THE GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE FIFTH ANNUAL REPORT.

FOR THE YEAR 1876.

OFFICERS OF THE SURVEY:

N. H. WINCHELL, STATE GEOLOGIST.....In charge.
S. F. PECKHAM.....Chemistry.
M. D. RHAME.....Topography.
P. L. HATCH.....Ornithology.
ALLEN WHITMAN.....Entomology.
CLARENCE HERRICK.....Laboratory Assistant.

SUBMITTED TO THE PRESIDENT OF THE UNIVERSITY, DEC. 31, 1876.

SAINT PAUL:
PIONEER PRESS COMPANY.
1877.

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ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1876.

To the President of the University:

DEAR SIR:—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of the Geological and Natural History Survey of the State, being the fifth since the beginning of the survey.

Very respectfully,
Your obedient servant,
N. H. WINCHELL.

STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey.* 34 *pp.* 1860. *Reprint from the Wisconsin Reports for* 1858. *Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt.* 47 *pp.* 1860. *Reprint of a paper read before the American Geographical and Statistical Society, January* 31, 1856. *Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January* 25, 1861. 8*vo.* 26 *pp. Out of print.*
4. *Report of Hanchett and Clark, November,* 1864. 8*vo.* 82 *pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior,* 1866. 8*vo.* 23 *pages.*
6. *Report of H. H. Eames, on some of the northern and middle counties of Minnesota.* 1866. 8*vo.* 58 *pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota.* 1866. 8*vo.* 52 *pp. close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle river, incorporating Mr. James Hall's estimate of the copper prospects of that district,* 1866. 2 *pp.* 8*vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June* 17, 1871. 8*vo.* 16 *pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1872. *By N. H. Winchell.* 8*vo.* 112 *pp. with a colored geological map of the State. Published in the Regents' Report for* 1872. *Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year* 1873. *By N. H. Winchell and S. F. Peckham. Regents' Report*; 148 *pp.* 8*vo.*; *with Illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1874. *By N. H. Winchell.* 41 *pp.* 8*vo. with two county maps. Published in the Regents' Report for* 1874.
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year* 1875. *By N. H. Winchell, assisted by M. W. Harrington;* 162 *pp.* 8*vo*; *with four county maps and a number of other illustrations. Also published in the Regents' Report for* 1875.

[NOTE.—Of the foregoing, Nos. 1, 2, 4 and 6 are wanted by the Survey.]

REPORT.

I.

SUMMARY STATEMENT.

The field work of the survey was continued during a portion of the season of 1876, in the southeastern portion of the state, where the county of Houston, which borders on the Mississippi river, was examined in detail, and is herewith reported, with the necessary maps and diagrams. Later in the season the county of Hennepin was surveyed in the same manner. It was hoped that by an examination of these two counties, the latter of which embraces the interesting locality of the Falls of St. Anthony, which have receded several miles up the Mississippi from the point at which they existed in earlier geological ages, some new light would be thrown on some of the problems that invest the history of the drift, and which have presented themselves in new phases in the counties of Fillmore and Houston. In the detailed reports on Hennepin and Houston counties these problems are briefly discussed, in the light of such facts as we possess. In the further examination of the region of the Falls of St. Anthony, which embraces parts of the counties of Ramsey, Washington ad Dakota, the remainder of the great gorge excavated by the recession of the falls will come under careful inspection. Until these counties are surveyed the history of this excavation cannot be given. Some progress has, however, been made in this interesting investigation.

In the latter part of August an examination of the fossils of the Trenton was begun, including those of the Galena division. This is our chiefly fossiliforous formation. Favorable opportunities for collecting fossils from the Lower Trenton exist at Minneapolis and at St. Paul. Tolerably full collections of its fossils are found in the possession of the survey, which, added to those of the Academies

of Science at St. Paul and Minneapolis, will make it possible to give, finally, a pretty good description of the Trenton fauna, as exemplified in Minnesota. In this examination, which is but just begun, there have been identified, at least provisionally—

10 species of Cephalopoda.
11 species of Gasteropoda.
11 species of Brachiopoda.
3 species of Polyp Radiates.
2 species of Crustacea.
2 species of Protozoa.

These are entirely from points in the southern part of the state. Several species have been met with that cannot be identified by any published descriptions, and a few drawings have been made.

In this connection should be mentioned the interesting fact that some indications have been discovered of an unconformability between the Devonian and Silurian which will necessitate changes in the colored county maps that have been published. This evidence is at present entirely of a palæontological character, and shows the necessity of keeping that branch of the work abreast of the field work. In the western part of Fillmore county the Niagara limestone seems to be wanting, or at least reduced to in significant dimensions, since the Lower Devonian, or what has been regarded hitherto as rock of that age, lies but a few feet above that which contains undoubted Trenton fossils. Further examination of these outcrops is needed before the question can be fully settled.

In respect to the chemical work of the survey the report of Prof. Peckham shows what has been done. It is highly desirable that there be no further obstacles to the vigorous prosecution of the chemical investigations. The laboratory is now completed and well equipped.

In December, 1875, the Board of Regents took action ordering the commencement of thorough botanical observations, and the collection of specimens at the State University. A circular was issued asking the co-operation of the botanists of the state, and prescribing general directions for the work. A number of favorable responses have been received, and several valuable papers on the flora of different localities have been contributed. This portion of the work of the survey seems to have been eagerly taken hold of, and there is every prospect that the botany of the state will be thoroughly and at the same time economically worked up. Ultimately the aid of an expert will be needed to compare and

digest the material that may be gathered. It will certainly be vastly cheaper, as well as more satisfactory to the people of the state, to carry on this great work of a state survey *as a unit*, with its different parts in harmony where each can aid the other by the various opportunities that arise, than by scattering it along so that each part is done separately. This is particularly true of the field-work. This economy and co-operation is so palpably essential that it has already been demanded by the intelligent press of the state.*

The Board of Regents have also taken action looking to the examination of the ornithology of the state, in the appointment of Dr. P. L. Hatch as ornithologist. His results, heretofore published only in the Proceedings of the Minnesota Academy of Natural Science, will hereafter be reported to the survey, and ultimately a complete memoir on the Birds of Minnesota will be prepared. It is to be regretted that some such action had not been taken before, since many good specimens, and needed information from different parts of the state might have been secured with but little extra expense, in the prosecution of the field-work of the survey. Mr. Herrick has also collected about a hundred species of birds in the immediate vicinity of Minneapolis, which are stored in the Museum.

The entomology of the state was also begun by the Board of Regents the past year, by the appointment of an entomologist to the survey, and his first report is herewith published. He was instructed to confine himself to an investigation of insects injurious to farm products, especially to the ravages of the Rocky Mountain locust. This investigation was begun the year before by Mr. Whitman, under instructions from Gov. C. K. Davis.

Further correspondence has been had with Col. C. B. Comstock, in charge of the United States survey of the lakes, in reference to the determination of the latitude and longitude of points in Minnesota by the officers of the Lake Survey. At his request certain points were designated, the latitude and longitude of which, if ascertained, would aid the Geological and Natural History Survey of the state. In connection with the survey of Houston and Hennepin counties the usual topographical data are given.

A complete series of meteorological observations should be established at the State University. They are especially appropriate to the Agricultural College. The law ordering the survey requires the tabulation of statistics relating to the weather, and the investi-

* Compare the First Annual Report on the progress of the survey, Regents' Report, pp 41, 44, and 119: also the Fourth Annual Report, p. 11.

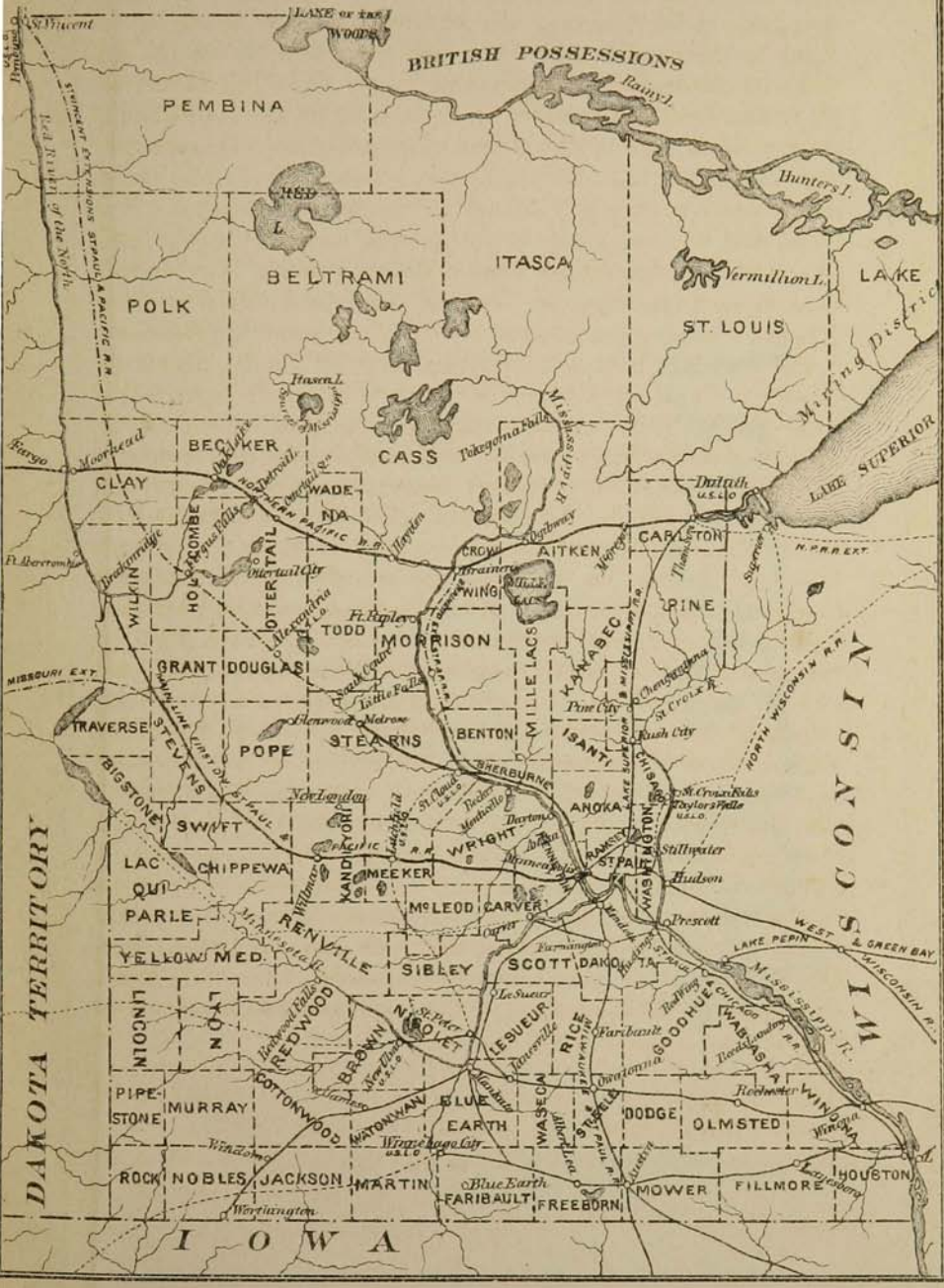
gation of the climate of Minnesota. An incomplete series of observations has been kept up by the writer at Minneapolis since the beginning of the survey and reported to the Chief Signal Officer of the Army at Washington. It requires, however, an outlay of about one hundred dollars for instruments to carry on the full series of observations contemplated by the Chief Signal Officer. To make a comparative study of the climate of Minnesota and of the northwest, with a view to the elimination and explanation of any peculiarities that Minnesota may possess, the observations of many observers at widely distant points must be collated. It is hoped that the survey may be able to avail itself of, if not to institute, complete observations made at the University. The Monthly weather Reviews, which are received regularly by the University Library, will be of the greatest service in accomplishing this work.

