

THE GEOLOGY OF LAKE AND PORTER COUNTIES, INDIANA.

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Occupying the extreme northwestern corner of Indiana are the two counties of Porter and Lake, together comprising 920 square miles of territory. This territory is bounded on the east by Laporte County, Indiana, on the south by the Kankakee River, on the west by Cook, Will and Kankakee counties, Illinois, and on the north by Lake Michigan.

Location and Area. According to the United States Survey, the area comprising these two counties lies in Townships 31 to 38, inclusive, north of the base line of Indiana, and in Ranges 5 to 10, inclusive, west of the Second principal meridian. Valparaiso, the county seat of Porter County, and located near its center, is in latitude 41 deg., 28 min., north, and in longitude 87 deg., .04 min., west, while Crown Point, the county seat of Lake county, is in latitude 41 deg., 25 min., .07 sec., north, and in longitude 87 deg., 22 min., 30 sec., west of Greenwich.

The two counties were at first united, but by an act of the Legislature approved January 18, 1837, that portion of their territory lying west of the center of Range 7, west, was organized as Lake County, and was declared to be independent after the 15th day of February, 1837. This division gave to Lake County an area of 500 square miles and left in Porter County 420 square miles. With its northwestern corner lying within 12 miles of the Court-house of Chicago, the area comprised in these two counties is destined to become as valuable as any of equal size in the State of Indiana.

GENERAL PHYSIOGRAPHY.

In the present paper we have to deal principally with the physiography or surface features of the area under consideration since not a single outcrop of paleozoic rock is known to occur in the two counties. Their 920 square miles is a *plain of accumulation*, being everywhere covered with a sheet of glacial drift ranging in known thickness from 90 to 141 feet.

If a person could rise in a balloon so as to get a bird's eye view of this plain, or if he would traverse it from north to south at intervals

of a few miles, he would see that it comprises three distinct belts or regions, each with well-marked surface characteristics. The region on the north and the one on the south would each be seen to be lower, and comparatively much more level than the one intervening. Along the upper margin of the northern region would be noted, however, a narrow strip covered with numerous hills and ridges of sand. The surface of the middle region, comprising more than half of the entire area, would in some parts be seen to be high and undulatory, in others more even and regular, but on the whole much more rugged and broken than either of the other two. To these regions the following names may be applied:

1. **THE CALUMET OR NORTHERN REGION**, so called because the Calumet River flows east and west through its full width, comprises approximately 250 square miles, 162 of which are in Lake County and 88 in Porter. On the western border of Lake this belt is 15 miles wide, but it narrows as it passes to the northeast until it is but eight miles in width, where it passes into Porter County, and but seven miles where it leaves that county at the northeastern corner. This region, as we shall see, owes its surface configuration partly to a former extension of Lake Michigan southward, and partly to the action of the wind on the sand thrown up by the present lake.

2. **THE MORAINIC OR MIDDLE REGION**. Four hundred and eighty-five square miles of the surface of the two counties are comprised in this belt, about 250 of which lie in Lake and the remainder in Porter. The higher altitude and more rugged surface of this area is due to its being covered with a much thicker mass of glacial debris which was dropped where it now lies by a lobe of the great Laurentian ice-sheet. Since its deposition its surface has been modified only by wind, frost and erosion by small streams. On the western border of Lake County this belt of drift is 17 miles in width. Where it passes into Porter County its width is approximately the same. In that county it trends to the northeast and gradually narrows until at the point where it leaves the county it is but about seven miles in width.

3. **THE KANKAKEE BASIN OR SOUTHERN REGION**. The remaining 185 square miles of the two counties are comprised in this region, 80 of them lying in Lake County and 105 in Porter. In the former county most of this area is marsh land, which up to the present has not been drained sufficiently for thorough cultivation. In Porter County the marsh area is much less, a large part of the Kankakee basin, being composed of rich, and at present, well drained prairie lands. A more detailed account of each of these regions will follow hereafter.

THE UNDERLYING ROCKS.

If through the great sheet of drift which covers the surface of Lake and Porter counties a bore be driven, as has been done in a number of places, solid or bed rock will be struck at varying depths. In Porter County and in the eastern two-thirds of Lake County this rock has been found to be the black Genesee shale of the Devonian age. In the south half of the western third of Lake County it is the Lower Helderburg limestone, while in the north half of the same area it is the Niagara limestone, both of the Upper Silurian age. Whatever its nature the formation immediately underlying the drift was, at one time, laid down as sedimentary rock in the bottom of a shallow sea, and several millions of years ago, was raised into dry land.

The black shale, which, during a very long period, formed the surface over the greater portion of this area, when first brought up from the deep bores in Porter and Lake counties, has a black to bluish gray color, but an exposure to air soon changes to a light gray or drab. It is a soft material, easily pierced by the drill, and is composed mainly of very fine grains of sand (silica) and alumina cemented together by iron (ferric) sulphide and thoroughly saturated with bitumens. The proportions of these constituents are shown in the following chemical analysis of a sample of the shale from New Albany, Indiana:*

ANALYSIS OF GENESEE SHALE.

Water expelled at 100°C.....	0.50
Volatile organic matter (bitumen).....	14.16
Fixed carbon (bitumen)	9.30
Silica	50.53
Pyritic iron and alumina.....	25.30
Calcium oxide	0.09
Magnesium oxide	0.12
Total	100.00

The bitumens doubtless owe their presence in the shale to the slow decomposition of a vast number of marine plants and animals which were deposited with the sand and iron sulphide by the turbid waters of the old Devonian seas. Once so deposited these organisms did not decay as do animals on land, since by the waters above and the mud and ooze about them they were shut off from the free oxygen of the air which is the principal agent in decay. They underwent, instead, a process of slow decomposition, the products or residue of which are

*See article by Hans Duden, in 21st Annual Report, Department of Geology and Natural Resources of Indiana, 1896, 108-119, entitled "Some Notes on the Black Slate or Genesee Shale of New Albany, Ind."

known as bitumens. These bitumens in time saturated the surrounding sediment and gave to it its distinctive black color. They have since remained closely associated with this sediment, which, by great pressure, has been compressed into shale or laminated clayey rock.

The bitumens, when separated by distillation or otherwise, will burn readily with a bright flame and without leaving a residue.* On account of their presence the shale itself may be set on fire and will burn until the bitumens are consumed. The sand, alumina and iron sulphide being non-combustible, the shale retains its shape after the bitumens are burned out, but is changed in color to a reddish brown. On account of this property of partial combustibility, the black shale is often mistaken for coal by persons who are unacquainted with its true nature.

This Genesee shale is known to be the formation immediately underlying the drift over quite a large area of the two northern tiers of counties in Indiana. In a strip eight to fifteen miles wide, extending from Jasper County in a southeasterly direction to the Ohio River at New Albany, it also lies next below the drift or forms the surface rock. West of this strip it lies at greater depths beneath the Subcarboniferous and Carboniferous limestones and shales which comprise the surface rocks of Southwestern Indiana. Its thickness as noted at a number of points in the State is as follows:

New Albany	104 feet.
Salem	103 feet.
Seymour	115 feet.
Bridgeport	124 feet.
Goshen	140 feet.
South Bend	95 feet.
Valparaiso	65 feet.
Crown Point	112 feet.

This shale undoubtedly once covered a much larger area south and east of the ones above mentioned; but during the long interval between its rise above sea level and its burial beneath the drift, that area was reduced by extensive erosion.

The Lower Helderberg, which lies next to the drift in the southern half of the western third of Lake County, is a buff or gray cherty limestone. Where it is exposed by erosion it is often irregular and uneven in its bedding. The best exposure of this formation in Indiana is along the Wabash River above and below the City of Logansport. Further northwest it comes near the surface at Monon and Rensselaer, in Indiana, and in Kankakee and Iroquois counties, Illinois.

* Mr. Duden, by a process of distillation, obtained from 8.5 pounds of the shale 65 gallons of 22 candle-power gas. He also states that in Scotland, in 1890, 62,500,000 gallons of crude petroleum and 25,000 tons of sulphate of ammonia, the latter a valuable fertilizer, were made from a similar shale.—*Loc. Cit.*, pp. 113-114.

The Niagara has been found by borings to underlie the drift in the vicinity of Hammond, Lake County, and between there and Chicago. Over a large portion of the eastern half of Indiana it also forms the surface rock. It is a bluish or buff, sub-crystalline limestone, usually rich in the fossil remains of those marine animals common to the epoch of its formation. Near Chicago this limestone contains much petroleum, but in such a minutely diffused state as to be wholly without value.

*The
Niagara
Limestone.*

Could all the drift be removed from the surface of Lake and Porter counties the elevations of the different portions of the exposed surface would be found to vary but little, and the three formations—Genesee Shale, Lower Helderberg and Niagara limestones—would be exposed as the surface rock, each occupying its respective area above mentioned. If the black shale could in turn be stripped from the area which it covers, beneath it would be found the Lower Helderberg, and beneath that the Niagara.*

GLACIERS AND GLACIAL DEPOSITS.

In the surface rocks below the drift which covers Lake and Porter counties there doubtless exist many shallow valleys and perhaps some deep ones, remnants of those of pre-glacial days. For, be it remembered that during thousands—aye, millions—of years, these surface rocks were once dry land. Decay and erosion were in action then as they are to-day. Sunshine and rain, wind and frost, trickling rills and strong streams, were ever at work, softening and sculpturing and wearing down the exposed rocks—forming clays and sand and gravel and bearing them away to lower levels. At the close of that period this area of surface rock resembled, probably, that of to-day in the driftless area of southern Indiana, being cut up by erosion into a complex network of valleys, ridges and isolated hills. Over these was a soil—formed from decaying rocks and vegetation—poorer, perhaps, than much of that which at present covers the surface of the two counties—resembling closely, perhaps, that now found in Scott, Jennings and Floyd counties, where the black shale has been the parent rock.

During this long period of erosion and decay mild climatic conditions had prevailed. But a change in these conditions came gradually to pass. For some, as yet unknown, reason the mean annual temperature of the northern hemisphere became much lower. The climate of

* Between the Genesee shale and the Lower Helderberg might be found the Upper Helderberg, and between the Lower Helderberg and Niagara the Waterlime. But in Indiana the Upper Helderberg is often very thin or altogether wanting, while in the northern counties of the State the Waterlime is so similar to the Lower Helderberg that the two are difficult to distinguish.

the regions to the east and south of Hudson's Bay became similar to that of Greenland to-day, or even colder. The snow, ever falling, never melting, accumulated during hundreds of centuries in one vast field of enormous thickness. Near the bottom of this mass a plastic, porous sort of ice was gradually formed from the snow by the pressure from above. This ice mass or glacier took upon itself a slow, almost imperceptible, motion to the south and southwestward. As it moved thus onward great masses of partly decayed rock and clay from hillsides and jutting cliffs rolled down upon it and were carried on and on until, by the melting of their icy steed, they were dropped hundreds of miles from the parent ledge. Large, irregular masses of rock from the region in which the glacier was formed were either frozen into its nether portion or rolled along beneath it, and as the ice sheet moved they served as great stone drags, grinding down and smoothing off the hills and ridges and filling up the valleys, until the irregular, uneven surface of the old preglacial rocks was planed and polished. In many places these imprisoned rocks cut deep scratches or grooves—the so-called "glacial striae"—in the surface ledges over which they passed. These, to the geologist, are excellent exponents of the direction in which the glacier moved.

From these striae, and from other evidence which it is difficult to otherwise explain, it is now believed that there were several distinct epochs in the glacial period. The great ice sheet which was first formed several times advanced and as often—by an increase in the temperature of the region which it entered—melted and receded; its retreat or recession being each time as gradual as its advance had been. Like a great army which has attempted the invasion of a country and has been compelled to withdraw, it would again assemble its forces and start in a slightly different direction. But perchance before it had reached the limit of its former invasion a force of circumstances would render a retreat necessary. Its advancing margin was not a straight line, but in lobes or long, gradual curves. Mr. B. F. Taylor has given the following graphic description of the ice sheet at the time of its greatest advance into the regions now comprising Indiana:*

"When the glacier covered most of Indiana the ice was at least 500 or 600 feet deep over the present site of Terre Haute, and nearly as deep over that of Indianapolis, and it thickened gradually northward. If an observer could have stood on one of the hills in Brown County at that time he would have seen to the east of him the great wall of the

*Studies in Indiana Geography, 1897, 102.

ice front extending south towards Kentucky, while to the west it would have been seen in the distance stretching away towards the southwest. For hundreds of miles to the east and west, and for 2,000 miles or more to the north, the glaring white desert of snow-covered ice, like that seen in the interior of Greenland by Nansen and Peary, would have appeared, stretching away out of sight with not a thing under the sun to relieve its cold monotony. It is hard to think of Indiana and her neighboring sister States as being clothed in such a shroud-like mantle as this. But it was in large part this same ice sheet, coming perhaps four or five times in succession, that covered the State with the inexhaustible soil of the drift, and made Indiana the fertile agricultural State that she is to-day."

Whenever a glacier has reached the limit of its advance and there halted a sufficient length of time to deposit a large amount of debris, such an accumulation is called a terminal moraine. This moraine does not consist, as is often supposed, of numerous large boulders, which have been dropped on the surface in more or less regular concentric lines. Such boulders are only an accompaniment, and constitute but a very small fraction of the moraine proper. The main portion usually consists of a thick bed of compacted tough clay in which are many pebbles and boulders of small size, and often pockets of gravel and sand. Such a moraine may be a number of miles in width and consist of many small parallel ridges, or it may have a number of subordinate ridges branching off in every direction from the main one. These "unite, interlock, separate, appear and disappear in an intricate and eccentric manner. Several of these subordinate ridges are often plainly discernible. It is usually between them and occupying depressions caused by their divergence that most of the larger lakes embraced in the moraine are found. . . . The component ridges are themselves exceedingly irregular in height and breadth, being often much broken and interrupted."* When very complex the term "morainic system" is often given to a terminal moraine.

As already noted, a large area of the present surface of Lake and Porter counties is covered by a portion of a terminal moraine possessing many of the characters above described. The city of Valparaiso is located near the crest of the main ridge, and for that reason the name "Valparaiso moraine" has been ascribed to it. According to Frank Leverett,† who has made a special study of a portion of this moraine, it begins near the Illinois and Wisconsin line and extends southward through portions of Lake, McHenry, Cook, Dupage and

* Chamberlain, T. C.—Third Ann. Report, U. S. Geol. Surv., 1883, 311.

† See Bull. Chic. Acad. Science, No. 2, 1897, p. 26.

Will counties, Illinois. In Will and southern Cook counties it turns to the southeast and enters Lake County, Indiana, from the southeastern portion of Will County. Throughout this course it ranges from ten to fifteen miles in width, and its inner border lies nearly parallel to the shores of Lake Michigan and distant from it about 12 miles. Its leading features in Lake and Porter counties will be described more in detail hereafter.

*The
Valparaiso
Moraine.*

From Porter County it extends northeasterly across Laporte County, the town of Otis lying near its inner margin. Still pursuing a northeasterly course, it extends through portions of Berrien, Cass, Kalamazoo, Barry, Kent, Ionia and Montcalm counties, Michigan, beyond which it has not been definitely traced. In the words of Dr. Chamberlain:* "It may be likened in a general manner to an immense U, embracing the great lake between its arms. This gigantic loop is over 200 miles in length and from 90 to 150 miles in width. The parallelism of this moraine to the lake shore is one of its most striking features."

Each of the great divisions or lobes of the main glacier has been given a special name by those geologists who have studied the limits of its advance. The division which once partly covered the area now comprising Lake and Porter counties is known as the Michigan lobe—its outline having roughly corresponded to the area at present occupied by Lake Michigan. Over the area now covered by the Valparaiso moraine other ice sheets had, no doubt, previously advanced and receded, but that moraine, as now limited, is due to the last advance of the great Michigan lobe. The final retreat of this lobe was towards the northeast.

As it slowly receded it left between the border of the inner slope of the Valparaiso moraine and the edge of the retreating ice a low area, which was soon covered with water from the melting glacier and from rainfall. A lake was thus formed whose waters were dammed up on the north and northeast by the ice of the retreating glacier, and on all other sides by the moraine which this glacier had left behind it. This lake continued to rise until it overflowed the moraine at its lowest point, which happened to be to the southwestward, near the present city of Chicago. At this point a channel was eroded, through which, for a long period, the waters of the glacial lake found their way to the Des Plaines River, and thence by way of the Illinois to the Mississippi. To this channel has been given the name "Chicago Outlet," and the glacial lake which formed it is known in geological literature as "Lake Chicago."

*Formation
of Lake
Chicago.*

* Third Ann. Report U. S. Geol. Surv., 1883, 322.

The area of this lake was necessarily a variable one; since the ice dam on the north was all the time slowly receding. However, the name Lake Chicago is applied to all its stages* from the time of the first opening of the Chicago outlet until its final closing on account of the overflow of the Great Lakes, finding for itself a new channel through the Niagara River.

On the south, Lake Chicago, during its first stage, extended into Lake County as far as the high sandy ridge passing east from Dyer through Schererville. East of this ridge the southern border of the lake lay south of Turkey Creek and Deep River, in the northern part of Ross Township. In Porter County it turned sharply to the northeastward, following the border of the moraine to near the center of section 18, Portage Township, then southeast up the valley of Salt Creek to section 32, where it again turned to the northeast. According to Leverett, who has studied carefully the limit of the lake in this region, the sand ridges which lead northeast from Crissman mark the southern limit of the lake proper in Porter County, so that the plain along Salt Creek and east from there to Chesterton and a narrow strip northeast of Chesterton along the Calumet River to near the line of Porter and Laporte counties was covered by a nearly enclosed shallow bay. This bay apparently opened into the lake proper at the Little Calumet, in section 31 (37 north, 6 west). There was probably a similar bay east of Deep River and south of the village of Lake, which opened into Lake Chicago at the head of Turkey Creek, south of Griffith.

I. THE CALUMET OR NORTHERN REGION.

The high ridge which was mentioned above as being the limit of Lake Chicago near Dyer, is but one of three prominent ridges or beaches which mark in part the old shore line of that lake in Lake and Porter counties.

The one at Dyer is the upper beach thrown up by the first stage of the lake. To it the name of Glenwood Beach has been given by Mr. Leverett,† since the beach is well exposed near the town of that name, a few miles south of Chicago. In Illinois it has been traced by Leverett from the Illinois-Wisconsin line. North of South Waukegon it lies but one or two miles from the present shore of Lake Michigan. Between Waukegon and Winnetka the beach has been cut away by the encroachment of the waters of Lake Michigan. Below Winnetka it extends a little south of west through Oak Park, Maywood, and La Grange, to near

* Leverett—Bull. Chic. Acad. Science, No. 2, 1897, 65.

† See Bull. Chic. Acad. Nat. Science, No. 2, 1897, 66, *et seq.*

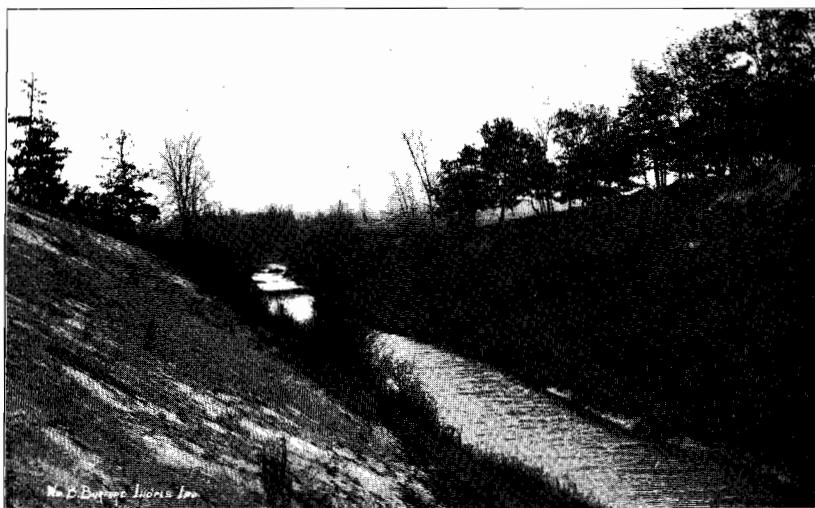
Willow Springs, where it turns to the southeast. Between Willow Springs and Glenwood it is not prominent, the old shore line being "carved on the inner face of the Valparaiso moraine, with banks 5 to 20 feet or more in height, but with only occasional deposits of gravel and sand." Near Glenwood, in the northwest quarter of section 25, (36 north, 13 east), the beach line diverges from the moraine and from this point to Dyer lies from one to two miles to the north of its border. Throughout this distance the beach is composed mainly of deposits of sand and gravel thrown up to a height of 6 to 15 feet above the surrounding surface. In many places these deposits are spread out over an area a half mile or more wide, in the form of small parallel ridges with numerous depressions or sags intervening.

At Dyer, 15 miles due south of the Illinois-Indiana cornerstone, the beach enters Indiana. Here the small ridges have combined into one prominent one, composed mainly of fine sand, whose crest rises rather abruptly 25 to 40 feet above the lowlands of Cady Marsh to the north. The level of the base of the ridge, where crossed by the Monon Railway at Dyer, is 636 feet above tide, so that the crest of the ridge is 80 to 95 feet above the present level of Lake Michigan. The width of the crest itself is but 40 to 70 feet, this distance being practically level. On the south side the slope is much more gradual than on the north, the entire width of the base being 40 to 60 rods. This ridge continues unbroken due east from Dyer about two and a half miles. Small trees of the black oak, *Quercus velutina* Lam., and thickets of crab-apple and other shrubs cover its slopes and crest throughout this distance and have prevented the moving of the sand by the wind. A mile west of Schererville the continuity of the ridge is broken. Sand hills or dunes begin, some of which are 25 to 30 feet in height. These extend two miles east of Schererville, where they end in section 12 (35 north, 9 west).

From this point the shore of the first stage of the glacial Lake Chicago no longer coincides with the beaches which owe their origin to it. The former, as already mentioned, passes to the eastward south of Turkey Creek, while Glenwood Beach sets in again near Griffith, and extends in a northeasterly direction through Ross. A mile and a quarter beyond this station, in section 29 (36 north, 8 west), it joins the Middle or Calumet Beach. Between Griffith and this junction the Glenwood Beach is a half mile or more wide and is composed of several broken ridges of dunes, covered with small black oak timber. Beyond the junction the two beaches—Glenwood and Calumet—lie side by side and trend northeastward to near the Calumet River, two miles northeast of Crissman, Porter County, where they suddenly terminate. Between the station of Lake and this terminal point these two beaches



Calumet Beach near Highland, Lake County, Indiana.



Hart Ditch, cut through Calumet Beach, $1\frac{1}{4}$ miles west of Highland, Lake County, Indiana.

VIEWS OF CALUMET BEACH.

consist of two or more parallel ridges, each 20 to 30 feet above the depression between them. Several smaller ridges lie also parallel to and north of them.

