
GEOLOGY OF SAC AND IDA COUNTIES.

BY

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INTRODUCTION.

LOCATION AND AREA.

The two counties which form the basis of the present sketch are situate in the northwestern part of Iowa. They are separated from the north line of the state by the width of three counties, and from the western border by the length of one, Woodbury. Cherokee and Buena Vista counties lie immediately north, Calhoun on the east, Crawford and Carroll on the south. They are prairie counties, yet, as we shall see, not wholly without native forest, with the general topography of the state at large, yet possessed of features of peculiar interest, like all the counties round about, yet offering problems not a few to the thoughtful student, and affording in all that makes for surface description or definition, a physiognomy at once unique and full of interest.

PREVIOUS GEOLOGICAL WORK.

For such reasons, doubtless, these two counties received, thirty years ago, at the hands of our pioneer geologist, Dr. White, more than usual attention. Geological views have changed somewhat since his day, chiefly in the direction of the more exact delimitation of the superficial strata, but in geography and topography the descriptions in White's Report, here written by Mr. O. H. St. John, leave little to be desired.*

Dr. White also investigated very carefully and satisfactorily all the more important lakes of Iowa and give a good account of them.†

His explanation of the so-called "walled lakes", one of which occurs within our present limits, is very clear and he seems to have been the first to refer the accumulation of debris, gravel, bowlders, etc., in ridges around the borders of shallow lakes to its proper cause, namely the shoving of the expanding ice, winter after winter, acting upon the gently sloping shores. He even gives us a figure illustrating this.‡

*Report of the Geological Survey of the State of Iowa, by Charles A. White, M. D.
1870: Vol. 2, pp. 150-164
†Op. cit. Vol. 1, pp. 70-78
‡Op. cit. Vol. 1, p. 77.

Dr. Wilder has also discussed, more in the light of present knowledge, the same "walled" lake, and gives account of its relation to surrounding topography, in the proceedings of the Iowa Academy of Science.*

PHYSIOGRAPHY.

TOPOGRAPHY.

The topography of these counties, thus lying side by side in the midst of the northwestern Iowa prairie, is far from uniform. As already hinted it is everywhere suggestively diverse. The farmers of the region have long since distinguished between east and west Sac, for instance, and the hills and valley-lands of Ida. This diversity is referable, of course, to the recent geologic history of the whole northwest and simply finds in our present area a more conspicuous illustration.

If one begins with Ida county he finds a land of high prairie fields perfectly drained in almost every township by a divergent and far-spreading drainage system, from broad, ample valleys worked back and up almost to the last section. It is accordingly true that some of the highest land in the county is the flattest. The prairies about Holstein are in many places almost level, yet, as anyone who consults the map may easily see, not far removed from the sources of streams flowing north, south, east and west. A study of Griggs township and its topography affords a key to the whole drainage situation of this and several adjoining counties north and west. The Battle creek valley is a beautiful region with gentle slopes on every side, a comparatively broad flood-plain widening to meet that of the Maple. Perhaps the fairest view of a typical erosion system may be had from the cemetery hill in section 22 of Battle township: from this point the valley of the west fork of Battle creek stretches to the southeast on a summer day in unrivalled beauty; the flowing outlines blending; no flood-plain; simply a winding valley the sloping sides now covered with farms, groves and lines of cottonwoods, with meadows, fields of corn and wide spread crops of whitening grain. Below the United Presbyterian church, Battle township, the valley widens, and the creek winds about in alluvial soil.

*Iowa Academy of Science, Proceedings, vol. 7. p. 77.

The valley of the Maple shows similar characteristics, especially in its tributaries. The Maple river crosses Ida county almost diagonally from northeast to southwest and on its way cuts through an old time plateau or ridge that trends in a direction almost at right angles to the course of the stream. Holstein occupies the crest of the plateau, but high hills representing the remains of the ridge may be traced southeastward through Logan and Blaine townships, through Richland, Wheeler, Levey and Viola townships of Sac county and on into Carroll county. Where the river cuts this old divide the hills are more precipitous and the valley narrows. This is especially noticeable above the mouth of Silver creek; but from this on southwest we have a distinct flood plain from one-half mile to a mile in width, in which the present stream winds back and forth, sometimes with considerable deposits of sand, as at the old town of Ida Grove and west. Here the river has cut down pretty well to base-level and Ida Grove is more than two hundred feet lower than Holstein.

South of Ida Grove is another divide, where the valley of Maple river is separated from that of Soldier river. Here again we have a characteristic erosional topography. There is probably not an acre not directly connected with the general drainage system. From the tops of the hills south of Ida Grove and the Maple valley one can see nearly the whole county. Along the south the valley of Soldier river stretches from east to west; northward and westward are the valleys of Battle creek and the lower valley of the Maple; northeast lies the valley of the Maple river proper with that of its principal tributary, Odebolt creek.

From the hills in Logan township one can see all of Galva and Silver Creek townships; from the church hill in Griggs township the valley of the Little Sioux is plainly seen and the trains of the Illinois Central railway that move up and down from Cherokee; from two or three selected points one may see the entire limits of the county; surely this for a prairie is a land of beautiful landscapes.

The topography of Sac county is in part similar, in part extremely different. The northwest portion of the county is high and comparatively level, though generally well drained;

the southwest is quite hilly, while the center is described as a "gently rolling prairie" with long valleys trending generally to the south. In both counties the topography becomes more and more rugged as we move southwards; thus south and west of Odebolt and Arthur in the direction of Soldier river the landscape presents a succession of hills and narrow valleys indicative of recent and vigorous erosion.

The eastern half of Sac county is, however, very unlike all the rest. Here the country, except in the immediate vicinity of the streams, is poorly drained; marshes are not infrequent, and gravelly knolls often appear in curious disorder, lending little or no assistance in the problem of disposal of surface waters. Here are the lakes, the ponds, the slow creeks, the wide, flat, black prairies, (Fig. 62) the sandy fields, characteristic of



Fig. 62—View on the Wisconsin drift plain. A prairie highway.

all this section of Iowa to the east and north. Those who have read the present series of reports will immediately recognize here the characteristic features of our latest drift. The two sides of this county differ in topography by the weathered

record of many thousands of years. In the immediate neighborhood of the Coon river, however, we have a number of well drained farms for reasons that may presently appear.

Wall lake.—But doubtless the most striking topographic feature of the prairie lands we now survey remains yet to be considered. Wall lake in Sac county, although perhaps not the only one of the name, is yet by far the most noteworthy. It is the largest of the walled lakes of Iowa and has been longest known to fame.

Here we have a handsome sheet of water a little more than two miles long from east to west, and about half as wide, with curving contour, headlands, bays, more or less of wooded shore, all exceedingly pretty on a fair summer day, attractive to the Indian of long ago, nor less to thousands of his supplanting white brothers who visit it year after year simply to enjoy the beauty of its transparent waters. Here and there are sandy beaches where one might bathe, small steam-boats and yachts ply back and forth in public service, and at the western end a strong perennial mineral spring affords remedial waters for the approval of all who still seek the fountains of perpetual youth and health. The following analysis of the waters here is furnished the passing visitor at Lake View. It may be observed that the principal minerals held here in solution are calcium and magnesium, the lime, as is to be expected, greatly preponderating. The bicarbonate in the case means simply that the springs issue where carbonic acid gas is in excess as is apt to be the case in or about the blue clay where there is organic matter slowly undergoing decomposition. The spring doubtless emerges just above the blue clay.

Each gallon of spring water contains:—

Sodium chloride (common salt).....	1.124 grains
Potassium sulphate.....	285 "
Sodium sulphate.....	1.596 "
Calcium bicarbonate.....	18.111 "
Magnesium ".....	9.470 "
Sodium " (soda).....	.336 "
Iron ".....	.032 "
Sodium phosphate.....	trace
Alumina.....	.150 "

Silica	1,180 grains.
Organic matter.....	trace
Total.....	32,284 grains

The waters of the lake are not very deep, perhaps fifteen or twenty feet at deepest, and are maintained at permanent level by a dam across the outlet at the eastern side. There are furthermore several places along the shore where a slight excavation would seem sufficient to turn the waters out upon the lower lands around so that there is the semblance of an artificial embankment. One may drive along such a levee along the south shore of the lake. Furthermore, by all the testimony of the pioneer, the lake was one time walled; granite bowlders piled upon each other in series that often presented the appearance of definite order, were originally characteristic, as we are told, of a large part of the perimeter of this lake. Parts of this wall remain and are still pointed out to the interested traveler. Most of the wall has been hauled off piecemeal to make foundations for barns and houses, but still enough remains to satisfy the antiquary. A great bowlder near the spring may serve as sample of some corner stone, a tumbled group along the northern shore, (Fig. 63) might tempt us to imagine some titanic tower or cairn now gone to ruin, but at the east side of the lake some rods of what purports to be the original structure here may still be seen in place, bowlders of rather small and uniform size all ranged as stubborn rip-rap piled three or four feet high along the low curving shore.

Dr. White saw this thing and well understood its significance and I cannot do better here than quote from his report.*

"The lakes are almost without exception very shallow and the water in them is usually low in late autumn, so that when winter comes, it is frozen to the bottom over so wide a margin from the shore, as to leave in some of them very little unfrozen water in the middle. In some of the shallower ones, indeed, the water is occasionally all frozen and the fish killed by that means. This was the case a few years ago with Walled lake in Wright county, but it has since been partly re-stocked by the fry that reaches it from the rivers by way of the outlet at the time of overflow.

*Report of the Geol. Surv. of the State of Iowa, by Charles A. White, M. D., Vol. 1, pp. 75-76.

The ice, of course, freezes fast to everything upon the bottom, whether boulders, sand, gravel, or mud, and the expansive power of the water in the act of freezing is exerted upon them, acting from the center of the lake in all directions towards its circumference. Those who are familiar with the expansive



Fig. 63—Part of the "Ancient Wall," north side of Wall Lake.

power of ice in the act of forming, will readily see that under such circumstances it would be more than sufficient to move the largest boulder up the gentle slope of the bed of the lake. It is true that the motion resulting from one winter's freezing would hardly be perceptible, but the act repeated from year to year, and from century to century, would ultimately move everything upon the bottom beyond the reach of the ice. The tracks of boulders thus moved have been observed, being as unmistakable in their character as are those which a mussel leaves behind it in the sand.

Thus it will be seen that whatever was originally upon the bottom of the lake within the reach of the ice, whether boulders,

sand, gravel or mud, has been constantly carried toward the shore, where we find them collected in perfectly natural disorder, and forming a ridge just where the expansive power of the ice ceased. Below the line of freezing the same kind of material would of course remain unmoved upon the bottom, because there is nothing to disturb it."

But no description of Wall lake is adequate which does not take into account at the same time the great lake-like valley which extends from the west end of the lake southward and westward to the westward flexure of the Boyer river in Levey township near the little station McCloy. This large depression, until recently an undrained marsh, is four or five times as great in area as Wall lake itself and looks at first sight as if it might at one time have been part of it. There are yet many men ready to tell the traveler how in days gone by there were in the marsh abundant fish, and how its waters at times went into the southwest extension of the lake. At present the lake is cut off from the marsh by a low divide, scarcely perceptible, and drainage is in progress which will probably reduce the whole marsh some day to fertile fields. That lake and marsh are parts of the same basin there is no doubt. Both taken together constitute, it is most probable, part of an old river valley, possibly the old valley of the Boyer then flowing east, away from the divide, later herein described, now cut through between McCloy and Herring or in that neighborhood. It seems more than likely that the Boyer waters now going to the Missouri may have once contributed to the Des Moines. This view has been already discussed by the present writer.* It may now be added as confirmatory of this view that parts of the Coon river valley east of the lake are no doubt old, representative of a pre-Wisconsin channel, and the course of the present outlet seems to follow the line that would put the marsh, the lake and this older channel into direct communication.

