneer agriculture, but they did provide fields for pasture and hay which did not need an axe to clear them. Many of the early settlements made in the neighborhood of these swamps were unfortunate because the undrained areas fostered the rapid spread of malaria, and the pioneers in such sections usually suffered most from the disease.[24]

CONCLUSION

Battle Creek has been described as a city with four separate functions: manufacturing, commerce, health, and education represented respectively by the factories, the commercial core, the sanitarium and the college. These cores and the other functional areas of the city have been delineated, and their spatial relationships have been indicated. The fundament has also been discussed, and the landforms and the drainage have been shown to be the results of glacial deposition and erosion. The vegetation is correlated in a general way with climate and in detail with surficial conditions. The prairies forms of an earlier climate, still further complicate the vegetational pattern. The relationships existing between the present-day city and the fundament, such as the distribution of street patterns and the location of transportation areas, have been pointed out.

There still remain, however, many areas the presence of which has not been discussed. These are for the most part forms of an earlier stage of sequent occupance. Just as the presence of the prairies such as the Goguac and the Climax, cannot be explained in terms of present-day climate and surface, so certain urban forms cannot be explained in terms of present-day use. In a later paper the author will trace the sequent occupance of Battle Creek and will show the relationship between it and certain existing urban forms. Likewise the relationship which each of the cores and the city as a whole bear to the surrounding areas which they serve will be described.

STATE TEACHERS COLLEGE
MURFREESBORO, TENNESSEE

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STRAW PLATE I

FIG. 1. The Kellogg Company

FIG. 2. The Postum Company

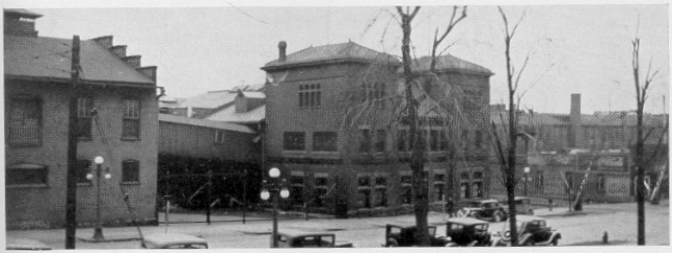

FIG. 3. The American Steam Pump Company, at edge of commercial core. Note older style of architecture as compared with that shown in Figures 1-2

STRAW PLATE II

FIG. 1. The Oliver Farm Equipment Company. Note older style of architecture as compared with that shown in Plate I, Figures 1-2

FIG. 2. View of shopping district of Battle Creek

FIG. 3. Second-class commercial district. Compare with Figure 2

STRAW PLATE III

FIG. 1. Concentration of outlying commercial areas on road to Verona

FIG. 2. Detail of front view of Battle Creek Sanitarium

FIG. 3. View of one of the newer buildings of Battle Creek College

STRAW PLATE IV

FIG. 1. View of third-class residence near commercial core. From architectural style it was judged to be a decadent area

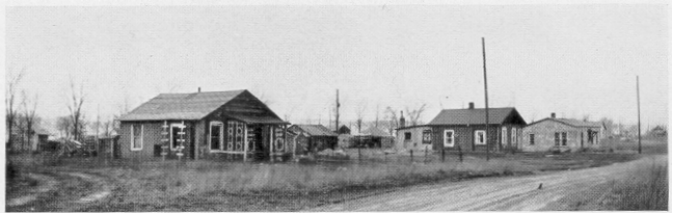

FIG. 2. View of third-class residence associated with industry in northeastern part of city. Note poor construction of houses as compared with those shown in Figure 1

FIG. 3. View of first-class residence northeast of commercial core

STRAW PLATE V

FIG. 1. View of suburban residence in northern part of Battle Creek

FIG. 2. View of second-class residence

FIG. 3. An outcropping of Marshall sandstone in old glacial channel in northeastern part of Battle Creek