North of the Calumet River, in Westchester and Pine townships, Porter County, the two beaches are in places separated by a narrow marsh lying just north of the Michigan Central Railway. East of Furnessville the Glenwood Beach lies mainly south of the Michigan Central Railway, while the Calumet Beach lies north of it as far eastward as the vicinity of the Northern Indiana Penitentiary, in Laporte County. Over most of this distance their combined width is about three-fourths of a mile. Between their northern limit and the Lower or Tolleston Beach, lying to the northward, is a great marsh, eight miles long by one-half mile wide, which extends from Michigan City westward to old City West. (See map.)

For some reason, probably that of a great recession of the ice dam to the north of the glacial Lake Chicago, accompanied, perhaps, by a lowering of elevation far to the northeast and the cutting of an outlet in that direction, the waters of Lake Chicago ceased for a time to flow through the Chicago Outlet. They withdrew wholly from the area which they covered in Lake and Porter counties—and even a large part of the southern end of the present Lake Michigan is supposed to have been dry land.

After a long period, by another glacial advance, or an elevation of the territory embracing the northeastward outlet, perhaps both, the waters of Lake Chicago again advanced southward and began to flow through the southwestward outlet. A new beach was thrown up north of the old Glenwood Beach. Since it lies close to the Calumet River throughout much of its course the name "Calumet Beach" has been ascribed to it.

In Illinois, according to Leverett, it is difficult to distinguish from the upper beach until the Chicago River is reached. Between the Chicago and Des Plaines rivers it lies from one and one-half to three miles distant from the Upper beach, but follows the same general direction. At Summit it turns to the southeastward and follows that direction to the north end of Blue Island ridge, where it turns southward and passes by Washington Heights to the Calumet River east of Blue Island. Then ensues a break due to the location of the old Sag Outlet, through which Lake Chicago discharged. East of this break, near the Illinois Central Railway, the beach again appears, and, passing eastward through Lansing, crosses the State line into Indiana about one and a half miles south of the Little Calumet River. Continuing eastward along the north border of Cady Marsh, it passes through Highland,

*The Middle
or Calumet
Beach.*

and, as already noted, joins the Upper or Glenwood Beach northeast of Ross. Beyond this point its course through Lake and Porter counties practically parallels that of Glenwood Beach and has been traced in connection with it.

Between the State line and the junction above noted the Calumet Beach consists of a single prominent ridge of sand, possessing practically the same characteristics as the Glenwood Beach east of Dyer. Its north slope is much more abrupt than the south one, and the crest ranges from 25 to 35 feet above the Calumet Plain to the northward. Just west of Highland this crest is 150 yards wide. Where excavations have been made by burrowing mammals many coarse pebbles and pieces of limestone an inch or more square have been thrown out, suggesting a mixture of gravel with the sand some distance below the surface.

At the crossing of the Hart ditch, one and a fourth miles farther west, a cut is made 45 feet deep through sand alone. The crest is here about 140 yards wide, and the base probably as wide again. This ridge, with its wooded crest standing so high above the great treeless Cady Marsh on the south and the Calumet Plain on the north, is a prominent feature of this section of Lake County. The elevation of its crest at Highland is 55 feet above Lake Michigan.

Once again the waters of Lake Chicago receded and for a time stopped flowing through the Chicago Outlet. When they again advanced they threw up the third of these prominent sand ridges, called the Lower or Tolleston Beach, since it passes through the Indiana town of that name. It has been traced by Leverett from Evanston, Illinois, south through Rose Hill Cemetery to Lincoln Park, Chicago, beyond which it is obliterated for quite a distance. From Englewood it passes southeasterly to Hyde Park, and then south near Pullman, Kensington and Riverdale. Near Dolton, south of the Calumet River,

*The Lower
or Tolleston
Beach.* it turns more to the eastward and enters Indiana in section 12 (36 north, 10 west), less than two miles south of Hammond. Trending eastward, it passes through the villages of Hessville, Tolleston and Miller's, in a line about mid-

way between the Little and Grand Calumet rivers. East of Miller's it deflects slightly to the northward and through Porter County lies parallel to the present shore of Lake Michigan, and distant from it nowhere more than a mile. It has here, however, been largely covered by the dunes of the present lake so that it is difficult to distinguish from these later deposits. In its extent through Lake County this beach is composed of a broken ridge of sand dunes varying in height from 20 to 30 feet, and covered with dwarf black oak and other trees and shrubs peculiar to a sandy soil.



CALUMET BEACH.

Showing cut of Hart Ditch and wagon bridge, Lake County, Indiana.

In both Lake and Porter counties all that interval lying between Tolleston Beach and Lake Michigan is covered with sand, there being no such broad, level plains as occur along the Little Calumet, between the Calumet and Tolleston beaches, and along Cady Marsh between the Upper and Middle beaches. In Porter County, as already noted, this interval is covered with high sand dunes. North of Miller's such dunes also cover most of the area, but west of that station a series of

Low Beaches. low beaches or sand ridges appear which lie parallel to Tolleston Beach and cover the whole interval between it and the present lake. These beachlets, for the most part, rise but 8 to 15 feet above the level of Lake Michigan and are 6 to 10 rods in width, with narrow swamps or swales intervening, which become dry in summer. Leverett has counted 32 of them on the line running north from Hessville. They were evidently formed after the waters had ceased to flow through the Chicago Outlet and hence were thrown up by the waters of Lake Michigan rather than those of Lake Chicago.

Similar low beaches are found in the vicinity of Jackson Park and Englewood, Illinois. Between their southern ends and the western ends of the beaches in Lake County a low sandy plain intervenes whose surface is nowhere more than 10 feet above the present level of Lake Michigan. This is supposed to have been an open bay at the time the beachlets were forming, but has since been partially filled with sand, leaving Lakes George and Wolf, in Indiana, and Calumet, in Illinois, as remnants of its waters.

West of Hobart, and included within the area supposed to have been covered with the waters of Lake Chicago, is a morainic ridge about four miles long by one mile wide. Its surface is higher than that of the surrounding country and covered with glacial till. This ridge was evidently an island whose surface lay above the waters of Lake Chicago at the time of its highest stage.

Beneath the sand north of Tolleston Beach occasional layers of gravel are struck at varying depths, and mingled with these, as well as with the sand, are numerous remains of fresh water mollusks, both univalve and bivalve. But little data was available concerning the thickness of the sand. Well sections at Liverpool show it to extend to a depth of 10 to 16 feet; at Lake 20 to 22 feet, and at the powder works, near Miller's, 40 feet. At Hammond, where it ranges from 23 to 30 feet, it overlies a blue pebbly clay, 60 to 85 feet in thickness. This clay appears more homogeneous and finer-grained, and less tough and compacted, than that found underlying the Valparaiso moraine, farther south. These qualities are probably due to its deposition by the waters

of Lake Chicago, the finer particles as they settled down from suspension in water having been distributed more uniformly than if dropped by a melting glacier. Beneath this clay lies the Niagara limestone or surface rock of preglacial age. Aside from the dunes the sand will probably vary from 20 to 40 feet in depth and will be found to overlies the subaqueous clay above mentioned throughout most of the area north of the Lower Beach.

Within the area covered by the bays of Lake Chicago mentioned on page 33 there are large deposits of a very fine-grained silt or marly clay. Of these the one near Hobart is best known, having been exposed in a large pit to a depth of 25 feet, and pierced by a *Silt* *Deposits.* ^{Arbore} 132 feet without reaching its base. It is a dark drab in color, becoming lighter by exposure. As is customary with such deposits, it lies in thin layers, two to nine inches thick, separated by a slight coating of sand. It contains quite a percentage of lime disseminated evenly through it, and for this reason burns to a whitish or cream color. It is wholly free from pebbles or impurities of any kind, and is extensively used at Hobart for the making of pressed front brick and terra cotta lumber.* This silt is exposed at Garden City, on the county line two miles southeast of Hobart, also at several points north of Porter and Chesterton along the Calumet River. It has also been found in a number of wells in the western part of Portage Township, Porter County.

The northern limit of Lake and Porter counties comprises 33 linear miles of the southern beach line of Lake Michigan, one of the grandest bodies of fresh water on the globe. Along this beach was for years the only public road in the area now comprising the two counties, all overland communication between Ft. Dearborn—Chicago—and Detroit in the early part of the present century having been along its sands.

The limits of this beach line are ever changing. Water and wind are, every second, tearing from it in one place and adding to it in another. From Michigan City southwest for ten or more miles the removal is probably greater than the accumulation, but along the remainder of the Indiana shore the beach line is being widened. In the latter portion a person walking along the margin of the water can see that each wave throws up a minute ridge of sand, so minute, in fact, that it is scarcely visible. Perhaps the next succeeding wave carries it away. But if it be thrown high enough to remain unmolested until it has time to dry, its particles are caught up by the wind and carried farther inward. In most cases they are piled up for a

* For analyses of this clay and a more detailed account of its uses see the article entitled "The Clays and Clay Industries of Northwestern Indiana" in the present volume.

time along the foot of a ridge or dune, which is found from 50 feet to 100 yards back from the water. If a stiff breeze be blowing, the traveler over this beach is bombarded by the fine, sharp-edged particles of sand, many of which strike against his face and produce a stinging sensation. These grains are composed of small angular pieces of quartz and have a light-brownish tint.

The amount of this sand which has been thrown by the waves of Lake Michigan on to the shores of Porter and Lake counties has been computed by Dr. Edmund Andrews,* as follows: "For 25 miles west from Michigan City the beach maintains an average cross section of about 6,000 square yards, and its contents are 264,000,000 cubic yards. In this division the beach is in the form of a lofty belt of sand dunes, about one-third of a mile wide and in places 160 to 200 feet in height. In the next eight miles west (extending to the Indiana line) the beach spreads out into a broad belt of low parallel ridges, about two miles in extreme width. This division has a cross section of about 16,000 square yards, after deducting the sand which was deposited by Lake Chicago. Its contents amount to 225,280,000 cubic yards." It will thus be seen that at a low estimate half a billion cubic yards of material have been added to the surface of these two counties by the waters of the present lake.

The dunes constitute the most striking and characteristic feature of the shore line. They are great sand ridges, sometimes continuous for a mile or more, but more often broken or cut by "blow-outs" into isolated rounded hills. The highest of these hills in Porter County is Mt. Tom, in section 12 (37 north, 6 west), northwest of old City West. Its crest is 190 feet above Lake Michigan. Northeast of Miller's, Lake County, are a number reaching a height of 150 feet above the lake. In some places, notably about Dune Park, Porter County, the ridges are for long distances wholly destitute of vegetation. Their bared surface, 50 to 100 feet in height, with the sand piled just as steeply as it will lie, gleams and glistens in the sunlight and reflects the summer's heat with unwonted force. Other ridges and rounded hills, especially those back some distance from the lake, are often covered with black oak, northern scrub pine (*Pinus banksiana* Lambert), stunted white pine (*Pinus strobus* L.), and many shrubs and herbs peculiar to a soil of sand. The roots of this vegetation form a network about the sand grains and prevent the leveling of the dunes. In time, however, a tree is uprooted, or a forest fire burns off the vegetation. The protecting network of rootlets is destroyed. A bare spot results over which the winds freely play. A great storm from the north or northwest scoops out a small

* Quoted by Leverett in Bull. Chic. Acad. Sci., No. 2, 1897, 80.

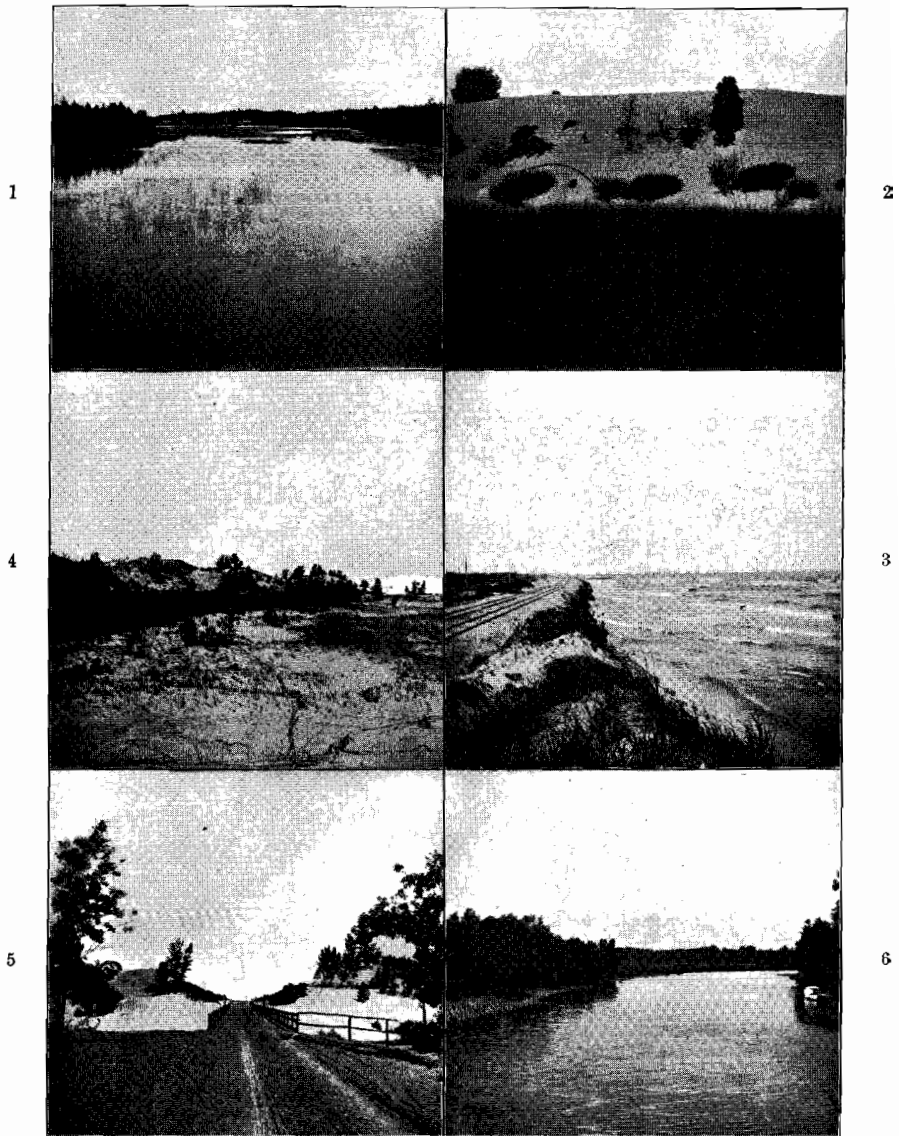
bowl-shaped cavity, and, carrying the sand either south or southeastward, drops it over the hillside. The cavity is cut deeper and wider by succeeding storms, and a great "blow-out" in time results. Where a few years before stood a high hill or unbroken ridge now exists a valley, or a cavity in the hillside, acres, perhaps, in extent, and reaching nearly to the level of the lake. The sands which once were there now constitute new hills or ridges which have traveled, as it were, a greater distance inland. In many places the drifting sands have wholly or partly covered a tall pine or oak tree. Where but partly covered, its dead (sometimes living) top projects for a few feet above the crest of hill or ridge. One may rest in its shade and not realize that he is sheltered by the *upper* limbs of a large tree whose trunk and main branches lie far beneath him embedded in the sands.

But few forms of animal life dwell among these dunes. Vegetation is not plentiful enough to furnish sustenance. A lizard scampering rapidly along will sometimes be seen, but even they are scarce. The twitter and chirp of bird is seldom heard. Insect life is less abundant than in any area of equal size in the State. Back, away from the sound of the breaking waves, a peaceful quiet pervades. There may one sit and literally watch the growing of the hills. There will he come to realize, as never before, how the slow, unceasing action of some of nature's milder forces have modified to so great an extent the surface of the earth. Around him on every side is matter—sand. Coming in from over the lake is the force—wind. Slowly but surely building up about him is the result of the action of the force on matter—hills. Thus have dunes been formed, here or elsewhere, for ten thousand times ten million years.

Where the gravel road from Hobart strikes the lake north of Miller's is a portion of the beach which is destined to become a noted resort. It is 150 yards or more wide, with a gradual slope from the foot of the first ridge to the water. The bathing is excellent. The scenery about the Calumet, the mouth of which is but a short distance away, is very fine, while from the tops of near-by dunes one can obtain some magnificent views over Lake Michigan, or over the rugged surface to the south and east.

Another portion of the beach which affords fine bathing and some excellent scenery lies north of Furnessville, but the facilities for reaching it are, at present, not of the best.

Between the station of Pine, Lake County, and the State line no dunes occur, and the present beach, i. e., the one washed by the waves of storms, is, in general, much narrower than that to the eastward. Along most of this distance the water line is closely paralleled by three



1. Down the Calumet, north of Miller's, Ind.
2. A sand ridge northwest of Duno Park, Ind.
3. The shore of Lake Michigan, east of Whiting, Ind.
4. A sand flat, with swamp and hill in distance.
5. Bridge across the Calumet, north of Miller's, Ind.
6. Down the Kankakee, from the Monon Railway, Lake Co., Ind.

VIEWS IN LAKE AND PORTER COUNTIES.

railways, whose artificial roadways are in places protected by piling. In places east and west of Whiting large amounts of refuse slag from the furnaces of the Illinois Steel Company at South Chicago have been dumped to prevent erosion. The presence of this slag and piling detracts greatly from the natural beauty of the lake front.

Near the shore the bottom of Lake Michigan is uniformly covered with sand. At the shore line this sand is about ten feet deep and it extends out to where the water reaches a depth of about 35 feet. Beyond this depth of water the lake bottom is composed of a stiff, tenacious blue clay, which is said to contain partings or pockets of sand, from whence, in part, comes the supply which is constantly being carried shoreward by the waves. Much of the sand is doubtless blown from the dunes by south winds back over the lake, and, falling on its surface, is again brought to land. Moreover, by storms and by ice jams in the spring, all projecting points along the lake are slowly worn down and the material composing them is carried out to be again returned and built up in a new place. Thus much of the sand is in constant circulation, and the necessary new supply is not so great as it appears to be.

*The
Sand
Supply.*

Much gravel, consisting of pebbles ranging in size between a hen's egg and a small marble, is washed up by the waves to within a foot or two of the water margin. In many places it is raked out by hand and carted beyond the reach of the high storm waves, and afterwards loaded and shipped by rail to Chicago, where it is used in roofing and concrete pavements. The immediate source of this gravel is doubtless the blue glacial till which forms the greater part of the floor of the lake, since the composition of the pebbles plainly show that they came originally from formations which lie far to the northward.

Thousands of trainloads of sand are annually shipped to Chicago from the dunes of the present lake, as well as from the ridges near Tolleston and Griffith. It is mainly used in elevating the beds of railways and in filling lots. Much money has been realized from its sale by parties who, years ago, had the foresight to purchase large areas of the dune land, then considered almost worthless.

This northern region of the two counties is drained by the Calumet River, a stream peculiar for the direction of its flow, its low banks and the sluggish motion of its waters. Except near its source it resembles more a great artificial ditch than a natural waterway. Its banks, where present, are seldom more than 10 feet above the water level. Its head waters are in Laporte County, but close to the Porter County line. Entering the latter county in the southeast corner of section 25 (37 north, 5 west), about one-half mile north of the northern border of the morainic

*The
Calumet
River.*

region, it flows westward across the two counties and leaves the State at the southwest corner of section 12 (36 north, 10 west), but three miles south of the line of its entry into Porter County. From this point its direction is northwesterly for about seven miles to the bluff at the southeastern corner of Blue Island, Cook County, Illinois. Here, turning on a sharp curve, it flows first northeast, then southeast, and, crossing once again into Lake County, continues for 14 miles almost due eastward until it empties into Lake Michigan at the northeastern corner of section 31 (37 north, 7 west), but two miles north and two west of where it first entered Lake County. About a half mile above its mouth, where crossed by the road leading from Miller's to the lake beach, it is about 300 feet in width, and runs between some lofty sand ridges. In August, 1897, its waters at this point were shallow and almost filled with aquatic vegetation.

To distinguish the two parallel portions crossing Lake County, the southern has received the name Little Calumet and the northern, Grand Calumet. The former lies between the Calumet and the Tolleston beaches of the glacial Lake Chicago, while the Grand Calumet lies north of, but parallel to, the Tolleston Beach until the latter comes so close to the present lake shore as to head off the stream and force it to flow into the lake. The singular course of the Calumet through the two counties is wholly determined, therefore, by the presence and trend of these ancient sand ridges, and by a morainic ridge lying north of the greater part of its length in Porter County.

One other peculiarity of the Calumet is its apparent possession of two mouths. It is a double-headed monster. The Indiana mouth above mentioned is the original one. The other empties into (or receives from) Lake Michigan at South Chicago, and a channel from that point passes between Calumet and Wolf Lakes and connects with the river proper near the south line of section 31 (37 north, 15 east), about four miles northwest of the center of the city of Hammond. This channel is said to be artificial and to have been opened by Indians about 90 years ago. They pushed their canoes on one line through the marshes until a permanent channel was worn, through which the water freely flowed. This, as well as the main stream between the junction and Hammond, has, within recent years, been dredged, and small steamers now daily ply between Chicago and Hammond.

Throughout the full length of its course in Lake County and in Porter County west of Chesterton, the waters of this strange stream have, in the summer season, but little perceptible flow. In places they spread out a half mile or more wide, and the channel is so clogged with the leaves of the water lily and other aquatic plants that a boat can scarcely be forced along. "But in the late winter or early spring-

time, when the melting snow and heavy rainfalls fill to the brim the low banks, the overflow covers a large amount of surface, justifying the expression of the early geographers that 'the country around the extreme south bay of Lake Michigan has the appearance of the sea marshes of Louisiana.'** It is then that the marshes of the Calumet become the temporary home of thousands of water-fowl and the paradise of sportsmen.

II. THE MORAINIC OR MIDDLE REGION.

This region comprises, approximately, 485 square miles lying across the center of the two counties. It is covered by a sheet of drift which at Crown Point is 141 feet and at Valparaiso 125 feet in thickness. The upper portion of this drift is, as already noted, a part of the great Valparaiso moraine, the origin and general trend of which has been given. Where this moraine crosses the State line and enters Lake County it is about 17 miles in width, extending from near Dyer to a point opposite Sherburnville, Illinois. The greatest height or main crest on this line is southwest of the town of Brunswick, in section 36 (34 north, 10 west.) A weaker crest line which forms the watershed in western Lake County runs parallel with the inner border of the moraine from near Orland, in Cook County, Illinois, southeastward, entering the State of Indiana about six miles north of the main crest line, section 36 (35 north, 10 west.) The surface in this vicinity and for some miles north and northeast of St. John's is more broken and irregular than farther southward. The soil immediately overlies a thick bed of clay, in which are mingled many pebbles and small bowlders. In northern Hanover Township the surface is undulatory, but not broken by deep ravines. Farther south a high, rolling prairie region sets in, which covers the southern part of Hanover and the northern two-thirds of West Creek townships. The soil of this prairie, as that of several to the eastward, is a rich, black loam, which covers to a depth of from one to three feet the clay till of the moraine. This clay varies in thickness from 40 to 65 feet. Beneath it is a sand stratum from 20 to 70 feet thick, which furnishes plentiful water.