The year has been one of special activity in the University Museum. Besides the display of the casts of fossils purchased of Prof. H. A. Ward, and the mammals obtained in the Custer expedition to the Black Hills, in 1874, the invertebrates purchased of H. T. Woodman in 1872 have been examined and labeled, and placed on exhibition. Considerable collections of plants have been made, including some fungi ; about a hundred species of birds have been prepared for mounting, and several hundred specimens illustrating the paleontology of the Trenton formation have been named, and await the construction of cases for exhibition. At the close of the Centennial exhibition at Philadelphia eight boxes of ores and minerals were obtained from the various exhibits, mostly by donation, and have already been safely deposited in the storage room in the basement of the University, where, along with more than forty other similar boxes and cases, they also await the construction of other cases for their exhibition. In addition to these a purchase was made at Hoboken, N. J., of a fine general collection of mineral species, with many duplicates, especially intended to illustrate mineralogy. These consist very largely of crystalline forms. This collection, costing $400, will comprise at least forty boxes in excess of those already mentioned. For full details in respect to the Museum the reader is referred to the report on the Museum.

MAP OF MINNESOTA.

Showing Locations of the Counties.

Total area 83,531 Square miles.



GEOLOGICAL MAP OF HOUSTON COUNTY, MINN.

By N. H. Winchell, 1876.

REFERENCE

- Rail Roads
- Proposed Rail Roads
- Timber
- Swamp
- Creeks
- Bluffs
- Roads

- Trenton Lime Stone
- St. Peter Sand Stone
- Lower Magnesian
- St Croix Sand Stone

WINONA COUNTY

MONEY CREEK
HOUSTON
MOUND PRAIRE
LA CRESCENT
YUCATAN
SHELDON
UNION
HOKAH
BROWNSVILLE
CALEDONIA
MAYVILLE
BLACK HAMMER
CROOKED CREEK
WILMINGTON
WINNEBAGO
SPRING GROVE
JEFFERSON

FILLMORE COUNTY

MISSISSIPPI RIVER

WISCONSIN STATE

STATE OF IOWA

T104 N.
T103 N.
T102 N.
T101 N.

R VII W.
R VI W.
R V W.
R IV W.

II.

THE GEOLOGY OF HOUSTON COUNTY.

Situation and Area.

This county is the most southeasterly in the state, and contains sixteen government towns, forming very nearly an exact square. Its area is about 576 square miles, or 364,084.79 acres, according to the records of the State Land Office. It contains no lakes, but there are low lands both along Root river, and along the Mississippi, between the high bluffs, which are flooded most of the year. These lands when meandered by the original survey, and the actual water area of these rivers within the county, should be added to the aggregate acreage as above stated. The county seat is Caledonia. Houston, Hokah and Brownsville are the other principal towns, the last being the oldest in the county, having been settled in June, 1848.

Natural Drainage.

The general drainage is toward the Mississippi river, which lies along the east side of the county. Through the northern tier of towns Root river passes to the Mississippi. Thompson's creek joins it from the southwest at Hokah, and the south fork of Root river at Houston. It receives Money creek, Silver creek and Stover creek from the north, while Pine creek passes through the township of La Crescent and joins the Mississippi from the northwest a few miles below the village of La Crescent. Winnebago and Crooked creeks drain the southeastern portion of the county. There being no foreign drift in this county, these streams run in their ancient channels and several hundred feet below the general upland level. The loam which covers the county is generally almost impervious to water, so that these deep drainage courses do not operate to abstract the moisture from the surface soils so dis-

astrously as they would in more sandy soils. It is only along the immediate river bluffs that any injury to the soils from this cause is noticeable. These streams furnish water power at frequent points, even more than have been improved. At some of these points the following flouring mills have been erected:

At Riceford, on Crystal creek, one custom mill, by Oatman and Co., having a power of 18 feet head. This creek issues from the rock bluffs within a few miles of Riceford, nearly all in one volume.

At Riceford Mr. V. T. Beebe also has a custom mill with 12 feet head of water.

There is a custom mill on Bear creek, near the state line, (Sec. 34, Spring Grove,) owned by Mr. Swartzhoff.

At Freeburg, on Crooked creek, is a custom mill owned by Hill and Graff, with 16 feet head of water, and a sawmill owned by Wm. Oxford. Here are also two other mill privileges.

On Winnebago creek (Sec. 22 Winnebago) is a stone mill owned by B. T. Barbour, and on Sec. 15 a custom mill owned by McMillin, Johnson & Clark.

At Sheldon, on Beaver creek, is a mill of 12 feet power, owned by John Blain, and another of the same power owned by Snyder Brothers.

J. & C. B. Howe have a saw mill on Sec. 24, Yucatan.

Nathan Vance has a flouring mill on Sec. 12, Money creek, with 12 feet fall. Fox and Perkins have another on Sec. 30, with 10 feet power, from which shipments are made by railroad.

There is a mill at Houston with 7 feet fall, in the Root river, belonging to Mr. Grorsland.

There is a shipping and custom mill SE. ¼ Sec. 23, Houston, with 20 feet power, owned by G. W. McSpadden.

At Brownsville are two mills, one by Shaller Bros. of 2 run of stone, and 12 feet power, for shipping flour, and the other by J. Hankey, of 5 feet power and one run, for custom.

At Hokah all the mills ship flour. One is owned by C. Fischer, situated on Thompson creek, and has 24 feet of water fall; another by White and Brothers, and a third by E. Thompson. The last two have a fall of 9 feet in Root river. At Hokah the Railroad Machine Shops, and the Plow Factory also run by water power.

There is also a mill on Pine creek, near the county line (Sec. 3 La Crescent,) with 4 run of stone, and 13 feet fall, owned by Graff & Co., for custom and shipping; and another on the same creek, S. W. ¼ Sec 9, by J. D. Cameron, having 9 feet fall and 4 run of stone, for shipping.

The Toledo Woolen Mill, by Fletcher and Webster, S. W. ¼ Sec. 5, La Crescent, on Pine creek, has 7 feet power. This is built of stone quarried near.

Surface Features.

The topography of Houston county is very similar to that of the eastern, and particularly that of the northeastern part of Fillmore county. Taken altogether it is produced by the same causes. The strata cover the same geological horizons, at least the same as the non-drift-covered portions of Fillmore county. It varies from undulating to rough and hilly. The surface of the rock was gorged by numerous canons, each with its tributary gorges, prior to the spreading of the loam. These gorges are not so narrow as in much of the western and central parts of Fillmore county, but are of the same character as those in the Shakopee and St. Croix areas—broader and smoother, allowing the loam, when deposited, to enter their deepest recesses and to spread itself evenly over the whole. While the loam itself becomes thicker and more clayey toward the Mississippi river, it has so effectually and so deeply covered the whole country that generally a rolling or undulating surface has resulted which is almost free from the peculiar sink-holes so common in the Trenton area, but is characterized by deep, wide valleys and long ridges. The bluffs that enclose the valleys are sometimes tillable, or at least turfed over from top to bottom. They are of all hights from the more shallow depression sufficient for ready drainage, to valley lines over five hundred feet deep. The whole of Root river valley, which is in the St. Croix sandstone, is over five hundred feet in depth, with limestone capping the bluffs. Some of its tributary valleys are equally deep and wide, but the smaller tributary valleys become shallow and more rocky as the gorges ascend in the Lower Magnesian—the whole system making a series of deep valleys along the river and of alternating vales and ridges at greater distance from the main valley. The county is nowhere destitute of excellent natural drainage. There are very few of the characteristic sink-holes of the Trenton, that formation having but a small superficies in the county, and that not within the reach of important drainage couses which were capable of producing the preglacial gorges. Within the Shakopee area have been seen three or four similar sink-holes, but they differ from the Trenton sink-holes in being more plainly a part of continuous ravines and in being broader in comparison to their depth.

If the valleys excavated by drainage were filled up, the county would be very nearly flat, the highest part being in the southwestern corner, in the area of the Trenton limestone. The great diversity of surface that appears arises entirely from the effect of erosion by streams and atmospheric forces, on the rocks, which consist of alternating sandstones and limestones. This effect would be still greater, or rather would be still more apparent, were it not that the loess loam, which is very thick in this part of the state, tones down, with its overspreading canopy, the roughness which the rocky surface really possesses, leaving it actually one of an undulating or rolling character except along the immediate river bluffs, where the rocks frequently appear in craggy bluffs and cause precipitous or steep hillsides. The valleys excavated by the streams are remarkable and instructive. Not only have the larger streams cut out gorges of enormous depth in the rocky floors on which they run, but every little creek and tributary runs in a gorge which shows the same rock-sculpture. Even the freshet creeks, and the rivulets born after every summer shower, dry entirely the greater part of the year, find their way to the main valleys through rock-bound, canon-like valleys. This makes the county present the usual characters of southern latitudes where the northern drift sheet has not been spread. There is nothing more evident than that these valleys antedate to the great ice age. In other portions of the northwest where the drift does prevail, larger streams than those found in Houston county have generally worn their channels only through the drift sheet. The Mississippi river itself, above the Falls of St. Anthony, has no rocky bluffs. It very rarely even strikes the rock. It is occupied still in dissolving and removing the materials of the drift which covers that portion of the state. It would require a great many interglacial periods, or pre-glacial periods, to excavate it as deeply as the same valley is wrought in the southeastern portion of the state. In the limestone areas the valleys are narrow and more generally rock-bound; they widen out so as to inclose good farm lands on the bottoms in the sandstone areas. This distinction, however, is less evident than in Fillmore county, where the St. Peter sandstone plays a more important part in bringing about the present topography. It is, however, well illustrated in the upper portion of many of the tributaries of Root river. In descending one of these valleys from the upland the first descent is very rocky and very impracticable. This is caused at first by the cut through the Shakopee limestone. The Jordan sandstone that underlies the Shakopee sometimes relieves this ruggedness a little, but its thickness is so small compared to

that of the whole Lower Magnesian that it is barely observable in this way. Through the underlying St. Lawrence limestone the descent is also rough and the valley narrow, with little or no arable land in the valley. On reaching the horizon of the top of the St. Croix sandstone the change introduced into the aspect of the valley is very noticeable. It widens, the rock is seen exposed in a nearly continuous escarpment along the tops of the now more distant bluffs, the descent is easy, the stream flows with a winding course, and is perhaps fringed with a small shrubby growth, the lower slopes of the bluffs on either side are turf-covered, and finally a rich alluvial soil, spreading out over the bottoms shows here and there a spot that has been cleared and cultivated. This character then extends to, and follows, the whole course of Root river to its mouth, the valley constantly increasing in width, and showing a terraced condition, where ancient floods or periods of high water have stood, and whence, after vast accumulations of alluvium, have retired, reducing the river at last to its present insignificant dimensions. This is the general character of the valleys tributary to Root river, but this succession of changes can be seen within Houston county only in those tributary valleys on the south side of Root river. Those on the north side enter on the St. Croix sandstone before reaching Houston county. The best agricultural portion of the county is in the center and southwest quarter. The valleys throughout the county are generally wooded, and in the eastern part of the county a great deal of the upland is also wooded. Taken altogether the county may be denominated rolling, broken and hilly, though there are also some fine prairies that are simply undulating. All the farms are well drained naturally.

The following measurements by aneroid will show the depth of some of the valleys below the immediate upland at the points named.