PEDOLOGIC EVIDENCE OF CHANGES OF CLIMATE IN MICHIGAN*

JETHRO OTTO VEATCH

THE evidence that the northern part of the United States was covered by a continental ice sheet in the recent geologic past is so convincing that a glacial period is accepted as a fact. Also, a priori, the climate of the land surface exposed by the final retreat of the ice sheet could not conceivably have been the same as the present climate, but must have been much colder. One may speculate whether the change to the warmer condition which exists at present was gradual or whether the curve of change had peaks and hollows of temperature and precipitation, and the scientist may use geologic, ecologic, or pedologic facts to support his theories. For example, ecologists have collected evidence to substantiate a theory that a warmer and drier period existed in the recent past, during which the prairie region extended from Illinois eastward, possibly as far as Pennsylvania.[1]

Some observations which the writer has made, during studies on the genesis of the soils and on the classification of natural land types in Michigan, are here presented with the expectation that they may have value for those who are interested in conjectures regarding the changes in postglacial climate and in theories to account for the existing phenomena of soils, the types and distribution of the original cover of vegetation, and certain topographic features of the state, such as dry valleys and basins. A hypothetical curve of postglacial climate in Michigan is illustrated in Figure 1.

The great number of small prairies in the southwestern part, which may be regarded as relicts of former larger bodies,[2] support the belief that a widespread prairie condition existed in the southern section of the state. The profiles of the soils on these “relicts” are markedly different from the dominant forest soil profile of the region and, therefore, may be regarded as abnormal or azonal. The soil difference lies mainly in the darker color and the greater thickness of the surface horizon and the weak development, or absence, of the leached gray or yellowish A_2 horizon of the forest soil profile. These prairie soils, however, are not wiesnboden soils (dark-colored because of wet conditions), since water does not stand on the surface and since the substratum is comparatively dry. Nor are they rendzinas, since the parent material is not sufficiently calcareous. The soils are, in fact, generally strongly acid in reaction to depths of two to three feet. In addition, the profile generally indicates that the soil is comparatively old, or mature, since a compact clayey B horizon is developed.