This matter is still further discussed in describing the rivers and streams, under the head of drainage, but it is worth while to notice that we have here a most attractive problem that deserves, and will well reward, the effort of some intelligent

*Iowa Geological Survey Series, Volume 12, pp. 330, 331.

local student. Wall lake has an inscription written on the ground; the inscription may be read and interpreted to men in modern speech.

DRAINAGE.

The drainage of the region studied has been already more than once suggested. The greater part of the territory we describe slopes gently south and west. Thus from Holstein to Charter Oak, the fall is about two hundred feet from railway station to railway station, from Arcadia in Carroll county to Charter Oak, nearly the same, while from Holstein to Arcadia, almost directly southeast, the fall is only eighteen feet. Holstein is the highest point in Ida and Schaller the highest in Sac, and the former is only fifty feet higher than the latter. That is our counties lie upon the crest of the great divide recognized indeed by Dr. White, separating the waters of the Missouri from those of the Mississippi slope. For the trend of this ridge, with a map compare, for instance, the following points all upon the summit of the divide referred to: Boyden, 1425, Marcus 1455, Holstein 1438, Arcadia 1420, Templeton 1460, etc. This highland determines the drainage of the counties, with one remarkable exception hereinafter to be discussed,—the course of the Boyer river. All the streams rising west of the crest should flow south and west; all those taking origin east of the divide should flow south and east,—and in general they do but not without exception as we shall see presently.

The Maple river.—The Maple river crosses Ida county from northeast to southwest and so crosses apparently the line of the divide; really it takes rise on high prairies to the north of Holstein and Schaller where is one point higher than any in this section of the state, namely Alta, a station just west of Storm Lake, nearly one hundred feet higher than Holstein, and so able to send the waters gathered on its western side across the divide here sketched, but not without deep erosion. Witness the steep hills that flank the river on each side as it crosses the line of division just defined, as for instance from the south line of Logan township north for several miles. The station at Ida Grove, somewhat above the flood-plain of the river, is two hundred feet below that of Holstein and a little more than

three hundred feet below that at Alta, so that the amount of fall is great, sufficient thoroughly to drain all the contiguous farms, as we see.

The waters of the Maple are perennial in liberal supply and have for years afforded sufficient water-power for a little mill still in active service at Ida Grove. The valley below the mouth of the Elk is wide and fine with a broad flood-plain, now occupied with beautiful farms.

The principal eastern tributaries of the Maple are Silver creek, Elk creek and Odebolt creek. Silver creek rises in Coon township of Sac county and with Elk creek, which has a similar origin, forms the drainage system for all the northwest part of Sac county. Their valleys are deep as they approach the Maple and are bordered by long and in some places rather steep hills. Odebolt creek is an important stream draining the central part of western Sac county and passing by a long deeply excavated valley almost directly west to enter the Maple at Ida Grove. Steep hills flank the valley on each side and are especially noticeable in the neighborhood of Arthur and near the county line. A succession of long valleys lead into the Odebolt from the south, coming down from a high ridge which forms a divide separating the valley of the Odebolt from that of Soldier river on the south. The latter stream bends up in a peculiar arch through the southern townships of Ida county, occupies a deep valley with many little tributary creeks from the north side, which make an extremely broken country, but all yielding easily to tillage. All the hills from top to bottom are year by year covered with corn. All these streams are remarkable for their deep erosion; all of them are said to be perennial, fed by seeping springs, which emerge probably, in many cases above the blue clay. The creek bottoms are alluvial soil, in which not a pebble or boulder is to be seen. In many cases the bed of the stream is, however, black.

The Boyer river.—The drainage situation on the eastern side of the divide as here discussed is entirely different. The Boyer river and the Coon are the principal streams. The former rises in Buena Vista county south of Storm lake and occupies a shallow but well eroded valley that passes directly south

through almost the center of Sac county. In the eastern part of Levey township and the western part of Viola, the stream enters upon a comparatively very wide flood plain two or three miles in either direction. Here seems to have been an old time center of erosion, produced by the convergence of many minor streams, the Boyer the largest, all uniting to form a river that then flowed *east*. As one follows the course of the present river westward he is at once struck with the narrowness of the valley which trends now almost directly southwest. The excavation in section 32, Levey township, is less than a mile wide and grows narrower as one descends the stream; at length, just about Boyer station on the line of the Chicago & Northwestern railway, the hills no more than half a mile, or even less, distant, the flood plain is less than forty rods wide.

Beyond this point the stream valley gradually widens as we should expect, though still very narrow as far down the stream as Deloit, the terrane to be eroded being the same as we descend toward the Missouri flood plains.

The high ridge or divide spoken of in discussing topography is cut through just about where the valley begins to narrow in its southwesterly course, and it seems likely that here the present river occupies the channel of a stream once coming from the southwest. The present channel of the Boyer west of the divide was at that time occupied possibly by a small stream flowing as now southwest. The damming of the waters about Wall lake, made at first a great lake of all this wide flood plain valley, already referred to, and its overflow and final escape seems to have cut out the narrow valley now occupied by the Boyer, as described, from Herring southwest to the neighborhood of Deloit.

The Coon river.—The Coon river rises in the marshes of Buena Vista county, receives, or did receive, a tributary from Storm lake, traverses Sac county by a tortuous channel in a general southeasterly direction, makes a horse shoe bend and emerges from the county flowing northeast, about five miles north of the southeast corner.

Above Sac City the valley is generally narrow, with steep sides furrowed by hundreds of sharp little ravines indicative of recent erosion and general newness of topography; below Sac

City the valley is at first considerably wider, where it joins that of Cedar creek, a stream of perhaps so far equal volume. Below the mouth of the Cedar the valley is very much wider, more than a mile in width, with abundant gravel trains and benches of gravel and sand among which the current has lately excavated a crooked channel. At the entrance of Indian creek there is, of course, a natural widening. At school house No. 8, Coon Valley township, the valley is a mile and a half wide between banks, but from this on, especially where the river turns directly south, it enters a rapidly narrowing valley. Immediately south of Grant City the distance from bluff to bluff is certainly not one-half a mile and the flood plain of the present stream not more than half of that. Beyond these narrows the river turns north and, as stated, presently leaves the county flowing northeast in a somewhat widened channel.

The principal tributary on the west is Indian creek, a perennial stream flowing almost parallel to the Coon, rising in marshes in the north part of the county that to all appearance might quite as well have drained into the Coon. The history and relations of these streams to each other will be argued farther on.

All these streams are fed by springs. When not surcharged by storm-water the currents are clear and cool. The springs are not large, some might be better called seeps; but they are numerous, especially along the valley of the Coon. One such, or rather a group of such springs, supplies Sac City with water. These emerge on a gentle slope a few feet above the bed of a small creek that enters the Coon river from the east. There are no exposures that enable the observer to trace the origin of these waters but from the data at hand it is probable that they come out over the omnipresent blue clay.

There are similar springs near Grant City, some of which have origin above blue clay, others above a different clay or shale to be later on described, but in every case the springs seem to represent surface waters from no distant gathering ground, waters that soak through the looser overlying clays, drift and

gravel and are finally sent out as they encounter a less pervious though by no means indurated horizon. A fine little spring rises in the southwest quarter of section 14 in Sac township.

On the whole these two counties are exceedingly well drained; some parts of eastern Sac are, of course, undrained and there are flats here and there elsewhere that must be ditched or tiled, but the drainage of by far the greater part of our territory is complete.

STRATIGRAPHY.

The stratigraphy of the land we study is for the most part simple enough. We have the usual sheets of drift, whelming the country almost absolutely from side to side, their members appearing in the ordinary sequence, covered withal over large part of the area by the fine clay-like deposit, which White named the bluff deposit, but which men nowadays familiarly know as loess.

This we say is *almost* universal. There do occur, nevertheless, in the extreme southeastern part of our territory some slight exposures of older formations, sandstones and shales, and there are along the river channels here and there deposits that are neither drift nor loess, deposits left as a product of erosion of sweeping waters: these are alluvial. With these two slight exceptions all the surface of the two counties is either simple or loess-covered drift.

The following table shows the sequence of the geologic strata with which we have here to do as they are now generally recognized and named:

GROUP.	SYSTEM.	SERIES.	STAGE.	FORMATION.
Cenozoic	Pleistocene	Recent		Alluvium
		Glacial	Wisconsin	Gravel trains Wisconsin clay
			Peorian	Loess
			Kansan	Buchanan gravel Kansan drift
			Pre-Kansan	Pre-Kansan drift
Mesozoic	Cretaceous	Upper Cretaceous	Colorado	Benton { Prionocyclus shales Chalk Shale and clay
			Dakota	

CRETACEOUS SYSTEM.

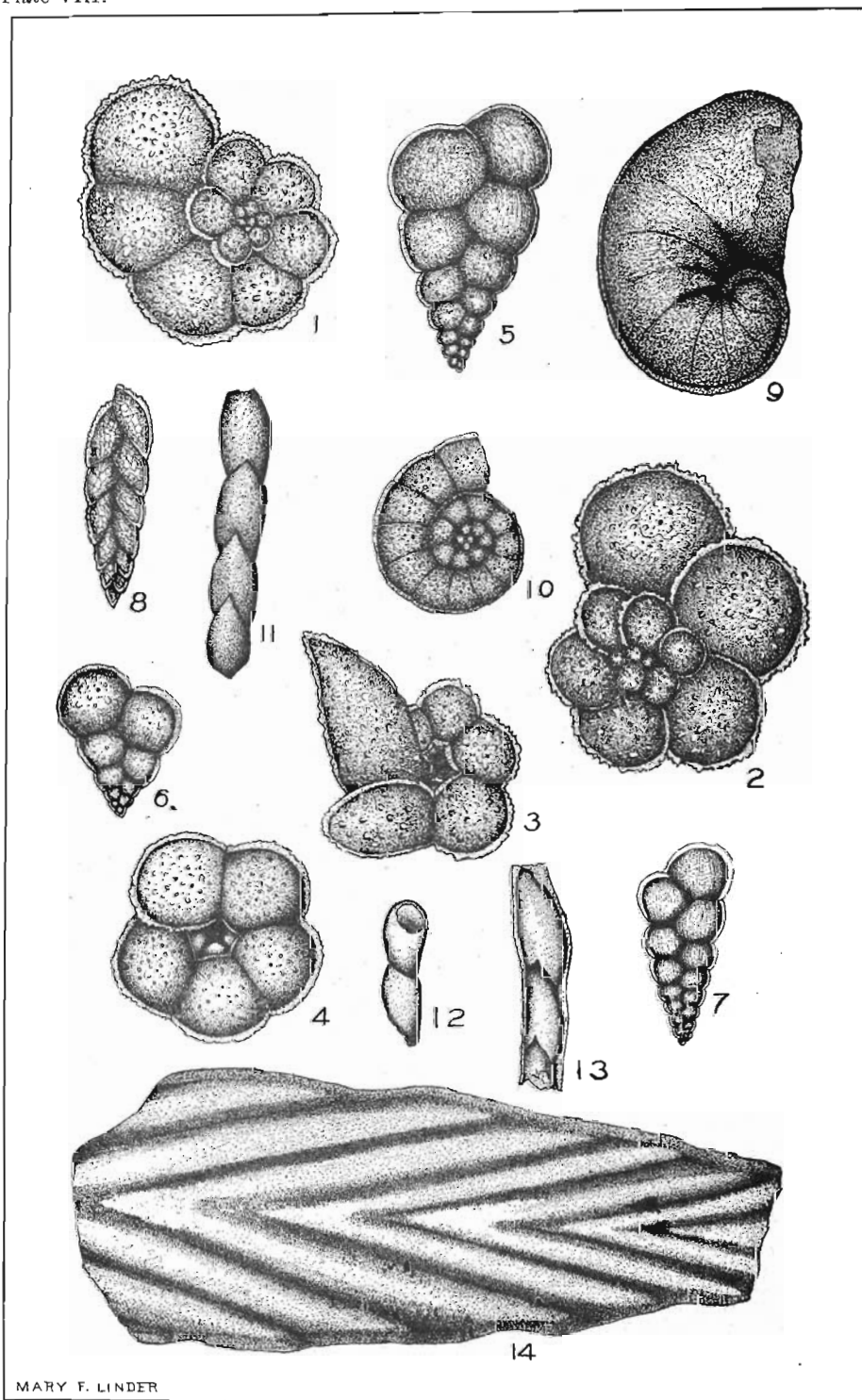
The Cretaceous rocks of the world were so named because as exposed along the coasts of France and England, where first they were studied, these rocks are largely chalk. On either side of the straits of Dover they stand as great crumbling walls of white so friable that the wonder is they have not long since disappeared. It is strange enough to find this same crumbling material piled up away here in the middle of the American continent and to find by its fossils that it has the same age and history, and represents the same stage in the upbuilding of the world. The most distinctive fossils are microscopically small, but extremely abundant: so abundant that they actually make up a large part of the substance of this most singular material. These tiny fossils, greatly magnified, are shown in Plate VIII.