Sec. 17, Caledonia, 3 miles south of Sheldon. Beaver creek, at the great spring, is 230 feet below the tops of the bluffs, which embrace the Shakopee limestone, Jordan sandstone and a part of the St. Lawrence limestone.

At Sheldon the bluffs are 420 feet high.

At Houston the bluffs north of the city are 520 feet above the level of water in Root river in summer.

At Hokah Mt. Tom rises 530 feet above the flood plain of Root river.

On Sec. 11, Union, the ridge between Thompson's creek and

the railroad, at the sculptured rock, rises 355 feet above the highway directly south of the ridge.

At Brownsville the hight of the bluff above the flood plain of the Mississippi is 495 feet. Mr. Fred. Gluck, of Brownsville, measured the same by triangulation in the winter season, and obtained 486 feet as the hight above the ice. Railroad surveyors are said to have obtained 483 feet as the hight of the same bluff. The most of this hight is made up of sandstone, there being but 105 feet of limestone in the upper part of the bluff, belonging to the St. Lawrence formation.

Elevations on the Caledonia and Mississippi Railroad.

This road runs from the Mississippi river westward 14¼ miles up the valley of Crooked creek. It is graded, but not yet furnished with track. These levels were furnished by Mr. Till, engineer of the road. The datum is the level of the track of the C. D. & M. R. R., just north of Crooked creek, Sec. 35, Town 102 N., Range 1 W.:

Datum	0.
Freeburg	21.92
Water at Oxford's dam, Freeburg	42.95
Crossing of Crooked creek at Sec. 36, 102 N., R. 1 W. (Powlesland's) bottom	56.32
Crossing of Crooked creek at Sec. 36, 102 N., R. 1 W. (Powlesland's) grade	65.32
Crossing of Crooked creek, SE. ¼ Sec. 26, 102 N., 2 W., below the junction of S. Fork—bottom	76.74
Crossing of Crooked creek, SE. ¼, Sec. 26, 102 N., 2 W., below the junction of S. Fork—grade	86.74
Surface of water at crossing of Crooked creek, NE. ¼ Sec. 22, Mayville	152.13
Bottom of creek at crossing of Crooked creek, NE. ¼ Sec. 22, Mayville	151.85
Bottom of creek at second crossing below John Molitor's, Sec. 16, Mayville	236.70
Grade at second crossing below John Molitor's, Sec. 16, Mayville	244.87
Bottom of creek at first crossing below John Molitor's, Sec. 16, Mayville	250.77
Grade at first crossing below John Molitor's, Sec. 16, Mayville	256.72
Dorsh's quarry, Sec. 17, Mayville, grade	333.10
Natural surface at the Methodist church, Caledonia	551.18
Summit, Natural surface, NE. ¼ Sec. 13, Caledonia	571.57

Elevations on the Houston, Hesper and Southwestern Railroad. (Proposed.)

This line runs from Houston, on the Root river, where it intersects with the Southern Minnesota Railroad, southwestwardly, ascending the valley of Beaver creek, through Sheldon, Caledonia and Spring Grove townships. The following data were furnished by Dr. F. Worth, president of the conpany. The datum point was at Houston, on the grade of the S, M. R. R. where it crosses the line between sections 33 and 34, seven hundred and eleven feet above the ocean :

	Sections.	Above Houston.	Above the Ocean.
		Feet.	Feet.
Crossing township line between	4 and 9	6	717
Crossing section line between.....	8 and 9	7	718
Crossing section line between.....	7 and 8	7	718
Crossing section line between.....	7 and 18	9	720
Crossing section line between	18 and 19	23	734
Crossing section line between.....	19 and 30	29	740
Crossing section line between.....	30 and 31	49	760
Sheldon village plat on section 31.....	.....	79	790
Crossing section line between.....	31 and 32	76	787
Crossing section line between.....	32 and 5	82	794
Crossing section line between.....	5 and 6	87	799
Crossing section line between.....	6 and 7	109	820
Crossing section line between.....	7 and 12	118	829
Crossing section line between.....	12 and 13	119	830
Crossing section line between.....	13 and 24	167	878
Crossing section line between.....	24 and 25	248	862
Crossing section line between.....	25 and 26	269	883
Crossing section line between.....	26 and 35	331	1,042
Crossing section line between.....	35 and 34	384	1,095
Crossing section line between.....	34 and 3	395	1,106
Crossing section line between.....	3 and 4	422	1,133
Crossing section line between.....	4 and 9	428	1,139
Crossing section line between.....	9 and 8	457	1,168
Crossing section line between.....	8 and 17	494	1,205
Crossing section line between.....	17 and 20	500	1,211
On section 17, highest point.....	.....	524	1,235
Crossing lines between sections.....	20 and 19	456	1,167
Crossing lines between sections.....	19 and 30	462	1,173
Crossing lines between sections.....	30 and 25	476	1,187
Line between Houston and Fillmore Co...	.....	562	1,273
Crossing section line between.....	25 and 26	437	1,148
Crossing section line between.....	26 and 35	442	1,153
State line west of center of Sec. 35, Newburg Township.....	.....	465	1,176

Notes on the Plats of the United States Survey in Houston County, on record in the Register's Office at Caledonia. (The county was surveyed in 1852-3-4.)

T. 101 *N.*, 3 *W.—Fractional; East part of Jefferson.*

This is embraced wholly within the river bottoms of the Mississippi. It is timbered but low, with some marsh and standing water. Mag. Var. 8° 15' to 8° 50'. Acreage, 3,169.76.

T. 101 *N.*, 4 *W. West part of Jefferson and South part of Crooked Creek.*

The Mississippi bluffs run north and south across the east end of this town, which embraces some marsh and slough land in the eastern tier of sections. These bluffs, which unite with those of Winnebago creek from the west, in the southeastern corner of the town, introduce in that portion a very rough and rocky character of surface. The town is nearly covered with timber. Mag. Var 7° 36' to 8° 45'. Acreage, 22,546.52.

T. 101 *N.*, 5 *W. Winnebago.*

This is crossed by Winnebago creek, which receives several tributaries from the north and from the south. There is a tract of prairie in the southwest corner of the town, and another in the northwest corner. The remainder is either timbered or shrubby with oaks and aspens. The creek valley is deep and rocky. Mag. Var. 8° to 8° 52'. Area, 23,045.05 acres.

T. 101 *N.*, 6 *W. Willmington.*

This town is about equally divided between prairie and timber, which are irregularly intermingled. Waterloo creek, in Secs. 29, 32 and 33, runs in a deep valley, with steep and rocky banks. Mag. Var. 5° 49' to 8° 31'. Area, 23,037.13 acres.

T. 101 *N.*, 7 *W. Spring Grove.*

Along the northwest edge of this town the South Fork of Root river causes a deep valley, which is rough, timbered, and rocky. The rest of the town is variously overspread with mingled prairie and timber or oak bushes, with gently undulating and sometimes rolling surface. Mag. Var. 5° 3' to 9° 5'. Area, 23,045.12 acres.

T. 102 *N.*, 4 *W.* *Crooked Creek and South part of Brownsville.*

This town is named from the creek which crosses it from west to east, south of the center. This creek, with its branches, causes a rough and rocky surface, with deep gorges over a considerable area. The town has no natural prairie. Mag. Var. 7° 35' to 8° 45'. Area, 20,403.73 acres.

T. 102 *N.*, 5 *W.* *Mayville and West part of Crooked Creek.*

In the central portion of this town are the sources of Crooked creek, which leaves the town toward the southeast, in Sec. 25. With the exception of small portions of Secs. 31 and 32, this town has no prairie, but the heaviest timber is along the creek and its tributaries. The surface is undulating to rough. Mag. Var. 6° 57' to 8° 30.' Area, 22,976.20 acres.

T. 102 *N.*, 6 *W.* *Caledonia.*

Beaver creek is the only stream in this town. It causes a rough and bluffy surface in Secs. 19, 18, 7, 6, 5, 8 and 17, flowing northward. A little more than one half is of prairie, the timber being along the creek and in the eastern side of the town. Mag. Var. 6° 13' to 9° 35'. Area, 23,063.95 acres.

T. 102, *R.* 7 *W.* *Black Hammer.*

The south fork of Root river crosses the western portion of this town in a northerly direction, accompanied by a heavily timbered and rocky tract affecting nearly one-half of the town. There is an irregular strip of prairie which enters the town from the southeast and runs northwest past the center. Mag. Var. 5° 24' to 8° 15'. Area, 23,042.34 acres.

T. 103 *N.*, 4 *W.* *North part of Brownsville and South part of Hokah.*

This is a border town along the Mississippi, and in the north has some bottom land east of the bluffs. In the southern portion the river approaches near the bluffs. No prairie is shown. The Wild Cat creek joins the Mississippi at Brownsville, Sec. 26, and Thompson creek flows across the northwest corner. These streams, like others in the county, run in deep, rocky valleys, and cause a

great diversity of surface some distance on either side from the immediate valley. They have a great many tributary valleys which do not contain streams, but which are equally deep and bluffy. Mag. Var. 7° 35' to 9° 1'. Area, 20,912.18 acres.

T. 103 *N.*, 5 *W.* *Union and South part of Mound Prairie.*

Root river, with its tributaries, the Crystal, Bear, and Thompson creeks, causes a rolling, and even a rough, surface over much of this town, with frequent rock exposure. There is a small area of prairie covering Sec. 4, with adjoining parts of 5, 8, 9 and 3; but the greater part of the town is represented as timbered, or overgrown with small oaks and aspens, and with hazel. Mag. Var. 6° 39' to 8° 51'. Area, 22,951.16 acres.

T. 103 *N.*, 6 *West.* *Sheldon and South part of Houston.*

The South Fork of Root river, with its tributaries from the south, Beaver, Crystal and Badger creeks, covers this town with a network of deep valleys, in many places very rough. In the eastern portion of the town the surface is more uniform and open. Mag. Var. 6° 39' to 8° 54', Area, 22,854.31 acres.

T. 103 *N.*, 7 *W.* *South part of Yucatan.*

The South Fork of Root river crosses the southeastern quarter of this town. The whole town is rough and wooded, except a narrow prairie belt occupying the river bottoms. Mag. Var. 6° 35' to 9° 15'. Area, 23,045.67 acres.

Town 104 *N.*, 4 *W.* *North part of Hokah, and East part of La Crescent.*

This is a Mississippi river town, and between the line of the river bluffs and the channel of the river is a belt of bottom land, much of it marshy, from two to four miles wide. The Root river cuts a deep gorge across the southern part of the town, and Pine creek crosses the northern portion. Mag. Var. 7° 45' to 8° 58'. Area, 20,398.03 acres.

T. 104 *N.*, 5 *W.* *Prairie Mound and West part of La Crescent.*

This town is crossed by Root river, along the southern two tiers

of sections. It has a belt of prairie within the rocky bluffs, covering Secs. 33, 34 and 35, and a marsh in Secs. 30 and 31, but the rest is more or less wooded. Pine creek also crosses the northeastern portion of the town. Mag. Var. 7° 45' to 8° 49'. Area, 23,045.07 acres.

T. 104 *N.*, 6 *W.* *Houston and East part of Money Creek.*

This town is broken by Root river and Money creek. It also has Silver creek in the eastern portion. There is a belt of prairie land along the south side of Root river, within the rock bluffs, and in the western portion of the town in Money creek valley, but the most of its area is wooded and broken. Area, 22,984.56 acres.