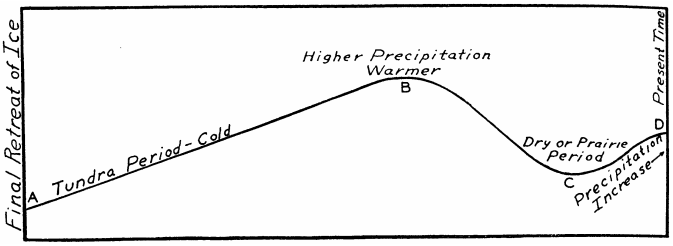

FIG. 1. Hypothetical curve of climatic changes in Michigan

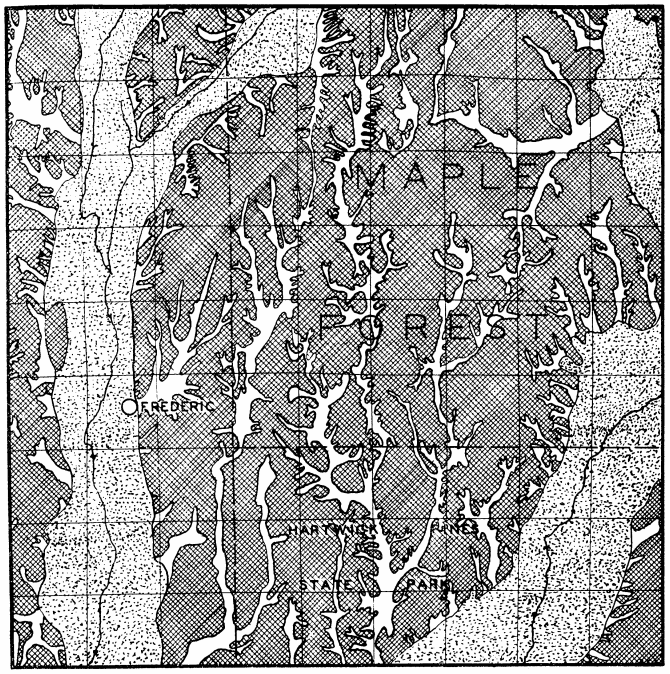

FIG. 2. Part of Crawford County, Michigan, showing dry valleys

Dry valleys

Plateau highland

Valleys of glacial origin, occupied by streams

These prairie soils very probably were much more widespread in southern Michigan than at present, and the assumption is that their nearly complete extinction by encroachment of forest has been due to a change in climate. The climate during the prairie period may have been warmer and drier than now or it may have been characterized merely by a greater range in temperature or a greater difference in distribution of the total precipitation. Conditions might have been sufficiently dry for the formation of a chernozem soil; but if so, all observable evidence of such a profile has been obliterated. However, there is evidence farther west in the Prairie Region to support a theory that the dry climate of the High Plains advanced eastward. It is assumed, therefore, that a drier period than the present existed during the formation of the prairies in Michigan.

The postulation of a dry period may be necessary to explain the existence of dry valleys which are a common feature of the topography in many parts of the state. In numerous places these valleys are dendritic and, therefore, can hardly be explained as constructional features of glacial origin. Illustrations of dry valleys which may represent shallow stream dissection are presented in the sketch map, Figure 2, and in Plate I, Figure 1. The disappearance of the streams possibly occurred during the dry or prairie period, and the precipitation has not since increased sufficiently to restore them.

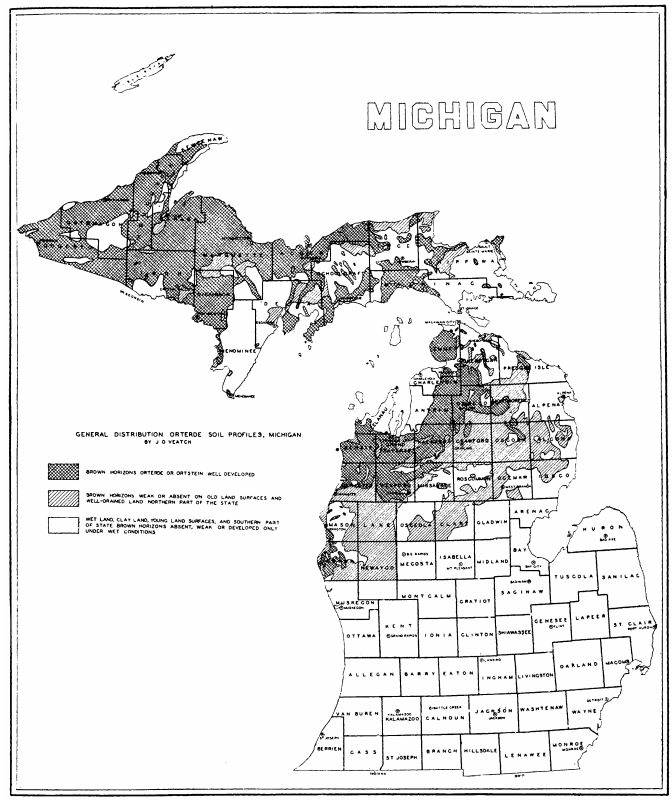

FIG. 3

It is possible that during this dry stage there was a general shrinkage in the volume of water in the inland lake basins also. There is good evidence that many lakes once stood at higher levels. The argument may be advanced that extinction of lakes and the recession of water levels could have been caused entirely by filling by aquatic vegetation and by natural drainage effected by the downcutting of streams. However, there are numerous basins which do not have stream outlets, but which exhibit good evidence that water levels at one time stood much higher than at present. This evidence consists of thin mucky soil, not underlain by water or by the residue of purely aquatic vegetation; of dry marl deposits of lacustrine origin; and of soil profiles now relatively dry, but which exhibit features characteristic of a wet or water-covered site. There are numerous instances of former lakes which now contain no water at all and in which any peat that may have accumulated has disappeared or has been completely changed to a mineral soil. Some of these dry lake basins, particularly on the outwash plains in Muskegon, Oceana, and Newaygo counties, exist at present as small prairies, having thick dark-colored humous soil. The soil profile could not have formed under the present climate on dry sand parent material, and it is perhaps of significance

that species of Opuntia, Andropogon, Artemisia, and Astragalus, and other species common on the prairie land of states to the westward, are growing here.