The main crest of the moraine passes along a wooded ridge about a quarter of a mile north of Cedar Lake and thence along a low, curving ridge to the fair ground south of Crown Point. Between this city and Cedar Lake and extending southward almost to Lowell is a wooded table-land, in places quite broken, where the clay of the mo-

* Ball, Rev. T. H.—Lake County, 1884, 178.

rairie comes close to the surface. East of this wooded belt the rich rolling prairies again set in and cover the greater portion of the morainic area embraced in the eastern third of Cedar Creek and the western half of Eagle Creek townships.

North of Le Roy, in sections 1 and 12 (34 north, 8 west), the crest of the moraine is cut by a branch of Deep River flowing northward. In this region the Lake Michigan watershed extends farther southward than at any other point in Indiana. According to the report of the United States Deep Waterways Commission for 1896, the crest of the moraine at the lowest point near the head waters of Deep River and Eagle Creek is 747 feet above tide, or 165 feet above the waters of Lake Michigan. Just south of the divide, in Le Roy, is a flowing well which furnishes a plentiful supply of good water. The bore was sunk through clay to a depth of 65 feet, when a water-bearing stratum of sand was encountered.

In the Court House yard at Crown Point the surface is 714 feet above tide. At this level a bore was begun in 1889 and put down to a depth of 3,100 feet in search of gas. No accurate record of the formations passed through was kept, but, from a partial record and samples of drillings shown me by Mr. W. A. Clark, the following section was made:

SECTION OF DEEP BORE AT CROWN POINT.

1. Drift.	{ Soil and clay	15 feet.
	{ Sand	100 feet.
	{ Blue clay	25 feet.
2. Genesee shale		112 feet.
3. Lower Helderberg and Niagara limestones.....		433 feet.
4. Niagara shale—bluish green		55 feet.
5. Clinton limestone		57 feet.
6. Hudson River shale—bluish green.....		122 feet.
7. Trenton limestone		556 feet.
8. Sandstone, alternating from brown to white.....		1,625 feet.
Total		3,100 feet.

The upper two-thirds of the Trenton limestone, struck at 919 feet, was darker brown than the lower third, the latter being whitish, with streaks of pure white sand scattered through it. The bore filled with salt water from the Trenton to within 100 feet of the top.

The water supply of Crown Point is derived from the stratum of sand which immediately underlies the surface clay. At the water works, in the north part of the city, are two eight-inch wells located but 12 feet apart, which furnish an average supply of 200 gallons a minute, and can furnish 400 gallons in an emergency. The soil and

clay at this point are 40 feet thick and the wells penetrated the underlying sand to a depth of 20 feet. The water is "hard," containing lime and iron salts, and has a tendency to encrust the pipes through which it flows. For drinking purposes and household use its quality is excellent.

The northern slope of the morainic region is in Lake County much more narrow and abrupt than the southern. It contains several small prairies, and in the eastern portions of Winfield and Ross townships a number of low ridges or gently undulating swells, with intervening sags. In general, especially on the prairie, the soil is a rich black loam, but on some of the ridges mentioned it is a whitish clay.

On the whole, it may be said that the surface of the moraine in Lake County is much less rugged and irregular than in Porter. The large bowlders, usually accompanying such a moraine, are far less numerous in the former county. But one or two were seen which were more than 18 inches in diameter. Even the smaller ones were scarce and in most places have been carefully gathered for use in the foundations of buildings.

The general trend of the morainic belt in Porter County is to the northeast. Where it enters the county it is about 15 miles in width, extending from section 10 (35 north, 7 west), about two miles north of the town of Woodvale, to the southwest corner of section 22 (33 north, 7 west), two miles southwest of Hebron. At the latter town its surface is about 48 feet above that of the Kankakee marsh lands, three miles to the southward. The crest of the moraine crosses the county line a little south of the common corner of the four townships of Ross, Winfield, Porter and Union. Thence it extends a little north of east to a point about a mile east of Valparaiso, where it is cut by Salt Creek flowing northward. Beyond this stream it extends from Emmetsburg in a northerly direction to Liberty Township, where it trends to the east and passing across the southern tier of sections of Jackson Township enters Laporte County.

North of Emmetsburg, in section 11 (35 north, 6 west), the height of the moraine, as determined by Leverett, is approximately 840 feet, and near the center of section 30 (36 north, 5 west), Mr. Henry Rankin has run a level which showed the surface to be 306 feet above Lake Michigan, or 888 feet above tide. This latter point is probably the extreme height to which it reaches in the two counties.

The topography of the morainic belt of Porter County is much more varied than in Lake. Immediately north and west of Hebron are a number of high wooded ridges composed of clay and covered

for the most part with timber. Horse Prairie, a higher undulatory region, then sets in and covers the greater portion of the south half of Porter Township. Boulders of large size begin to appear. The following section of an open well sunk on the land of Hon. Geo. C. Gregg, east half of section 34 (34 north, 7 west), two miles north of Hebron, was furnished by Mr. Gregg, and will give an idea of the morainic material in that vicinity:

SECTION OF WELL NORTH OF HEBRON.

1. Soil and stiff yellowish clay	12 feet.
2. Blue clay—comparatively free from pebbles.....	17 feet.
3. Sand, similar to that in ridges to the northward....	18 feet.
4. Hard, sticky blue clay with flint pebbles.....	20 feet.
5. Coarse blackish sand.....	4 feet.
Total	71 feet.

Plenty of good water was found in the blackish sand. It was necessary to curb the upper stratum of sand, No. 3 of the section, as it caved in very badly. The total thickness of the drift at Hebron, on a level, probably 30 feet below this point, was found to be 108 feet.

North of Horse Prairie, in sections 13, 14 and 15 (34 north, 7 west), a stiff, clayey subsoil comes near the surface, and a timbered area begins which covers the northern half of Porter and the southern half of Union townships. This area is much broken, especially along the crest of the moraine. The soil over much of it is a whitish clay, which produces fair timothy hay, but poor crops otherwise.

The northern half of Union Township is in part covered with a sandy soil. This starts in about sections 23 and 24 (35 north, 7 west), and extends to the Grand Trunk Railway or to the border of the moraine. A spur of the moraine about two miles wide extends into Portage Township to the southeastern corner of section 13, and embraces a portion of Twenty Mile Prairie.

In the western half of Center Township the moraine begins to show more prominently, there being many high ridges which intersect one another at various angles. Their component materials, where exposed, are mainly a stiff yellow clay, with many limestone pebbles which are angular and but little water-worn. In several places occur deposits of gravel a few feet in thickness, but in general it is too fine to make good road material. The city of Valparaiso is located on the slope of one of these subordinate ridges southeast of the main crest of the moraine. The level at the station of the Grand Trunk Railway, in the northern part of the city, is 820 feet; that of the Court House yard 803 feet, and that of the Pennsylvania road, in the southern part of the city, 736 feet above tide.

At a still lower level—718 feet—in the southwestern part of the city, a deep bore was put down for gas in 1889. From data and specimens of drillings kindly shown the writer by Mr. C. W. Dickover, the following strata were shown to have been pierced:

SECTION OF DEEP BORE AT VALPARAISO.

1. Soil and drift	125 feet.
2. Genesee shale	65 feet.
3. Corniferous and Lower Helderberg.....	230 feet.
4. Niagara limestone	270 feet.
5. Niagara shale	5 feet.
6. Clinton limestone—white to steel gray.....	55 feet.
7. Hudson River limestone.....	110 feet.
8. Hudson River shale—bluish green.....	160 feet.
9. Trenton limestone*	330 feet.
Total	1,350 feet.

At a depth of 1,290 feet salt water was struck, which rose to the top of the well.

In Liberty Township the northern slope of the moraine is much more narrow and abrupt than in any part of its course in the two counties. From the road a mile or two east of Gosset's mill one gets, looking across a branch of Salt Creek to the south and southwest, a fine view of the morainic hills, since they are from 100 to 150 feet above the level of the observer. To the northeastward the irregularities of the surface become more pronounced, and in Jackson Township, especially in sections 13, 14 and 15, many of the features of a typical, unmodified terminal moraine are present. Here is found an intricate series of subordinate ridges putting out in every direction from the main one. Boulders are very plentiful and in several places were noted to be sole material used in the construction of fences. The largest ones seen in the two counties were in this vicinity. There are also numerous large rounded depressions, some of them embracing an acre or more in extent, which recall vividly the sinkholes of southern Indiana. Alternating with these are corresponding rounded knobs or knolls, the crests of which, in a number of instances, are 80 feet or more above the bottom of the depressions. These "knobs and basins," as they are called, owe their peculiar formation to the irregular deposition of the glacial debris, there probably having been a great isolated mass of ice imbedded in the debris where each basin

* The upper 280 feet of this stratum was somewhat darker colored than the lower 50 feet, and had been called by Mr. Dickover "Galena limestone." This is only a synonym for the upper or later portions of the Trenton formation, which in Illinois and Wisconsin are lead bearing.

now exists. By its melting a cavity was left which was separated by a mass of drift material from a somewhat similar cavity where another ice mass had been imbedded. The shape and size of each cavity or basin depends upon the shape and size of the ice block and the amount of drift originally covering it. Where an impervious bed of clay was left or has accumulated in the bottom of the "basin," the latter often fills with water and a small lake results. Such was doubtless the origin of Bull's Eye Lake, two miles north of Valparaiso, whose area is but one-half acre, and whose waters are 45 feet in depth.

The northern border of the morainic belt extends diagonally across Liberty Township from its southwestern to its northeastern corners. Thence it passes through sections 6 and 5 in the southeastern corner of Westchester Township. Bending to the east, then south and again east, it follows closely the border line between Pine and Jackson townships. Turning north along the county line, it finally leaves the county from the east side of section 36 (37 north, 5 west.)

Just within the borders of the moraine, on the southeast quarter of section 1 (36 north, 5 west), is a flowing well which was put down in June, 1897. Its section, as furnished by the owner, Edward Stevens, shows the following strata:

- | | |
|--------------------------|----------|
| 1. Soil and gravel | 3 feet. |
| 2. Blue clay | 60 feet. |
| 3. Sand | 21 feet. |

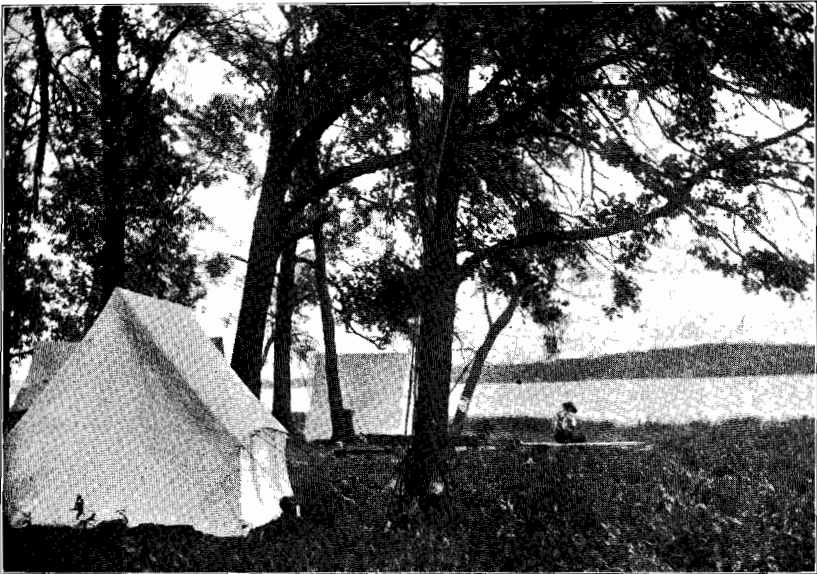
On September 10th the water was rising through a two-inch pipe to a height of four feet above the surface. Through a three-quarter-inch pipe it had risen 25 feet above the surface, but had failed to rise to the top of an additional pipe 18 feet in length and of the same diameter. The rate of flow was about six gallons per minute. The source of this water is probably on the slope of the moraine to the southward.

North of the border of the morainic region proper, as traced above, there exists in Porter County a long, narrow ridge, whose surface is a till of clay. This ridge lies north of the Calumet River and extends east and west through Westchester and Pine townships. Its average width is about a mile. The surface is quite regular except where cut by erosion. The soil is a whitish clay, well adapted to the production of timothy hay, but producing poor crops of the cereals. This ridge, like the one west of Hobart, was an island whose surface lay above the waters of the shallow bay of Lake Chicago, which covered and modified the area between it and the morainic region to the south.

The southern margin of the morainic belt in Porter County extends from a point almost a mile south of Hebron in a northeasterly direc-



Looking west across the lake. Ice houses on opposite shore.



A camp on the west shore.

VIEWS OF CEDAR LAKE.

tion, crossing the southeastern corner of Porter Township and passing diagonally across Morgan and the southeastern corner of Washington townships. The southern slope is much more subdued or less broken and irregular than the northern. The soil is usually a whitish clay and far less rich and productive than that of Morgan Prairie, which borders a large portion of this region on the east.

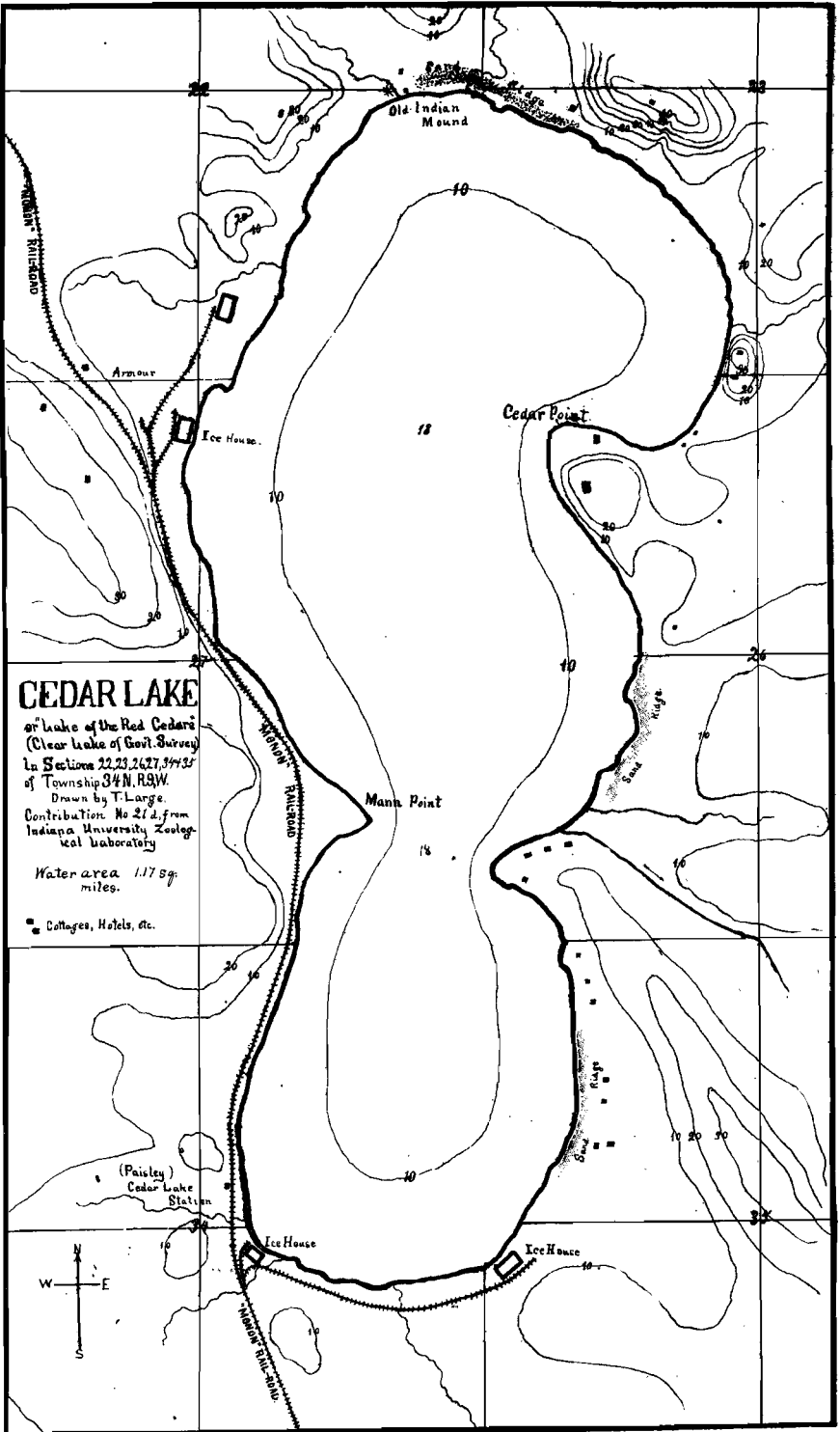
With the exception of Lakes Wolf and George, in the northwestern corner of Lake County, which, as already noted,* are but remnants of a once shallow bay of Lake Michigan, the lakes of the two counties are of morainic origin and should be treated in this connection. Those which the citizens have esteemed large enough to be worthy of names are Cedar Lake and Fancher Lake, in Lake County, and Eliza, Quinn, Flint, Long, Bull's Eye and Clear lakes, in Porter County. It is a noteworthy fact that each of these lies very close to the summit of the main crest of the moraine.

The largest, most handsome and best known of these lakes is Cedar Lake, or "Lake of the Red Cedars," located in parts of sections 22, 23, 26, 27, 34 and 35 (34 north, 9 west), on the line between Center and Hanover townships, about four miles southwest of Crown Point. Its general outline somewhat resembles that of a kidney. Its length is about two and one-eighth miles and its greatest breadth a little more than three-quarters of a mile. Its water area, as computed by Thomas Large, † is at present about 1.17 square miles.

Cedar Lake owes its origin to the irregular deposition of the surrounding drift. On all sides, except the south, it is embraced by wooded ridges of sand or clay, those to the north rising 60 feet above the level of its waters. Between these ridges, on the southern slope of the moraine, a long, low valley was left by the retreating ice sheet. The bottom of this valley was covered with an impervious stratum of clay. In its depression collected the waters of the melting glacier and the lake resulted. Its waters once covered all the low, marshy land to the southward and overflowed the lowest part of the rim of its basin toward the Kankakee. At that time they covered the present shores as far as the foot of the ridges on the east and north and were probably 40 feet deep in places. Now they nowhere exceed 20 feet in depth. Within the memory of man they have receded from 50 to 90 feet from the former margins. This recession and consequent lowering of depth is mainly due to three causes, viz.:

* P. 37. Fish Lake, in the extreme northeastern corner of Porter County, is a wet weather lake which is practically dry in summer.

† See Proc. Ind. Acad. Sci., 1896, 299 and 301. The accompanying map of Cedar Lake was also drawn by Mr. Large and published in the Proc. of the Academy, *loc. cit.* By permission it is reproduced in this connection.





GLIMPSES OF CEDAR LAKE.

a. Artificial Drainage. To reclaim 200 acres of comparatively worthless marsh land—at its southern end—a ditch was cut on its eastern side which lowered the level of the water from 8 to 12 feet. This outlet is the present source of Cedar Creek, which flows southward through the town of Lowell and empties into the Singleton ditch.

b. The Growth and Decay of Aquatic Vegetation. Beneath the shallow water along its western and southern margins there are thick beds of muck and black mud. In these beds grow luxuriantly spatter-dock, rushes, ditch moss, algae and many other aquatic plants. These die down and the matter which they have withdrawn from the air and solidified within their stems is added to the surface of the muck. The latter is, therefore, ever thickening and encroaching upon the water area.

c. Decrease of Water Supply. Situated, as it is, so near the crest of the moraine, the area from which the lake draws its supply of water is very limited, being but a few square miles in extent. This supply comes wholly from the rain of the season, which, soaking into the earth, finds its way through springs into the immediate basin of the lake. Since the settlement of the surrounding region much timber has been cut away and the land so drained that the water flows rapidly away instead of soaking into the ground and finding its way into the lake as formerly. At present the season's evaporation is, probably, almost as great as the supply. For these causes the area and depth of the lake have for years been slowly diminishing and will continue to diminish until it wholly disappears.

Within the past ten years many cottages have been erected on the wooded ridges about Cedar Lake. The Monon Railway, which runs along its western border, has possessed itself of the high wooded ridge on that side and has transformed it into a so-called park. Thousands of visitors are each season brought from Chicago and from the cities to the southward. The quiet beauty and repose which for centuries existed along the margins of the lake have forever disappeared. In their stead have sprung up those artificial surroundings which the ever-increasing wants of the Nineteenth Century seeker after pleasure demand and eventually secure.

Fancher Lake is located in the Lake County fair grounds, northwest quarter of section 17 (34 north, 8 west), one mile south of Crown Point. It covers about 20 acres and in places is said to be 35 feet in depth. Lying on the very crest of the moraine, it doubtless occupies a kettle hole or basin formed by the melting of an imbedded ice mass. Its waters flow northward, finding their way into Lake Michigan by the way of Deep River and the Calumet.

Lakes Quinn and Eliza are located about a mile apart, in sections 12 and 1, respectively (34 north, 7 west), near the northern line of Porter Township, Porter County. The former covers an area of about 12 and the latter 40 acres. Eliza is but one-half mile south of the divide and is much the more handsome, being surrounded on all sides by oak groves. Wolf Creek is the outlet of both lakes, flowing southward from Eliza through Quinn, and then southeasterly into Sandy Hook Creek.

Lying three and one-quarter miles a little east of north of Valparaiso and about a mile east of the crest of the moraine is Flint Lake. Its waters cover an area of 95 acres and have an average depth of about forty feet. It is surrounded by high ridges, those on the east and north being wooded. Its western and a portion of its southern margins, like those of Cedar Lake, have mucky banks, while those of the east and north are sandy, a condition due to the prevailing westerly and southerly winds, which create a breaking of the waves along the eastern and northern shores, and so prevent the formation of muck.

The waters of Flint Lake have receded more than 50 feet from the edges of their former margins. This recession is due to the same causes as have brought about that of Cedar Lake. Flint Lake, however, is the source of the water supply for the city of Valparaiso, 600,000 gallons being at present drawn from it each day. Its artificial drainage is, therefore, somewhat excusable. It lies 243 feet above Lake Michigan and 14 feet above the Court House yard at Valparaiso, its waters being brought to that city by both gravity and direct pressure. If the lake continues to recede at the present rate it is only a question of a few years until the city will have to seek another water supply.

Long Lake occupies a narrow morainic valley a short distance northwest of Flint Lake. It is about three-fourths of a mile in length by 40 rods in greatest breadth, and is connected with Flint Lake by a small drain. The natural outlet of both is one of the branches of Crooked Creek, a tributary of the Kankakee.