But these Cretaceous rocks are not all chalk. Mixed with the deposits of chalk are layers and sheets of limestone, beds of sandstone and clay and often thick deposits of marl and shale. In a very restricted area in southeastern Sac county we have a considerable variety of these deposits.

It remains to be said that the Cretaceous series of rocks often carries coal, sometimes of excellent quality, and that it probably immediately overlies, in many parts of Iowa, rocks of the Carboniferous or coal-bearing system, so that we are not surprised to hear reports of coal discovered by those who sink wells and other borings in our section.

DAKOTA STAGE.

The Dakota Sandstone.—The lowest strata of the Cretaceous rocks as we find them exposed in Sac county, are very friable, coarse-grained, yellow, heavy bedded sandstone. There is an exposure, some fifteen or twenty feet high, along the south bank of Coon river, just below Grant City. The beds appear to dip back under the hill in a southeasterly direction, but the exposure is so slight that this is not easily determined. The rock is so coarse and friable as to be easily crumbled in the hand, although it seems to harden somewhat in the weather. The lateral extent of this exposure is small. It may be definitely followed only for a few rods, as here described; but the sandstone is reported by well diggers in many places in the vicinity, and is no doubt continuous far to the north and west.



MARY F. LINDER

1, 2, 4. *Globigerina cretacea* d'Orbigny. 3. *Globigerina digitata* Brady. 5, 6, 7. *Textularia globulosa* Ehrenberg. *Bolivina punctata* d'Orbigny. 9. *Cristellaria complanata* Reuss. 10. *Anomalina ammonoides* Reuss. 11, 12, 13. *Nodosaria consobrina* d'Orbigny. 14. *Frondicularia* sp?

This is the famous sandstone of western Nebraska and Dakota and all the eastern Rocky Mountain region. In the Black Hills, beds of it may be seen piled up hundreds of feet thick, so that our little Sac county exposure is only one of the most eastern outcrops of a vast formation, a formation that in this latitude underlies all the plains and prairies of the west.

Our little exposure has been brought to light by the erosion of the river valley here and is cut in two by a small ravine, now somewhat choked up by bowlders, sand and other debris. If one follows back a little way up this ravine he comes upon considerable beds of very tough clay, red and drab and white and yellow, sticky and plastic when wet, when dry almost as hard as rock and, where unaffected by the weather, possible of excavation only by a pick. This body of clay represents, probably, a formation known everywhere as overlying the Dakota sandstone, and called the Fort Benton shales. These clay or shale deposits as here revealed we now proceed to describe.

COLORADO STAGE.

Fort Benton Shales.—A few rods down the river from the point last named there is, next to the water's edge where the stream undermines the bank, a considerable exposure, ten or fifteen feet perhaps, of impure clay mixed with irregular laminae and plates of hematite or iron ore, weathering and breaking up slowly into a confused mass to which the overlying soil and drift contributes. This formation probably forms here the bottom of the river, for across the river in the southeast corner of section 11, a little higher up the river, we have a similar exposure with intermingling layers of sandstone. Further west, but still in the southeast quarter of section 11, the clays and shales are exposed up some forty feet above the river and clearly high above the sandstone of section 12 as described in the preceding paragraph. Here we have a perfect exposure of the Benton shales. Materials from shafts sunk here by those looking for brick clay show a fissile, drab-colored fireclay-looking substance, to be excavated only with the pick, but weathering into fine clayey soil. In the material removed by digging was

found a single fossil imprint, identified by Prof. Calvin as the imprint of *Prionocyclus wyomingensis*, a characteristic Fort Benton shales fossil, so that our horizon is so far determined.

Farther up the river, perhaps two miles, measured along the stream, we find at the water's edge a small exposure of pure bluish clay carrying a seam of jet black carbonaceous matter that seems to be largely clay as it refuses to burn when dry. The seam is about an inch and a half in thickness. There are similar outcrops here and there between the point last mentioned and that described in section 12, but none so pure or remarkable as this.

In lot 58 in the southwest of section 11, the face of the bluff shows a small but beautiful exposure of comparatively pure chalk. The material is white or cream colored, light, soft; so soft that it may be easily crushed in the fingers. The microscopic examination of this material reveals an abundance of the minute foraminifera which are characteristic of the chalk deposits of the world. The exposure at present shows only a few feet of the material, but it doubtless extends much deeper; probably down to some of the clay beds we have been considering since a spring hard by emerges apparently from the base of the chalk and above the impervious clay. This would indicate a chalk deposit of fifteen or twenty feet.

Above the chalk at this point we have lying in the surface detritus abundant fragments of limestone, evidently of local origin. The particular horizon to which these fragments belong was not discovered; we only know that it is above the chalk deposit just described. It is even possible that a section here might show chalk both above and below. At any rate the limestone fragments carry bits of the shells of *Inoceramus labiatus*. The topography does not indicate the presence in the bluff, of any considerable thickness of limestone. The hills are all eroded with comparatively gentle rounded slopes. It is probable that our *Inoceramus* beds here consist of no more than a single parting sheet or layer an inch or two in thickness.

A tentative table of the Cretaceous exposures at and near Grant City may be arranged in some such way as follows:

	FEET.
Inoceramus beds and impure chalk.....	?
Chalk	15
Pure blue clay with carbonaceous seams.....	5
Gray or drab colored shales, Benton	15
Coarse-grained sandstone, typical Dakota.....	12
Clays mixed with sandstones, with ferruginous plates and laminæ	10
	57

These are in every case moderate estimates. The total thickness, measured in altitude, may be less, but it seems that the Cretaceous came upon a surface already deeply eroded, so that one cannot reckon too closely upon successive horizons even where the rocky members evidently change.

PLEISTOCENE SYSTEM.

The isolated exposures thus far discussed, though sufficiently suggestive of what we may everywhere expect *beneath* the soils of these two counties, are insignificant indeed when compared to the vast bodies of clay and gravel, sand and drift to which we now give heed.

To the ordinary observer these are all alike, they are simply a confused mass in which rock of every description may be found in pieces of almost every size. It is, however, generally recognized that down under the surface soil at varying depths the color of the deposit changes. Everybody knows of the blue clay and refers to it as a datum line in connection with the search for water. This blue clay is also for the geologist a horizon of reference and marks for him the place of the most wide-spread member of the Pleistocene system.

KANSAN STAGE.

The Kansan Drift. The Kansan drift in Iowa is an almost universal thing and here underlies at various depths the entire surface of the two counties. As ordinarily exposed in different parts of the state the Kansan offers three phases;— *the blue clay*, an unweathered, exceedingly hard, tough or tenacious clay more or less sandy and filled with scattered pebbles and “nigger-heads” or hard boulders, generally of moderate size, though

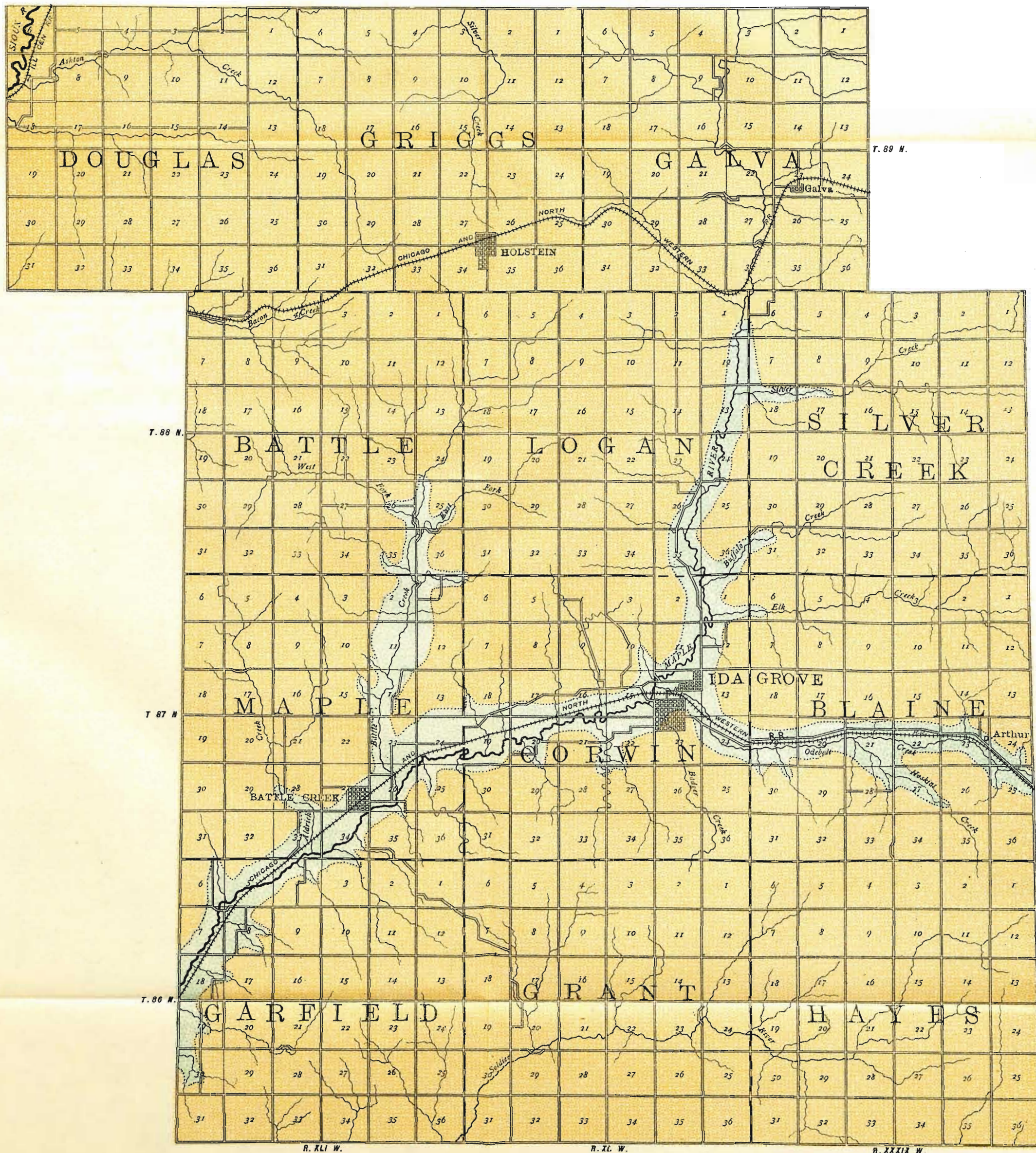
sometimes quite large, with often pieces of half-rotten wood as well; *the yellow till*, simply the weathered phase of the blue clay and blending with it both in color and structure, through apt to be more decidedly intersected by curious irregular planes of cleavage, jointed, we say, the wood now all disappeared, and the joints stained by filtrations from above; and finally the *Buchanan gravel*.