During this predicated relatively dry and warmer interval most of the old and higher dunes along the shore of Lake Michigan may have been formed, and likewise the features clearly of wind origin on some of the dry sandy plains inland. Also, it is possible to explain by this warmer period the far northward advance of the common northern hardwoods, such as the sugar maple, the beech, and the oaks, and in particular the sparse occurrence of sassafras, as far north as Manistee and Clare counties, and butternut in the upper part of the state. We might also assume that the sugar maple, the beech, and other hardwoods were able to establish themselves on what are now dry sites in the northern part of the state, and that these hardwood species were at one time more widely distributed than at present.

Probably the most cogent pedologic evidence of changes in climate since glacial times is the podsol profile which is common on dry or well-drained sandy land in the upper portion of the state. This particular soil profile is characterized by a gray or whitish highly leached horizon of sand or silt, underlain by a yellowish, brown, or umber-colored horizon, in which the coloring matter is largely organic and which may contain a segregation of iron oxides and may or may not be cemented. This orterde or ortstein horizon occasionally reaches an extreme thickness of four or five feet, but is generally from six to twenty inches thick. If we assume cold conditions succeeding the final retreat of the ice sheet in the southern part of the state, tundra and podsol soils must have been present at one time. These have now completely disappeared except for relict features in some of the profiles. In the northern part of the Southern Peninsula the podsol profile on the drier or better-drained land probably occupies not more than half of the area, but in the Upper Peninsula it covers perhaps as much as 75 per cent. The simple geographic fact of distribution of this soil profile is evidence within itself of changes in climate. The distribution of relatively dry podsol soils is illustrated on the map, Figure 3, and the occurrence of an ortstein horizon on a high dry ridge of sand is illustrated in Plate I, Figure 2.

In short, the soil profiles of the state appear to exhibit as many features inherited from past climates as from the present. There are dry, hardwood podsols, such as the Kalkaska and Autrain soil types; profiles which are characteristic of waterlogged podsols and swamp soils, but which are now on dry sites; oxidized red clayey B horizons typical of a warmer climate than the present; and dark-colored humous soils which developed under a grass or treeless cover.

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[1] Transeau, E. N., "The Prairie Peninsula," *Ecology*, 16 (1935): 423-437.

[2] Veatch, J. O., "The Dry Prairies of Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 8 (1927) : 269-278. 1928.

VEATCH PLATE I

FIG. 1. Dry postglacial valleys, Leelanau County, Michigan

FIG. 2. A soil inherited from a past climate. A thick, leached gray horizon and a conspicuous ortstein, or sand hardpan, on a high, dry sand ridge. Ten miles south of Newberry, Luce County, Michigan

THE GEOGRAPHY OF A PART OF THE NORTHWEST CUMBERLAND PLATEAU OF KENTUCKY PART I. PHYSICAL GEOGRAPHY*

LEONARD S. WILSON

INTRODUCTION

THE western limit of the Northwest Cumberland Plateau is the steep, heavily forested Pottsville escarpment which rises from the Highland Rim as a physical barrier to travel (Fig. 1). This escarpment provides a physiographic, as well as a geologic, boundary between the maturely dissected Cumberland Plateau and the lower lands to the west. It has served, also, from earliest times, as a barrier to the movement of the occupants.

The area is one of the more colorful historical parts of the United States. The majority of the inhabitants are direct descendants of the pioneer families who entered the wilderness, prior to 1800, through Cumberland Gap and moved northward along Wilderness Trail and Boone's Trace from the Valley of Virginia to isolated valleys of the plateau. Nor did the historical interest of the "Kentucky Mountains" culminate in the frontier era. In 1862 the northern advance of the Confederate armies was halted in this part of the plateau because of the inability of the supply divisions to maintain their routes of communication. This was caused in part at least by the mature dissection of the area.