Clear Lake is located partly in section 24, Jackson Township, and is cut by the line between Porter and Laporte counties. It has no outlet and its waters are 25 feet in average depth, and cover an area of about 30 acres. In the words of Dr Chas. R. Dyer,* all of these morainic lakes in Indiana "are geologically young, being confined to the very latest moraines of the glacial period. They are mere babes born yesterday and destined to die to-morrow. The present dominant race of men may pass away and leave these lakes still lying like bright jewels among the hills: but every one is doomed to final extinction.

*Stud. in Ind. Geog., 1897, 59.

'The hills are shadows and they flow
 From form to form, and nothing stands:
 They melt like mist, the solid lands,
 Like clouds they shape themselves and go.'

But of all features of the landscape, lakes are the most ephemeral. As long as they remain they will continue to contribute to the service and delight of man. They fed the savage with fish, but they feed the more highly developed man with beauty, and afford means for that relaxation and healthful pleasure which the conditions of modern life demand."

The drainage system of Lake and Porter counties is governed almost entirely by the topography of the surface of the morainic region. The watershed or divide separating the basin of Lake Michigan from that of the Mississippi corresponds very closely to the crest line of the moraine already traced. With two exceptions, all streams which start south of that crest line find their way into the Kankakee, while all but one of those starting north of it flow into Lake Michigan. The exceptions noted are the branch of Deep River rising near Le Roy, which has been mentioned as cutting the crest east of Crown Point; and a branch of Salt Creek, which has its source in Bull's Eye Lake, north of Valparaiso, and flowing southward and then westward around that city, unites with another branch which rises in the northern part of Morgan Township, and cuts the crest south of Emmetsburg. West Creek, rising near St. John's, flows southward, cutting the main crest between Hanover and Brunswick.

Just north of Cedar Lake, in section 23 (34 north, 9 west), is one of the best marked portions of the watershed in the two counties. A narrow ridge, not over three rods wide and six to eight feet in height, separates for a distance of 150 feet a marsh on the north from the head of a shallow ravine on the south. The waters of the marsh, which is fed by springs, flow, eventually, into Lake Michigan, while those from the ravine find their way, after many wanderings, into the Gulf of Mexico. The divide is also very narrow in Union Township, Porter County, just north of Lake Eliza, and again in section 34, in the south half of Jackson Township, between the head waters of Coffee and Crooked creeks.

Aside from the Calumet and Kankakee rivers, all the principal streams which drain the two counties have their sources on or near the crest of the divide. These are, in Lake County, West Creek, rising near St. John's and flowing southward through Hanover and West Creek townships; Cedar Creek, the outlet of Cedar Lake, flowing southward through Cedar Creek Township, and

*The Water
 Shed.*

Drainage.

Eagle Creek, the outlet of a small lake northeast of Le Roy and flowing south. The waters of these three are collected by the Singleton ditch in the Kankakee basin.

On the north of the divide one of the branches of Deep River has its sources in Fancher's Lake and in a marsh two miles northwest of Crown Point. This unites in the northeastern corner of Center Township with the branch from near Le Roy, and flows northeasterly to the county line about a mile southeast of Woodvale. Thence it bears northwest to the mouth of Turkey Creek, in section 1 (35 north, 8 west); thence northeasterly through Hobart to near the station of Lake, where it again turns west and empties into the Calumet, in section 14 (36 north, 8 west). Throughout its course from Woodvale northward it is a slow flowing, sluggish stream, with its bottom of clay or mud. In its waters the fresh water mussel, *Anodonta grandis* Say, and allied mud-burrowing species exist in enormous numbers, while in the mill ponds at Woodvale and Hobart great masses of aquatic vegetation spring up and during the hot days of August and September decay and throw off a disagreeable odor. Since 1883 the amount of water at Woodvale has been sufficient only to run a corn mill, and all wheat has been ground by steam.

In Porter County the streams south of the divide are Sandy Hook and Crooked creeks, both of which are of small size and sluggish in flow. The former has for its tributaries Wolf Creek, the outlet of Eliza and Quinn lakes, and the West Branch of Sandy Hook. These drain Porter and the west half of Morgan townships. Two branches of Crooked Creek rise near the divide in the south part of Jackson Township, and a third is the outlet of Flint Lake. This stream drains Washington and the east half of Morgan townships and empties into Reeve's ditch in the Kankakee marshland.

North of the divide are Salt Creek and Coffee Creek, the former being the larger and more important of the two, draining eastern Union and Portage, a part of northern Morgan, all of Center and most of Liberty townships, and emptying into the Calumet, in section 31 (37 north, 6 west). Its waters are sufficient in amount to furnish power for three mills, one just south of Valparaiso, another (Pierce's) in section 16 (35 north, 6 west), and a third (Gossett's) in section 21 (36 north, 6 west). Above each of these the stream widens into a large mill pond, that at Gossett's being a mile long and a quarter of a mile wide. Coffee Creek rises on the crest of the divide in the south half of Jackson Township, and, flowing west of north, drains southwestern Jackson, northeastern Liberty and a part of Westchester townships, emptying into the Calumet a little north of Chesterton. Its current

in Jackson Township is more rapid than that of any other stream in the counties, and at Long's mill, in section 20 (36 north, 5 west) the supply of water is sufficient to turn a large turbine wheel the year round. Several small tributaries of the Calumet drain the northern half of Jackson Township.

III. KANKAKEE OR SOUTHERN REGION.

All that area of the two counties lying south and southeast of the southern border of the Valparaiso moraine is comprised in this region. In Lake County this morainic border extends to the old northern shore line of the Kankakee Marsh and the area south of that line was, at one time, all overflowed or swamp land. In Porter County, about 65 square miles of swamp land proper and 40 square miles of prairie are included within the region under consideration. The prairie portion lies 10 to 40 feet above the level of the main marsh and slopes gently down to it. Along Sandy Hook and Crooked creeks a strip of marsh land, in places two miles in width, extends a number of miles northward into the prairie region, and the difference in level between the two is more abrupt.

The Kankakee River, which forms the southern boundary of the two counties, is noted for its low banks, its sluggish current and the crookedness of its channel. From its source in a large marsh about three miles southwest of South Bend, St. Joseph County, section 16 (37 north, 2 east), it flows in a southwesterly direction through that county to the Laporte County line, from which point it forms the boundary between the counties of Laporte, Porter and Lake on the north and St. Joseph, Starke, Jasper and Newton on the south. Crossing the State line near the southwestern corner of section 1 (31 north, 10 west), it flows a little south of west to Kankakee, Illinois, where it receives the Iroquois River from the south. Thence it flows almost due northwesterly to near the northeastern corner of Grundy County, where it unites with the Des Plaines, the two forming the Illinois River.

Between its source and the point where it crosses the State line, in the extreme southwestern corner of Lake County, the distance is about 75 miles. Within this distance the stream is said to make 2,000 bends and to flow over a total length of 240 miles. According to the survey made by Dr. J. L. Campbell, in 1882, the difference in level between the source and the State line is but 97.3 feet, showing a fall of but 1.3 feet to the mile. For this reason its waters, above the crossing of the Monon Railway, section 33 (32 north, 8 west), have an almost imperceptible flow, and in many places wild rice, rushes, lily pads and

aquatic grasses so choke the channel as to cause the flooding of the marshes during a summer freshet. Between the Monon Railway and the State line the velocity of the flow is greater, owing to a slightly increased slope and fewer bends.

In Indiana the bed of the Kankakee is composed mainly of sand and fine gravel. But in a few places, as just west of Dunn's bridge, in the southeastern corner of Porter County, it contains rather extensive beds of coarse gravel. Only at one point, where visited by the writer, was stone seen in its bed. This was just across the State line in Illinois, where, in front of the residence of Daniel Parmlee, the current is more rapid than elsewhere noted, and a number of large bowlders are located near the middle of the channel.

The amount of water which the river now discharges varies with the season much more than formerly. According to measurements made by Dr. Campbell* in August, 1882: "The sectional area at the State line was 543 square feet, the mean hydraulic depth 4.5 feet, the calculated mean velocity 2.35 feet per second, and the volume of discharge 1,271 cubic feet per second." This was during an average low-water stage of the river. The least flow is during extreme cold weather, when the great marsh, which borders the river, and which acts as a sort of reservoir or feeder, is frozen solid. In 1882 there were almost 500,000 acres of this marsh land within the valley of the Kankakee. It resembled an immense sponge, slowly absorbing the water during the wet season and as slowly oozing it forth during the dry, so that the flow throughout the year was quite regular and uniform in amount. At present, on account of the drainage of a large portion of this marsh, especially in St. Joseph, Starke and Laporte counties, the water flows off much sooner after it falls and consequently the river is higher during the autumn and spring floods and lower at other seasons than formerly. From careful measurements made for a series of 12 years at Wilmington, Illinois, it was found that the average volume carried by the Kankakee during the extreme high water was 30,000 cubic feet per second.† Since the partial drainage of the upper portion of the marsh there is little doubt but that during the spring floods the discharge across the State line is fully 25,000 cubic feet per second.

In 1872 Rev. T. H. Ball, of Crown Point, wrote of that portion of the Kankakee bordering on Lake County: "A river is known to be there. The blue line of trees marking its course can be discerned from the prairie heights; but only occasionally in midwinter or in a

* Rep. Upon Improv. Kank. River, 1882, 16.

† See Leverett.—Ann. Rep. U. S. Geol. Surv., XVII, 1896, 740.

time of great drought can one come near its water channel. So far as any ordinary access to it from this county is concerned, it is like a fabulous river, or one the existence of which we take on trust."* Now, within Lake County, five north and south roads reach its borders through the marshes, while three wagon and two railway bridges span its waters. In Porter County six roads lead to it, and one railway and three wagon bridges cross it.

The Kankakee marshes comprise the most extensive body of swamp land in Indiana. The original area of this marsh land in the seven counties drained by the Kankakee was, as already noted, almost a half million acres. For many years schemes of various kinds have been proposed, and hundreds of thousands of dollars have been spent, in endeavoring to reclaim a portion or all of these lands. State aid has been invoked and a large sum appropriated and expended in removing a rock ledge at Momence, Illinois, but this was only a beginning, and, as yet, the end is not in sight. In Lake County there exists, at the present time, 50,000, and in Porter County about 40,000 acres, which, for at least four months of the year, are covered with from one to five feet of water; and during four of the remaining months this area is an immense bog or quagmire.

*The
Kankakee
Marshes.*

In these two counties the marshes occupy a broad valley between the border of the moraine and the channel of the river. The mean elevation of this valley is 90 feet above the level of Lake Michigan and 160 feet above the waters of the Wabash River at Lafayette, Indiana. The surface of this marsh land is, for the most part, a great treeless plain, with an average slope of about 1.2 feet to the mile in a westerly direction. On the immediate border of the river there is a strip ranging in width from a fourth to one and one-half miles, which is heavily timbered. In the southeastern corner of Lake and on adjacent territory in Porter County this timbered area widens and comprises about ten square miles. The only other timber is found on the so-called "islands" or "groves," whose surfaces rise 10 to 20 feet above the general level of the marsh. The largest of these in Lake County is Fuller's Grove, in sections 4 and 5 (32 north, 8 west), between the Griesel and Singleton ditches. It is one and a half miles long by one-third of a mile in width. Others are Oak Grove, south half of section 16 (32 north, 9 west), and South Island, in sections 13 and 24 (32 north, 8 west), each of which are about one by one-quarter miles in area; Beech Ridge, section 9 (32 north, 7 west); Ridge Island, sections 10 and 11 (32 north, 8 west); Crab-Apple Grove, section 19

* Lake County, 1834-1872, 16.

(32 north, 9 west), and others, are smaller. All were once covered with a heavy growth of oak, hickory, black gum and other timber, the best of which was long ago removed by the early settlers along the northern border of the marsh. The surface of these islands, when cleared, becomes fair grazing lands, but the soil is in general too sandy for cultivation. On the majority of the "islands" are houses, in which dwell the owners or renters of the surrounding marsh lands.

The open marsh is covered with a rank growth of wild grasses, bullrushes, sedges, reeds, wild rice and other semi-aquatic vegetation. Over a large area which has been sufficiently drained much of this growth is annually cut, either for bedding or marsh hay.

*Vegetation
of the
Marshes.*

In other places the surface is either too rough, being cut up with sloughs and bogs, or never dries sufficiently to allow teams to pass over it. Oftentimes, after a long drouth, thousands of acres are burned over by a fire which sweeps along with great rapidity, consuming everything in its path.

Between the woodland bordering the river bank and the marsh, as well as around the margin of most of the islands, there are dense thickets of elbow brush, *Cephalanthus occidentalis* L., willows, swamp dogwoods, soft and red maples and other swamp-loving shrubs. These grow so densely that a person has no little difficulty in forcing his way among them. In some places, as at Stowell's ranch in south-eastern Porter, sections 1 and 2 (32 north, 5 west), and at Gales, in southern Lake, section 26 (32 north, 9 west), large areas of land whose soil is a rich sandy loam rise above the surrounding swamps. These areas were less heavily timbered than the islands above mentioned, and comprise valuable farming lands.

In general the soil of the marsh is a dark, sandy loam, very rich in organic matter. For century upon century a thick mass of vegetation has fallen and decayed, and mingled with its remains have been the particles of sand and clay brought down as sediment by the overflowing

*Soil
of the
Marshes.*

waters. No richer soil occurs in the State, and its depth in many places is from three to five and even six feet. Like all soils composed of similar materials, it is very porous and has the power of taking up and retaining large quantities of water. Beneath the soil is a sand, darker colored and containing a greater mixture of calcareous and earthy matter than that found near the shores of Lake Michigan. When thrown up by the dredge it packs and becomes hard, forming excellent roadbeds wherever it has been put to that use. Below the sand are layers of fine gravel and below that the omnipresent blue clay of the older glacial tills lies next above the surface rock.

All of the materials lying between the blue clay and the soil are the sedimentary deposits of a great post-glacial river, for the valley itself doubtless owes its origin to the flow of waters which followed the melting of one of the later retreating ice sheets. This flow was at first sufficient in volume and velocity to erode the present valley to quite a depth through the underlying clay. Later, on account of a diminution in the supply of water, as well as the gentleness of the slope, the current became too sluggish to erode much deeper or to carry coarse material, and only the finer sediment was brought down. From a still farther diminution in the water supply, as well as by the building up of a sedimentary dam near the western end of the valley, the water for a long period ceased to flow, and a lake of shallow depth resulted. Where the waves or currents of this lake washed against the higher portions of its bed, or its shores, accumulations of sand and mud were thrown up from its bottom. These increased in size, and, rising above the water, became covered with trees. The surface of these "sand islands" has ever since remained above the flow of waters and, as a consequence, their soil lacks those rich organic constituents, formed by the decay of aquatic plants, which are possessed by the soils of the surrounding marsh.

*Origin of
Kankakee
Valley.*

Again, by a new accession of water from the northwest, the barrier at the foot of the valley was washed away and the river of the present had its beginning.* At first its waters flowed the full width of the valley, but in time their volume decreased and a portion of the river's bed became bare in summer. Over this a vegetation sprang up and decayed. A soil was started above the sands and was added to each year by the decay of the summer's vegetation and the sediment brought down by the overflow in spring. The main current of the stream was thus gradually narrowed until it reached its present size. The annual overflow is yet sufficient to cover the porous soil and to fill its every interstice with water, which, on account of the gentle slope, cannot flow rapidly away after the subsidence of the flood. Thus the valley remains a marsh, and will so remain until a complete system of drainage furnishes a more rapid outlet for the waters which are absorbed during the annual overflow.

Quite a percentage of the marsh land in the two counties has been already partially reclaimed by large ditches either dredged by private enterprise or by assessment against the adjacent lands. In Porter County the largest of these is Reeve's ditch, beginning on the county

*This alternate increase and decrease in the volume of the water may have corresponded in time with the increase and decrease in the waters of Lake Chicago, already noted.

line, in the southeast quarter of section 24 (33 north, 5 west.) Thence it runs southwestward across section 25 and then due west to Grand Junction, east half of section 36 (32 north, 6 west), where the old mouth of Crooked Creek unites with the Kankakee. A mistake was made in the construction of this, as in several other of the large ditches, in that the sides were left almost perpendicular instead of with at least a 45 deg. slope. As a result, freezing has caused the sides to slough off and partially fill the ditch, so that it only serves as a drain in wet weather.

*Drainage
of the
Marshes.*

In Lake County the Singleton ditch is the main one, the others being tributary to it. This ditch extends from Eagle Creek, in section 29 (33 north, 7 west), in a generally southwesterly direction to the river, crossing the State line near the southwest quarter of section 25 (32 north, 10 west). It was begun in 1882 and completed in 1886; being constructed under the general ditching laws, with an average assessment of about \$2.00 per acre on all lands between the river and the north margin of the marsh. It was 20 feet in width by 5½ feet to 7 feet in depth, but its sides were too abrupt, and it now needs re-dredging throughout its full length. By its construction a large acreage of the marsh was reclaimed sufficiently for the cutting of wild hay. Along the northern border minor secondary ditches soon allowed the raising of cereals on a strip a mile or two wide.

The Brown ditch was constructed in 1888, mainly as a shore ditch to prevent the spreading of water from the river northward. Through it the water flows in all seasons, even in great drouths. In length it is about 14 miles, extending from section 4 (32 north, 7 west), to the Singleton ditch, near the west end of Ash Grove, section 29 (32 north, 9 west). Other subordinate ditches are Griesel's and Ackerman's, shown on the accompanying map.

The report of Dr. J. L. Campbell on the drainage of the Kankakee marshes, published in 1882, has become very scarce. It is thought best, therefore, to incorporate in this connection the conclusions and recommendations of Dr. Campbell relative to the draining of those portions of the marsh lands lying in Porter and Lake counties. These conclusions were based on an accurate survey of the entire region, made by authority of an act of the Legislature, approved April 11, 1881. Under the head of "General Improvement," Dr. Campbell says:* "The drainage and recovery of the Kankakee marshes will in-

*"Report Upon the Improvement of the Kankakee River and the Drainage of the Marsh Lands in Indiana," 1882, 15.

*Campbell's
Report
on the
Drainage
of the
Kankakee
Marshes.*

clude: First, the construction of a better main channel than now exists, for the flow of the river; second, the straightening and deepening of the beds of the streams which empty into the main stream; and third, the digging of a large number of lateral ditches through the swamps to the improved channels.

"The portion of the work which seems properly to belong to State and National supervision is the improvement of the main channel of the river. The other parts of the work may be left to the owners of the land, to be executed under our general drainage laws."

For convenience in describing the necessary improvements, the river and marsh lands were divided into seven divisions. Of these, the conclusions regarding divisions III., V. and VI. are those which are quoted, since they deal with the drainage of the lands in Porter and Lake counties.*

"DIVISION III. extends from the terminus of Division II. at the mouth of Mill Creek, section 7 (34 north, 2 west), *by a new channel*, to Grand Junction, at the mouth of Crooked Creek, section 36 (33 north, 6 west).

"The Kankakee River below the mouth of Mill Creek has a belt of timber along its banks, which would make the cost of straightening the river very great.

"The great deflection of the river from the general direction of the valley makes it important to shorten the distance by a new channel.

"The line proposed for the improvement lies in a remarkable part of the valley. The line will be clear from timber obstruction, except about one and a half miles at the lower end, where it passes through the belt of river-bank timber into the old channel. The line lies for the most part in a series of deep marshes, now impassable, and well known in the neighborhood as a deep slough, sand channel, etc. The new channel will take the greater part of the water of the improved river above Mill Creek, and all the surface drainage on the north side in Laporte and part of Porter counties. The length of the division will be 21.5 miles.

"The proposed dimensions for the new channel for this division are at the upper end—width of bottom 27 feet, width at top 51 feet, depth 8 feet, area of cross section 312 square feet. At the lower end—width at bottom 33 feet, width at top 57 feet, depth 8 feet, area of cross sec-

* Division IV. was subordinate to III., and included the improvement of Yellow River and the present channel of the Kankakee along the line of Division III., for the purpose of draining the territory south of that river. The estimated cost of this division was \$80,000.

tion 360 square feet. The mean measure will be—width at bottom 30 feet, width at top 54 feet, depth 8 feet, area of cross section 336 square feet.

“These dimensions will give—mean hydraulic depth 5.23 feet, calculated mean velocity 2.405 feet per second, mean volume of discharge 808.4 cubic feet per second. The volume of discharge at the lower end will be 878.4 cubic feet per second.

“The mean dimensions will give—for each linear yard 37 1-3 cubic yards, for each mile 65,707 cubic yards, for the division 21.5 miles, 1,412,700 cubic yards; the cost of which, at 7 cents per yard, will be \$98,889; or, at 10 cents per yard, \$141,270.” But 6.75 miles, or 443,522 cubic yards, of this division lie in Porter County. This, at 7 cents per yard, would cost \$31,046, or, at 10 cents per yard, \$44,352.

“DIVISION V. extends from Grand Junction, section 36 (33 north, 6 west), *by a new channel*, to a point in the river in section 33 (32 north, 8 west), near the bridge on the line of the Indianapolis & Chicago (Monon) Railway.

“At Grand Junction, the new channel or the Upper Kankakee, the old channel or the Yellow River section, and Crooked Creek, unite their waters and form the enlarged lower river.

“From Grand Junction to the State line, and to Momence, Illinois, there is plenty of water for the purposes of navigation, and it is desirable that the improvement below Grand Junction should be made with reference both to drainage and navigation. The route proposed for the new channel will be through the open marsh, entirely free from timber obstruction, except one mile of river-bank timber on the west end, and is admirably located with reference to the drainage of some of the deepest marshes in the entire valley.

“Another route may be adopted, nearly, if not quite, as good as the one proposed, by running the new line more directly west after it enters Newton County, and terminating in the river north of the point above mentioned; thence by the straightened river to the terminus at the State line. The cost of the two routes will be about equal. The length of the division will be 16 miles.

“The dimensions proposed for the new channel for this division are—at the upper end, width at bottom 36 feet, width at top 63 feet, depth 9 feet, area of cross section 445.5 square feet. At the lower end—width at bottom 42 feet, width at top 69 feet, depth 9 feet, area of cross section 499.5 square feet. Mean measure—width at bottom 39 feet, width at top 66 feet, depth 9 feet, area of cross section 472.5 square feet.

"These dimensions will give—mean hydraulic depth 6.06 feet, calculated mean velocity 2.7 feet per second, volume of discharge 1,275.7 cubic feet per second. The volume of discharge at the lower end station will be 1,358.6 cubic feet per second.

"The mean dimensions give for each linear yard 52.5 cubic yards, for each mile 92,400 cubic yards, for the division (16 miles) 1,478,400 cubic yards; the cost of which, at 7 cents per yard, will be \$103,488, or, at 10 cents per yard, \$147,840.

"The old channel of the river below Grand Junction receives no important creek, and only a small expenditure will be required to keep this channel open for its limited drainage area."

"DIVISION VI. extends from the terminus of Division V., along the general line of the river to the State line.

"The increased velocity of the river in this division, owing to its increased slope and the general direction of the stream, make the improvement desirable along the general line of its present flow.