T. 104 *N.*, 7 *W.* *North part of Yucatan and West part of Money Creek.*

This town has prairie bottom-land along Root river, which crosses it from W. to E. in the southern half, and along Money creek in Secs. 1, 2 and 12. The rest of the town is more or less wooded, with a rolling surface Mag. Var. 7° to 8°. 45'. Area, 23,179.03 acres.

The Soil and Timber of Houston county.

The soil of the county is formed by the loess loam. It is very fertile, and apparently very enduring. It is mainly a clayey deposit, without stones or gravel, but yet in some places becomes arenaceous, the sand grains being very fine. The loess is hardly pervious to water. In the scarcity and costliness of common wells, many farmers resort to the expedient of retaining the surface water, after rains, in open reservoirs produced by throwing a low dam across some of the shallow drainage valleys that intersect their farms, thus forming with the common loam a small pool or lake for the use of their stock. Except on the brows of the bluffs which inclose the valleys this loam is thick enough to make a reliable subsoil as well as surface soil. In some of the valleys it is very thick, but here it is apt to be influenced by the causes that produced the river terraces and to mingle with the ordinary alluvium. On the uplands generally where it may not have been reduced by wash, its average thickness might reach 30 feet, but in some of the valleys material of the same aspect is sometimes encountered to the depth of over one hundred feet.

In the valley of Root river, and also along the Mississippi, the soil of the alluvial terraces, greatly resembling that of the loam in the uplands, is apt to be more sandy, and sometimes becomes very light and very poor. These materials are generally seen to be in obliquely stratified layers, and to embrace, in the Mississippi valley, small gravel stones of northern origin. The immediate flood plain of these rivers presents still another variety of soil. While it is generally sandy, and often very light, it is also a very rich soil, and is apt to be enduring by reason of the Nile-like overflows to which it is subjected, and the decomposition of large quantities of vegetation. This variety of soil sustains some of the heaviest forests to be found in the county.

The county is supplied with plenty of timber for fuel, and with some that is useful for lumber. The following list comprises a nearly, if not quite, complete catalogue of the trees and shrubby plants of the county:

Quercus rubra. *L.* (?) (Red Oak.)
Quercus macrocarpa. *Michx.* (Burr Oak.)

[These two oaks are common in the uplands. As brush and small trees they often form thickets. There are also trees of the black oak, or what are accepted as black oak by the farmers, and it may be that only the black and bur oaks exist in the county. Although considerable time has been spent in the attempt to identify this oak, mentioned in former county reports as *Q. rubra*, with doubt, it is still unsettled. There seem to be two species in some places, but in others the characters are blended in one. There is a plain popular distinction between the red and the black oak, and solitary trees of the latter are often seen of large size standing in the midst of brush, belonging apparently to a former forest growth now destroyed, while the former is very abundant as small trees or underbrush, often presenting some of the popular characteristics of the latter.]

Quercus alba, *L.* (White oak.)
Populus tremuloides, *Michx.* (Aspen.)
Populus grandidentata, *Michx.* (Great-toothed poplar.)
Populus monilifera, *Ait.* (Cottonwood.)

[Of these poplars, the first two are by far the most common, but in proportion to their numbers make fewer large trees than the last. They rarely exceed six or eight inches in diameter, while the cottonwood sometimes becomes two or three feet in diameter, as seen in the Root river valley at Houston. The cottonwood has a rough bark. The bark of the aspen may be distinguished from that of the great-toothed poplar at a distance by the fact that the former becomes white, or mottled with white, as the tree gets the size of three or four inches in diameter, while that of the latter maintains its greenish or dingy-yellow color.]

Populus balsamifera, *L.* (Balm of Gilead.) [Common in cultivation. There are some fine large trees of this kind at Mr. Powlesland's, Sec. 36, Crooked Creek.]

Populus dilatata, *Ait.* (Lombardy poplar.) [Only seen in cultivation.]
Acer rubrum, *L.* (Red maple.)
Acer saccharinum, *Wang.* (Sugar maple.)
Acer saccharinum, *Wang.* Var. nigrum, *Gray.* (Black Sugar-maple.)
[Sometimes known as Rock Maple.]

Ulmus Americana, *L. (Pl. Clayt.) Willd.* (American Elm.)
Ulmus fulva, *Michx.* (Slippery Elm.)

[The first named elm is very common, and acquires a very large size in the bottom lands of the Root river, but the latter is comparatively rare. As with the oaks, the popular ideas of the elm do not agree with the scientific distinctions of Prof. Gray's Manual. Good observers and woodsmen insist invariably that there are three elms found commonly in the central and southern part of the state, viz., *Rock*, *Water* and *Red.* The first is easily understood to be the well known *American* or *White Elm*, the last the common *Slippery Elm*, but the second is not distinguishable by any botanical characters. It is named from the abundant discharge of water or sap, which it furnishes on being wounded or cut, especially at certain seasons of the year. In addition to these, sometimes a so-called *Swamp Elm* is insisted on. Prof. Harrington has reported the *Corky Elm* from Olmsted county, and this may be one of the elms popularly recognized. The demands of the geological work have not yet permitted the careful examination of these distinctions.]

Tilia Americana, *L.* (Basswood.)
Carya amara, *Nutt.* (Bitternut.)
Carya alba, *Nutt.* (Shag-bark hickory.)

[Of these the former furnishes the great bulk of the hoop-poles for flour barrels cut in the southern and central portions of the state, the latter being a much more rare tree. It is only in Houston county that the shag-bark hickory is known to occur generally. It is exceedingly rare in Fillmore county, and does not occur in the Big Woods.]

Juglans nigra, *L.* (Black Walnut.)
Juglans cinerea, *L.* (White Walnut or Butternut.)
[The former is comparatively rare, but the latter is one of the most common trees along valleys.]
Fraxinus Americana, *L.* (White Ash.)
Fraxinus sambucifolia, *Lam.* (Black Ash.)

[The former is often seen as a large tree, but the latter is rare, having been noted only in the timbered bottoms of the Root river at Houston.]

Prunus Americana, *Marsh.* (Wild Plum.)
Prunus Pennsylvanica, *L.* (Wild Red Cherry.)
Prunus Virginiana, *L.* (Choke Cherry.)

Prunus serotina, *Ehr.* (Black Cherry.)
Pyrus coronaria, *L.* (American Crab-apple.)
Negundo aceroides, *Mœnch.* (Box Elder.)
Crataegus coccinea, *L.* (Thorn Apple.)
Crataegus tomentosa, *L.* (Black Thorn.)
Celtis occidentalis, *L.* (Hackberry.)
Betula excelsa, *of American Authors.* (Gray Birch.)
Betula alba. var. populifolia, *Spach.* (?) (White Birch.)

[Of these two birches the latter is quite common, but the former is rare. The outer bark of the latter is snowy white, and the tree rarely becomes larger than three or four inches in diameter, and indeed is usually less than two. It frequents rocky banks and sterile soils, being rarely seen except along a hillside, where its white small trunks make it very noticeable. The former has been seen only in moist, rich lowlands, with large timber surrounding, and is apt to grow, unless injured, to a large tree of a foot or two in diameter. It is probably the same as *B. lutea, Michx. f.* of Gray's revised manual. Its twigs and bark are so aromatic as to cause it to be mistaken for the black, or cherry-birch of the Middle and Eastern States, which has not yet been reported as occurring within the State of Minnesota.]

Pinus Strobus, *L.* (White Pine.)

[On Crooked creek; at La Crescent; on Bear creek; on Winnebago and Money creeks.]

Ostrya Viginica, *Willd.* (Ironwood.)
Salix—Sp. (?) [Various species; one species becomes a large tree, as seen in the bottoms at Houston.]

Gymnocladus Canadensis, *Lam.* (Kentucky Coffee tree.)

[The Coffee tree occasionally is seen, even 18 inches in diameter, and is used for lumber. It was particularly noted about Houston.]

Larix Americana, *Michx.* (Tamarack.)

[Only known on Pine creek.]

Cornus circinata, *L'Her.* (Round-leaved Cornel.)
Cornus sericea, *L.* (Silky Cornel.)
Cornus paniculata, *L'Her.* (Panicled Cornel.)

[Along the ravines.]

Cornus alternifolia, *L.* (Alternate-leaved Cornel.]
Gaultheria procumbens, *L.* (Wintergreen.)

[Seen only at Mound Prairie.]

Alnus incana, *Willd.* (Speckled Alder.)
Diervilla trifida, *Mœnch.* (Bush Honeysuckle.)

[Along the bluffs of the Mississippi.]

Rhus typhina, *L.* (Stag-horn Sumac.)

[Rare; seen at Brownsville.]

Sambucus Canadensis, *L.* [Common Elder.]
Castanea vesca, *L.* (Chestnut.)

[Cultivated; seen on Sec. 29, Union.]

Robinia Pseudacacia, *L.* (Locust.)

[Only cultivated.]

Gleditschia monosperma, *Walt.* (Water Locust.)

[Only in cultivation; seen at Hokah.]

Rosa blanda, *Ait.* (Early Wild Rose)
Rosa Carolina, *L.* (Swamp Rose.)

[This is a bushy rose, eight feet high and less.]

Rhus glabra, *L.* (Smooth Sumac.)
Rhus Toxicodendron, *L.* (Poison Ivy.)
Abies balsamea, *Marshall.* (Balsam Fir.)

[Only in cultivation.]

Rubus strigosus, *Michx.* (Red Raspberry.)
Rubus villosus, *Ait.* (High Blackberry.)
Rubus occidentalis, *L.* (Black-cap Raspberry.)
Rubus ———(?) (Low-bush Blackberry.)

[More or less trailing.]

Juniperus Sabina, *L.* Var. procumbens, *Pursh.* (Trailing Cedar.)

[Hokah and Sheldon.]

Juniperus Virginiana, *L.* (Red Cedar.)
Apocynum androsæmifolium, *L.* (Dogbane.)
Carpinus Americana, *Michx.* (Water Beech.)
Spiræa opulifolia, *L.* (Nine-bark.)
Zanthoxylum Americanum, *Mill.* (Prickly Ash.)
Amorpha canescens, *Nutt.* (Lead Plant)
Lonicera parviflora, *Lam.* (Small honeysuckle.)
Amelanchier Canadensis, *Torr. & Gray.* (Juneberry.)
Vitis cordifolia, *Michx.* (Grape.)
Ampelopsis quinquefolia, *Michx.* (Virginia Creeper.)
Celastrus scandens, *L.* (Bittersweet.)
Clematis Virginiana, *L.* (Common Virgin's Bower.)

[Common in the valley of Root river, below Hokah.]

Viburnum Lentago, *L.* (Sheepberry.)
Viburnum Opulus, *L.* (High-bush Cranberry.)

Ceanothus Americanus, *L.* (Jersey Tea.)
Aristolochia Sipho, *L'Her.(?)* (Pipe Vine.)
Ribes Cynosbati, *L.* (Gooseberry.)
Ribes floridum, *L.* (Wild Black Currant.)
Ribes rotundifolium, *Michx.* (Gooseberry.)
Corylus Americana, *Walt.* (Hazel.)
Symphoricarpus occidentalis, *R. Br.* (Wolfberry.)
Dirca palustris, *L.* (Leather-wood.)

[This was found along the bottoms of Beaver creek, in Caledonia township, in the neighborhood of the Great Spring. The wood, instead of being "very brittle," as described by Gray, was pliable and spongy, resembling a green cornstalk. This was in the month of July.]

Smilax rotundifolia, *L.* (Common Greenbrier.)