Although long settled, this land is still in the process of expansion. Isolated from more recent lines of communication, the Northwest Cumberland Plateau has remained practically untouched by the spread of agricultural and industrial developments in eastern United States. Centrally located in the eastern part of the country, it has been characterized as lying within the Cfa climatic zone.[1] Here the native vegetation is composed of mixed hardwood tree associations. In some sections this typical native cover is interrupted by stands of yellow pine, outliers of the southern pinery.

LIMITS OF THE AREA

The actual limits of the area under consideration do not correspond in any way to physical or cultural boundaries. Because of the size of the Northwest Cumberland Plateau, about 6,000 square miles, as well as the absence of roads, the present study was restricted to a representative part of it. An arbitrary triangle of land lying between Burnside, Monticello, and Stearns was chosen[2] (Fig. 2).

The triangle covers an area of approximately 500 square miles. It consists of eastern Wayne County and the southern half of Pulaski County as well as the western half of McCreary County. The average elevation is about 1,200 feet, with an average local relief of 400 feet.

Throughout the triangle the surface rock is Rockcastle Conglomerate, a resistant coarse-grained sandstone, deposited during the Mississippian period and later uplifted. Because of the dip of the deposits of the conglomerate, as well as of the underlying limestones, it is apparent that uplift was stronger on the western margin of the area than on the eastern. In spite of the direction of uplift the higher portions of the area are in the eastern section. This lack of relationship between the rock strata and surface elevations suggests that the surface was originally a peneplain.

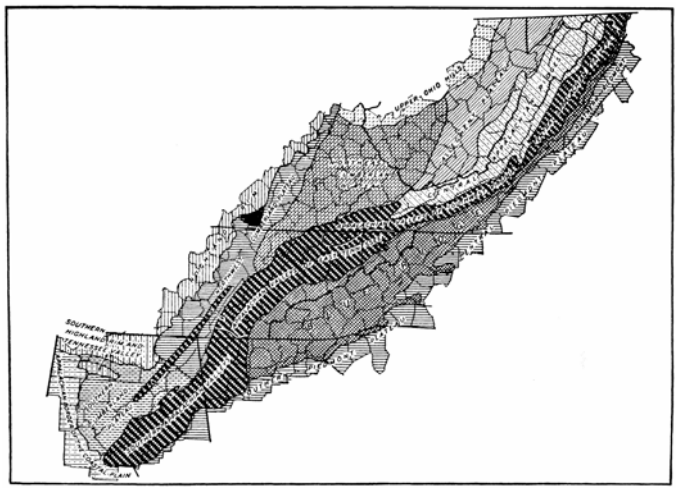

FIG. 1. Physiographic subregions of the southern Appalachians (from "Natural Land Areas," a map prepared by C. P. Barnes and F. J. Marschner, Bureau of Agricultural Economics, U. S. D. A., Washington, D.C.). The position of the area under discussion is indicated by the solid black triangle. Scale: 1 inch equals about 100 miles

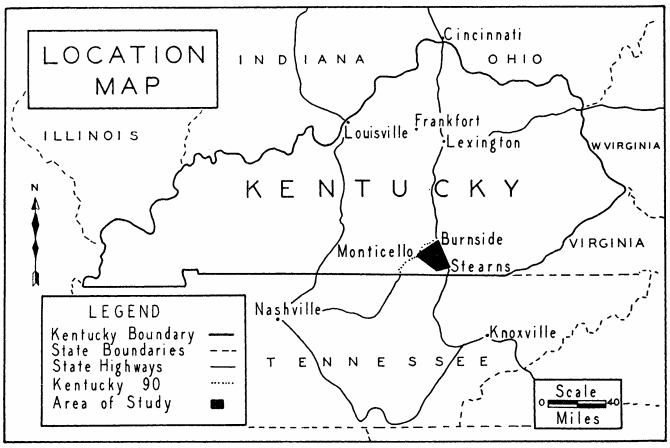

FIG. 2

DRAINAGE

The area in question is a part of the watershed of the Cumberland River, one of the largest tributaries of the Ohio River. In its upper reaches the Cumberland divides at Burnside into the North Fork and the South Fork. Here the South Fork flows in a meandering course northward from Tennessee, dividing the triangle into two nearly equal parts.