As already intimated, the blue clay forms, in popular estimation, a sort of bottom to the whole surface series. Underneath it there is generally found a bed of sand or gravel with abundant water, and exploration ceases. These gravels have come to be known in American literature as Aftonian gravels and seem to indicate a still deeper sheet of drift.

The thickness of the blue clay varies greatly, as also the depth at which it lies beneath the surface. Wells are commonly reported in Sac county at twelve or fifteen feet where water is found above the blue clay. In some instances blue clay is reported at five feet below the surface. In Ida county the blue clay lies generally much deeper; often it is reported at twenty-five to forty feet. However, in Silver Creek and Galva townships the depth was given at ten or fifteen feet and about Holstein seven or eight. The thickness as quoted by well-diggers ranges from sixty to one hundred and fifty feet.

Exposures of the blue clay are seldom seen for the reason that the formation is naturally uncovered by erosion only. It is accordingly discoverable in the beds or banks of streams, in either locality generally covered by debris either from above or alluvial. However, there are exposures not a few, in all parts of the territory now before us. There are fine exposures along the banks of Porter creek in Ida county about the county line and below, where springs emerge above the clay. A cutting of the Chicago, Milwaukee and Saint Paul railway immediately north of Sac City reveals the blue clay at its base and in the ditch along the track. A seeping spring by the river, on the west side, near Grant City in the northeast of section 10, comes out from beneath a bed of remarkable ferruginous gravel and flows down over an exposure of very tough blue clay which appears to belong here.

*See Volume VIII of the present series of Reports, p. 215 and pp. 241-244. Also the Journal of Geology. Vol. 6, pp. 176 et seq.



IOWA GEOLOGICAL SURVEY

MAP OF THE
SUPERFICIAL DEPOSITS
OF
IDA
COUNTY,
IOWA.

BY
T. H. MACBRIDE.
1905.

Scale 1:25000
1 1/2 0 1 2 3 4 5 Miles.
1 1/2 0 1 2 3 4 5 Kilometers

LEGEND

ALLUVIUM
KANSAN DRIFT
OVERLAIN BY LOESS

DRAWN BY F. C. TATE

An exposure of the gravels in question was observed in section 27, Corwin township in Ida county, where in the valley of a small creek the following section was made out:

- | | |
|--|--------|
| 4. Loess, yellow, of unknown thickness | |
| 3. Loess? bluish or blackish-blue..... | 2 feet |
| 2. Ferretto zone | 3 feet |
| 1. Gravel and sand | 2 feet |

The gravel pit used by Ida Grove, a mile or two southwest of the city is probably to be placed here, but the materials have been sorted over since.

An exposure of these gravels in Sac county has already received mention in connection with the blue clay near Grant City. Here the exposure is small and shows ferretto only. The iron is so abundant that it not only impregnates the water but forms immediate and extensive deposits in vegetation, on sticks and stones, all the way down to the river; in fact we have a chalybeate spring.

The most satisfactory exposures of the whole Kansan, indeed the whole Pleistocene system in this part of Iowa, are to be seen in Carroll county just south of our present field. Here in the recent cuts of the Chicago Great Western railway, east of Carroll, the face of the cutting is in some parts still fresh enough to enable us to read the succession of deposits.

Everywhere, however, the Kansan is represented by yellow or brownish-yellow till, made up of hard, jointed clays mingled with sand and bowlders or even with bowlders of sand revealed now by limited bodies or pockets of sand in the substance of the drift itself. These are not infrequently observed on the face of railway and highway cuttings. This phase of the Kansan is the common drift of Ida county, and in Sac county is discoverable everywhere west of Indian creek. East of Indian creek this whole formation is covered by a later drift presently to be described, but nevertheless exposures of Kansan yellow till are frequent, particularly on the west side of Indian creek and along the bluffs and banks of Coon river.

Buchanan Gravels.—The Buchanan gravels are less seldom observed than the Kansan drift. These followed in deposition immediately the withdrawal of the Kansan ice,

were first subject to weathering and erosion, and are now represented in sectional exposures generally, by a line of sand or smaller bowlders capping the drift and separating it from the overlying loess. In many cases, however, the gravels rest immediately upon unmodified blue clay and seem not only unweathered and undisturbed themselves but seem also to have in some way prevented the oxidation of the lower member. These gravels are commonly heavily stained with iron, sometimes to the extent of consolidation more or less complete, forming dark or red-brown sheets and streaks extending horizontally sometimes for considerable distances. Such features have received the name *ferretto* zone (Italian *ferretto*, a small piece of iron).

From this locality the following section may be recorded:

- | | |
|---|---------------|
| 5. Wisconsin drift with bowlders..... | 3 to 10 feet |
| 4. Loess with fossil shells..... | 3 to 20 feet |
| 3. An old surface soil, more or less leached, carrying
fossils, shells, bits of vegetation, etc..... | 3 feet |
| 2. Ferretto zone..... | 3 to 4 feet |
| 1. Kansan till, yellow..... | 10 to 20 feet |

A similar section may be studied just north of Sac City. This will be given farther on.

IOWAN STAGE.

The Loess.—Over all the hills and valleys of Ida county and the western half of Sac county, except the flood plains of the larger streams, there spreads a mantle of peculiar soil commonly named among the farmers as yellow clay, but, by White called bluff-material, because it abounds along the Missouri bluffs. In the present series of reports this yellow clay bears the name of *loess*, a word of German origin said to have been originally applied to certain calcareous, argillaceous or clayey deposits along the Rhine, but in the Mississippi valley applied to describe the wide-spread yellow surface deposits illustrated by the material now before us.

This loess forms the subsoil of the finest farming lands of Iowa. Its depth increases to the west, varying from a few feet in Sac county to many yards in Woodbury and Monona. Fine exposures are to be seen in every part of the region it affects, although sometimes on hillsides in the vicinity of the

larger streams it seems to have been all denuded by storm water, or by the wind. In the cut immediately south of the Wall Lake station of the Illinois Central railway the Kansan drift is exposed for twenty feet or more, but there is no trace of loess, though here to be expected. The same thing is true of all the slopes and hilltops along the Boyer river in the neighborhood of the town of Wall Lake. In the southwest quarter of section 29, Wall Lake township, a well in process of excavation showed loess six feet. Eighty feet of drift was encountered here above the blue clay, and thirty feet below this lay a considerable forest bed.

Fine exposures of loess *conforming to an eroded* Kansan surface may be seen on the line of the Chicago Great Western railway, west of Carroll. The railway cuts in Ida county are too old to be of service here. But there is a fine exposure of loess lying immediately upon the Kansan drift at the bridge by the old mill near Ida Grove. A boulder lies directly in the line of contact; there is no indication of weathered material and no gravel or ferretto. The loess is reported at twenty feet in thickness on the hill above.

On the heights south of Ida Grove, in south Corwin township, the loess is much lighter, full of *loess kindchen* or concretionary little lumps of lime, and sometimes passes into fine sand. Along the Odebolt, east of Ida Grove, there are considerable exposures of sand, and these are in some instances at least capped with loess of the more sandy type.

WISCONSIN STAGE.

The Wisconsin drift.—The whole of eastern Sac county, as already stated, has a peculiar topography; it has its own stratigraphy and history as well.

If one drives east from the town of Early two miles to the school-house No. 1, he will find just east of the school-house a small hill on the south side of the highway. The exposure or bank formed by the cutting for the road shows loess, such as just described, covered by about fifteen feet of drift. This drift is different from the Kansan, here far below, and extends eastward and northward and northwestward for many miles in

northern Iowa. If we could turn north at the school-house named we should find a similar exposure on the north side of section 2 on the west of Indian creek, and we should find the same drift following the creek, about one-fourth of a mile east of school-house No. 7, Delaware township; while school-house No. 4 in the same township sits upon a low hill or mound of the same material, and school-house No. 3, two miles farther north, is just a little west of a swell of similar material.

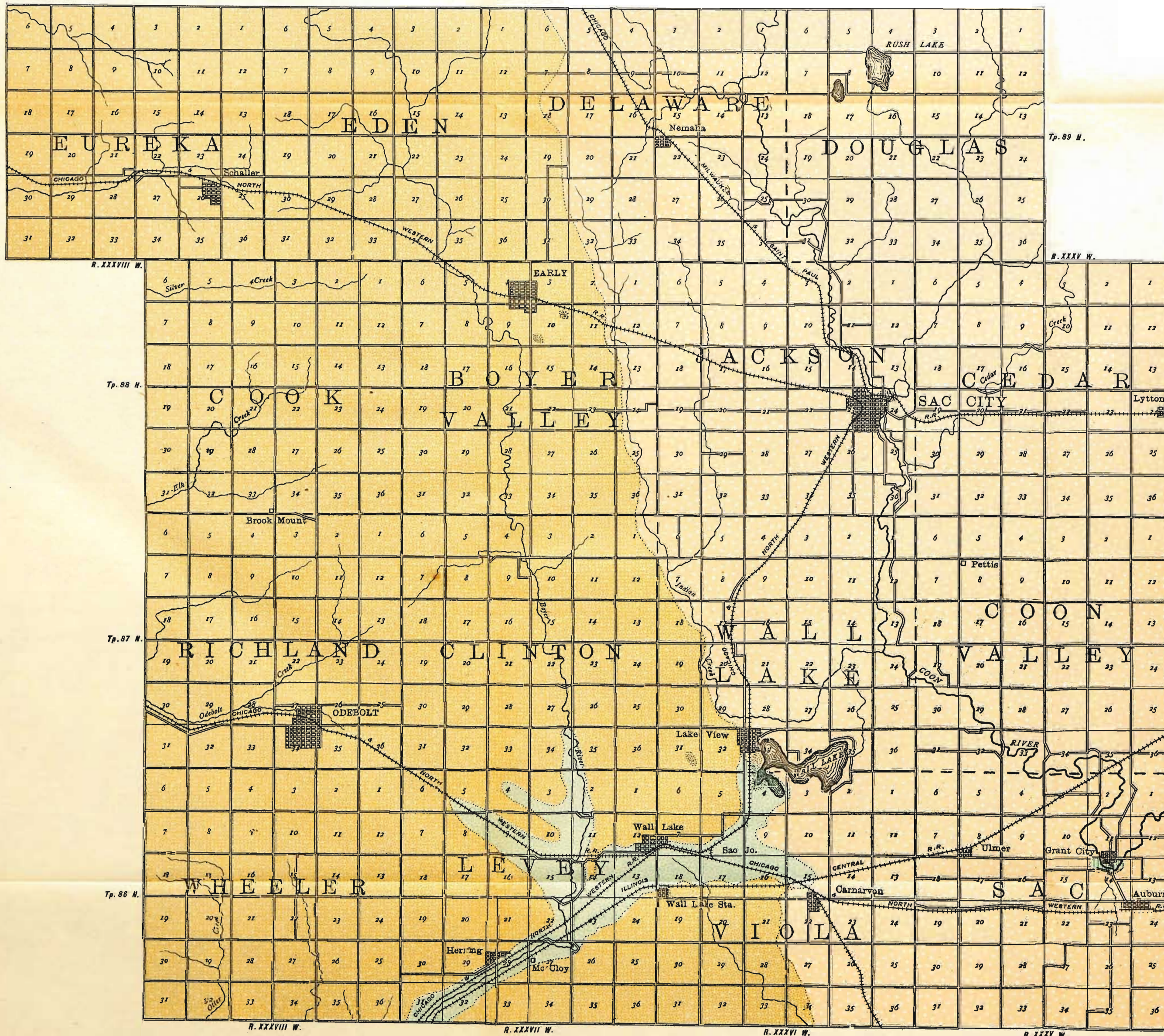
Could we turn south at the school-house first named, No. 1 in Boyer Valley township, we should be able to trace the same peculiar drift all the way down Indian creek, mounds of sand and gravel often appearing generally a little east of the stream, although evidences of the Wisconsin were traced in sections 23, 26 and 25, Boyer Valley township.