"A new channel in section 33 (32 north, 8 west), one mile in length, and a similar one, chiefly in sections 1 and 2 (31 north, 9 west), two and a half miles long, will be required. The dimensions of these new channels are estimated the same as in Division V.—per mile, 92,400 cubic yards— $3\frac{1}{2}$ miles, 323,400 cubic yards; and their cost, at 7 cents per yard, will be \$22,638, or, at 10 cents per yard, \$32,340.

"The other improvements in this division will consist in a general straightening of the channel, the removal of timber obstruction and dredging the channel to secure an additional depth of two feet, the estimated cost of which will be \$69,000.

"The estimated length of the division after the improvement has been made will be 15 miles.

"In addition to the cost of construction, the question of maintenance of the new channel requires consideration. The same causes which produced the present crooked river will, in a less degree, affect the straightened stream, and continued care will be required to preserve an unobstructed flow.

"If we assume that the river now has an approximately stable bed, the result mainly of the free action of natural forces on the sandy soil, it is evident that any increase of velocity will affect this stability and introduce a disturbing element which will require special attention.

"The banks of the new channel will likewise deliver quantities of sand into the current until they assume their proper angle of rest and are protected by grass or other vegetable growth.

"The lateral ditches will also bring down masses of sand, which will, if left uncared for, form bars where these ditches empty into the river.

"To meet these difficulties it will be necessary to keep at work one or two dredging machines until the new channel has assumed a partially stable condition.

"Grass grows most luxuriantly in all parts of the Kankakee Valley, and from this cause we may expect that the banks will be covered very rapidly. After the drainage has been once accomplished and the lands brought under cultivation, there will be a great diminution of the volume of water to be carried off.

"The absorbent power of the reclaimed land and the evaporating surface will be increased, and the quantity of surplus water will be proportionally diminished.

"The diminished volume will give a relative increased capacity, with less depth, and thus by degrees the new channel will become stable, while at the same time it fulfills all the requirements for complete drainage."

The minimum cost of the improvements for draining the Kankakee marsh lands west of the mouth of Mill Creek was thus estimated by Dr. Campbell to be \$294,015, and the maximum \$390,450. Subtracting from these two amounts, respectively, \$67,843 and \$96,918, the estimated necessary cost of that portion of the excavation lying in Laporte County, we have \$226,172 and \$293,532 as the estimated maximum and minimum cost of all improvements between the east line of Porter County and the State line.

From the Porter County line the new channel could be extended eastward to connect with the present river at Lougee's wagon bridge, section 24 (33 north, 4 west), a distance of three miles. Assuming Dr. Campbell's figures of the mean excavation to the mile for Division III. to apply to this extension, its cost would be \$13,798, at 7 cents per cubic yard, or \$19,712, at 10 cents. The total cost of draining the lands would, therefore, according to Dr. Campbell's plans, be between \$239,970 and \$313,244. In addition to the marsh lands north of the river, fully 70,000 acres would be reclaimed in Jasper and Newton counties on the south, so that the cost would be less than \$2.00 per acre for the 160,000 acres in the four counties.

Taking into consideration their proximity to Chicago and the excellence of their soil, there is little doubt but that these lands, if permanently drained, would command from \$40.00 to \$60.00 per acre. It would seem, therefore, that private enterprise would have long since provided for their drainage. But in this instance private enterprise

has been waiting for State aid, which has been granted only to the extent of partially removing the barrier of rock at Momence. If the State would appropriate \$300,000 for straightening the river and reclaiming the lands, it would be only a loan of money; soon to be repaid, for the increase in the taxable value of those lands would soon bring back to her coffers far more than the amount expended. The principal reason why such an appropriation is not made doubtless lies in the fact that the lands are, for the most part, owned in tracts of from one to ten thousand acres, instead of by many individuals. The people of the State do not believe in increasing the wealth of these speculative owners by temporarily taxing themselves. Still, as a business enterprise, the State would, in time, be largely the gainer, and a portion of her area now practically valueless would soon be known as the garden spot of northern Indiana.

GENERAL FEATURES.

Although the prairies of the two counties belong, for the most part, to the morainic region, their consideration has been purposely omitted until after that of the Kankakee marsh, since that marsh is but an embryo prairie; i. e., a prairie now in the course of formation.

We have already noted the fact that the irregular deposition of drift gave rise to the basins of morainic lakes. Where these basins

are deep valleys or pot holes, they still contain water. *Prairies.* Where large areas were covered with but a shallow depth of water, those areas were first lakes, then swamps, and finally prairies. The change from one to the other was gradual, and in many places is still going on.

Near the close of the glacial period the surface of the morainic area of Lake and Porter counties contained a number of large shallow basins, which were covered by the melting waters of the glacier. For many, perhaps thousands of years, the waves piled up sands from the deeper portions of these basins into the "sand islands," or present wooded groves, which here and there dot the prairies. Everywhere in the shallow water aquatic plants were slowly decaying, and their organic matter, mingling with the fine sediment which was constantly settling, gave rise to that peculiar soft black mould or loam which forms the main portion of typical prairie soil. After a time, by evaporation and other causes, the water was removed from the surface of each of these shallow lakes, and a swamp resulted. This in turn gave way to a wet prairie, and this to a dry prairie with a compact sod of grasses. As long as the earth was covered with water no seeds of trees

would germinate. Neither would they germinate after the water disappeared, for the soil was too full of humic acid formed by the decaying of the aquatic plants. Finally the sod became so thick and tough that if the conditions of germination had been favorable the rootlets of the sprouting seed could not have penetrated it. These reasons are responsible for the treeless condition of all typical prairies.

In passing back from the margin of the Kankakee marsh lands towards the higher prairies on the moraine, the wet and dry prairies merge by such insensible degrees that it is very difficult at times to fix a point of separation between them. The surface appearances are very much the same. The plants are all herbaceous and belong practically to the same families, differing only in that some prefer dry and others moist situations. The likeness of the soil is still more striking. The same kind of sub-soil is overlain by the same black spongy mould. The "islands" of both marsh and upland prairies are also essentially the same in composition and in the kinds of timber which cover them. No one who carefully compares the characters common to both can for an instant doubt but that the origin of the one has been similar to that of the other.

The greater irregularity of surface in the upland prairie which causes it to be termed *rolling*, is due in part to irregular deposition of drift, the deeper parts of the lakes having been over the lower portions of the present prairie, and in part to the erosion of the waters as they slowly found their way through the countless lagoons of the swamps to lower levels.

In several places in the two counties small prairies have been formed by the work of beavers. Dams were thrown up. Ponds or small lakes were formed, and the sand from the bottom of these lakes was washed out in several localities about their margins. Beaver Dam Marsh, northwest of Crown Point, in section 1 (34 north, 9 west), now in a transition stage between a swamp and a prairie, is an example which may thus be traced to the work of beavers. The sand along the road which runs across the marsh was washed up from the bottom of the lake, where it was originally deposited as a part of the Valparaiso moraine.

The principal prairies of Porter County are Twenty Mile Prairie, in Portage and Union townships; Morgan Prairie, in Morgan Township, and Horse Prairie, in Porter Township. In Lake County, Robinson's Prairie, near the center; Lake Prairie, in the southwest, and Eagle Creek Prairie, in the southeast, are the largest, most fertile and most beautiful.

When the two counties were first settled the wooded islands and the timbered uplands, with their clayey and sandy soils, were considered more valuable than the prairies. The settlers had come from well-timbered countries and had the erroneous belief that land that would not produce trees would not produce cereals. Many of the prairies, as Twenty Mile Prairie, Whippoorwill Prairie, and much of Morgan Prairie in Porter County, and those on the northern half of the morainic region in Lake County, were wet prairies, and for years yielded only swamp hay and pasture.

At present the prairie soils are considered far more valuable than those of the woodlands. The elements entering the former through the medium of decayed aquatic plants and animals have been in proper proportion and in sufficient quantity to give them extraordinary fertility. Their depth is so great that successive crops of the same kind can be cultivated year after year; the lower portions being as rich in the necessary elements of plant food as are the upper.

FARM PRODUCTS.

Especially are these prairie soils suited to the production of grass and hay. As natural meadows, they fed for centuries countless numbers of buffalo and deer. They now yield for the domestic animals of man thousands of tons of the best of timothy and wild hay.

Hay Production. In 1896 Lake County ranked second and Porter County third among the 92 counties in the State of Indiana in the production of timothy hay. The former produced 36,560 acres, yielding 49,356 tons;* the latter, 25,570 acres, yielding 34,438 tons. This does not include the upland prairie hay nor the lowland marsh hay. Probably as many or more tons of the latter are produced than of the timothy, though statistics are not available. Thousands of acres are annually cut, stacked, baled and shipped to Chicago. If the yield of timothy hay is short, good prices are realized. If timothy is plentiful, much of the marsh hay must be sold for bedding and packing at lower prices. Wild hay from upland prairies ranks next to timothy in quality, and sometimes brings even a better price. The largest hay fields in the State are in these two counties. In the north-east corner of Pleasant Township, Porter County, in 1897, were two full sections—1 and 12 (33 north, 5 west)—of raw prairie in one field, every foot of which was mowed. Another field, containing 2,000 acres, formerly in meadow, but now pastured, lies north of Fuller's Island, in Cedar Creek Township, Lake County. It has been partially reclaimed by the Griesel and Singleton ditches.

* Allen County ranked first by a very small margin, producing 36,826 acres and 49,715 tons. These figures are from the 12th Report, Indiana Dept. of Statistics, 1896, 436.

The prairie soils also yield bountiful crops of corn and oats, but wheat is not a success, especially in Lake County, where, in 1897, but 809 acres, yielding 12 bushels per acre, were produced. *Production of Cereals.* The freezing of the soil causes it to "heave" and throw out the roots of the plant, and the latter winter-kills. In Porter County, especially on the uplands of Washington, Jackson, Liberty and the eastern half of Center townships, a much larger acreage is sown; the average for the last three years being about 12,000 acres, with an average yield of nine bushels to the acre.

Much of the sand-covered area of the two counties, now considered waste land, will be found to be admirably adapted to the raising of small fruits and certain vegetables. Wherever wild berries and wild grapes grow luxuriantly, there, with a little care, can tame ones be successfully cultivated. *Small Fruits and Vegetables.* Within recent years the growing of strawberries has been carried on to quite an extent on the sandy lands in the vicinity of Furnessville. This fruit is especially suited to a sandy soil, and hundreds of acres could be grown in the Calumet region on land which now produces nothing but weeds. Where they have been planted and given proper attention they have yielded bountifully and have found a ready market in Chicago. The raising of raspberries has also proven successful in the same vicinity, as well as on the sandy lands southwest of Kouts, in Pleasant Township, Porter County.

On the crests and slopes of the higher sand ridges along the shores of Lake Michigan wild grapes grow abundantly, and the fruit reaches a large size. The vines spring, apparently, from a mass of pure dry sand. But a careful examination will soon show that only the surface of the sand is dry. Six or eight inches below the surface there is moisture even in the driest of seasons. It rises, by capillary attraction, from the very base of the ridge or dune, and the surface itself would be moist were it not for the constant evaporation. Moreover, the sand is not pure silica, but contains sufficient calcareous and organic matter to furnish plentiful food for the wild grapes, wild grasses and numerous shrubs and trees which spring from its surface. That tame grapes will thrive and yield abundantly on these sands has been proven by Mr. A. Stamford White, of Chicago. In 1894 he planted in Concord grapes three acres on the southern slope of a sand ridge, in section 3, Pine Township, Porter County. On September 10th, 1897, each vine was loaded with as fine fruit as one could wish, which was just ripening. The only drawback was due to the exceptional drouth of that season, which had caused the leaves of some of the vines to shrivel and drop, and so exposed the fruit to the blistering rays of reflected

sunlight. This would not happen in an ordinary season. Numerous peach and cherry trees had also been planted on the same ridge and were growing thriftily, but were yet too young to bear. Plum trees will also doubtless bear well, since many clumps of wild trees were noted on the "sand islands." Wild huckleberries grow plentifully in the Calumet region, and from Tolleston a thousand bushels a year were formerly shipped.* The huckleberry seems to be especially adapted to the sandy ridges, and is one of the most prolific and highly esteemed of the wild midsummer fruits.

The more level sandy areas, when first cultivated, produce for a few seasons excellent sweet potatoes, watermelons and pumpkins. By a careful system of fertilization a plentiful yield of all vegetables which flourish best in a sandy soil could be obtained. This has been proven in a locality along the Monon Railway, south of Hammond, where, for several seasons, hundreds of carloads of night soil have been shipped from Chicago and used as a fertilizer. As a result, an abundant yield of vegetables has been obtained from land once thought to be barren. These are in turn shipped to the Chicago market, thus furnishing a pointed example of that constant circulation of matter forever going on.

In the marshes wild cranberries grow indigenously, and when the season is not too dry excellent crops are produced. Much of the marsh land now uncultivated could be made to yield a handsome revenue if planted to this fruit. The largest, best-flavored and highest-priced berries can be readily grown on drained marsh land which has been properly prepared by cultivation so as to remove the natural growth of bushes, weeds and grass; and which can be flooded in late autumn and early spring. Where muck underlies the sod the latter should be removed and about four inches of sand mixed with the former: since the muck alone produces plentiful vines but few berries. Four years are necessary for the plant to come into full bearing, when the yield is from 100 to 150 bushels per acre, the wholesale price of the better berries being seldom less than \$2.00 per bushel. Plentiful water for flooding the marshes can be readily obtained by putting down driven wells and equipping them with windmill pumps. By this means also water in unlimited quantity can be had for irrigating fruits and vegetables grown on sandy lands adjacent to the marshes. Large areas of the marsh land now uncultivated will also produce paying crops of peppermint and celery, both of which plants require rich, moist soil for their successful raising.

* Ball, Rev. T. H.—Lake County, 1884, 159.

Next to hay, the most valuable farm product of the two counties is milk. Among Indiana counties, in 1897, Lake ranked third, and Porter fifth, in number of milk cows, there being in the former 9,832 and in the latter 8,218.*

The numerous railways passing through the counties to Chicago have each one or more daily "milk trains," which stop at platforms erected at intervals of two or three miles and gather up the liquid product for the Chicago market. The demand for milk in that city is constantly on the increase. The cash return therefor is sure, profitable and quick to reach the producer's pocket. As a result, the number of dairies in the two counties is constantly increasing, while the acreage devoted to the raising of cereals grows proportionally less.

Fifty years ago Lake and Porter counties contained much valuable timber, but the older and larger trees have almost all been removed, and what remains is mostly "second growth." As already noted, the wooded groves or "sand islands," of both the prairie and the marshes, are thickly covered with small-sized black oak, *Quercus velutina* Lam., white oak, *Q. alba* L., bur-oak, *Q. macrocarpa* Michx., and in places the shell bark and pignut hickories, *Carya alba* Nutt., and *C. porcina* Nutt. Much underbrush exists among these trees, and about the borders of the islands, especially sassafras, hazel, crab-apple and hawthorne shrubs.

On the sand hills along the northern border, notably in Porter County, grew many large-sized white pine, and black and white oaks, but sawmills were erected in several localities on the lake shore, and the hills were soon stripped. The gray or northern scrub pine, *Pinus banksiana* Lambert, now far outnumbers the white pine in that region.

No hard or sugar maple trees and but few beech grow indigenously in Lake County, but on the clay uplands of Jackson and Pine townships, in Porter, they are found in numbers. Here, also, grow red oak, *Q. rubra* L., shingle oak, *Q. imbricaria* Michx., and the wild cherry. Sycamore, river or red birch, *Betula nigra* L., and the soft or silver maple, occur along the banks of the Kankakee and the Little Calumet, but they do not reach the size which they attain in central Indiana.

MINERAL PRODUCTIONS.

Porter and Lake are pre-eminently agricultural and manufacturing counties and contain but few mineral productions of value. No coal or building stone occur within their bounds, and neither natural gas

* Allen County was first with 11,002; Marion second, with 10,016, and St. Joseph fourth, with 8,716.

nor petroleum have as yet been found. Deposits of clay suitable for making pressed front brick, terra cotta lumber and other high-grade clay products are located near Hobart, Porter and Chesterton, on the Deep and Calumet rivers. Clay suitable for ordinary brick and drain tile occurs in a number of localities in the morainic region. These deposits are described in detail in another paper in the present volume.

Molding sand of excellent quality occurs in abundance at several localities in the two counties. The best-known deposits are on the lands of L. H. Robbins and Theodore Swear, near McCool, Porter County, sections 7, 8 and 17 (36 north, 6 west). These deposits occur over the greater portion of the three sections, and shipments have been made from them for six years.

In 1897 a carload a day was shipped from the Swear land (section 17) to the Illinois Steel Company, at South Chicago, and four cars a week from the Robbins land to foundries in Chicago. The owners haul the sand to McCool and load it on the cars, receiving from \$7.50 to \$10.00 per carload at that station. The principal bank on the Robbins land, one-half mile northeast of McCool, showed the following exposure:

Soil	1 foot.
Fine grained buff clay containing much silica or free sand—"loam"	2 feet.
Coarser, darker molding sand.....	3.5 feet.

The soil is stripped; the "loam" separated from the molding sand and sold for lining ladles and cupola furnaces, and the molding sand for making castings. Each foot in thickness yields about 70 carloads per acre.

Southeast of Valparaiso, in southwest quarter of section 34 (35 north, 5 west), and north half of section 3 (34 north, 5 west), are also deposits of molding sand, much of which has been shipped to Chicago in recent years. The main deposits are close alongside the "Nickel Plate" Railway. The sand here is a dark brown, averages from two and one-half to three and one-half feet in thickness, and is overlain by six inches of soil. On the roadside one-fourth of a mile east of the Methodist Church, near the center of section 15, Washington Township, Porter County, is also an exposure of molding sand, deeper-red in color and three feet in thickness. It underlies six inches of soil and overlies a thick deposit of ordinary sand.

In Lake County the only deposit of molding sand noted was one and a half miles southeast of Hobart, on the land of William Frank, southeast quarter of section 33 (36 north, 7 west). Where exposed, this deposit is from eight to ten feet thick and is overlain by eight

inches of soil. It has been tested in Chicago and in the foundry at Hobart, and is pronounced of excellent quality. The Nickle Plate Railway runs within one-eighth of a mile of this deposit, which doubtless covers the greater portion of the quarter section. The following record of a bore put down 200 yards south of the above exposure was furnished by Mr. Frank:

Soil	1	foot.
Molding sand—heavy	4	feet.
Molding sand—lighter	4.5	feet.
Blue sand	6	feet.
Blue clay	76	feet.
Blue sand and clay mixed.....	96	feet.
Total	187.5	feet.

Both this deposit and the one near McCool are within the area at one time covered by the bay of Lake Chicago, mentioned on page 33, and were doubtless deposited by that sheet of water.

Peat exists in quantity in many of the marshes of the two counties. In Lake it is especially abundant in the Cady Marsh, northeast of Dyer. In Porter, the marsh north of Furnessville and the one along Sandy Hook Creek, in Morgan Township, contain it in great abundance. It is formed by the partial decomposition of plants beneath the surface of the water.

The gaseous constituents of the plants mostly escape, but the carbon is left behind. The decay of the plants is prevented by the water, which shuts off the free oxygen of the air, the main agent of all decay, and also by a peculiar antiseptic property which peat itself possesses. Each generation of plants takes gaseous carbon dioxide from the air, solidifies it within the plant body, and then adds it to the soil. A bog is therefore composed of the solid matter of thousands of generations of plants. The peat can be readily cut, dried and pressed into a valuable domestic fuel. At one time quite an industry of this kind was started at the Cady Marsh, but cheap coal, brought in by the many railways, has brought it to an end.

Beneath the peat bogs, especially in the Calumet region, there usually occur great quantities of limonite or bog iron ore. In the marsh north of Furnessville masses of it weighing many hundreds of pounds have been unearthed. This ore is too impure, however, to compete with the hematite and other high-grade iron ores of the Lake Superior, Missouri and Georgia mines. At one time a large blast furnace for reducing the bog ore of the Kankakee region was in operation at Mishawaka, St. Joseph County, but, like a number of others in central and southern Indiana, it has long since gone out of blast.

Gravel suitable for road purposes should be found in quantity in the higher ridges of the morainic region, but a careful search has not, as yet, revealed its presence. It is plentiful in the clay soil of the

Gravel. uplands, and seems to have been scattered through this soil and not accumulated in vast beds as in the moraines

of central Indiana. The largest deposit noted in Lake County was near West Creek, in section 7 (32 north, 9 west). It was excellent in quality, but was but two and one-half feet thick, and was overlain with three feet of earth and underlain with coarse sand. It is my opinion that careful investigation will yet reveal large deposits of gravel in the higher ridges east and west of Lowell, and in some of those north and west of Hebron.

Several small deposits have been found just south and west of Valparaiso, one of which, called "Sugar Loaf," 20 feet in height and covering half an acre, was used on the streets of that city. A deposit three feet and more in thickness was noted east of Bell Marsh, on the side of the Valparaiso and Laporte road, in the southeast quarter of section 10 (35 north, 5 west). The appearance of the surrounding country is very favorable to the discovery of large deposits in this vicinity. The absence of good road material is a great drawback to the rapid development of the two counties, most of the gravel which has heretofore been used having been shipped in at great expense from Joliet, Illinois.

In September, 1897, it was reported at Chesterton that an outcrop of rock, *in situ*, had been discovered near Gosset's mill, in the western part of Liberty Township, Porter County. A visit to the place showed that on the land of John Tratebas, northwest quarter of section 21 (36 north, 6 west), the supposed rock was being taken out from a bluff of Salt Creek. The following section was exposed:

- Stone.*
1. Soil and clay 2.5 feet.
 2. Sand, strongly impregnated with a solution of carbonate of lime.....14 feet.
 3. Calcareous sandstone formed by the cementing action of carbonate of lime on the grains of sand..... 4 to 6 inches.
 4. Sand 3 feet.
 5. Gravel 6 inches.
 6. Blue clay ? ?

The sandstone, No. 3, was evidently of very recent formation, and the blocks of it were very rough, uneven and irregular in size. The owner was endeavoring to get out enough of it to strengthen the mill dam, but found it a difficult task on account of the heavy overlying

deposit of sand. The cementing principle being carbonate of lime, readily soluble in rainwater, the stone, when exposed, will doubtless soon disintegrate into loose sand.

Other than bowlders, this was the only stone noted in the two counties, and the assertion was frequently made by citizens that no outcrop is known. Richard Owen, however, in his Report of a Geological Reconnaissance of Indiana, 1859, 205, makes the following statement:

“On Mr. Howell’s elevated land, about three-quarters of a mile southeast of Valparaiso, on section 30 (35 north, 5 west), we were shown good gray crystalline limestone which had been quarried and burned into lime; but as the layer is only two or three feet thick, and apparently local in extent, it was soon abandoned. Unfortunately, no fossils were found, the lithographic or lithological character, however, indicates a rock of Upper Silurian age.”