[This was seen growing very luxuriantly in the sandy alluvium of the Root river bottoms, below Hokah, associated with the Virgin's Bower and the Climbing Bittersweet. In the same vicinity were also the wild grape, the Virginia Creeper, and a number of herbaceous vines. The leaves on the different parts of the Greenbrier differ very noticeably. Those on the large annual shoots, which run 10 or 15 feet, are ovate and heart-shaped, large, 3 inches long; those of the fruiting stems or branchlets are rarely heart-shaped, but are ovate, and less than half the size of the former. Both sorts are rough on the edges, and on the prominent ribs beneath, and are barely pointed. The Carrion Flower, *Smilax herbacea, L.*, was doubtfully identified in the ravines on the north side of the valley at Houston.]

It is noticeable that many of the valleys, particularly those running east and west, as Crooked creek valley, have the bluffs along the north side of the creek destitute, or nearly so, of timber, but are heavily timbered along the opposite bluffs, on the south side. This may be due to warm days in winter or early spring, when the sap may have started in the trees on the north bluffs, followed by severely cold weather, before the actual setting in of steady warm weather. Of course the sun's heat would be quickest felt on the bluffs facing south. This process, repeated for a good many years, would injure and at last destroy the timber on the north bluffs, if it were ever possible for trees to have come to maturity there, while timber on the south bluffs would escape these sudden changes, owing to the shaded condition of the bluffs during the warmest portion of the day, and would only experience a steady increase of warmth due to the progress of the season.

The Geological Structure.

The rocks of Houston county are embraced wholly within the Lower Silurian. They are as follows:

The *Trenton limestone*, confined to the southwestern quarter.

The *St. Peter Sandstone*, in an irregular area surrounding the area of the *Trenton* above.

The *Lower Magnesian* formation, comprising the three parts, *Shakopee limestone*, *Jordan sandstone* and *St. Lawrence limestone*, and underlying the greater portion of the county.

The *St. Croix sandstone*, which is found only in the bluffs of the Mississippi and Root rivers, and of their tributary valleys.

The accompanying map of the county shows the superficial areas to which each of the foregoing formations pertains. Owing to the frequent deep valleys the geographical boundaries of the formations make very crooked and tortuous lines. Although these valleys are more or less filled with the loess loam, the topography still is so marked, pertaining to and even caused by each different formation in the county, that the outlines of the geological structure are very evident to the observer. As in Fillmore county, there is more or less doubt about the position of the boundary between the St. Peter and the Lower Magnesian. The incoherency of the St. Peter causes it to crumble easily, and to leave no evidence of its final dissolution where the exact contact between the formations cannot be examined—and the loam generally securely hides this horizon.

The Trenton Limestone.

The greater portion of this formation, which is found within the county, is of the Lower Trenton, so-called, and produces the same topographical features as in Fillmore county. The reader is referred to the report of progress for 1875, where the geology of that county is given, and the effect of the Lower Trenton on the surface features is discussed and illustrated by diagrams.

This formation is found in Spring Grove and Willmington townships. It runs also in a narrow, but interrupted belt, nearly to Caledonia, where it may be distinctly seen, in its peculiar features, and its flat-topped mounds, or tables, a mile west of that village. There is reason to suppose that it formerly extended much farther east than it does now, covering the most, perhaps the whole, of the county, and being continuous with the horizon of the same formation on the east of the Mississippi river, in Wisconsin.

The usual characters of the Lower Trenton, both lithological and palæontological, were the only ones noticed in Houston county It has been opened for quarries only in the vicinity of Spring

Grove. It generally presents a stained and long-weathered aspect, as if split and dissolved by the action of water. The layers are at first about an inch in thickness, but become thicker, by adhering to each other, on being wrought to some depth, and possess a blue color.

The St. Peter Sandstone.

This lies next below the Trenton. Its area embraces not only the slope from the high table-land of the Trenton area, but also a belt extending in width from the foot of that slope over the more level country surrounding, so that its irregular area is often a mile or two in width. As already remarked, while its upper limit has a very easily recognized location, by reason of the terrace like topography of the Lower Trenton, its lower horizon is often very uncertain on account of the very easy and gradual destruction of its layers, and the prevalence of the loess loam.

The character of this sandstone in Houston county is about the same as described in other counties, and need not be detailed again here. It was noticed, however, that for some reason it is more frequently hardened by iron, or lime and iron in Houston county, into a firm rock, which causes it to sustain a weathered exposure without crumbling rapidly away, than in counties further north or west where the northern drift prevails. This, however, is purely an accidental and surface quality, the interior of the formation being about the same as at other places. The cement which it possesses in Houston county, in its exposed portions, in excess of the same at other points, is no doubt due to the water by which it has been submerged and stained during the deposition of the loess loam.

The thickness of the St. Peter sandstone was very satisfactorily ascertained on the S. W. ¼ Sec. 17, Wilmington. The well of Mr. O. A. Bye is situated near the Trenton bluff, and by uniting the known depth drilled in the sandstone with aneroid measurement of the bluff, the St. Peter was found to be between 75 and 80 feet thick, the Shakopee below having a thickness of 64 feet.

The Shakopee Limestone.

The continuity of this formation from the Minnesota valley to the Mississippi, and its identity with the limestone at Shakopee, where it was first recognized as a distinct member of the Lower Magnesian in Minnesota, was fully established in the survey of

Houston county. It is everywhere distinct as the uppermost portion of the Lower Magnesian, and is everywhere separated from the other great calcareous member of the same formation by a sandstone as distinct and continuous, and as clearly recognizable, as the St. Peter sandstone. There can be no further question of its existence and its great extent. There seems every reason to believe also that it exists across the Mississippi, in the state of Wisconsin, but at this time there is no distinct published notice of its occurrence there. The Lower Magnesian in Wisconsin has been divided by Prof. R. Irving, of the Geological Survey of Wisconsin, into three parts, as exemplified near Madison, (*American Journal of Science and Arts, June*, 1875,) but there is much reason to believe that his proposed subdivisons do not include the Shakopee limestone at all, and that the distinctions in the Lower Magnesian which he mentions are wholly confined to the St. Lawrence limestone of Minnesota. This subject was discussed by the writer in the *Bulletin of the Minnesota Academy of Natural Sciences, for* 1875, when this hypothesis was first published. It is rendered still more plausible, in the absence of further facts in Wisconsin, from the fact that even in Houston county the St. Lawrence exhibits variations of composition and lithology which are comparable to those Prof. Irving describes.

The characters of the Shakopee in Houston county are not noticeably different from those mentioned in the reports of progress for 1873 and 1875. Its bedding is much less regular than that of the St. Lawrence. It is apt, indeed, to be disturbed by cherty, or concretionary masses, which on the weathering away of the bluffs become detached and fall into the bottom of the valley, where they lie long after the non-silicious portions of the rock have dissolved and disappeared. Such cherty lumps are often a foot, or even two or three feet in diameter. They are roughened by cavities opening on the surface, by dissolution of the most calcareous parts, and by the natural openings and pores they acquired in the act of formation. They are the only portions of the formation in which fossils have been found in Houston county. These masses sometimes show surfaces of drusy quartz crystals, also amethyst crystals, and great quantities of pyrites, oxydized and hydrated so as to produce a limonite, the form of the crystal alone remaining to indicate the original mineral. A careful study of these fossils has not yet been made, but there is some evidence, from the handling to which some of them have been subjected in the examination of the Trenton fossils now going on, that the Shakopee limestone is the equivalent of the Chazy of New York, a formation which has

not been recognized in the state, though the St. Peter has been regarded by Prof. Hall as its equivalent.

This formation does not appear in the bluffs of the Mississippi river, in Houston county, nor in those of Root river generally; but its line of strike is some miles back in the country away from the immediate bluffs. This is due to the crumbling nature of the Jordan sandstone which underlies it, and which operates, in that respect, to tear down the Shakopee in the same manner, and for the same causes, as the St. Peter on the Trenton. To this fact, and to its general resemblance to the St. Lawrence limestone, may be attributed the non-discovery of this limestone by the United States geologists who have reported on the geology of the state, or by others, whose examinations were largely confined to the main water courses, before the general settlement of the state and the construction of good roads. Its area is embraced, on the colored map of the county, in that assigned to the Lower Magnesian.

This limestone may be seen frequently in the central portion of the county, in the upper reaches of the ravines which radiate in all directions from the vicinity of Caledonia. It is seldom quarried, or used for any purpose, for the St. Lawrence limestone is generally accessible in the immediate neighborhood, and that is much more desirable for building-stone, or for lime-making. In descending the ravine toward the quarries east of Caledonia the Shakopee is the first limestone seen exposed. The quarries are much lower—in the St. Lawrence. It may be seen also in the upper tributary valleys that feed Badger, Beaver, Crystal and Thompson creeks. It causes the first rugged or rocky portion of those valleys. It is exposed in the tops of the bluffs at the great spring, Sec. 17, Caledonia, three miles south of Sheldon. Its thickness at Mr. O. A. Bye's, Sec. 17, Willmington, when drilled through, was found to be 64 feet, which is probably about its average thickness throughout the county.

The Jordan Sandstone.

The lithological features of this sandstone are nearly the same as those of the St Peter, but it has only about one-half the thickness of the St. Peter. Its area of outcrop is quite small, and its exposures are few. As it lies between two hard limestones, which are apt to form perpendicular, walled bluffs, its line of outcrop is known by a belt of non-exposure of rock separating the Shakopee from the St. Lawrence, which is less steep in the ascent, and perhaps turfed over. It often becomes rusty and firm from a cement

of iron, when it endures longer exposure, and is seen as detached blocks in the valleys. Some blocks of this kind are visible by the roadside in the ravine that descends to the quarries of Aikin and Molitor, a mile east of Caledonia.

The St. Lawrence Limestone.

This is the most important formation in the county. It not only occupies a greater superficial area of outcrop than any other, but it takes the most prominent part in causing the varied topography of the county. It surmounts the St. Croix sandstone, an easily eroded rock, into which the valleys are deeply and rapidly cut, and maintains a bold and sharp outline along their tops. It is the immediate cause of a great many hills and ridges. It confronts the observer in every nook and on every promontory, along the whole course of the Root river, and down the Mississippi bluffs as far as the state line, and it is especially conspicuous in the little valleys that ascend from the streams, and that often are more rocky than the larger valleys.

The thickness of the St. Lawrence in Houston county is about 200 feet, though other geologists have reported it as 250 feet thick at La Crosse. It is a dolomite, or magnesian limestone. Its layers, while generally regular and useful as a building-stone, are also sometimes very much brecciated, rendering it at once more firm, but also more refractory. It furnishes more stone for building than all the other formations of the county combined. It is of a light, lively color, and endures the weather perfectly, showing not the least change in the oldest buildings in which it has been used

The St. Croix Sandstone.

This name was applied, in the first annual report, provisionally to the light-colored and often friable sandstones which occur along the Mississippi river in Minnesota, and which have by some been regarded as the stratigraphical equivalent of the Potsdam sandstone of New York. This was done because, in the existence of another formation, of different lithology, affirmed also to be the equivalent of the New York Potsdam, it was necessary to have some designation for each of them. It seemed from considerations there given, that the lower of these two sandstones was the probable equivalent of that formation in New York, and in subsequent reports, while no facts have been gathered that confirmed that

view, the survey not having been carried on where these rocks are exposed, the provisional name has been continued. It is only in the county of Houston that any opportunity has been afforded for an examination of this formation, since the season of 1872.