In fact, Indian creek is fairly the western border of the new drift all across Wall Lake township to the town of Lake View. Sometimes boulders, gravel patches, etc., suggest that the Wisconsin ice reached the western slopes leading to the creek, but in general the west bank of this little stream is Kansan and the east Wisconsin.

But it is time we defined more particularly the drift last named.

The Wisconsin drift as shown in Sac county exhibits two phases, it is either in the form of a calcareous, grayish-yellow, pebbly clay, rather light and loose, never jointed or ferruginous; or it occurs as piles of fresh-looking gravel and sand often where cut through, cross-bedded and water laid.

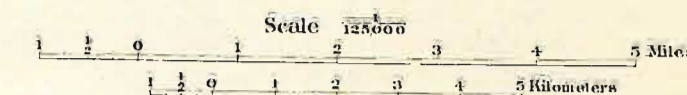
An illustration of typical Wisconsin drift may be seen by anyone entering Lake View from the east along the north shore of the lake. The road cutting offers a fine exposure, ten or fifteen feet high. This section may be compared with the sections in the cut south of Wall Lake station on the Illinois Central railway, by anyone desiring to note the difference in composition and color between the newer and older, the Wisconsin and the Kansan drift-sheets. Wisconsin gravels may be seen in the gravel pits at Lake View as well as in many another section among the sandy hills north of the town, as in section 17, Wall Lake township. Where the Wisconsin drift is level, the



IOWA GEOLOGICAL SURVEY

MAP OF THE
SUPERFICIAL DEPOSITS
OF
SAC
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1905.



LEGEND

- ALLUVIAL DEPOSITS
- WISCONSIN DRIFT
- KANSAN DRIFT
OVERLAIN BY LOESS
- DAKOTA

INDUSTRIES

- GRAVEL PITS
- CLAY WORKS

DRAWN BY F. C. TATE

soil is exceedingly black and rich, fine-grained and inclined to be sticky, "does not sour" says the farmer. There are sections of such soil on the flat prairie immediately west of Sac City.

The relations of this Wisconsin drift to the older Kansan are well shown in an exposure in the northern part of Sac City or just north of the city limits. Here on the west side of the Chicago, Milwaukee and Saint Paul railway tracks appears the section already noticed. The section is as follows:-

- | | |
|---|----------|
| 5. Wisconsin drift, with calcareous pebbles, bowlders, etc.,
and surface soil..... | 3 feet |
| 4. Loess, more or less leached, whitish..... | 2 feet |
| 3. Ferretto, a ferruginous line..... | 6 inches |
| 2. Kansan drift, yellow till..... | 20 feet |
| 1. Blue clay, exposed by digging..... | |

This exposure may be traced with more or less clearness along the west side of the railway tracks.

The exposure in the cut east of Carroll may now be compared. While the limits of the Wisconsin drift as overriding the older deposits may generally be fairly well determined by surface features, sections that show the actual situation are not common. The valley of the Coon river at Grant City to which we have already given so much attention affords another section of the same sort, although not quite so satisfactory since the loess is lacking. The exposure affording the section is found on the south side of the Hicks road leading west from the main road from Auburn to Grant City. The section here is as follows:

- | | |
|---------------------------------|----------|
| 4. Wisconsin drift..... | 15 feet |
| 3. Gravel and sand..... | 4 inches |
| 2. Kansan drift..... | 30 feet |
| 1. Talus covering, unknown..... | 10 feet |

The town of Grant City rests apparently upon a bed of Kansan. Just above the mill the crest of the hill shows some very ferruginous gravel. Wells in the town are said to be twelve to eighteen feet in depth and to furnish abundant water from quicksand. This may represent the Buchanan stage. The soil in town is more loess-like and is successfully used in the manufacture of brick. The valley of the Coon here is very new; the channel of this peculiar bend was cut since Wisconsin times or during the time when the Wisconsin ice was receding. The

drainage waters moving south from Sac City in what was probably the old channel of some stream, if one may judge by its size or width, were headed off on the southeast by the Altamont or terminal morainic hills which occur about Auburn. These hills are not high, but they are there, and were sufficient at the outset to shunt the southward flowing waters to the northeast, making the curious and otherwise inexplicable bend around the site of Grant City. The narrowness of the channel here, not this alone proclaims its newness; but all the tributary channels here as well. Look at the deep canyon-like valleys approaching from the south, their precipitous walls still uneroded. The east and west road south of Grant City bridge follows a "hog-back", in places just broad enough for the highway. It is to this newness that we owe the Mesozoic exposures already proved so curious and interesting. In an older valley these soft sandstones, chinks and shales had long since disappeared by the sweep of perpetual, long continued erosion. A fine morainic ridge extends east and west about the latitude of sections 25 and 26 in Sac township. Auburn owes its comparatively high location, locally high, to the moraine. The schoolhouse and the Roman Catholic church, are plainly on morainic swells, and behind the church, northward is a sand-pit telling the same story. These are morainic knobs. A singular marsh between Auburn and the river is another peculiar fact evidencing a recent disturbance of the original drainage of the country. Here are ponds of water within a short distance of the river and some of its tributary streams but yet undrained, draining possibly in the opposite direction to meet the river possibly farther down. There is a very pretty little mound north of the highway in section 13 of this same township. In fact when we come to look at the matter, all the geology of the two counties is centered here, or at least may be studied here within the area of a few square miles.

These Auburn hills and those already referred to along Indian creek, those about Wall lake, are part of the local terminal moraine; i. e. they mark in a general way the westward limit here of the sheet of ice that some thousand of years ago spread this newer drift. Had the ice pushed farther west, these hills

had been all spread and flat like the marshy prairies farther east. It is interesting accordingly to know their limit. We have seen that in the north part of the county they are limited by Indian creek. Indian creek, however, north of Wall lake, turns east among the hills and finds its way into the Coon river, while the hills sweep on around the lake, curve around towards Carnarvon and leave the county somewhere about north of Breda. The reader may consult the accompanying map. These hills accordingly form part of a belt of such topographic features extending from Minnesota more or less continuously far south and southeast and we have but a section of this belt. It appears too that the Indian creek drains the outside, or western edge, of the general moraine, while Coon river follows the inside, or the eastern edge.

The Wisconsin Gravels.—It remains for us to describe still another formation in this connection. At the time of the melting of the Wisconsin ice considerable floods of water, we must believe, especially in summer, made their way from the front of the receding glacier. Not only so but these floods carried with them enormous quantities of gravel and sand, with finer silt as well, of course, which were carried and spread far down the principal channels of escape. Evidences of this are to be seen on every hand when one approaches a glacial border. Sac county is by no means without its typical illustrations.

In the first place the Coon river itself, acting in those days as a drainage channel, was filled with gravel, wherever an old channel existed, from side to side. As the new channel at Grant City was deepened and the floods at length subsided, the residual stream cut out the present channel for the current and its narrow flood plain and left the accumulations of gravel as high terraces all the way along its course. Sac City is situated upon one of these terraces, gravel trains they are called, and another may be seen at the crossing of the river between sections 29 and 32 in Coon Valley township, and indeed all the way along the wider part of this valley.

Again part of the Wisconsin drainage from the vicinity of Early seems to have gone out by way of the upper Boyer. This was apparently choked off somewhere about Carnarvon, for

it became filled with gravel and sand from Early south to the great marsh already described, and occupies to-day in many places a channel re-excavated since that time. About Wall lake the escaping drainage was also slow, the current was not strong enough to carry it away, and vast bodies of gravel were deposited close to the glacier's front. Lake View is situated on this terrace and the excavations south of town give us some indication of the depth and amount. This deposit probably continues away to the bend of the Boyer already referred to.

There are signs too that the glacial drainage at first entered the upper Boyer from the country east and south of Storm Lake. In sections 1, 2 and 11 of Eden township is a widely excavated valley, probably part of some earlier stream-bed now filled with gravel, but occupied by a small creek fed by little springs that seep here and there from the banks. The present rivulet can hardly have excavated this abrupt valley, nor is it efficient now to do more than form a small winding channel in the wide bottom. About Early are considerable and not infrequent deposits of gravel that represent probably an over-wash from the drainage of the Wisconsin front. Thus the school-house rests upon a gravel mound. The cemetery east of town occupies such a hillock. In fact the town's supply of water is reported from gravel at a depth of 12 feet. One-half a mile east of town is a gravel pit with the following section:

4. Surface soil..... 1 foot
3. Yellowish gravel 4 feet
2. Pale, buff-colored, sandy clay 1 1/2 feet
1. Gravel with ferretto streaks, of depth unknown; exposed.. 6 feet

This in section 10 of Boyer Valley township. In the southwest quarter of the same section is another gravel pit more extensive. Here we have the following section:

4. Surface soil..... 1 foot
3. Ferruginous gravel with rotten bowlders..... 6 feet
2. Fresh looking gravel, mostly sand, no iron..... 5 feet
1. Water-laid, cross-bedded sand of unknown depth; exposed 15 feet

Farther south in the southwest quarter of section 3 of Clinton township is more gravel and sand and so in different places along this part of the Boyer valley.

It is difficult to account for these exposures or deposits on any other theory than that possibly at one time or some time in course of the advance or recession of the Wisconsin ice this part of the present Boyer valley served as a drainage channel from its front. Perhaps at that time the ice had not covered the region of Wall lake and south, and the drainage was chiefly this way, but was later cut off to the east and south as already suggested, and the Boyer then first slackened in rapidity, then became entirely choked, making a lake not only where we find Wall lake now, but far to the west until at length an exit was found to the southwest by the way of the Deloit narrows.

For its confirmation or rejection such speculation will require more exact and long continued study than has been possible in the present survey.

Alluvial Deposits.

Closely related to the deposition of gravels just described lies the latest deposit of all in the territory we discuss. But whereas the gravel was laid down under other conditions by floods that have long since ceased to act, the alluvium is a constant accumulation due to erosive forces acting since the ice retreated, and acting all the time. There is much alluvial soil in the valleys of the older streams. The wide flats of the Boyer valley and even some parts not so wide show great quantities of alluvial soil. In the neighborhood of Herring the Boyer winds about in a bed of deep black soil, does not often reach the underlying sands, and not a boulder is to be seen in the whole flood plain. Everything is covered with alluvium. The same thing is true of the narrower valley of Soldier river, of the valley of Battle creek and to some extent also of the Odebolt and Maple. The accumulations from surrounding slopes and hills, held by vegetation through thousands of years, were gradually filling up their valleys faster than stream and storm water could carry the soil and sand away. In the vicinity of Ida Grove these alluvial deposits are as much as fifteen feet thick, and are probably nearly as extensive along the Boyer. Since the occupation of the country by civilization erosion on the slopes is much more

rapid but the discharge of storm water unchecked by the old-time vegetation of grass and sedge is also more rapid and violent, so that alluvium is not only not accumulating, probably, at present, but is diminished year by year by the floods of spring.

Soils.