This statement was not observed until after my return from the field. The only information I have since been able to gain concerning the stone mentioned is from Henry Rankin, of Valparaiso, as follows: “I have interviewed Judge Wm. Johnstone about the limestone. He was raised within a mile of it. When a boy he has seen Mr. Howell burn lime on the northwest quarter of the section cited. He describes the stone as not in strata, but set up on edge, and says there were several cords of it.” It is more than probable, therefore, that the stone mentioned by Dr. Owen was of drift origin, and not formed *in situ*.

Numerous springs occur throughout the counties, but the water is, in general, free from mineral constituents. At the Willow Dale Stock Farm, one-half mile north of Crown Point, are, however, several fine springs which yield a copious supply of mineral water. The owner, Mr. W. J. Davis, kindly furnished the following copy of an analysis made by Dr. T. C. Van Nuys, formerly chemist at the State University:

ANALYSIS OF WATER FROM WILLOWDALE SPRINGS NEAR CROWN POINT, IND.

	<i>Grains Per Gal.</i>
Potassium sulphate—potash salts (K_2SO_4)	0079.94
Sodium sulphate—Glauber’s salts (Na_2SO_4)	0011.31
Sodium carbonate—carbonate of soda (Na_2CO_3)	0139.79
Sodium chloride—common salt ($NaCl$)	0018.34
Aluminum sulphate—aluminum salts ($Al_2(SO_4)_3$)	0065.24
Calcium bicarbonate—salts of lime ($CaH_2(CO_3)_2$)	1929.06
Magnesium bicarbonate—salts of magnesia ($MgH_2(CO_3)_2$) ..	1165.08
Silicic acid ($Si(OH)_4$)	0166.39
Total	3575.15

The water is colorless and clear. Specific gravity, 1,000%, No iron or manganese was found. T. C. V.

At Hammond mineral water flows from six artesian wells, which average about 1,840 feet in depth, and at East Chicago, from one, 1,830 feet in depth. Two of those at Hammond are located on the grounds of the Western Starch Association, and the water flows from a vein which was struck at 1,850 feet.

A chemical analysis of this water, which will probably hold good for that flowing from the other wells at Hammond, showed the presence of the following mineral salts:

ANALYSIS OF ARTESIAN WATER FROM WELLS ON GROUNDS OF THE WESTERN STARCH ASSOCIATION AT HAMMOND, IND.

	<i>Grains Per Gal.</i>
Silica	1.022
Oxide of iron and aluminum.....	.058
Carbonate of lime.....	10.003
Carbonate of magnesia.....	9.283
Sulphate of soda.....	29.894
Chloride of sodium.....	20.913
Carbonate of soda.....	3.260
Sulphate of lime.....	38.308
Total	112.741

Two artesian wells, flowing water of high repute, are located in Porter County. One is the Blair well, in the extreme northeastern corner of the county, about one and one-half miles southwest of Michigan City. This well flows about 80 gallons per minute of water which a few years ago was much used for medicinal purposes. A bathhouse and sanitarium were erected, and many guests visited the place each year and were benefited by the treatment. Since the death of the owner the use of the water has been practically abandoned. The depth of this well was 840 feet, and an analysis of the water by Dr. P. S. Hayes, of the Chicago College of Pharmacy, showed the presence of the following mineral salts:

ANALYSIS OF ARTESIAN WATER FROM BLAIR WELL, NEAR MICHIGAN CITY, INDIANA.

	<i>Grains Per Gal.</i>
Chloride of sodium (NaCl).....	360.4794
Chloride of magnesium (MgCl ₂)	45.6550
Sulphate of potassium (K ₂ SO ₄)	17.9968
Sulphate of magnesium (MgSO ₄).....	31.9730
Sulphate of calcium (CaSO ₄)	84.4024
Bicarbonate of calcium (CaH ₂ (CO ₃) ₂).....	147.8503
Silica (SiO ₂)	1.7523
Total solids determined	690.1092
Hydro-sulphuric acid, total in volume at 62° F, 11.1719 cubic inches.	

The second well flowing mineral water in Porter County is located on the grounds of the Chicago Hydraulic Press Brick Company, at Porter, twelve miles southwest of Michigan City. It was bored in search of gas to a depth of 860 feet, and at present flows about 75 gallons per minute of water which is highly charged with hydrogen sulphide, as well as the following mineral salts:

ANALYSIS OF THE PORTER ARTESIAN WATER.

	<i>Grains Per Gal.</i>
Sodium chloride—common salt (NaCl)	208.76
Calcium chloride—chloride of lime (CaCl ₂)	51.93
Magnesium chloride—salts of magnesia (MgCl ₂)	38.71
Ammonium chloride—salts of ammonia (NH ₄ Cl)	0.44
Potassium chloride—potash salts (KCl)	13.18
Potassium sulphate—potash salts (K ₂ SO ₄)	17.08
Calcium carbonate—carbonate of lime (CaCO ₃)	11.14
Silica	1.10
Total	342.34

This analysis was made by Dr. J. H. Salisbury, Professor of Chemistry in the Women's Medical College, Northwestern University, who speaks of the water as follows: "The water from Porter is very free from injurious organic matters. It is very useful for drinking at the well in cases which need alterative or laxative treatment; and is also useful for baths and for sanitarium purposes. Its sulphuretted hydrogen will not be long retained if exposed to the air."

RAILWAYS.

The 920 square miles comprised in these two counties is less than one-fortieth of the area of Indiana, yet they contain more than one-fourteenth of the total miles of railway in the State. Of the \$154,841,971 of railway property assessed in Indiana in 1897, \$15,539,249, or more than one-tenth, is within these counties and pays taxes into their treasuries.

Among Indiana counties, Lake easily ranks first in the number of miles of railway within her bounds. Porter stands third, being excelled only by Laporte, her much larger eastern neighbor. Nine great trunk lines cross both counties from east to west and in Lake the Monon runs almost the full length of the county from north to south. The two counties thus stand at the main door of entry into Chicago. Across their bounds all passengers to and from that city to the Eastern States must travel.

Besides these ten great systems, five belt railways, each connecting with almost all the roads entering Chicago, cross a portion or all of

Lake County, and one of them, the Elgin, Joliet & Eastern, extends nine miles into Porter. The principal business of these belt roads is the transferring of freight from the main trunk lines east of Chicago to similar lines running west from that city. Crossing and intersecting, as they do, the Calumet region, they give to that area most excellent shipping facilities. Many capitalists have, of recent years, availed themselves of these facilities, and about Hammond, East Chicago, Whiting, Hobart, Porter and Chesterton have been located some of the largest and most flourishing factories in Indiana. In fact, its many railways, its proximity to Chicago and the cheap prices at which factory sites can be secured within its bounds, now mark the once despised and little valued Calumet region as one of the future great manufacturing districts of the world.

In order to give exactly the railway statistics of the two counties, the following table from the "Proceedings of the Indiana State Board of Tax Commissioners for 1897" is inserted:

Railway Statistics of Lake and Porter Counties in 1897.

NAMES OF ROADS.	MAIN TRACK.			SECOND MAIN TRACK.			SIDE TRACK.			ROLLING STOCK.			Improvements on Right of Way.	Total of Roads.	Total of Counties.
	Miles.	Per Mile.	Total.	Miles.	Per Mile.	Total.	Miles.	Per Mile.	Total.	Miles.	Per Mile.	Total.			
LAKE COUNTY—															
Baltimore & Ohio & Chicago.....	17.86	\$22,000	\$392,920	11.42	\$8,000	\$91,360	11.59	\$3,500	\$40,565	17.86	\$2,500	\$44,650	\$1,460	\$570,955	
Chicago & Erie	24.42	25,000	610,500				17.16	3,500	60,060	24.42	2,500	61,050	8,350	739,960	
Chicago & Lake Shore Eastern	7.94	10,000	79,400	7.51	5,000	37,550				7.94	1,500	11,910	400	129,260	
Chicago & Calumet Terminal.....	10.93	18,000	196,740	.99	6,000	5,940	12.82	3,500	44,870	10.93	3,000	32,790	2,750	283,090	
Chicago & Grand Trunk.....	16.53	32,000	528,960				3.83	4,000	15,320	16.53	3,500	57,855	3,600	605,735	
Chicago, Hammond & Western.....	3.82	2,500	9,550				.40	1,500	600				100	10,250	
Elgin, Joliet & Eastern.....	23.70	20,000	474,000				7.76	3,000	23,280	23.70	2,500	59,250	2,720	559,250	
East Chicago Belt.....	3.04	2,000	6,080											6,080	
Lake Shore & Michigan Southern.....	18.25	40,500	739,125	18.25	10,000	182,500	7.45	4,000	29,300	18.25	6,000	109,500	1,750	1,062,675	
Louisville, New Albany & Chicago.....	33.54	16,600	556,764				10.88	3,500	38,080	33.54	2,500	83,850	2,295	680,989	
Michigan Central.....	16.40	32,500	533,000	16.40	10,000	164,000	11.41	3,500	39,935	16.40	5,000	82,000	6,170	825,105	
Montpelier & Chicago.....	10.81	14,000	151,340				3.09	3,000	9,270	10.81	3,000	32,430	800	193,840	
New York, Chicago & St. Louis.....	18.03	32,000	576,960				5.65	4,000	22,600	18.03	3,000	54,090	1,770	655,420	
P., C., C. & St. L. (Chicago Division).....	22.12	34,000	752,080				8.37	4,500	37,665	22.12	5,000	110,600	3,885	904,230	
Pittsburgh, Ft. Wayne & Chicago..	20.07	56,500	1,133,955	20.07	10,000	200,700	10.54	5,000	52,700	20.07	7,000	140,490	6,475	1,534,320	
State Line & Indiana City.....	7.56	7,000	52,920				3.16	2,000	6,320				2,800	62,040	
Indiana, Illinois & Iowa.....	11.26	15,000	168,900				1.02	3,000	3,060	11.26	1,500	16,840	650	189,500	
Joliet & Northern Indiana.....	15.51	16,000	248,160				2.29	3,000	6,370	15.51	2,500	38,775	2,080	295,855	
Total.....	281.79		\$7,211,354	74.61		\$682,050	122.41		\$430,995	267.37		\$936,130	\$48,055		\$9,308,584
PORTER COUNTY—															
Baltimore & Ohio & Chicago.....	16.59	\$22,000	\$361,980				4.11	\$3,500	\$14,385	16.59	\$2,500	\$41,475	\$2,690	\$423,530	
Chicago & Erie	16.62	25,000	415,500				3.50	3,500	12,250	16.62	2,500	41,650	1,450	470,750	
Chicago & Grand Trunk.....	15.28	32,000	488,960				4.91	4,000	19,640	15.28	3,500	53,480	12,340	574,420	
Chicago & Indiana Coal.....	3.22	14,000	45,080				.14	3,000	420	3.22	2,000	6,440		51,940	
Elgin, Joliet & Eastern.....	9.12	20,000	182,400				4.11	3,000	12,300	9.12	2,500	22,800	850	213,980	
Lake Shore & Michigan Southern.....	15.57	40,500	630,585	15.57	\$10,000	\$155,700	10.37	4,000	41,480	15.57	6,000	93,400	3,860	925,045	
Michigan Central.....	17.04	32,500	553,800	17.04	10,000	170,400	5.01	3,500	17,535	17.04	5,000	85,200	4,100	831,035	
Montpelier & Chicago.....	16.61	14,000	232,540				2.38	3,000	7,140	16.61	3,000	49,830	1,310	290,820	
New York, Chicago & St. Louis.....	16.97	32,000	543,040				1.98	4,000	7,920	16.97	3,000	50,910	1,250	603,120	
P., C., C. & St. L. (Chicago Division).....	15.48	34,000	528,320				5.34	4,500	24,030	15.48	5,000	77,400	2,580	630,330	
Pittsburgh, Ft. Wayne & Chicago..	16.47	56,500	930,555	12.57	10,000	125,700	4.51	5,000	22,500	16.47	7,000	115,290	17,200	1,211,295	
Total.....	158.97		\$4,913,760	45.18		\$451,800	46.36		\$174,680	158.97		\$637,795	\$47,630		\$6,230,665

WOLF LAKE HARBOR.

Since Indiana at present possesses but one harbor on the shore of Lake Michigan, namely, the one at Michigan City, the question of opening another at Wolf Lake, north of the city of Hammond, has been agitated for several years past.

Wolf Lake is located in the northwest corner of the State of Indiana and in the northeast corner of the State of Illinois, within 500 feet of Lake Michigan. It has an area of about five square miles and is from three to fourteen feet deep. It is surrounded and touched by ten great trunk lines of railway, viz.: Baltimore & Ohio; Lake Shore & Michigan Southern; Pennsylvania; Wabash; Chicago & West Michigan; Michigan Central; New York, Chicago & St. Louis; Chicago & Erie; Chicago, Indianapolis & Louisville, and the Pandhandle; and by five belt lines of railway, viz.: Lake Shore & Eastern; Chicago Belt Line; Chicago & Calumet Terminal; Elgin, Joliet & Eastern, and Chicago Terminal Transfer Company. These belt lines pass around the city of Chicago, crossing and connecting with the 24 great trunk lines terminating in that city. Two eight-inch pipe lines from the oil fields of Ohio and Indiana, through which is pumped crude oil for fuel and for refining in the largest oil refinery in the world, located at Whiting, just east of Wolf Lake; and two eight-inch pipe lines from the natural gas fields of Indiana also pass close to the borders of the proposed harbor.

The existing natural advantages for a harbor at Wolf Lake over those of the Chicago River and the Calumet River are many and have been summarized as follows:

First—The entrances to the Chicago and Calumet harbors are from the east; that of Wolf Lake would be from the north. The storms that wreck the vessels on the south coast of Lake Michigan are from the north. Only three years ago 23 vessels were wrecked in one storm on the shores of Lake Michigan, near Wolf Lake. Why they were unable to make the harbors at Chicago and Calumet can readily be seen. If there had been a harbor at Wolf Lake, such as is now proposed, it is believed that all of these vessels could have entered in safety. The same cause that wrecked so many vessels in this storm wrecks vessels there every year.

Second—The Chicago and Calumet rivers are narrow—200 feet wide and less—and must of necessity always remain so. A strip 300 feet wide from Lake Michigan to Wolf Lake has been dedicated to the government, and the riparian owners propose to donate all their right,

title and interest in and to so much of said lake as the government may wish, to make a commodious inland harbor for commercial and naval purposes.

Third—The Chicago and Calumet rivers are filling up from sewage and other causes from eight to twelve inches per year, as shown by the engineer's report, and are continually forming bars at the end of the jetties. Such continual filling requires a constant dredging, equal in amount to that required to dredge a new river the full length, width and depth of the proposed improvement, once in every 12 to 15 years. Wolf Lake has not filled one foot since Columbus discovered America. The sand on the bottom of this lake is as clean and bright as it was 400 years ago, and, once dredged, will ever remain so.

Fourth—It is conceded by all that the bridge and tunnel nuisance of Chicago adds 25 per cent. to freight, and what is true of Chicago is to a great extent true of the Calumet, and will continually grow worse. The people of Hammond, in common with all the great Northwest, have to bear this extra freight. Wolf Lake is not and never will be bridged or tunneled.

Fifth—Narrow rivers are poor harbors of refuge. They are broader at the entrance than at any other place, and as the waves converge they grow higher and more vile; hence Chicago is asking for outer harbors. Every one of theoretical or practical knowledge must know that outer harbors are of little value compared with inland harbors, and that they are maintained at an enormous expense. To the inland harbor at Wolf Lake the vessels could go for refuge, and, while the storm was raging upon the sea, they could load and unload their cargoes in safety.

Major Marshall, the engineer in charge, says that Wolf Lake must eventually be the terminus of the Lake Michigan and Mississippi waterway. All the country, including the Little and Grand Calumet rivers and the cluster of small lakes near the southern shore of Lake Michigan, is known locally as the Calumet region. Of it Major Marshall says: "Here the manufacturer recognizes a location after his own heart. Here, converged by lake, rail and pipe lines, are iron, lumber and copper from Michigan, bituminous coal from Illinois and Indiana, anthracite and coke from Pennsylvania, and crude oil and natural gas from Indiana. Here is a large resident laboring populace. Here is the market—the great Northwest—and here are shipping facilities unrivaled in the world. Here the car or vessel can be loaded and leave without delay on any of the 24 trunk lines of railroads, or the Great Lakes, direct for almost any point in the United States or Canada. The terminal facilities, access to Lake Michigan at numerous points

along the Calumet River and system of lakes connected therewith; the ample land-locked natural basin, needing only deepening by dredging for the construction of great wharves and derricks, will furnish a commodious harbor scarcely excelled in or on the Great Lakes. All these advantages point irresistibly to the Calumet region as a proper terminus of a great waterway between the Great Lakes and the Mississippi River."

Much work has already been done by private individuals which can be utilized towards the construction of a future harbor. A brief resumé of this work is as follows: 100 feet of inside work, well and substantially built, to prevent Lake Michigan from cutting behind the piers; a 600-foot pier, of the best quality of white oak, worth, according to the United States Engineer's report, \$18,000, built from the water's edge 600 feet out into Lake Michigan from the northwest side of the harbor; 375,000 cubic yards of dredging in Wolf River and Lake at a cost of over \$30,000. The interest of private individuals in the project keeps a dredge continually at work in Wolf Lake on the line of the proposed improvement. The sand dredged out of the proposed basin will be required to fill in around the margin of the lake outside of the dock line.

Such a harbor as is proposed would be of inestimable value to the people of Indiana as a whole. That the people outside of the immediate vicinity are interested in the project is evidenced by the fact that all the State officials, the Board of Trade of Indianapolis, and the entire delegation of Congressmen and Senators of the State, two years ago united with the people of Lake County in a petition to Congress for an appropriation. Congress appropriated \$8,000 towards the work, but as there had been no plans prepared by the War Department, the Engineer in charge refused to expend the money. The committee in charge succeeded in getting the extra session to re-appropriate the same sum in the Sundry Civil Bill, and the President vetoed the entire bill.

Among Indiana cities, Hammond at present ranks next to Indianapolis as a manufacturing center. The 967 factories which were reported to the State Statistician in 1896 showed an annual productive output of \$132,713,421. Of this sum the factories of Indianapolis contributed \$27,770,820; those of Hammond, not including Whiting or East Chicago, \$20,245,099, and those of Ft. Wayne, which ranked third, \$9,509,627. The population of Hammond, East Chicago and Whiting, the towns surrounding Wolf Lake, is about 40,000. Thirty-seven large industries, with an invested capital of more than twenty millions of dollars, are located in these three cities. These factories consume

annually more than 350,000 tons of fuel and ship more than three millions of tons of material. It is a well-known fact that transportation rates by water are less than one-third those by rail, yet, with the site for an excellent harbor within their very midst, the inhabitants and manufacturers of these cities must transport everything by rail. All these facts go to show that the harbor at Wolf Lake is practicable and needed. Every person in Indiana and the great Northwest who helps to pay the 25 per cent. additional freight made necessary by the defects of the other harbors at Chicago should use his energy in endeavoring to further the construction of a new Indiana harbor at Wolf Lake.

ARCHÆOLOGY.

Among the lakes, streams, prairies and dunes of the two counties the Red Man and his predecessor, the Mound Builder, found, for centuries, a dwelling-place congenial to their wants. There flesh and fur were plentiful. Fishes and mussels abounded in the streams and lakes. Wild fowl by myriads in their migrating seasons came and went, stopping to feed among the marshes. Buffalo, deer and grouse, in untold numbers, inhabited the prairies: while beaver, muskrat and otter crowded the overflowed basins of the Calumet and Kankakee. Nor was the food supply limited to flesh. Wild fruits—huckleberries, grapes, plums, cranberries, sand cherries and many others—flourished in profusion along the sand ridges. Wild rice grew by acres in the marshes, while acorns and the nut of the hazel and the hickory abounded in the groves.

Such an abundance and variety of food—ready for the taking—could but attract primitive man. The first white settlers found plentiful evidence of his former presence. On the “sand islands” and higher levels of the prairie and the marsh were his mounds and his burying grounds, and in places plots of cleared ground where had been his gardens and his fields. Many skeletons of Indians have been exhumed from the burying grounds. With them were usually found fragments of pottery, mussel shells, stone beads, flint arrowheads, bones of animals used as food, and, oftentimes, implements of iron. These remains denote that with the dead was buried food believed to be sufficient to last during the journey to the “happy hunting grounds.”

South of Orchard Grove, Lake County, on a sand island now owned by John Brown, of Crown Point, northeast quarter of section 21 (32

*Mounds
in Lake
County.*

north, 8 west), is the so-called Indian Battle Ground. When first noted by the whites a low breastwork or artificial ridge enclosed on two sides about three acres of ground. Within this enclosure were some 200 holes, each about three feet in diameter and four feet deep. They resembled individual rifle pits scooped in the sand. In 1897 the outlines of the ridge were still visible, and also many depressions where the pits had been. As to when and by whom the entrenchments were made, not even tradition furnishes a knowledge. Remains of similar breastworks and pits are said to exist on Oak Grove Island, section 16 (32 north, 9 west). Numerous skeletons have been found in the immediate vicinity of both entrenchments.

Several mounds are located about the shores of Cedar Lake. From one of these, on the north side of the lake, about twenty skeletons, some pieces of lead ore and some arrow points were taken in 1880. A bur-oak tree, six feet in circumference, and containing 200 rings of annual growth, grew on the mound above some of the human remains. The largest mound is on the west side of the lake. In 1837* its surface was 12 to 15 feet above the surrounding level, but is now much lower. So far as known it has never been explored.

On the farm of J. P. Spalding, south of Orchard Grove, northwest quarter of section 33 (33 north, 8 west), are the remains of two large mounds. They have been plowed over for almost sixty years, yet portions of human skeletons, arrowheads and pottery are still at intervals unearthed by the ever-leveling plowshare.

One mile south of Hobart, on the land of William Frank, southeast quarter of section 32 (36 north, 7 west), are the sites of four mounds which have been nearly leveled by cultivation. They have never been excavated, and only a part of a stone tomahawk and a few small flints have been found in the field in which they are located.

Just north of the mill at Woodvale, in a field annually overflowed by Deep River, is a large mound, in shape resembling a flat-iron. It is 190 feet in length by 75 feet in greatest width, and its surface is 22 feet above the level of the field in which it stands. Ball states† that in 1836 there was not a tree or shrub on its surface, but many oaks and other trees, some of which are 14 inches in diameter, now grow upon its crest. Although thought by most observers to be artificial, it is my opinion that it is a natural formation cut off from the surrounding highlands by the waters of Deep River. The artificial mounds of this region are always composed of clay, but the material

* Ball, Lake County, 1884, 333.

† Lake County, 1834—1872, 73.

thrown out by numerous woodchucks, 8 to 15 feet below its crest, shows this one to be composed largely of sand, which is the material underlying the surface clay in the highlands of the vicinity. Numerous other mounds are scattered here and there in Lake County, but, for the most part, they are small and but few of them have been systematically explored.