It is not intended here to enter upon an examination of the evidences of the parallelism of this sandstone with any eastern formation, nor to cite or compare authorities one way or the other. Considerable has been written on the sandstones of the Lake Superior region as developed in Michigan, Wisconsin and Canada, tending to show the existence of two distinct sandstone formations. Prof. Irving (American Journal, 3rd Series, Vol. VIII, p. 46.) reports *three* different sandstones existing in the northwest involved in this disputed horizon, as exemplified in his study of northwestern Wisconsin, viz.: (1) Copper-bearing, highly tilted sandstones, conglomerates and shales, associated with trap. (2) Horizontal, aluminous, red sandstones, lighter than those associated with the trap, which "*appear to dip* underneath the light colored Lower Silurian sandstones of the Mississippi Valley," and (3) the light-colored sandstones of the Mississippi valley. In this he agrees with Dr. C. Rominger (Vol. I, p. 95, Palaeozoic Rocks, Geological Survey of Michigan,) who makes them—(1) Copper-bearing rocks, (2) Lower Division of the Lake Superior sandstone, and (3) the Upper Division of the Lake Superior sandstone. Brooks and Pumpelly, however, do not make mention of but two series of sandstones in the Lake Superior region, viz.: (1) The copper-bearing series, and (2) the Silurian sandstones. (Michigan Geological Survey. Vol. 1. Part I, pp. 75 and 185; and Part II. p. 1.) Foster and Whitney in 1851 referred all the sandstones in question to the Potsdam of N. Y., regarding them as deposited over an uneven surface, producing local cross-stratification and unconformability. (Report on the Geology of the Lake Superior Land District. Part II, p. 120.) In this they were seconded by Prof. James Hall, and followed by Prof. J. D. Dana in his Geological Manual, First Edition. More lately, in 1862, Prof. Hall parallelized the uppermost of these sandstones with the New York Potsdam, (16th Regents' Report, p. 119,) with the cautionary remark that "it may not yet be regarded as proved that the sandstone from which I have described these fossils is in all respects the equivalent of the Potsdam sandstone of New York, Vermont and Canada. It may represent more, or it may represent less than that formation. The *lower* accessible beds of the Mississippi valley may represent the Potsdam of one hundred and fifty or two hundred feet in thickness in the typical localities in New York,

while the middle and upper beds of the west may be of epochs not represented in that part of the series studied in New York." As long as the Potsdam sandstone at the typical localities in New York was accepted as the base of the fossiliferous primordial strata, while at the west there are two recognized sedimentary sandstones, though not yet proved fossiliferous, lying below the sandstones of the Mississippi valley, it seems quite presumptious to affirm the horizontality of the light-colored sandstones with the New York Potsdam, especially when, as admitted by Prof. Hall, "there are no species of fossils in the western sandstones which are positively identical with those of New York." It would be more in keeping with recognizing stratigraphical laws, to allow that formation which in New York begins with the top of the "azoic" to begin there also in Minnesota.

In this state of the question concerning these sandstones it seems justifiable to retain for the present the term St. Croix, inasmuch as there can then be no misunderstanding of the horizon under consideration. It is perfectly legitimate, in the further investigation of this question, for the geologists of states further east to inquire which of the sandstones lying below these beds may be the equivalent of the New York Potsdam, for it seems as if on ascertained stratigraphical evidence, as well as on lithological and palæontological facts that are undisputed, these beds occupy a much higher horizon. They seem rather to be embraced in the great calciferous or Canadian epoch.

Although these sandstone beds occupy the river bluffs along the Mississippi and the Root river throughout the county, they afford but very few opportunities for satisfactory examination. They are in the lowest part of the bluffs and are generally hid by a sloping talus that is usually turfed over. The only point at which a useful section of their composition could be had was at Hokah. The general section at this place, as nearly as it could be made out, is as follows, in descending order:

General Section at Hokah.

	Feet.
St. Lawrence limestone, of the Lower Magnesian, about	200
Slope, unseen	30
Sandstone, line of constant exposure	30
Slope, rock unseen	30

Whitman's quarry, made up as follows:

1. Broken, shaly, and sandy, crumbling and fragmentary 10
2. Shale bed, greenish, with remains of trilobites 1

3. Tough, persistent layers, like an indurated, arenaceous shale, with green sand, in thin layers	12
4. Crumbling sand, in oblique stratification	3
Rock very similar to No. 3 extends downward, covering the horizon of an old quarry east of Hokah, now abandoned as worthless, embracing a thickness, that is generally a turfed slope, of about	150
Rusty, coarsely arenaceous sandrock with Lingulepis (Lingula)	10
Crumbling, white sandrock, massive	25
Variegated, arenaceous quartzyte, purple and white, hard and persistent; level with the top of the dam	2
Massive, white sandrock	20
Total rock, about	523

The hight of Mt. Tom at Hokah, by aneroid, above the flood plain, was found to be 530 feet.

At an old quarry east of Hokah, and across Thompson's creek, now abandoned because the rock is worthless for all purposes, the general aspect of the layers is much like that at Whitman's quarry, but the sand is less firmly cemented, making a stone not so good. It is a shaly and arenaceous standstone, of coarse and fine grain, marked with fucoids and abundant greensand, and is below the stratigraphical level of Whitman's. In the same bluff, about twenty-five feet higher, is a blind shoulder or terrace which is more likely to contain the layers of Whitman's quarry. This stone as taken from Whitman's quarry, although very shaly, becomes firm and enduring on exposure.

At Houston the bluffs north of the village are 520 feet in hight, and of this the lower 420 feet at least belongs to the St. Croix sandstone. They probably contain the St. Croix 20 feet further up, shown by the toppling over of huge blocks of St. Lawrence limestone, from the crumbling out of friable sandrock along the salient angles of the bluffs. The interval of the sandstone layers is mainly turfed over so as to render an inspection of their contents impossible, except at points near the top and near the bottom. There is a line of nearly constant exposure about 40 feet below the top of the St. Croix, occupying an interval of 30 or 40 feet, which is particularly noticeable along the north side of the river, and was mentioned in the report on Fillmore county. There is another exposure of these beds near the level of the river at the dam at Houston. The former consists of a hard, firm sandrock, and the latter is soft and crumbling, with cross stratification. Above the line of constant exposure, about 25 feet, is a blind terrace which occasionally reveals the rock which causes it.

It is a sandstone, and is included in the foregoing thickness of 420 feet.

At one mile north of Sheldon there is an apparent dip in the outcropping upper edge of the St. Croix, as it strikes across the bluffs. Its direction is perhaps a little west of south, and amounts to two or three degrees. It is entirely local, and the corresponding upward dip in the opposite direction is invisible. The bluffs south and north have their usual hight.* No such dip was noticed in any other part of Houston county, but it is very likely this is on the strike of the noticeable dip in these formations which has been mentioned by Dr. Owen and by the geologists of Iowa as occurring in the bluffs of the Mississippi river at McGregor and Lansing, in the State of Iowa.

In Caledonia township, Sec. 2, the following section was taken:

Section covering the junction between the St. Croix and the St. Lawrence.

	Feet.
Slope, covered with large blocks of limestone	200–300
Even layers of limestone quarried	12
Hid. Mainly limestone, like the next	40
Limestone, broken and curling bedding. Cherty, arenaceous or massive with some green sand	25
Lime and sand, lumpy with irregular concretions, mainly massive	15–20
Soft sand, with cemented or quartzitic lenticular lumps	10
Soft, massive sand. (Causes the blind terrace at Houston)	25

The line of constant exposure mentioned as occurring at Houston, near the top of the St. Croix sandstone, lies below this section. This line is more evident in the north than on the south bluffs—due, probably, to the erosive action of the prevailing winds, which are from the southwest, and to the greater scarcity of timber on the north bluffs, as already noted under the head of *Soil and Timber*.

The fossils that have been gathered from this formation consist very largely of trilobite remains. They will be examined as opportunity may be afforded in the future progress of the survey.

On Sec. 11, Union township, the sandstone which has been mentioned as having a nearly constant line of exposure, is sculptured, along the north bluffs, into isolated columns and tables, with some rounded buttresses which present a very conspicuous and highly interesting instance of atmospheric erosion. There

* Compare *Geology of Iowa, Hall & Whitney*, 1858, *Part II, p.* 51.

can be no doubt that the bluffs themselves are the result of the erosion of the valley by water by a process that began thousands of years before the glacial epoch, but the present condition of most of the curious forms, like that of the "sculptured bluffs," is certainly due to the effect of wind in conjunction with moisture and frost. There are also cavities and sheltered nooks, and deep, crooked passages and sharp niches in which the wind could barely enter, and from which there could not have been any wind exit sufficient to have maintained a current capable of producing the most of this sculpture, which, moreover, are lichen-covered, and bear an aspect of age and roughness that forbids their reference to any present atmospheric forces. These can be explained only by the solvent action of water in agitation, and are comparable to the purgatories that are often seen about the rocky shores of lakes or of the ocean. But when the rock shows a recent, fresh erosion, and is soft and crumbling, the present forms are due to more recent causes, and can only be assigned to wind and frost.

The Drift.

The true northern drift is not spread over this county. It contains no drift clay, nor boulders of foreign origin. There is a thin deposit of foreign gravel at Riceford, in the extreme southwestern part of the county, and there is a terrace along the Mississippi river that is made up of gravel and sand of northern origin, but this county wholly escaped the operation of those forces which spread the well-known drift clay and boulders over the most of the state. Whether any former glacial era caused it to be covered with the ice of the northern glaciers cannot be determined, since the materials left by that era, if any there were, may have been decomposed, and may have entered into the stratified clays and the soils of the Mississippi valley further south under the combined influence of time, and the intense activity of the destructive forces of the latest glacial era.

There is to be seen occasionally a local drift, or debris, derived from the rock of the country round about, and this sometimes has a deceitful resemblance to true northern drift, yet it can always be distinguished from it on examination. On the northwest quarter of section 25, Caledonia, along the road, near the brow of the Shakopee limestone, there is a bank of such loose materials. There is a cut of about three feet, which consists mainly of rusty loam, rather sandy, embracing large masses of black quartzite, which also vary to a lighter color but show very little, if any, lime.

Other lumps consist of pyrite crystals, now converted to limonite, and of rusty, hardened sandstone, perhaps from the St. Peter. These last, indeed, comprise perhaps a majority of the stony masses. There are also large quantities of ordinary chert, and an occasional piece of water-worn limestone. The bank shows no stratification, but consists of these materials simply mingled with the loam. The whole appears red and rusty, but discloses not a single piece but can be referred to the Lower Magnesian formation.

As to the cause of this exemption of a part of southwestern Minnesota, and portions of Wisconsin, Iowa and Illinois adjacent, from the forces of the northern drift epoch, there has been but one opinion advanced, so far as the writer is aware. It is that of Prof. J. D. Whitney, who attributes it to the *non-submergence of this region since the deposit of the Silurian rocks and their elevation above the ocean.* If it were demonstrated or generally believed that the prevalence of the drift in other parts of the Northwest, in the same latitude, is due to the submergence of the continent beneath the ocean since the Tertiary age, this assumed cause would be apropos. But on the contrary it is pretty generally agreed by geologists, both in America and Europe, that the drift is due to the former existence of glaciers that covered the surface of the country, and, moving generally southward, not only brought from the northern regions the foreign substances that constitute the drift, but required, for their existence, that the land surface should be raised several hundred feet at least above the ocean during their prevalence.* Again there is every reason to suppose this region *has been submerged* since the age of the Silurian. It is difficult to conceive what could have produced the horizontal lamination of the loess loam, unless it be attributed to the action of standing, or but slightly agitated water. This loam not only exists along the immediate river valley, but is spread widely over the highlands of the whole district. It is true there is no evidence of its having been the product of marine depositions, on the contrary it is evidently of fresh water origin ; but that the country has been deeply submerged and remained so for a long period within recent geological time can hardly be questioned. There is also reason to believe that some portions of it were buried beneath the waters of the Cretaceous ocean.