The soils of any locality, using the term to designate the loose surface materials appropriate to man's use in the cultivation of the earth, vary according to the nature of their origin. Soils arising from the decomposition of limestone rock will have one character; those from sandstone manifestly another. The soils of the counties we are studying are all so uniformly good that people sometimes think them all alike and yet they differ decidedly. We have before us soils of at least three distinct types: we have the soils developed upon loess, upon drift and the alluvial soils just described.

The loess soils prevail, as has been seen, over by far the larger part of our area. These soils are exceedingly fine in composition and excellent in fertility. There are probably no better soils in the world than those about Odebolt. Indeed, the whole of Ida and western Sac may be cited as a region unexcelled in natural adaptation to ordinary agriculture.

Eastern Sac, as has been shown, has a different history and shows a different though likewise excellent soil. Here the sub-soil is always drift, either the Wisconsin pebbly clay rich in lime, or the lighter, more sandy body of the moraine. The latter gives the lightly tilled, warmer, quicker garden soil just east of Indian creek or south of Auburn: the former finds illustration in the black prairies just west of Sac City. The gravel trains in the wider parts of the Coon valley also afford a lighter, somewhat sandy soil.

About Grant City the hillsides are still exceedingly steep for reasons above set out. These steep bluffs were covered with forest and were better adapted to such purposes. They are too steep to cultivate, and even as pasture fields are comparatively worthless. If completely denuded, they will again yield to the forces of erosion not only to their own undoing but to the destruction of the fertile flood plain that lies below, covering this with masses of sand and gravel from the falling slopes.

Similar slopes covered with native wood appear at Ida Grove and here and there along the Maple river. Those near Ida Grove contribute much to the beauty of the locality and should for public reasons, if for no other, be kept wooded forever. Nature has herself indicated in such places the appropriate crop, and our wisdom shall not soon transcend hers. These steep hillsides and sharp ravines, very few indeed, constitute practically the only untillable parts of these favored counties. The few marshes in eastern Sac can be drained and then are tillable as any.

ECONOMIC PRODUCTS.

From an economic standpoint the soil of the field is the best thing to be found in these two counties; nevertheless we have already encountered several sorts of material which may be advantageously used in manufacture. Perhaps the first of these in relative importance is

Clay.

Clays suitable for making brick occur in many places. Indeed in the loess-covered part of our area there is no lack of material ready to hand. The loess of eastern Iowa is everywhere used for this purpose with satisfactory results. The same material is used in Lyon and Sioux counties. Nevertheless the manufacture of brick at Ida Grove seems not to have been a success. The material used was a rather sandy loess found a short distance east of the city. The reason for abandoning the enterprise could not be ascertained.

At Grant City, Mr. George Hicks has been burning brick on a limited scale for many years. The material is a sandy, light, silt-like soil found at the surface. The brick are of fair quality and have been used in construction of buildings in the village, buildings which present a very creditable appearance indeed. Last year (1904) Mr. Hicks burned about 50,000 brick. So far as could be ascertained this is the only brick-yard in Sac county. Wood is the fuel used.

The clays and shales which have been described as Benton shales on the pages preceding, are now being made the subject of experimentation. A very considerable body of this shale

can be easily exposed a short distance southeast of Grant City, and, as the samples shown are entirely free from objectionable materials, there would seem to be no reason why brick and tile of the hardest and finest might not be made at Grant City. Fort Dodge coal is not far away by direct railway connection. This same material was successfully used five or six years since at Hawarden, making an excellent brick of "yellow red" color.

There are other clays in the neighborhood of Grant City that deserve attention; a bed above the sandstone in the southwest quarter of section 12 should be made the subject of experiment. Any of these exposures, if of sufficient extent, should be better than the pebbly clay of the Wisconsin drift, because free from lime.

Gravel.

The gravel beds of Sac county are of great extent and of no small economic value. At Sac City a bed near the Chicago, Milwaukee and Saint Paul railway station is used in the manufacture of artificial stone. In the absence of bedded rock and of clay suitable for making brick, in this vicinity, the manufacture seems very promising.

The gravel beds at Lake View have for many years furnished ballast for the Chicago & Northwestern railway, and hundreds of car-loads have been hauled away for such in all directions. Gravel for such purposes may be found all along the course of Coon river.

But perhaps the most important local value of these vast gravel deposits and banks lies in the increasing employment of such material in the construction of streets, highways and walks. The people of Iowa have just begun to build good roads, and once the movement becomes general, as it is sure to do, these piles of convenient gravel will be reckoned not the least of the economic resources of certain fortunate counties. Hardly a town in northwest Iowa but has somewhere its gravel pit, and even the country roads are beginning to show the effect of systematic gravel treatment. Lake View, a small town of six hundred people, has cement walks almost continuously on every street. This indicates the future of the gravel once deemed

worthless. Such material in Ida county is not so abundant, but there are some pits already in use. One about two miles southwest of Ida Grove supplies that little city with constructive materials. Others of less importance are used by the farmers in different parts of the county.

Lime.

The Cretaceous chalk already described was at one time extensively mined on the north side of the bluff where occurs the present exposure and burned for lime. The excavations have long since been filled, and overgrown with small trees, but traces of the kiln may be seen. The lime was used by the pioneer of this section in lieu of better, but was unsatisfactory because of the rapidity with which it set, perhaps because of its purity, chalk being one of the purest forms in which lime, or calcium carbonate, occurs. The chalk at Grant City has not been analyzed, but would probably compare closely with that of Plymouth county, analyzed several times, and showing a large per cent of calcium carbonate and very little magnesium. Now it seems that the magnesian limestone makes a better lime, not a whiter lime or a purer lime but a lime more easily used. Our chalk beds are accordingly not of service in the manufacture of lime. Such chalk, however, is sometimes used as an essential constituent of cement, and it is possible that the deposit may one day be of value for this purpose; but this cannot be predicted without exact analysis..

Building Stone.

Bedded rock suitable for constructive work does not occur in either county. The Grant City sandstone is too soft and friable for the purpose. Boulders are practically the only building rock to be had. In eastern Sac these were once common, but have been largely picked up, although a great many are still to be seen. They abound about Lake View, Wall Lake, as has been seen, and along Indian creek. In Ida county boulders are comparatively scarce. Even a stream like Soldier river does not seem to uncover many so deep is the alluvium of the valleys.

Coal, Oil, Gas.

So far as can be ascertained there are no exposures of coal in this region. The nearest approach to coal that has been encountered is found in the seam of carbonaceous or black clay to be seen along the Coon river near the water's edge at Grant City. Coal has been reported again and again by those who have sunk shafts for the purpose of investigation. It appears that a company of practical miners at one time set up machinery and sank a shaft some hundreds of feet between Auburn and Grant City and found coal in veins of considerable thickness, but were deterred from further attempts on account of the fact that the overlying strata gave no promise of sufficient roof to make mining practicable or possible. The late Mr. J. P. Carr of Grant City reported the sinking of exploratory shafts in the north half of section 12. Coal was first encountered at a depth of 150 feet where a seven inch vein was pierced. At 160 feet a second vein was reached which proved to be twenty-three inches in thickness "very good coal". Disagreement among those in charge of the investigation led to the abandonment of the enterprise at this interesting juncture.

Similar explorations and results are reported from the neighborhood of Sac City. It appears that at one time the county supervisors offered a considerable prize for the discovery of coal in the county, "\$4000 for a four-foot vein of coal" it is said; but the reward was never paid. There are however many men who are convinced that coal exists beneath a considerable amount of overlying drift.

As would appear from facts recorded, the rock formations immediately underlying the drift in Sac county are of Cretaceous age. Now the Cretaceous rocks do, in some parts of the country west of us, carry coal and good coal at that. But the Cretaceous of Iowa so far has yielded no good coal. In Plymouth county, almost directly west, the Cretaceous coal has been quite thoroughly explored. A vein of coal a foot and a half thick may be seen along the bluff by the Sioux river in section 32, township 91 N., range 48 W. This vein is, however, of poor quality, a lignite in fact; and careful investigation demonstrated that its mining would be unprofitable.*

*The student is referred to Vol. VIII of the present series of Reports, p. 361.

It is of course possible that better veins may be reached farther east in Cretaceous strata, but the probabilities are all the other way. It is furthermore possible that outlying bodies of coal belonging to the Fort Dodge coal fields may be found farther west, beneath these Cretaceous rocks; but it is very doubtful whether the Carboniferous rocks were ever laid down in northwestern Iowa at all; and, even if they were, it is yet to be shown that any that may exist below the Cretaceous contain coal. The chances that such is the case are believed to be small. A five-foot vein of coal was reached near Le Mars at a depth of 381 feet which it is thought may be Carboniferous.*

As for oil and natural gas, the state of the case is much the same. All that is known on the subject discourages expectation of profitable ventures in the oil industry. Every deep well that is sunk is a test along these lines. There are in northwest Iowa hundreds of these wells and not one so far has revealed the presence of bitumen or oil. Of course, the oil promoter has not omitted to visit various places in Iowa and to make all necessary finds, at Danbury, Manilla, Greenville and elsewhere; but in none of these cases was the outcome satisfactory to local interest. Certain gases are developed wherever organic matter undergoes decomposition. Such gases sometimes accumulate in pockets under and in the drift; usually in limited quantity. But generally speaking the conditions for the accumulation of gas and oil are lacking in this part of Iowa. The whole matter of gas production in Iowa rocks has been well discussed in the administrative report in Volume eleven of the present series, and need not be further elucidated here.

Water Supply.

The streams already described under drainage afford in these counties a constant source of water supply to the valleys through which they pass. The Maple river, Battle creek, Soldier river, Coon river, the Boyer are all perennial streams, largely fed by springs, but acting also as channels for the discharge of vast floods of storm water on occasion. Cedar creek in northeastern Sac county is also a fine stream of clear water the year round, so reported.

*Iowa Geol. Surv., Vol. VIII, p. 364.

As in other parts of the prairie country, however, the chief dependence for water is upon wells. Every little city almost has water-works supplied from a town well which is more frequently a large excavation in a convenient bed of gravel. This is the case at Lake View, Wall Lake, Odebolt, Ida Grove, and Early. Sac City has a fine supply in springs already described, while Holstein boasts one of the deepest wells in the country, 2004 feet deep. Ordinary wells are thirty to forty feet deep and the water rises to within seven or eight feet of the surface.

On the farms shallow wells are still in common use, ranging in depth from twelve to forty feet. In fact so far, the water supply has been abundant, good and easily accessible.

Water Power.

The Coon river and Maple are both sufficient in constant flow to be serviceable for water power. Dams have been erected at several places and those at Ida Grove on the Maple and at Sac City on the Coon are still serviceable. At Grant City the water power did service for a long time both for grinding and sawing, but the dam has been carried out in part and lies a ruin, while steam has lately been set to run the mill. The distance across the bend of the river is so short, much less than a mile, that a tunnel has been more than once suggested which would probably give us water power abundantly sufficient for electric light, and all purposes of manufacture.

ACKNOWLEDGMENTS.

Thanks are due to many persons living in the two counties, who have abundantly aided in the investigations here recorded: more especially to Mr. G. M. Parker, Mr. George Hicks, Auburn, Mr. Chas. Kent, Grant City, and Mr. Chas Pelumlder of the same village. Mr. Pelumlder has checked up the list of woody plants in the notes following. Thanks are also due for determination of fossils, to Professor S. Calvin, former director of the Survey.

FORESTRY NOTES FOR SAC AND IDA COUNTIES.

To one less familiar with the flora and natural resources of the State the presence of natural forest in the counties that make up the northwest prairie is a matter of continued surprise. There are to be found residents even, who will gravely assert that when the pioneer first visited many of the counties of the northwest there was "not a tree in the county fit for a fence-post." The pioneer himself, if he still survive, knows better; he was more observant. He will tell you that not a single county in the whole of Iowa was ever without some indications of native forest.