Among the private collections of prehistoric and other relics made in Lake County none excels that now owned by J. W. Youche, Jr., of Crown Point. It was mainly collected by W. W. Cheshire, now of Washington, D. C., while he was Clerk of the Court and County Superintendent of Lake County. It comprises several hundred stone axes, celts, hatchets, spearheads, pestles, mortars, hammers, gorgets, banner stones, etc., etc. Some fine spades, pipes, "shuttles" and chisels are also in the collection. Special mention can here be made of but six of the articles which are somewhat unique in character. First, a copper arrowhead (Fig. 1), $4\frac{3}{4}$ inches long by $1\frac{1}{4}$ inches wide, with three small notches on each side of the shaft. It was found in St. John's Township about five miles northwest of Crown Point. Second, a polished stone of whitish quartzite (Fig. 2), in shape and size somewhat like the half of an egg cut lengthwise. It has a spoon-shaped indentation on the flat side, and a lengthwise groove on the convex side. No description of such an article is found in any work on archæology at hand. It was found about five miles east of Crown Point, in Winfield Township. Third, a "shaft rubber" of fine sandstone (Fig. 3), six inches long, one-half inch thick and one inch wide, flat on both sides and edges and with a narrow groove running the full length of one side. It was found on the Kankakee Marsh, four miles southwest of Lowell. There was probably another part to correspond with the one in the collection, and the two were used in polishing the shafts of arrows. Fourth, a ceremonial stone (Fig. 4) made of compact reddish porphyry, very highly polished, double hatchet-shaped and with sharp edges. It was found in the northern part of Lake County. Fifth, a plummet or net sinker (Fig. 5), one and one-eighth inches in diameter, made of close-grained granite. It is smoothly polished and regular in shape, with a hole through one end for attachment, and was found in Lake County, near the Kankakee River. Sixth, a gorget (Fig. 6) made of fine-grained variegated slate, highly polished, and about three-sixteenths of an inch in thickness. One of its ends has 15 small notches cut in it, and it was probably used as a counting device. It was found near the central part of Lake County.

The last piece to be mentioned in this connection is more modern and is still in possession of Mr. Cheshire, who claims that "it is the



FIG. 1—i.

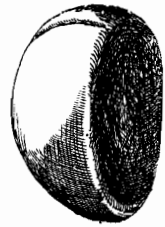


FIG. 2—i.

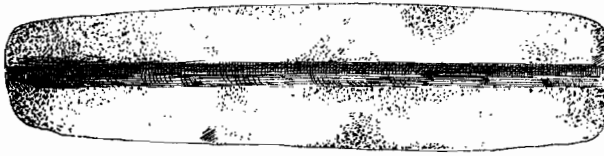


FIG. 3—i.

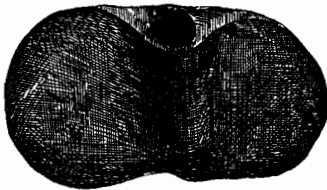


FIG. 4—i.



FIG. 5—i.

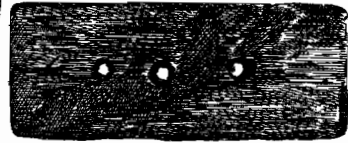


FIG. 6—i.

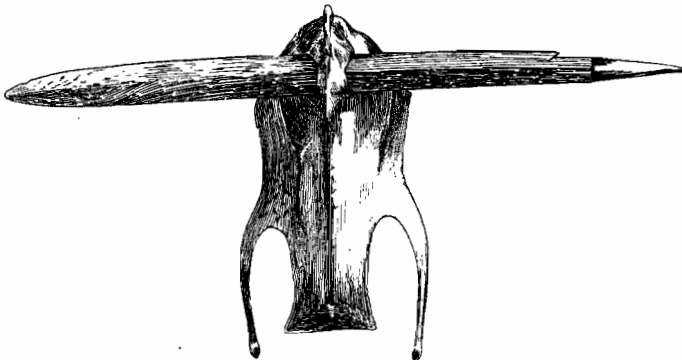


FIG. 7—i.

most unique specimen of its kind on earth." It consists of the breast-bone of a wild goose transfixed by a bone arrowhead (Fig. 7), 9 inches long, a half inch wide, slightly curved, and with four sides or faces. By request Mr. Cheshire kindly furnished the following information concerning it: "The goose was shot on the Kankakee Marsh south of Lowell, October 20, 1871, by H. N. Clement, a farmer living near the marsh. The very curious points about it are: (a) That the arrowhead should strike the keel of the breast-bone exactly in the middle; (b) that it should stop with its length exactly divided by the keel; (c) that the shaft to which it was evidently fastened should drop off when it struck the bone; (d) that a callous should grow around it, holding it fast; (e) that the goose should be fat and well after carrying it in that trans-fixed position. Prof. O. T. Mason, of the National Museum, says that no people of the world make such arrowheads except those of the Yukon Valley, Alaska; and he therefore concludes that the arrow was shot into the goose in that valley, remained there until it grew fast and the goose wore it as a breastpin down into Lake County, Indiana. The goose was going south when shot."

In the collection of Rev. T. H. Ball, of Crown Point, is a celt of hammered copper three and one-half inches long, one and one-half inches in greatest width and one-quarter of an inch thick. It was taken from a wolf's burrow just west of Cedar Lake. Nicholas Schutz, of Dyer, possesses a large collection made in that vicinity. In it are some fine "rolling pins" or cylindrical pestles and a small and very handsome granite pipe. Another collection of almost two thousand arrowheads, stone awls, banner stones, etc., is owned by Fred Black, of Hobart. A large number of these are from the Morrison Farm, near Liverpool, section 19 (36 north, 7 west), where a few years ago a cache containing numerous unfinished, as well as finished, flints was unearthed.

PORTER COUNTY has not been found to be as rich in prehistoric remains as has Lake. The High School at Valparaiso possesses a goodly collection, but the data pertaining to the specimens is mostly lacking, and a specimen without data loses more than half its value. On the farm of Hon. Nelson Barnard, section 24, Jackson Township, some fine specimens have been taken—among others a hammer of granite $4\frac{1}{2}$ by $3\frac{1}{2}$ inches in size, with a deep groove passing around the center. In the southeast corner of the county, on the farm of S. L. Stowell, section 2 (32 north, 5 west), a celt formed of diorite, finely polished and ten inches long, has been found; also a cache of more than a peck of flint arrowheads. Oliver Hoffman, of Boone Grove, has some fine specimens found in the vicinity of that town.

Dr. J. K. Blackstone, of Hebron, had also at one time a large collection from the south part of Porter County, but it has become scattered. In it was some pottery, taken from a mound on the Maxwell farm, south of Hebron, and a fine plummet from a point three miles south-west, near the Lake County line.

The mounds of Porter County are also much less numerous than those of Lake. Four miles east of Hebron, near Cornell Creek, section 9 (33 north, 6 west), one was excavated some years ago by Hon. G. C. Gregg, and a number of skeletons were found. The mound was composed wholly of black earth (muck?) which had been carried from the banks of the creek some ten rods distant.

The finest group of mounds in the two counties is located about one and a half miles a little north of east of Boone Grove, Porter County. At present eight are visible on an area of about 30 acres, but a number have probably been leveled by cultivation. Seven of the eight are in a piece of high wooded ground close to Wolf Creek. The one nearest the creek is the largest of those in the woods. It is 210 feet in circumference and its crest is 10 feet above the surrounding level. Growing on it are a number of black oak trees, one of which is 4.5 feet in circumference. A *second* mound is located 150 feet a little north of west. It is 170 feet in circumference and eight feet high, with a flatter top and fewer trees growing from it. One hundred yards to the northwest is the *third*, 180 feet in circumference and but four feet high, with a black oak 5.7 feet in girth growing from its side. These mounds are in the northwest quarter of section 34 (34 north, 6 west), the third being about 40 rods east of the section line. The *fourth* and *fifth* mounds are situated in the same quarter section, about six rods east of the section line and 1,000 feet south of the section corner. One is 175 feet in circumference and six feet high, the other 75 feet in circumference and four feet in height. Excavations were made in four* of the five mounds mentioned in October, 1897, but no skeletons or implements of any kind were found. Pieces of charcoal and ashes were quite common in three of them, and in the other several flakes of flint and a part of an arrowhead were secured. The *sixth* and *seventh* mounds are lower and about 100 feet in circumference. They are situated in the extreme southeastern corner of section 28 (34 north, 6 west), and have never, as far as known, been disturbed.

The largest mound of the group is located in a cultivated field in the northeast corner of section 33 (34 north, 6 west), 420 feet south

*No. 5, the larger of the two near the section line, was excavated by a party under my direction; Nos. 1, 2 and 4 by Supt. Wood of the Valparaiso schools, and a number of his pupils.

and 310 feet west of the corner of the four sections. It is 300 feet in circumference, 12 feet high, and almost a perfect sugar-loaf in form. The owner of the farm, Mr. John Wark, of Valparaiso, kindly gave his consent to the excavation of this mound, and on October 6 and 7, a ditch was dug three feet wide, 32 feet long, and, at the center of the mound, 14 feet in depth. The mound was found to be composed of a compact, yellowish clay, in which were a few scattered pebbles of small size. In the exact center and ten feet from the crest, the earth became darker, harder and more compact. Six inches lower was a layer of black organic matter, in which were the remains of a very badly decayed human skeleton. It lay in a reclining position with its head to the south. Only a few pieces of bone and 14 teeth were removed, the remainder crumbling to dust. The crowns of the teeth were hard and solid, but the fangs for the most part crumbled like the bone. No implements of any kind were found, though the excavations were extended four feet lower, and over an area 5x7 feet in the center of the mound.

In the original field notes of this locality, made by the United States Land Survey in 1834, the north and south line between sections 33 and 34 is said to pass over "a large artificial mound surrounded by a number of smaller ones," and a copy of the original plat now in the State Auditor's office shows this larger mound on the line, with nine smaller ones in a circle about it. As noted above, all the mounds are at some distance from the line, and if smaller ones surrounded the larger, as shown on the plat, they have long since been leveled by cultivation.

Who were the Mound Builders? Whence came they? Whither did they go? These questions are as yet unanswered, and probably ever will be. Their works and their implements show them to have practiced agriculture and to have been in many respects more civilized than their followers, and, perhaps, descendants, the Red Men. Their mounds are scattered throughout the Western States, in some places in great numbers. Some were erected for sacrificial purposes; some for signal or lookout stations—while more, perhaps, mark the burial places of their priests, their great warriors or their rulers. As we, by lifting heavenward a monument of granite or of bronze, pay tribute to the memory of our great men, so these primitive people built mounds of earth above their noted dead, giving to the chief or king the higher and more prominent.

NOTES ON THE FAUNA OF LAKE AND PORTER COUNTIES.

Each species of animal on earth has, in time, become adapted to a certain environment. If the elements of that environment be largely present in any prescribed area, the animal, or a closely allied form, may be sought for, even though its known center of distribution be in a far distant locality. The number and variety of animals inhabiting any limited area depends, therefore, upon the variety of its topography and the character of its soils. Possessing, as they do, lakes, rivers, swamps, upland woods, prairies and sand hills, Lake and Porter counties can but possess a large and varied fauna. To give anything like an accurate account of the fauna of such a region, one must reside therein for years. He must visit daily the haunts of the animals, note their coming and going, their food habits and their life histories. Passing, as I did, but hurriedly over the region, a few notes concerning such vertebrate forms as were seen, or those whose presence was deemed worthy of especial mention by the citizens of the counties, and all that can be given in this connection.

Many of the animals which once roamed over the area under consideration are now wholly extinct or are only represented by scattered individuals in the far West and North. Among the largest forms which inhabited this region at the close of the glacial period were the two American elephants, now extinct. The smaller of the two, known as the mammoth — *Elephas primigenius* Blum.—was over twice the bulk and weight of the modern elephant and nearly one-third taller. It occurred in numbers over all of Europe and over the northern part of North America. A number of specimens so well preserved that wolves and dogs fed

The Mammoth and the Mastodon.

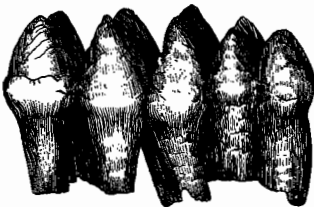


FIG. 8. Tooth of Mastodon.

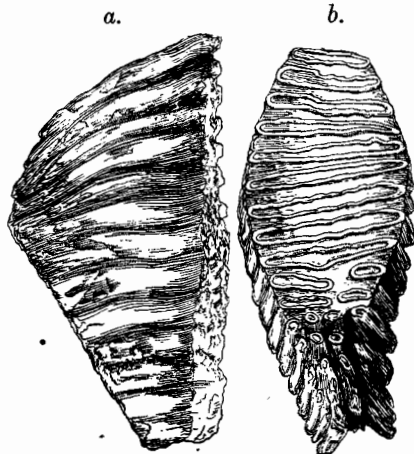


FIG. 9. Molar Tooth of Mammoth.
a, side view; b, grinding surface.

on their flesh have been found frozen in the ice in Siberia. From these it was learned that in life the skin of the animal was covered with a brownish wool and in parts with long hair. It was therefore enabled to withstand the severe cold of the northern regions.

The mastodon—*Mastodon americanus* L.—was of still larger size, being 12 to 13 feet high and, including the tusks, 24 to 25 feet in length. Its remains are readily distinguished from those of the mammoth by the teeth. The difference is shown in Figs. 8 and 9. These two great mammals roamed in separate herds over the prairies and along the margins of forests, lakes and streams, where they often became mired and perished in the bogs. It is on the site of former marshes that their remains are now mostly found. A skeleton of the mastodon unearthed in Iroquois County, Illinois, in 1880, had between the ribs a crushed mass of herbs and grasses, the remains of its last meal. These, on close examination, were found to be very similar to those now growing in that vicinity.

In Lake County an almost complete skeleton of a mammoth was found in a marsh on the head waters of Deep River, in the north half of section 35 (35 north, 9 west), about two miles east of St. John's. In Porter County remains of the mastodon have been found in the following localities: In the Kankakee Marsh, section 25 (33 north, 7 west), three miles southeast of Hebron; in a marsh by the side of Cobb's Creek, just east of Hebron; near Sandy Hook Creek, northwest of Kouts, and on the farm of Peter A. Bair, southwest quarter of section 27 (35 north, 6 west), two miles southwest of Valparaiso. In each case but a few teeth and one or two bones were exhumed while ditching, and no extensive search was made for the other portions of the skeleton. Close to the teeth found near Kouts were the antlers of a large elk which had perished in the same bog. Antlers of the same species have also been found in Lake County.

Buffalo and deer were once common in the two counties, but the finding of an occasional skull or pair of antlers are now the only evidence of their former presence.

The Opossum, *Didelphis virginiana* Shaw, though an animal of southern range, is occasionally taken in small numbers in both counties. A pair of porcupines, *Erethizon dorsatus* (L.), are in the State

Mammals. Museum from Laporte County, and though no definite record of its occurrence in Lake or Porter was secured, it doubtless belongs to their fauna. The muskrat, *Fiber zibethicus* (L.), is one of the most common mammals in the Kankakee and Calumet basins. According to Ball, from 20,000 to 40,000 a year were trapped in Lake County alone previous to 1884. Except in the marshes that

have been drained, their numbers do not appear to become appreciably less. The remains of dams thrown up by the beaver, *Castor fiber* L., are found in a number of localities in Lake County, but the animal itself had disappeared before the coming of the first settlers. The woodchuck, *Arctomys monax* (L.), is common among the upland wooded ridges, as is also the chipmunk, *Tamias striatus* (L.). The little striped gopher, *Spermophilus tridecemlineatus* (Mitchell), is common on the prairies and among the sand ridges. The gray gopher, *S. franklini* (Sabine), locally called the "prairie squirrel," was seen on several occasions along hedge rows on the borders of prairies, and one, which had already entered a state of hibernation, was captured, October 6, in the large mound excavated near Boone Grove, Porter County.

The fox squirrel, *Sciurus niger* L., is very scarce, but a few are said to reside in the upland woods in Jackson Township, Porter County. The gray squirrel, *S. carolinensis* Gmlin., and the little red squirrel or chickaree, *S. hudsonicus* Erx., are common in the timbered areas. Jet-black specimens of the first named are occasionally seen.

The otter, *Lutra hudsonica* (Lacpepe), was, in the early settlement, quite common, and a few are yet taken almost every Spring along the Kankakee. The skunk, *Mephitis mephitica* Cuvier, and the mink, *Putorius vison* (Schreber), are both rather common and both yield a considerable annual revenue to the professional trapper. The large gray timber wolf, *Canis lupis* L., once common, is still occasionally seen in the region of the Kankakee marshes, three having been killed by Oscar Dinwiddie in Eagle Creek Township, Lake County, in 1895.

About 16 additional species of mammals doubtless occur in the two counties, but the above constitute all which came to my notice or to which reference is made in my notes.

Mr. A. W. Butler, in his work on Indiana Birds in the present volume, has a number of notes pertaining to the birds of this region. For this reason no specific mention of those noted is given in this connection. Probably 225 or more species occur in the counties during a single year. Of these about 30 are *permanent residents*, i. e., reside in the region throughout the year. Common examples are the crow, blue-jay and quail. Probably 65 are *summer residents*, i. e., arrive from the South in the Spring, nest and rear their young, and depart southward again in Autumn. The orioles, catbird and chipping sparrow belong to this group. About 10 are *winter residents*, coming from the North in Autumn and departing northward in Spring, the snowbird and the tree sparrow being familiar examples. Eight or ten are *winter visitors*, such as the great white owl and the red cross-bill, which may or may not appear during the

coldest weather of the season. The remaining 110 are *migrants*; birds which regularly pass through the counties, northward bound in Spring and again southward bound in Autumn. The majority of the water fowl and warblers and a number of sparrows, thrushes and vireos are members of this class.

But few notes concerning the reptilian fauna were secured. The prairie rattlesnake still exists in small numbers; and probably 15 kinds of harmless snakes occur in the two counties. Among the sand dunes the six-lined lizard, *Cnemidophorus sexlineatus* (L.), was quite common. They scampered swiftly from one clump of grass to another; so swiftly, in fact, that a great deal of maneuvering was necessary to capture one with a butterfly net. This species has been heretofore considered rare in Indiana, having been recorded only from Knox and Monroe counties. The four varieties of lizard mentioned by Ball* were probably salamanders, since he states that they live in dark cellars. Ten or more species of this group probably occur in the counties. They can be readily told from lizards by their having the skin smooth instead of covered with scales. They also pass through a larval (tadpole) stage, while the lizard undergoes no such change. Sixty or more species of fish doubtless occur in the streams and lakes of the area.

NOTES ON THE FLORA OF LAKE AND PORTER COUNTIES.

While engaged in gathering data concerning the surface geology, notes were taken and specimens secured of a number of the scarcer and more characteristic plants of the two counties, especially those of the Calumet area, and the immediate margin of Lake Michigan. For the most part these notes pertain only to such plants as were in bloom in July and September, and to those whose distribution in Indiana is restricted to this region of the State. But little attention was given to the forms common to the entire State, as it is impossible for any one to gather data for anything like a complete flora of such an area, unless he is able to spend the greater part of several seasons in careful investigation.

The flora of the sand dune area is especially interesting and has been studied in the past by Rev. E. J. Hill, of Englewood, Ill., who has found there a number of species not elsewhere recorded from Indiana. Messrs. Higley and Raddin, in their "Flora of Cook County, Illinois, and a part of Lake County, Indiana,"† have published the results of much of Mr. Hill's work, as has also Stanley Coulter in the Proceedings of the Indiana Academy of Science for 1895.

* Lake County, 1883, 155.

† Bull. Chic. Acad. Sci., II, No. 1, 1891. This paper included the flora of that portion of Lake County lying north of the Little Calumet River. Reference to the paper in these notes will be by the initials H. & R.

A person interested in botany, and living in easy reaching distance of this area, could render a valuable aid to science by preparing a special paper, based on a number of years of observation on the variations, habitat and insect visitors of the different species of plants growing on the sand covered area along the south shore of Lake Michigan.

The nomenclature and order of the following list is that of Gray's Manual of Botany, sixth edition.

ANNOTATED LIST OF PLANTS.

Ranunculus pennsylvanicus L. f. Bristly Crowfoot.

Frequent along the borders of a marsh near Tolleston. July 29. Has been noted only in the northwestern part of the State.

Coptis trifolia Salisb. Goldthread.

Borders of a marsh near Calumet River, northwest of Miller's. In fruit. Recorded from Berry Lake and Pine Station by H. & R., and from the "Knobs" in the "Catalogue of the Plants of Indiana."

Asimina triloba Dunal. Common Pawpaw.

The pawpaw was noted as frequent in several wooded tracks in Jackson Township, Porter County, but not elsewhere in the area. It is not mentioned by H. & R., being partial to open woods in rich soil and not growing in sandy soil nor in prairie regions.

Sarracenia purpurea L. Pitcher Plant. Side-saddle Flower.

Common in a peat bog on the Hayward farm, one mile east of Merrillville, Lake County. This bog is noteworthy from the fact that a thicket of white pines (*Pinus strobus* L.) surrounds it, instead of the tamarack (*Larix americana*), which one would expect.

Cakile americana Nutt. American Sea-Rocket.

North of Miller's and Dune Park in the bare sand, within 200 yards of the lake margin. Often the only herb present on the areas in which it grows.

Hudsonia tomentosa Nutt. Woolly Hudsonia. Poverty Grass. False Heather.

Sand ridges north of Dune Park. Recorded by H. & R. from Pine Station, Miller's and along the ridge from Tolleston to Miller's. Grows in low, densely matted tufts. The leaves are closely appressed, and in late summer or autumn the plant resembles a dwarfed evergreen.

Lechea major Michx. Hairy Pin-weed.

Sandy margin of marsh near Tolleston. July 29. Known in the State only from Lake and St. Joseph counties.

Lechea minor L. Thyme-leaved Pin-weed.

Border of marsh north of Dune Park, September 7.

Hypericum prolificum L. Shrubby St. John's-wort.

Abundant along borders of swamps east of Whiting, within one-fourth mile of lake front. In flowering prime July 27.

Vitis labrusca L. Northern Fox Grape.

Frequent on the sandy, wooded "islands" of the Kankakee valley.

Vitis rupestris Scheele Sand Grape. Sugar Grape.

Grows abundantly on the top and sides of the highest sand ridges near Miller's and Dune Park. A southern form not before recorded from Indiana, the manual range being "Mo. to Tex., Tenn. and southern Penn." The fruit is larger and in more compact, rounded bunches than either that of the frost grape, *V. cordifolia* Michx., or the summer grape, *V. aestivalis* Michx. The leaves are also smaller and the vine spreads over the ground or low bushes, instead of climbing high, even where trees or tall shrubs are present.

Rhus typhina L. Staghorn Sumach.

Sides of sand ridges north of Miller's; scarce. Before recorded from Gibson and Posey counties.

Rhus copallina L. Dwarf Sumach.

Borders of marsh north of Tolleston. This form is probably more widely distributed through the State than the above, though neither is anywhere near so common as *R. glabra* L.

Rhus canadensis Marsh. Fragrant Sumach.