In the light of the more recent investigations of geologists it is safe to take for granted the following conclusions respecting the drift, so far as they bear on this question.

* Those interested in this subject will find it exhaustively treated in James Geikie's *Great Ice Age, and its relation to the antiquity of Man.* Second Edition, 1877.

1st. That the earth suffers such changes of climate that, after the lapse of long periods, the temperate latitudes become frigid, and are covered with continental ice-fields or glaciers, which have a slow movement southward.

2d. That between these periods conditions of more genial climate prevail, when vegetation and animal life return slowly to inhabit the countries from which they had been driven by the rigors of the previous cold.

3d. That the severity of the cold during the successive glacial epochs is not always the same; but that the ice-fields are more extensive during some than during others.

These continental ice-fields, while conforming in general to the laws and conditions of a solid, yet exhibited, as glaciers do now, many of the characteristics of a plastic body, warped and moved by the force of gravity, and hence exemplified many of the principles of running water. The tendency for them was to seek the low lands and to avoid the natural obstructions presented by mountains or by hills.

In examining the topography and the geological structure of the country lying to the north of this so-called driftless tract, it is evident that the great valley of the Lake Superior region, once occupied by glacial ice, would overflow, both first and last, along the lines of the lowest outlet, and that perhaps the higher and less passable parts along its southern barrier-shore would never be entirely surmounted. The continental glacier, in this region, would flow toward the southwest or south, guided by the main topographical features. In north-central Wisconsin is an isolated area of granitic and metamorphic rock, which not only extends to the shore of Lake Superior, but wedges out northeastwardly in the form of a long, high and persistent point or spur, in the southern part of Lake Superior, known as Kewenaw Point, in the State of Michigan. It is plain to see that this point would act on a crowding but somewhat flexible mass of ice as an entering wedge to split it into two main masses, and that the widening of the wedge, in the granitic region of northern Wisconsin, would perpetuate the division so as to cause, if other topography were favorable, a constant flow along the northwest side, and another in a more southerly direction, that would spread over northern Michigan and find its easiest exit through the valleys of lakes Michigan and Huron. According to Prof. R. Irving, and Messrs. Foster & Whitney,* the western end of Lake Superior lies in an Archaean synclinal trough

*American Journal of Science, 3d Series, Vol. VIII, p. 54. Report on the Geology of the Lake Superior Land District.

running southwesterly. This again would divert the flowing ice over the northeastern portions of Minnesota to the expense of northern Wisconsin. Glacial scratches on the rocks at Duluth, at the western extremity of the lake, have a west-southwesterly direction.

Now it is a striking coincidence that this driftless tract lies nearly south and in the lee of this wedge-like area of metamorphic rock, and would be protected from the ice-flow by it. It is hence reasonable to infer that the absence of the drift in this region is due to the existence of this protecting barrier lying to the north of it in Wisconsin, while further to the south the two main branches of the ice-flow again united and spread, before their final retirement, a continuous sheet of drift over central Illinois, and southern Iowa.

It is very evident, from the fact that the remains of an older drift sheet are found under the loam in some of the western parts of this tract, (see report on Fillmore county,) while the latest drift sheet does not spread so far nor so wide, that the last period of cold was far less intense than some former one had been. This last drift sheet is spread over the ancient soil, containing vegetation in a nearly continuous layer, the remains of a forest which flourished between the two glacial periods, along the margin of the last ice-field. This belt, characterized by buried soils and wood, crosses Fillmore and Olmsted counties, and it is probably true that wherever such remains are found, in a flat country like southern Minnesota, lying under glacial drift, they mark the point where glacier ice ceased to act powerfully enough to disrupt the old soils. Such ancient soils may have existed on the top of older glacial drift, or on any other surface. It is probable that it was during the prevalence of the last glacial period, or just as the ice began to recede so as to produce copious waters, that the loess loam of the Mississippi valley was deposited over this region, and that at the same time the waters of the Minnesota were augmented by the drainage of the entire Winnepeg and Red river valleys through its channel, some of them at first reaching the Mississippi through the Cannon and the Vermillion river valleys. At first these waters spread irregularly and widely, fluctuating with the seasons, so as to leave no recognizable beach lines; but at length when the most of the state had been left by the retreating glacier, they became more uniform in their volume and were confined to the actual river gorge. They seem to have maintained, for a long period, a pretty uniform stage at this point, for when, on the drainage of the Winnepeg basin toward the north, consequent on the final retreat of the ice beyond

the mouth of the Nelson river, in British America, the Minnesota was reduced to about its present dimensions, a high terrace was left along the Mississippi, through all this driftless region and also further south. The high water in the Mississippi ascended the gorges of the tributary streams, retarding their flow and causing similar terraces along their lower reaches.

[NOTE.—In the report for 1875 it was stated (page 66) that no drift-clay like that which covers the western part of Fillmore county had been seen overlain by the loess-loam, except that which pertains to the general drift sheet of the northwest, where the loam overlaps the later drift. In passing through Fillmore county in 1876, the remains of this ancient drift sheet were seen at numerous places between Sec. 4, Canton, and Lenora. At one point it is a light-colored, or ashen, gravelly clay which above is very irony or rusty. Over the surface are numerous fragments of chert with some small boulders of granite, and greenstone, and jasper and quartzite pebbles. This is the first satisfactory identification of the *old* gravelly clay within the loam-covered area, or driftless tract. It is covered with several feet of loam. It is seen similarly NE. ¼, Sec. 12, Canton.]

Alluvial Terraces.

There is a marked alluvial terrace that accompanies the Mississippi and Root rivers, and ascends their lower tributaries, but it does not seem to be true that all the streams are terraced before reaching the level of this terrace. This indicates that the high water which produced that terrace was due to backing up from the Mississippi, and that possibly the country itself in general was not more wet than it is at present; in other words, that the amount of surface drainage that passed down the valleys was no greater than now. Root river was simply wider and deeper, with a sluggish current, due to the greater volume of the Mississippi. The highest point at which the terraced condition of Root river has been observed is Preston, in Fillmore county, but it must certainly extend several miles further up that valley. By aneroid measurements, united with levels of the S. M. R. R., the hight of this terrace at Preston is found to be about 300 feet above the Grand Crossing of the S. M. R. R. near the mouth of Root river, while the same terrace at Hokah, likewise near the mouth of Root river, is only about 100 feet above the flood plain. It is also probable that the loam terrace, as seen at La Crescent, is the same continued to and coalescent with the Mississippi terrace; and there it is 90 feet above the Mississippi flood plain. This would necessitate a fall of about 200 feet in the Root river at its highest stage, in a dis-

tance of 50 miles in a right line. If this fall can be explained consistently with the assumed back-water condition of the Root river, at that time, it will further confirm the hypothesis that the Mississippi then drained the Red River and Winnipeg regions, receiving their waters from the Minnesota. It seems further that this explanation is necessary to the maintenance of that hypothesis; for if Root river was maintained at that high level by the demands of its own drainage area, then much more the Mississippi could also have been kept there without the aid of the Winnipeg waters. Root river valley, between the rock-bluffs, has an average width, through Houston county, of about two miles, and that would have been the width of the stream, with a depth of over one hundred feet.

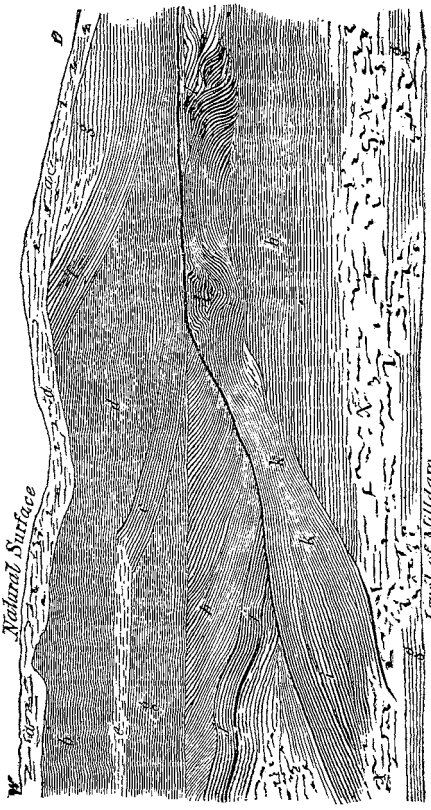
There is, besides this high, loam-terrace, a second terrace level, visible specially at La Crescent, on the Mississippi, which there rises 50 feet above the flood plain of the river and spreads out in a pleasant plateau on which the village has been located. This terrace is made of gravel and pebbles of northern origin, and was identified only along the Mississippi. The largest stones it contains are about 3 in. in longest diameter. It is passed through in wells, and seems to be entirely pervious to water, as all wells on it get water at about the level of the flood plain of the river. This material is used for grading, and road-bed, on the C. D. & M. R. R., and elsewhere. It consists entirely of rounded waterworn materials, the main part being the usual parti-colored quartzite pebbles, granitic, hornblendic, amyglaloidal, and lamellar, as well as uniform and massive. A great many of them have a red color, or some shade varying from red. The coarsest pieces are rare, found only in the upper portions of the *debris* of alluvial fans.

The following more special observations were made on these terraces in Houston county. At Sheldon, six miles from Root river, in the valley of Beaver creek, the terrace on which the Newberry House stands is 30 feet above the water of the creek below the dam. The materials of the terrace at this place are sandy loam horizontally stratified, with more clay near the top, and less evident stratification.

At Houston the only observable terrace, measured about a mile west of the city, is 65 feet above the flood plain. The track of the R. R., is about one foot above the flood plain of the river, which is 18 feet higher than the water below the mill-dam.

At Money creek the terrace rises 30 feet above the flood plain which is 20 feet above low water below the mill-dam. The contents of the terrace are stratified. On Sec. 30 in this town the

contents of the Root river terrace, and their arrangement, are shown by the following sketch which was taken on the spot:



The full hight of the bank is about 20 feet where the section is taken. At a point further to the right than is shown in the sketch a couple of bones were found, but in the confused and broken uppermost layer. They were where that layer comes down to the river, and about 3 feet below the surface, or 5 feet above the water of the dam, the surface of the bank sloping about 45 degrees.

At Hokah the village is on a terrace 65 feet above the flood-plain of Root river, and there is a distribution of loam about the bluffs at a higher level, (as well as at many other points along Root river valley) reaching to a hundred feet, or a little more, above the flood-plain. This loam appears in indistinct benches or terrace-levels, or patches of terrace, rising often with a slope, far up the rock-bluffs. It very rarely appears level, as a well-marked terrace. It

suggests rather a worn-out old terrace-level, the upper surface of which has suffered erosion by being gullied out and smoothed off toward the river. It is generally cultivated for farms, and has good wheat-fields, consisting of the same materials as the lower terrace. Its actual hight is difficult to ascertain.

SW. ¼ Sec. 22, La Crescent. By the roadside appears a terrace rising about 50 feet, which at the top consists of the fine loam of which the foregoing terrace is composed, showing at least eight feet of such material, while its lower 20 feet are of drift-gravel, which is coarse and obliquely stratified, the coarsest pebbles being one or two inches in diameter. This occurs on the rounded point of the rock-bluff which faces both valleys.

The village of La Crescent stands on a beautiful terrace of drift-gravel, generously laid out, with wide streets and alleys, 50 feet above the flood-plain of the Mississippi. This terrace slopes gradually toward the high rock-bluffs. It is surmounted, along the bluffs, by another terrace, rising 40 feet higher, which consists of loam.