It is surprising, too, the variety of forest trees that still find foothold even in counties most lacking in forest conditions, and accordingly in native trees. All the prominent tree-groups are represented from one side of the State to the other, and from north to south. Of course, this does not mean that the State was forest-covered; far from that; it means simply that all the more common trees that characterize our northern woods could be found in all parts of Iowa if one took trouble to explore. The annual prairie-fires, where these had sway, usually moving from southwest or west, were hot enough to keep down all manner of perennial vegetation; that is, to keep it well below the surface of the ground. Only those plants whose persistent parts survive the winter underground could stand the usual prairie fire. Trees are perennial plants, but if they started on the prairie they were burnt off at the end of the first season and if a shoot came from the root, it suffered the same fate again, and so on, year after year. Some trees could endure in these circumstances, but comparatively few. The bur oak, for instance, held on in this way, often for years together, producing at length a peculiar stump-like growth just above the ground, known to the pioneer as a "bench-grub." Sometimes two or three favorable years following in sequence a shoot would manage to start towards treehood and by and by a veritable tree or cluster of trees made up the forest of the prairie, the open grove of stunted or dwarfed bur oaks.

It chanced, however, over all the wide prairie there were found here and there localities where conditions topographical checked more or less efficiently the sweep of the annual fires. There were localities over which the fire seldom or never passed. Tree seeds that found by any means lodgement in such places grew, grew as thriftily sometimes as anywhere, rainfall and other climatic conditions being the same. Such localities were lands protected by lakes or ponds or bending streams or sterile grassless rocks or dunes or precipitous banks of streams. In all such places, and there are such in every region of the State, trees and shrubs of many kinds found not incongenial home and persist today in spite of the fact that the soil-greed of men is today less sparing than the old-time annual fire.

In Ida and Sac counties were several of these sheltered nooks still marked by groves of native trees. Ida Grove, the county town of the first named county, still conveys by its very name a memory of primitive conditions. A steep bluff, facing the southeast, swept by the encroaching Maple river at its base, afforded on all its precipitous sides, and in all its tributary ravines and valleys a suitable home for trees; there they were and there they are. Other similar nooks and steep hillsides along the Maple further north in the same county offered groves of similar character which in turn gave shelter to the homes of the earliest pioneers, and some old trees of the primeval forest in these localities are reported as yet standing.

In Sac county, the Coon valley, cut in many places deep down through walls of drift, and seamed by sharp, short, gully-like valleys leading in the tributary waters, offered all along its course conditions suitable for the protection and establishment of the forest and there are evidences still that a real forest in such places was not lacking. Stumps of large trees are encountered all the way up and down the river and occasionally, on the land of some pioneer still living, some of the ancient trees may still be seen, the seed-trees of the present forest where this is allowed to grow.

It is noteworthy that native trees seem to have been never abundant about Wall lake. There is a small grove on the north side of the lake protected by the contour of the shore, and there

are a few trees on to the east where many have been planted; but it is even reported that Wall lake had originally no trees at all. This is, however, a mistake; there were a few oaks, elms, and representatives of other species.

The following list includes the woody plants noticed in passing through the two counties described. It is probably not complete; but it is hoped that local students may take heed and be able to report additional species.

Tilia Americana Linn. Basswood. Linden. Linn. The linden grows abundantly in our wooded districts, and at the "settlement" of the country showed rather fine trees. Basswood lumber was at one time as common at the saw-mill as any other, except oak; but it is now seldom seen. The wood is fine-grained, soft, easily worked and useful for a great variety of purposes, durable enough if protected from the weather, but rotting in a year if left wet. The tree has an unpleasant way of coming up from the root which offers in the forest often three or four trunks in a place and makes the species less desirable for the street. Fine rows are, however, to be seen in many cities. The flowers of the linden afford food for bees and are the source of one of the most famous varieties of honey.

Xanthoxylum Americanum Miller. Prickly ash. The prickly ash is not an ash at all, nor at all thereto related. It is a rue, a family of plants little known among us. The hop-tree, not the hop, nor the hop-hornbeam, is a cousin. Our prickly ash is a shrub, common along creek and river-bottoms, with greenish flowers that come before the leaves and give rise later to dull reddish pods with one or two black seeds in each. Not without value, perhaps, as an ornamental shrub.

Acer Saccharinum Linn. *Acer dasycarpum* of authors. This is the common soft or white maple of all the prairie country. Probably native in all special localities above described, it has been universally planted and is still offered in nurseries. One of our most useful trees on account of its rapid growth, hardiness, freedom from insects, it has had a prominent part in the settlement of our State. The wood makes excellent fuel but is otherwise, at least in Iowa, of small value. The limbs are long and generally flexible, but suffer from the storms of summer.

unless the trees are in groves sufficient to protect and shelter one another. The practice of polling or topping this tree where planted for ornamental purposes, although now well-nigh universal, cannot be too strongly condemned. Such treatment simply ruins the tree, ruins its form to begin with, and sooner or later invites the destruction of decay.

Negundo Negundo (Linn.) Sudw. *Acer negundo* and *Negundo aceroides* of authors. Box elder.

The box elder, like the maple, was a favorite with the early planters. Like the maple it had in its favor hardiness, rapid growth, and a habit that affords abundant shade and shelter. Its wood also makes excellent fuel. As a lumber tree it has no value and in these later years it has been infested by a species of the Coreidae *Leptocoris trivittatus*, the box elder bug, to such an extent as to make the tree itself objectionable. Other and better species may henceforth well take the place of the maple, cottonwood and box elder, in the farmer's plantings.

Vitis Riparia Michx. Wild Grape.

The wild grape is common everywhere near streams and since the prairies have been cultivated, has become common also on farms, in planted groves, in hedges and even along the lines of barbed-wire fence, converting these betimes into more sightly green hedges. The fruit, late-ripening, is much esteemed for its fine flavor, not by birds and boys only, or such wild creatures, but by the cook as well, who finds no jelly quite equal in subtle aroma to that made from these native fruits of the thicket.

Ampelopsis Quinquefolia Michx. Virginia creeper.

This is perhaps the most common woody vine in the State. It springs up everywhere along fences in field and garden and climbs over thicket and grove. Trained about the porch it is a permanent and handsome ornamental vine, attaching itself alike by tendrils and by very curious little clinging disks, by which these on occasion terminate, so that the Virginia creeper may cling to a dead stump, a wall, an unpainted house or barn, and well deserves the name "American ivy". Care must be taken to distinguish from this plant the so called "poison ivy" which has its leaves in threes; the Virginia creeper has leaves in fives; hence the scientific name; *quinquefolia* means five leaves.

Celastrus Scandens Linn. Climbing Bitter-sweet.

The bitter-sweet is a common vine in thickets along the Coon river. It is singularly destructive of smaller trees, practically choking them betimes, by the twisting of its coils about the stems. It springs up easily from bird-scattered seeds and also rises everywhere from far-spreading orange-colored subterranean stems or roots. In autumn the ripening yellow or orange pods break open to display to birds, and other keen-eyed lovers of the beautiful, the scarlet seeds and the vine becomes ornamental.

Amorpha Fruticosa Linn. Wild Indigo Bush.

This is rather a pretty shrub about six to ten feet high, common along water-courses in the wooded districts. The flowers in summer are rather showy, deep indigo blue with yellow centers. Their color and abundance make the bush attractive as a possible ornamental plant—its only known possible economic value.

Gleditschia Triacanthos Linn. Honey Locust.

The honey locust is one of the fine trees of our northern forest. It grows with rapidity in good soil, preferably sandy, and makes magnificent wood suitable for all sorts of purposes, posts, lumber, fuel. The thorns with which the trunk and branches are abundantly armed suggest a desert origin, and are the great objection to the cultivation of the tree. Nevertheless the honey locust is found throughout our northern woodland and is not in the desert, and we have a variety without thorns but otherwise indistinguishable. The thorny variety is sometimes kept low by trimming and makes a fair hedge; the thornless trees ought to find place in the farmer's wood-lot.

The black locust, *Robinia pseudacacia*, occurs here and there in cultivation. This is another valuable tree; unfortunately often affected by borers. Recently these seem less injurious. If we can get rid of the insects, there is no better tree for general purposes; spreads by the roots and makes a forest by itself.

The coffee-bean tree, *Gymnocladus canadensis*, is here to be expected, but was not observed nor reported.

Rhus Glabra Linn. Smooth Sumac. Sumac.

The sumac is an exceedingly common shrub, appearing even on dry hillsides apart from all forest growth but in places not swept by the hotter fires; useful only as an ornamental plant.

Its leaves in autumn have their own peculiar red to contribute to the general autumn splendor and the fruit its deeper crimson.

The staghorn sumac, or velvet sumac, *Rhus typhina*, deserves introduction. It extends west along the north to Winnebago county and is a handsome native ornamental tree.

The three-leaved ivy, or *poison ivy*, an unmitigated nuisance, is a sumac and belongs here. It no doubt occurs in this district but was not observed.

Ribes Missouriense Mx. Wild Gooseberry.

An extremely thorny and prickly bush is this, common along western streams where other woody species occur; the fruit is generally unarmed and is gathered freely by women and children. What the plant might offer in cultivation is not known. It might by crossing bring greater hardiness to our cultivated sorts, already worn, and certainly merits cultivation and experiment.

Ribes Floridum L'Her. Wild Currant.

The wild black currant is a thornless handsome shrub, ornamental and innocuous. The flowers in May hang in fine large racemes, abundant; the later fruit is smooth, black and as edible at least as the cultivated black currant, though smaller. The species certainly deserves protection and cultivation.

Prunus Americana Marshall. Wild Plum.

The wild plums of the country were the joy and consolation of the pioneer and his family in all this western land. Here was a fruit, offered by nature herself, ready to hand, like the wild strawberry, excellent in sweetness and flavor, abundant in the orchardless, gardenless wild, innocent of all the arts of the gardener yet surpassing these. In fact these are the plums of the country yet. These alone possess the constitutional vigor to endure our western climate. The wild goose plum and the Miner plum are but well selected varieties of our native stock. The former originated from *P. hortulana*, which is surely very near *P. americana* albeit now listed as a distinct species.

The present species has fruit somewhat larger than that of the following, ovoid or egg-shaped, with a somewhat thicker skin, often clear yellow, passing through orange to red.

Occurs along the Coon river about Grant City.

Prunus Chicasa Michx. Wild Plum.

This is the little wild plum of the thickets. The trees are somewhat smaller than those of the species just mentioned, and the fruit globular, red, thin-skinned and very sweet when ripe.

Both species grow in dense clumps and thickets about wet places in the middle or at the border of the woods and are worth preserving on every account. Their fruit, of course, elicits our approval, but they are not less attractive when in bloom, filling the air with sweet perfume, and all summer long their thorny intricate branches form a *cheveux de frise*, a wall of defense for the scores of warblers and beautiful summer birds.

Prunus Virginiana Linn. Choke-cherry.

With fruit black and shining but edible to birds alone, the choke-cherry yet has a place in all our northern woods; evidence, if such were needed, that all fruits were not made for man. The tree is small, of erect habit, rather ornamental, but spreading badly from the roots, and thus less desirable for the lawn. Common along streams.

Prunus Serotina Ehrhart. Wild Cherry.

Here is one of our most hardy and excellent trees. The trunk rises straight and smooth and attains considerable size, so that in the days not long gone by wild cherry lumber, or simply cherry, was prized in the markets of the world. The tree springs readily from the seed, comes up everywhere responsive to the sowing of birds and is a beautiful ornamental tree wherever it happens to stand.