Grows in dense clumps along the lake shore, 100 yards or more from the margin of the water, east of Whiting to Brimson, near Miller's, etc. Much smaller and less spreading than on the rocky hillsides of Monroe and Crawford counties. For its distribution in the State see Proc. Ind. Acad. Sci., 1896, 137.

Polygala cruciata L. Marsh Milkwort.

Common along the borders of marshes north of Dune Park. Recorded also by H. & R. from near Hammond. The flowers vary from purple to pure white.

Baptisia leucantha Torr. & Gray. White False-Indigo.

Prairies and borders of copses; common throughout the central region of both counties.

Lupinus perennis L. Wild Lupine.

Crests of high wooded sand dunes, northeast of Miller's. In fruit July 28.

Amorpha canescens Nutt. Lead Plant.

Road sides in prairie regions; common.

Petalostemon violaceus Michx. Violet Prairie Clover.

Prairies and sand dunes; frequent.

Tephrosia virginiana Pers. Goats-Rue. Catgut.

Dry sandy hillsides; common in Calumet region north of Miller's, etc.

Lespedeza capitata Michx. Round-headed Bush Clover.

Low sandy soil north of Dune Park; frequent.

Lathyrus maritimus Bigelow. Beach Pea.

Sands along the beach of Lake Michigan, east of Whiting; frequent.
In flower and fruit July 27.

Prunus americana Marshall. Wild Plum.

Common on the beaches of old Lake Chicago and on the sand islands of the Kankakee valley.

Prunus pumila L. Dwarf Cherry. Sand Cherry.

Common in clumps along the sand ridges 100 feet or more from the water margin of Lake Michigan and extending back one-fourth of a mile or more. The fruit is very abundant, and when fully ripe is quite palatable, much more so than that of the next two species. Specimens bearing fruit vary in height from two to six feet.

Prunus pennsylvanica L. f. Wild Red Cherry.

A tall shrub or small tree which occurs sparingly along the sand ridges near Brimson and north of Miller's.

Prunus virginiana L. Choke Cherry.

Rather frequent along the sandy margins of swamps near Tolleston, etc.

Spiraea salicifolia L. Meadow Sweet.

Common in low, damp prairies.

Spiraea tomentosa L. Hardhack. Steeple-bush.

With the above, but much less common.

Physocarpus opulifolius Maxim. Nine-bark.

Swampy woods and banks of streams; frequent north of Miller's, Pine Station, etc.

Potentilla fruticosa L. Shrubby Cinquefoil.

A single clump, one mile east of Whiting in sandy soil, 100 yards from lake shore.

Pyrus arbutifolia melanocarpa Michx. Black Chokeberry.

Margin of swamp near Tolleston. Leaves larger, smoother beneath, and more rounded than in the typical form. Not before recorded from the State.

Parnassia caroliniana Michx. Grass of Parnassus.

Low moist grassy places; frequent.*

* For range in State see Proc. Ind. Acad. Sci., 1896, 136.

Ribes floridum L'Her. Wild Black Currant.

Frequent on a sandy wooded "island" in the S. E. part of Lake County. Not before recorded in the State north of Jefferson County.

Hamamelis virginiana L. Witch Hazel.

On sides of wooded sand dunes northeast of Miller's; scarce.

Lythrum alatum Pursh. Loosestrife.

Low damp prairies and marshes; frequent north of the Calumet.

Ludwigia polycarpa Short and Peter. False Loosestrife.

Abundant in swales near Tolleston. Before recorded from "Knobs," and Gibson and Vigo counties.

Opuntia rafinesquii Engelm. Prickly Pear Cactus.

Common on the low sand ridges of the Calumet region, growing where nothing else will. Flowers large and handsome.

Eryngium yuccifolium Michx. Rattlesnake Master. Button Snake-root.

Borders of damp prairies and roadsides; frequent south of the Calumet in both counties.

Nyssa sylvatica Marsh. Black Gum. Sour Gum. Pepperidge.

Sand ridges and islands; also on north margin of Cedar Lake; frequent.

Mikania scandens Willd. Climbing Hemp-weed.

Found in abundance covering the button-bush (*Cephalanthus occidentalis* L.) and other shrubs growing in the low ground 50 feet south of the wagon bridge across Sandy Hook Creek, five miles east of Hebron, Porter County, September 21. Before recorded in Indiana only from Gibson County. Manual range—"E. New Eng. to Ky. and southward."

Liatris scariosa Willd. Button Snakeroot.

Sand ridges near Dune Park; frequent.

Liatris spicata Willd. Blazing Star.

Margin of marshes and damp prairies; frequent.

Solidago ohioensis Riddell. Ohio Golden-rod.

Border of marsh near Dune Park, September 7. Known in the State only from Tippecanoe and Lake counties.

Aster novæ-angliæ L. New England Aster.

Common along roadsides in the central and southern portions of the two counties. One of the largest and most handsome of the asters, its numerous violet-purple rays quickly attracting the attention and admiration of the observer.

Aster sericeus Vent. Silky Aster.

Low sandy soil north of Dune Park; scarce. Not mentioned in the

State Catalogue, and, as far as known, not before definitely recorded from the State, though H. and R. mention it as frequent, without accrediting it to Indiana. Heads large and showy.

Aster polyphyllus Willd.

Borders of marshes north of Dune Park; scarce. Recorded from near Whiting by Coulter, loc. cit. p. 190.

Aster linariifolius L. Double-bristled Aster.

Sandy ridges north of Miller's and Dune Park. Readily known by the shortness of the stems, which grow in clumps from a woody base, and by the rigid linear leaves and showy heads.

Silphium laciniatum L. Rosin-weed. Compass-plant.

A typical prairie plant, yet common along the roadsides and on the upland prairies, especially in Lake County. The large, vertical and pinnately parted, radical leaves resemble somewhat those of the sensitive fern, *Onoclea sensibilis* L. The upland prairie hay formerly contained large numbers of these plants, which served the buyer in distinguishing it from the lowland hay. The former was considered the more valuable, and it is said that some farmers were in the habit of harvesting the compass-plants and afterwards mixing them with the lowland hay in order that it might be mistaken for that from the upland, and so bring a higher price.

Silphium terebinthinaceum L. Prairie Dock.

In similar localities, but more common than the last species, and readily distinguished by its large, undivided root leaves.

Silphium perfoliatum L. Cup Plant.

Sides of ditch near Dyer, Lake County. Not noted elsewhere.

Lepachys pinnata Torr. & Gray.

Roadsides and margins of prairies in Lake County; scarce. Leaves very rough.

Helianthus occidentalis Riddell.

Rather common in dry upland prairies and along sandy ridges.

Artemisia caudata Michx. Wormwood.

Side of sand ridge north of Dune Park; scarce. September 9. For the only previous State record of this and the next species, see Proc. Ind. Acad. Sci., 1895, p. 191.

Artemisia canadensis Michx. Hoary Wormwood.

North of Miller's at foot of sand ridge; scarce. September 8.

Oniscus pitcheri Torr. Pitcher's Thistle.

Sides of the highest sand ridges and dunes north of Miller's. In fruit, July 27. Known in the State only from Lake County.

Oniscus arvensis Hoffm. Canada Thistle.

This well known pest has undoubtedly gotten a foothold in northern Indiana, which will be troublesome to overcome. Numerous large patches were seen along the railways of the Calumet region, and a half acre or more flourished undisturbed near the center of the city of Hammond. Isolated specimens were also noted near Cedar Lake and other localities. It may be readily distinguished by its numerous small heads, which are less than half the size of those of the common thistle; also by its slender stem and upright flowering branches. It is seldom more than eighteen inches in height.

Lobelia kalmii L. Kalm's Lobelia.

Margin of low grassy pond north of Miller's, July 27. Frequent.

Campanula aparinoides Pursh. Marsh Bellflower.

Wet, grassy meadows; common. This and the preceding species occur, as far as known, only in the northern third of the State.

Gaylussacia resinosa Torr. & Gray. Black Huckleberry.

Common in the sandy soil along the borders of marshes in the Calumet region, especially in Lake County.

Vaccinium pennsylvanicum Lam. Dwarf Blueberry.

Common on the sand ridges and dunes in the northern third of both counties.

Vaccinium vacillans Solander. Low Blueberry.

Dry, sandy hills north of Miller's; scarce.

Vaccinium corymbosum L. Swamp or High Blueberry.

Margin of marshes in the Calumet region; common. Grows to a height of six to eight feet, and produces the blue huckleberry of the latter part of the season.

Vaccinium macrocarpon Ait. American Cranberry.

Noted growing wild only in the peat bog one mile east of Merriville, though doubtless occurs in numerous places in the swampy area of the Calumet region, which is well adapted to its cultivation. Much of the waste land of this area could be profitably put to that use.

Arctostaphylos uva-ursi Spreng. Red Bear-berry.

Sides of sand ridges within 100 feet of the lake shore east of Whiting and north of Miller's. In fruit July 28. Occurs only in the counties bordering on Lake Michigan.

Gaultheria procumbens L. Creeping Wintergreen. Checkerberry.

Abundant around the borders of a marsh northeast of Tolleston; also sparingly near Dune Park. It has also been taken by the writer at the Pine Hills, Montgomery County, but does not occur in Monroe County, as stated in the catalogue of Indiana plants.

Cassandra calyculata Don. Leather Leaf.

Margins of swamps east of Whiting, north of Miller's and near Dune Park; frequent. Occurs also abundantly in the tamarack swamps near DeLong, Marshall County.

Chimaphila umbellata Nutt. Prince's Pine. Pipsissewa.

High wooded sand dunes northeast of Miller's; scarce. In fruit July 28.

Asclepias verticillata L. Whorled Milkweed.

Sand ridges near the railways east of Whiting; frequent.

Acerates viridiflora Ell. Green Milkweed.

With the above, but scarce. In flower July 27.

Sabbatia angularis Pursh. Bitter-bloom. Rose pink.

Common about the margins of low, grassy meadows. One of the most handsome of our midsummer wild flowers. Occurs probably throughout the State.

Gentiana crinita Froel. Fringed Blue Gentian.

Borders of marshes north of Miller's and Dune Park. September 8 and 9. Occurs in suitable localities throughout the northern half of the State.

Veronica scutellata L. Marsh Speedwell.

Slough north of Tolleston; July 29; scarce. Recorded only from Steuben and Noble counties.

Gerardia purpurea L. Purple Gerardia.

Abundant in low, damp meadows, both in the Calumet region and the Kankakee Valley.

Pedicularis lanceolata Michx. Lanceolate-leaved Lousewort.

Borders of marshes north of Dune Park; scarce.

Utricularia vulgaris L. Greater Bladderwort.

Scarce in marshes north of Miller's, between the Calumet and the Lake Shore; July 28.

Utricularia cornuta Michx. Bladderwort.

With the above but much more frequent; also Sep. 8. *U. gibba* L.; *purpurea* Walt., and *resupinata* Greene, are also recorded from near Miller's in the H. & R. list, but no specimens were seen during my visit to that locality.

Monarda punctata L. Horse Mint.

This is one of the prevailing plants in all the sandy region north of the Kankakee, being as common in the streets and on the sandy ridges as is the dog fennel, *Anthemis cotula* DC., in the central part of the State.

Cycloloma platyphyllum Moquin. Winged Pigweed.

Sandy shore of Lake Michigan, east of Whiting and north of Dune Park; frequent. The first record for the State.

Salsola kali tragus L. Saltwort. Russian Thistle.

Found sparingly in loose sand within 100 yards of the margin of the lake, between Whiting and Dune Park. Is liable to spread and prove a very troublesome weed.

Euphorbia corollata L. Flowering Spurge. White Spurge.

One of the most common and characteristic plants of the sand covered area of the two counties. Noted here only because of its abundance.

Myrica asplenifolia Endl. Sweet Fern.

Noted just west of the station of Highland, where it was common in the sandy soil on the south slope of Calumet Beach. Recorded from Miller's by Coulter—Proc. Ind. Acad. Sci., 1895, 195. These are the only two records for the State.

Betula populifolia Ait. White Birch.

Sand ridges west of Miller's; scarce.

Betula papyrifera Marshall. Paper or Canoe Birch.

More frequent than the above. Not found more than three miles back from the lake, and not noted in Porter County. Most of the trees close to the lake have been killed by fire.

Betula nigra L. River or Red Birch.

Common along the banks of the Kankakee. Recorded in the Catalogue of Indiana Plants only from Gibson County, but has been noted by the writer in Martin, Vigo, Owen, Jackson, Putnam, Marion and Lake, so that it probably occurs throughout the western two-thirds of the State.

Betula pumila L. Dwarf Birch.

Borders of swamps north of Tolleston; common.

Alnus incana Willd. Speckled or Hoary Alder.

Banks of Calumet north of Miller's; frequent. Known in the State only from Lake County.

Salix glaucophylla Bebb. Broad-leaved Willow.

Sand ridges near the Calumet, north of Miller's; frequent.

Pinus banksiana Lambert. Gray or Northern Scrub Pine.

Sand dunes and ridges within three miles of the lake shore, between Whiting and Michigan City; common. Specimens 40 to 60 feet high were plentiful.

Juniperus communis alpina Gaud. Low Juniper.

This form is recognized by Britton & Brown* as a distinct species under the name of *Juniperus nana* Willd. It occurs sparingly north of Miller's on the sand ridges, forming dense circular masses six to ten feet

* Illustrated Flora, I., p. 60.

in diameter, with the individual stems about two feet high and recurving or depressed. The leaves are shorter and more numerous and the berries larger than those of the common *J. communis*. The latter is widely distributed over the State, while the one under consideration is a northern and eastern form not before recorded from within its bounds.

Spiranthes cernua Richard. Ladies Tresses. Screw Stem.

Borders of low damp meadows; frequent in the Calumet region.

Habenaria ciliaris R. Br. Yellow Fringed Orchis.

Frequent about the borders of a marsh northeast of Tolleston, July 29. In a paper entitled the "Distribution of the Orchidaceæ in Indiana,"* Miss A. M. Cunningham gives the known State records of this species as St. Joseph, Noble and Steuben counties. I have found it in numbers also at DeLong, Marshall County.

On account of the lateness of the season the above were the only two orchids seen by me in the counties, though H. & R. record *Liparis læselii* Rich., *Aplectrum hyemale* Nutt., *Corallorhiza innata* R. Br., *C. multiflora* Nutt., *Goodyera pubescens* R. Br., *Arethusa bulbosa* L., *Pogonia pendula* Lindl., *Habenaria tridentata* Hook., *H. virescens* Spreng., *H. bracteata* R. Br., *H. hyperborea* R. Br., *H. hookeri* Torr., *H. lacera* R. Br., *H. psycodes* Gray, and *Cypripedium spectabile* Swartz, from definite localities in Lake County, besides mentioning ten additional species as being found southeast of Chicago, in the territory covered by their list, without giving localities.

Aletris farinosa L. Colic Root. Star Grass.

Sandy soil near border of marsh north of Tolleston; scarce.

Smilacina stellata Desf. Star Flowered Solomon's Seal.

Very common on the "sand islands" of the Kankakee Valley, and the barrens of the Calumet region. I have never met this species in central or southern Indiana, though I have studied the plants of those regions for ten or more years.

Lilium philadelphicum L. Wild Orange-red Lily.

Borders of prairies; scarce. One specimen north of Cedar Lake, July 11.

Tofieldia glutinosa Willd. False Asphodel.

Margin of a swale, north of Miller's; July 28; scarce. Known in the State only from Lake, Fulton and Noble counties.

Commelina virginica L. Virginia Day-flower.

Frequent on the side of wooded sandy hills, northeast of Miller's.

Triglochin maritima L. Arrow Grass.

Shallow water of marshes north of Miller's; frequent, July 28. Recorded before in Indiana only from near East Chicago.

* Proc. Ind. Acad. Sci., 1895, 201.

Cyperus filiculmis Vahl. Slender Cyperus.

Side of sand hills at Dune Park; frequent. Known in the State only from Lake and Porter counties.

Cyperus houghtoni Torr. Houghton's Cyperus.

Side of sand ridge near Tolleston, July 29. The first record for the State, the manual range being "Mass. to Minn., Kans. and Oregon." A handsome species with the plumes two feet or more tall, the spikes numerous and densely flowered.

Panicum autumnale Boec. Diffuse Panicum.

Frequent along sides of the sand ridges in the Calumet region. Grows in dense tufts. The panicle much branched and spreading, and of a handsome purplish tinge. Recorded only from Lake and Vigo counties, but has been noted, by the writer, also in Jasper and Starke.

Zizania aquatica L. Indian Rice. Wild Rice.

Shallow water of marsh north of Miller's; scarce.

Ammophila arundinacea Host Sand-Reed.

Frequent on crests of the higher sand ridges and dunes all along the lake shore. The spike-like panicle eight to twelve inches in length and quite handsome.

Phragmites communis Trin. Reed.

One of the tallest members of the grass family, sometimes reaching a height of eighteen feet. Grows in dense isolated patches in the sloughs and swamps of the Calumet and Kankakee regions.

* * *

The 103 species above recorded comprise probably less than one-tenth of the flowering plants of the two counties, being only such as were especially noted or collected as I passed hurriedly from place to place. Higley and Raddin give definite localities for about 400 additional species in Lake County, many of which occur nowhere else in Indiana.

There is no better place for an extended botanical study of a limited area in the State than among the dunes, swamps, peat bogs, prairies and river bottoms of this area, and it is to be hoped that some one with leisure and ability will, before it is further modified by man, make a complete and permanent record of its flora.

ELEVATIONS.

A list of elevations of a number of points in the two counties is here given. It has been compiled from the following sources:

Gannett's Dictionary of Altitudes; Campbell's Survey of the Kankakee Region; data furnished by Henry Rankin, Ex-County Surveyor of Porter County; by Geo. Fisher, County Surveyor of Lake County, and by Frank Leverett.* The initials "G.," "C.," "R.," "F." and "L." after the location refer, respectively, to the authority cited.

ALTITUDES IN LAKE COUNTY.

Creston, railway—L.....	740	feet.
Crown Point, C. & E. Railway—G.....	702	feet.
Crown Point, Court House yard—F.....	714	feet.
Crown Point, Panhandle Railway at station—F.....	695	feet.
Dyer, M. C. Railway—G.....	638	feet.
Fancher Lake, surface of water August, 1896—F.....	713	feet.
Griffith, railway crossing—G.....	636	feet.
Hammond, M. C. Railway—G.....	595	feet.
Hammond, Nickle Plate Railway—G.....	598	feet.
Hessville, railway—G.....	623	feet.
Highland, railway—G.....	617	feet.
Hobart, P. F. W. & C. Railway—L.....	622	feet.
Kankakee River, old mouth of Eagle Creek—L.....	†660	feet.
Kankakee River, surface of water at Monon Railway bridge		
—C.....	635.7	feet.
Kankakee River, surface of water at State Line—C.....	624.3	feet.
Lake Michigan, mean surface level—G.....	†582	feet.
Leroy, railway—L.....	683	feet.
Little Calumet Marsh, sections 16 and 21 (36 north, 9 west)—L.....	595	feet.
Liverpool, M. C. Railway—G.....	627	feet.
Lowell, railway—L.....	690	feet.
Miller's, L. S. & M. S. Railway—G.....	625	feet.
Palmer, railway—L.....	733	feet.
Ross, M. C. Railway—G.....	638	feet.
Schererville, railway—L.....	644	feet.
Shelby, railway crossing—C.....	642	feet.
St. Johns, railway—L.....	697	feet.
Watershed, near head waters of Eagle Creek and Deep River—L.....	747	feet.

* In sending his data Mr. Leverett wrote as follows: "I send some elevations which I obtained from Mr. Gannett last winter, some of which I do not think appear in his Dictionary of Altitudes. Some are slightly different from the altitudes given in his Dictionary because of a revision which he has made in the light of fuller data. I have also inserted a few aneroid determinations which I made in Porter County. To these I have affixed the + sign."

† This level is from the report of the U. S. Deep Waterways Commission, below cited.

‡ The standard low water elevation of Lake Michigan as given by the U. S. Deep Waterways Commission for 1896 is 579.66 feet, and the high water elevation is 584.34 feet.

ALTITUDES IN PORTER COUNTY.

Chesterton, L. S. Railway—L.....	659	feet.
Chesterton, L. S. Railway—R.....	670	feet.
Coburg, B. & O. Railway—G.....	786	feet.
Coburg, B. & O. Railway, at summit—G.....	795	feet.
Crest of Moraine in section 35 (36 north, 6 west)—L.....	825 +	feet.
Crest of Moraine in section 11 (35 north, 6 west)—L.....	840 +	feet.
Crissman, railway crossing—L.....	645	feet.
Flint Lake, surface of water—R.....	825	feet.
Furnessville, railway—L.....	670	feet.
Gossett's Mill Pond, south end; northwest quarter of section 28 (36 north, 6 west)—L.....	620 +	feet.
Hebron, Panhandle Railway—L.....	713	feet.
Kankakee River, Dunn's bridge, surface of water—O.....	663.7	feet.
Kankakee River, Grand Junction, surface of water—C.....	660.5	feet.
Kankakee River, Baum's bridge, surface of water—C.....	659.4	feet.
Kouts, railway crossing—L.....	687	feet.
Liberty Township, east line, point of crossing B. & O Railway —L.....	687	feet.
Morgan Prairie, northwest quarter of section 36 (35 north, 5 west)—L.....	758	feet.
Old shore of Lake Chicago Bay, west of Wheeler, northeast quarter of section 3 (35 north, 7 west)—L.....	640 +	feet.
Old shore of Lake Chicago Bay, southeast quarter of section 28 (36 north, 6 west)—L.....	650 +	feet.
Porter, M. C. Railway—R.....	668	feet.
Salt Creek, crossing of P. F. W. & C. Railway bridge—L.....	650 +	feet.
Sandy Hook Creek, crossing of Panhandle Railway—L.....	673	feet.
Summit, near center of section 30 (36 north, 5 west)—R.....	888	feet.
Valparaiso, G. T. Railway—R.....	820	feet.
Valparaiso Court House yard—R.....	803	feet.
Valparaiso P. F. W. & C. Railway Station—L.....	736	feet.
Wheeler, P. F. W. & C. Railway—L.....	665	feet.
Woodville, B. & O. Railway—R.....	721	feet.

* * *

In the preparation of the foregoing paper on the Geology of Lake and Porter counties, I have been aided by a number of persons to whom acknowledgments are due. To Mr. Frank Leverett, of Denmark, Iowa, I am under special obligations for the use of notes pertaining to the physiography of the Calumet region—and for data used in the preparation of the accompanying map. Rev. T. H. Ball and Hon. J. W. Youche, of Crown Point; Mr. A. F. Knotts, of Hammond, and Mr. Henry Rankin, of Valparaiso, also furnished me much data; while Mr. Rankin, Herbert Ball of Crown Point, Hon. Jerome Dinwiddie of Hebron, Hon. Geo. C. Gregg of Hobart and E. L. and Hon. L. G. Furness of Furnessville accompanied me for a portion of the time during my researches throughout the area, and aided me in securing much data which might otherwise have escaped my attention.