Pyrus Iowensis Wood. *Pyrus coronaria* of authors. Iowa crab apple.

The crab apple, common by all our western streams where the forest obtains at all, is deserving of more attention than it has hitherto received. Its flowers in prolific abundance contribute no small share to the glory of our northern spring; its low rounded shape makes it an ornament in the field and where it stands in thickets cattle prefer its shelter. It forms the natural border of the grove and wood and is the home of all the familiar birds of song. There seems no reason why the crab might not be allowed to grow in the lowland alluvial pastures or by the

country highway. In the latter situation it certainly contributes to the appearance of the landscape and screens in so far the poles of the lawless telephone company.

The June-berry, or Shad-bush, *Amelanchier canadensis*, ought to be found on steep banks along the Coon, but was not observed.

Crataegus Crus-galli Linn. Cock-spur thorn.

One of the many native haws or thorn-apples. The particular species is noteworthy by reason of its abundant aborted branches developed as sharp, slender thorns often three or four inches in length; hence the common name. The fruit is globular, dull red, rather small. Of no economic value. Noted only in the Coon valley.

Crataegus Punctata Jacquin. *Crataegus tomentosa* var. *punctata* of authors. Red haw.

The red haw is everywhere common along streams where forest conditions prevail at all, and persists in pasture-fields along the river-bottoms despite the browsing of cattle. The fruit larger, sometimes an inch in diameter, varying from red to yellow, pleasant flavored. Well worthy of preservation, alike for its rounded form and dense branching and foliage and for its pleasant fruit in autumn.

The species of *Crataegus* are at present in a condition of great confusion. The trees here mentioned are those familiarly known under the names quoted. The revisers may give us half-a-dozen species owing to the importance they attach to characters which are extremely variable, to say the least; probably, we shall eventually be content with the few species listed by the older manuals.

Fraxinus Americana Linn. White ash. Ash.

The ash commonly planted on the farms of western Iowa and a most valuable tree is of this species. A related form *Fraxinus lanceolata* Borch, is found abundantly native along the Coon about Grant City. The ashes are all good forest trees and should hereafter form an important element in every farmer's grove. They grow rapidly, although somewhat slow in starting. With white pine, oak, walnut and ash the grove on the farm will never lack in beauty or service as shelter and the marketable or economic value of its timber product will grow

even more rapidly than the accumulation of material, since such products are, and for years will be, on a rising market.

Symphoricarpos Occidentalis Hooker. Wolfberry.

This is a common little shrub along the Coon, above Sac City and about Grant City; doubtless to be found along the Maple river as well. It is well worthy of cultivation for its showy axillary clusters of flowers in summer and the white fruit that hangs in fall, often long after the leaves have fallen. The snow-berry in common cultivation is a near relative.

Sambucus Canadensis Linn. Elderberry. Elder.

This familiar shrub or tree is said to be native. It is so easy of distribution, once the prairie soils are broken or brought to tillage, that it is impossible today to ascertain the original distribution. Often planted for its somewhat attractive fruit, its seeds are carried everywhere by birds and spring up in every unoccupied corner of garden, farm or woodland.

Viburnum Prunifolium Linn. Black Haw.

This is a small tree fifteen or twenty feet high growing in thickets, appreciated for its sweet blue-black fruit ripe in late summer. Reported from the woods about Grant City by Mr. Pelumlder.

Ulmus Americana Linn. White Elm; American Elm.

The American elm is an exceedingly common tree, one of the hardiest and best; dispersed by flying seeds, it springs up in all sorts of places, although preferring as a habitat the rich soils of our alluvial plains. It is one of our most useful trees for planting; grows well when transplanted, has a fine shape, when well selected, and makes the best street tree in the world. The wood is hard and tough, useful for fuel and makes a valuable lumber.

Ulmus Fulva Michx. Slippery Elm.

The slippery elm is much less common than the white elm and much less valuable. Isolated trees occur in our riparian woods but it is nowhere abundant. It has a tough reddish wood, probably, in some cases, as valuable as the wood of the preceding species. A few trees were noted at Ida Grove and at Grant City.

Celtis Occidentalis Linn. Hackberry.

Found in the same forest with the elm, the hackberry, by careless observers, is not infrequently mistaken for it. It is, however, an entirely different, though related tree. It differs in bark, wood, foliage and fruit. Nevertheless the hackberry is a beautiful and useful forest tree. It is an elegant ornamental tree, though for the street-side not so good as the elm. The growth is at first slow, but later the wood accumulates rapidly and makes excellent fuel.

Juglans Nigra Linn. Black Walnut.

It is always a pleasure to discover this excellent species in far out-of-the-way places. A tree of the eastern forest, reaching noblest proportions in southern Ohio and the valley of the Wabash, it yet holds its own to the very western limits of Iowa, and is known in the river-valleys farther west. Fine trees of this species once stood along the Coon and Maple rivers, and young trees twenty-five to thirty years old are to be seen today, though, in general, little cared for. Fine groves of walnut have been started in Battle Creek township in Ida county. The tree when cared for and planted in groves on rich or alluvial soil grows with great rapidity and promises much for the tree-culture of the near future. There is no use to plant the tree as a highway tree or in rows as is sometimes done. Especially is it idle to plant it alternately with cottonwood or Lombardy poplar. These trees will destroy and over-top the nobler sort. A successful planting of this species must imitate as far as possible the conditions in which the walnut occurs in nature; the seeds must be allowed to germinate where the trees are to stand and then the young trees must be somewhat protected, kept free from weeds until they get started. If planted on rich soil in a thick plantation, to be thinned as required, the young saplings will prune themselves, grow up straight and tall, and make wood as fast as an elm. There is a fine grove of this sort about one mile southeast of the town of Odebolt; but in general the walnut trees, so far planted in these counties, are wrongly placed and offer little encouragement to their owners.

Carya Alba Nutt. Hickory. Shell-bark Hickory.

The shell-bark hickory is common throughout Iowa but by no means abundant. It grows rapidly from the seed and may be

associated with the walnut as a valuable tree for the plantation. The wood, for certain purposes in manufacture and on the farm is reckoned indispensable and for fuel is unexcelled, or indeed excels every other. The nuts also have a marketable value and contribute to the simple pleasures of the fireside on a winter evening. It is satisfactory to find native trees of this species in northwest Iowa. It means that we can have the best of our American forest trees in our prairie counties.

Corylus Americana Walt. Hazel. Hazel-nut.

The familiar hazel furnishes everywhere the undergrowth of the forest, the border of the thicket, the cover, even of the prairie hill-top. Hazel bushes in eastern Iowa were the fore-runners of more important species. Out of the hazel thicket sprang the quaking asp, the oak, the hickory, so that the bush has its relations to other forest-flora. It springs readily from nuts dropped by blue-jays and other creatures and comes up commonly in the farmer's grove and along the hedgerow. The nuts have an increasing market value.

Ostrya Virginica Willd. Ironwood. Hop-Hornbeam.

One of our commonest forest trees in Iowa and one less frequently recognized is this. Apparently, many people do not recognize the tree at all, while some even consider it a species of haw. The tree is bushy when standing in open places, round-topped and covered with rather abundant foliage, but here the resemblance ceases. Its fruit resembles that of the familiar hop; consists in fact of a cluster of small sacs arranged on an axis. Each sac contains one seed, and, strange to say, the sac itself corresponds to the cup of an acorn, so that the ironwood is thus close kin to the oak and is not related to the haw at all, which, on the other hand, is a kind of apple.

The wood of the hop-hornbeam is of the toughest, the hardest and toughest perhaps to be found in our northern forest. Its chief value is in the manufacture of tool handles, and for other purposes about the farm and shop where strong hard wood is needed in small pieces.

Populus Tremuloides Michx. Aspen. Quaking Asp.

The little quaking asp occurs along all streams that are so fortunate as to be shaded by forest at all. Of small economic

value, it yet contributes to the cheerfulness and beauty of the spring and should be preserved if for ornament only.

Populus Deltoidea Marsh. *Populus monilifera* of the authors. Cottonwood.

This is essentially a prairie tree and isolated specimens are to be seen even yet in the middle of the field on farms once the open prairie. The cottonwood is a water-loving tree and in the elder days grew everywhere by sloughs and small streams and in low, undrained places, sometimes in rows, or scattered clumps but never in a grove or forest. Cultivation has not changed the nature of the tree. It has been planted in hundreds of places for grove and shelter, but only where the trees stretch out in lines along the highways do they show their natural vigor, majesty and beauty. When planted in groves or thickets, the trees of the interior presently die out and are generally unsatisfactory.

Trees thirty or forty years old, growing by the highway are now valuable as lumber-trees, and have been in many places cut for the mill. When properly sawed and dried the lumber is said to be excellent for framing and general construction.

The *Carolina poplar* offered now generally by peripatetic tree-sellers, is doubtless at best only a variety of the cottonwood. The tree is diœcious in flowering and it is said by some that the Carolina poplar is simply the staminate cottonwood.

The only objection to the cottonwood, its flying cotton when seeds mature, is obviated by planting staminate trees.

Of the trees above listed, maple, box-elder and cottonwood are essentially *the* trees of Iowa groves and prairie plantations; at least, such has been the situation. The time has come when better varieties should everywhere be sought out and planted.

Salix sp. Willow.

Several species of willow are native to the prairies of north-western Iowa. Two, *Salix cordata* with broad leaves a little silvery below, and prominent stipules, and *Salix longifolia* with long narrow leaves are common by all streams. *Salix amygdaloides* has been everywhere commonly planted along the roadsides and to form part of the farmer's windbreak, but of late is being cut away as inconvenient and expensive in the amount

of space necessarily occupied. All willows are useful as a crop for fuel purposes on wet and undrained areas; as the country becomes drier they yield place to other crops, whether of trees or other plants.

Quercus Rubra Linn. Red Oak.

The red oak is essentially a forest tree, does not push out as the bur oak beyond the forest area but grows only where forest conditions are, by the presence of other trees, already well set up. The red oak is a beautiful and valuable tree; as a lumber tree only less valuable than the white oak and bur oak, but much less desirable as a source of fuel.

Quercus Macrocarpa Michx. Bur Oak.

The bur oak is another widely-distributed and excellent tree, not half appreciated. It is the hardiest species we have, by far; the only one, in fact, that held its own through the millennia on these drift plains against the devastating fires. Bur oaks may be found in nearly every county of Iowa; often reduced by hardship and abuse, the stress of fortune and unequal climate—reduced to mere shrubs in size and habit—they receive the somewhat opprobrious title of scrub-oak and are deemed a cumbrance to the ground. These reduced forms on our western prairie hills are, it is true, of little value either present or prospective; but the bur oak under other conditions is a fine tree. If care be taken to plant acorns from the better style of tree, acorns from such trees as are found in better forest regions, the young trees resulting will grow rapidly and furnish in reasonable time a valuable product.

Fine young bur oaks were noted in all the wooded parts of both counties here considered and there are many quite large trees yet to be seen at various points along the Coon.

Smilax Hispida Muhl. Greenbrier. Cat-brier.

This plant is interesting as the only woody endogen known to our woodlands. It is abundant along the Coon river where its long green stems with black prickles, climb over the plum thickets and shine in singular attractiveness in the leafless season of the year.

Juniperus Virginiana Linn. Red Cedar. Juniper.

The juniper is the only native conifer in the northwest counties, but is well distributed throughout. Useful as an ornamental tree and wind-break, it has been very commonly picked up by farmers and others and transplanted to the grove and garden. Nevertheless the supply of seedlings still appears, no doubt planted by the migrating birds. Juniper grows rapidly in good soil and makes excellent post-timber. A cedar post is said to "last forever", but the statement lacks verification. At any rate juniper or cedar wood is the most durable known.