This drift-gravel must be attributed to the agency of the river. It has every feature of a water-worn alluvial deposit. It is not found in Houston county in any of the valleys of other streams, back from the Mississippi. It ante-dates the loess loam, as that is terraced above it, and probably bears the same relation to an earlier glacial epoch as the terraced loam does to the last.

At Brownsville the loam-terrace is 80 feet above the flood-plain of the Mississippi.

At Yucatan the terrace flat is 40 feet above the present flood-plain of the South Fork of Root river. The flood-plain is 6 feet above low water.

At Freeburg the terrace is 20 feet the flood-plain of Crooked creek, which is 5 feet above the water of the creek.

Wells in Houston County.

A few wells situated in the valley of Root river have disclosed vegetable remains at about the level of the flood-plain, and probably the terraces generally cover a layer of vegetable remains that was caused by the decay and burial of pre-glacial plants. This has only been detected, so far as known, at Hokah, and at La Crescent. At the former place the well of Isaac West was filled again because the "muck-bed" rendered the water unfit for use. The same is true of William Wykoff's and W. F. Weber's, and a number of

others. Probably the characters of Mr. Pidge's, as given below, are those common to most of them.

B. F. Pidge's Well at Hokah.

It is situated on the lower terrace.

	Feet.
Loam and sand	50 or 55
Vegetation, leaves, stick, muck, &c,	4
Sand, with some course pubbles, "literally filled with snail shells"	4
White sand, yielding water	5

The water of this well tastes rather peculiar, and at first it was not fit for use. Sometimes still it comes up black, like dye, but by use it becomes clearer, and is used for all domestic purposes, without injurious effects. Sugar of lead causes it to become milky white. Acetate of potassa produces no change; sulphate of zinc no change. When it rises in the bucket it is not clear, but somewhat cloudy, as if with clay.

The well of Mr. Thos. Fairbanks, at Mound Prairie, disclosed a bone, now said to be in the possession of Dr. Armstrong, at Hokah. Efforts that have been made to secure facts in referrence to this discovery, and further account of the bone, have been unsuccessful.

Wells in Houston County.

Owner's Name and Location.	Loam, Feet.	In the Rock, Ft.	Total Feet.	Kind of Water.	Remarks.
Timon Gilbertson, Spring Grove	7	40	47	Good.	
Mons Fladager, Spring Grove	8	122	130	Good.	Drilled.
Ingval Miller, Spring Grove	10	30	40	Good.	On lower ground.
Nels Hendrickson, Spring Grove	8	77	85	Good.	
Ole Thompson, section 7, Willmington	8	65	73	Good.	
J. Dailey, N. E. ¼, section 34, Caledonia	28	72	100		No water.
Public Well, Caledonia	25	245	270	Good.	
W. N. West, Caladonia	20	50	70	Good.	
A. Calmus, Caledonia	20	23	43	Good.	
M. Creagan, Caledonia	20	23	43	Good.	
O. A. Bye, S. W. ¼, section 17, Willmington	18	77	95	Good.	Two feet sandrock ; 64 feet limerock ; 11 feet sandrock.
W. H. Harris, Caledonia	18	33	51	Good.	
M. Newberry, Sheldon	36		36	Good.	The rock has never been struck at Sheldon.
J. B. Williams, Sheldon	36		36	Good.	
Cottrell Hotel, Houston	16		16	Good.	Eight feet to water. All alluvium.
W. R. Anderson, La Crescent	57		57	Good.	At 54 feet struck leaves, &c.
D. Gurley, La Crescent	49		49	Good.	Gravel and sand.
Sawyer House, La Crescent	45		45	Good.	Gravel and sand.
James Day, La Crescent	50		50	Good.	Gravel and sand.
James Brown, La Crescent	45		45	Bad.	Sticks and leaves ; refilled.
J. Knapp, La Crescent	63		63	Good.	Gravel and sand.
Wm. Miller, La Crescent	30		30	Good.	On lower ground.
Chas. Oldenbaugh, La Crescent	20		20	Good.	On low ground, near the rock bluff.
Thomas Minshall, La Crescent	37	11	48	Good.	On low bench.
Jos. Garner, La Crescent	30		30	Good.	On low bench.
Nicholas Prive, section 31, Caledonia	12	2	14	Good.	Four feet of water.
B. Smitz, section 32, Caledonia	12	10	22	Good.	Ten feet in sandrock.
N. Charles, section 32, Caledonia	12		12	Good.	
G. Anderson, section 4, Willmington			40	Good.	Drilled.
John Prive, section 33, Caledonia	12	90	102	Good.	
M. Blasen, section 33, Caledonia	12	36	48	Good.	
Ole Hanson, section 4, Willmington	15	55	70	Good.	Drilled.
Peter Carrier, section 32, Yucatan	55		55	Good.	In the valley : no rock struck.

Throughout the county are numerous springs, some of which are very large, and gush out along the valleys. They seem to be the outlets of subterranean streams. Those above Riceford furnish the water for the flouring mills at that place. There is also a large one on Sec. 17, Caledonia, three miles south of Sheldon. They seem to frequent the horizon of about 80 feet below the top of the St. Lawrence limestone, and indicate a shaly, or otherwise impervious, layer there in that formation.

Material Resources.

The rocks of the county do not contain any valuable minerals. They are everywhere abundantly exposed, and are quarried at many places for ordinary building-stone and for quicklime.

Building Stone.

At Spring Grove the Lutheran society is building a large church, of brick, the basement being from the Lower Trenton, in layers of four to six inches, taken from quarries near the village. The heavy trimmings are from the St. Lawrence limestone. The quarries are owned by George Timansen and Ole Tostenson.

The Toledo Woolen Mill, of Fletcher & Williams, Sec. 5, La Crescent, is built of the St. Lawrence, quarried near.

At Caledonia the St. Lawrence is extensively used for building, quarried about a mile east of the village. The German Catholic church is the principal building made of it, being also the largest building in the place. The county jail is a fine building of the same, the courses being about ten inches thick, rubble dressed, with trimmings of the same. The business blocks of Nicholas Koob, J. J. Belden, John Krantz, Joseph Vossen, Jacob Bouquet and Nix Erstine are also constructed of the same stone. The quarries are owned by John Molitor, John Dorsh, Anton Molitor, Widow Cunningham and John Aiken.

On Sec. 24, Spring Grove, Mr. K. Gilbertson has a two-story stone residence on his farm, quarried from the Trenton.

At Money Creek, Harvey Chapel has a quarry that furnishes good stone for building, though much of that which is used is taken from the surface near the tops of the bluffs, having been loosened and broken up by the weather.

On the NE. ¼ Sec. 11, Caledonia, is Mrs. M. Brown's stone house, built of the Lower Magnesian.

Mr. J. Kline has a fine farm-house of stone taken from the St.

Lawrence, on Sec. 19, Union. Near Mr. Kline's quarry is another owned by Henry Snure. There is another on Sec. 29, Union, owned by Michael Wilhelm. L. Svenson's is on Sec. 2, (S. E.) Houston.

The principal quarries at Hokah, now worked, are those of Nath. Whiteman, in the St. Croix sandstone, and Widow Prindle. The stone of Mr. Whiteman's quarry is a harsh, argillaceous sandrock, in layers a few inches thick, which becomes firmer on exposure. The best building stone lies higher up in the bluffs, and was opened in Mt. Tom by the S. M. R. R. for the construction of their shops. It is from the St. Lawrence.

At La Crescent the public school-house was built of stone from Potter & Taylor's quarry, likewise in the St. Lawrence, north of La Crescent, in the edge of Winona county.

Lang's brewery, Sec. 28, Hokah, is a large stone building near the river, built of limestone from near the top of the bluff.

There is also a fine stone farm-house owned by Wm. Splitter, on Sec. 21, La Crescent, in Root river valley. The Nunnery, Sec. 28, La Crescent, was constructed of stone got from the bluffs near, including also that used for quicklime. These are all from the St. Lawrence.

On Winnebago creek (Sec. 22, Winnebago,) Mr. B. T. Barbour has a stone flouring mill.

O. T. West has a limestone quarry at Brownsville, which supplied heavy stone for the railroad and for other uses. Mr. Job Brown's, at the same place, furnished the limestone foundation for the public school-house.

The foregoing are a few of the stone buildings in the county, but there are several others which, though noticed in the progress of the survey, were not carefully located, and cannot be referred to. The St. Lawrence supplies by far the greater portion of the building-stone used in the county. There is not a single known workable quarry in the Shakopee, though exposed as favorably as the St. Lawrence. It is uniformly ignored. It is harder to work, has cherty lumps and siliceous concretions which not only disturb the bedding but render it difficult to cut into desired shapes, and is generally in thinner layers. The color is much the same as that of the St. Lawrence, being buff, or slightly salmon-colored, but the St. Lawrence is, where most used for building, also somewhat open or vesicular in texture. Thus mortar sets firmly upon it, and forms a sutured attachment. When the St. Lawrence stone is first taken out it cuts more easily than after exposure for a few

weeks, a fact which seems to be true of nearly all good building stone.

Strength of Minnesota Building-stones.

A series of experiments has been carried on by Gen. Q. A. Gilmore, under the direction of Gen. A. A. Humphreys, Chief of Engineers, U. S. A., during several years, on the strength of varirious building-stones in the United States. The tests that have been made are conducted with great care and precision, and demonstrate the compressive strength, specific gravity and ratio of absorption, of the stones tested. In the report of the Chief of Engineers for 1875 is a general table giving results, and in that table are named the following building stones from Minnesota. Two-inch cubes were crushed under a powerful press.

Kind and Location.	Position in trial.	Strength of Specimen	Strength per Sq. Inch.	Specific Gravity.	Weight of Cubic Feet.	Ratio of Absorption.	Remarks.
Granytes.		Pounds.	Pounds.		Pounds.		
Dark Syenytic granyte, Duluth	On bed.	70,200	16,950	2.780	173.7	1-711	
Dark Syenytic granyte, Duluth	On bed.	75,200	18,200	2.800	175.	0	
Dark Syenytic granyte, Duluth	On bed.	66,500	16,025	2.800	175.	0	
Dark Syenytic granyte, Duluth	On bed.	67,200	16,200	... .	.....	Slight.	Specific gravity not reported.
Dark Syenytic granyte, Duluth	On edge.	67,950	16,387	....	.....	Slight.	Specific gravity not reported.
Light colored, St. Cloud	On bed.	63,200	15,200	2.69	168.2	1-239	
Light colored, St. Cloud	On edge.	73,200	17,700	2.69	168.2	1-239	
Other Granytes.							
Dark granyte, Quincy, Mass	.....	70,200	16,950	2.660	166.2	Very slow.	Cracked at 18,700 pounds.
Light granyte, Quincy, Mass	.....	58,200	13,950	2.695	168.7	Very slow.	Cracked at 17,200 pounds.
Bluish-gray, Keene, N. H.	On bed.	40,200	9,575	2.656	166.0	1-300	Used in inside of New Capitol, Albany, N. Y.
Limestones.							
Pink limestone, Kasota, Minn	On bed.	42,000	9,900	2.630	164.4	1-56	The "Shakopee" limestone. Specimen cracked at 26,200 pounds
Pink limestone, Kasota, Minn	On edge.	45,900	10,875	2.630	164.4	1-56	Did not crack before crushing.
Light-buff, Frontenac, Minn	On bed.	24,200	5,450	2.325	145.3	1-28	The "St. Lawrence Limestone."
Light-buff, Frontenac, Minn	On edge.	30,200	6,975	2.325	145.3	1-28	The "St. Lawrence Limestone."
Other Limestones.							
White, Marblehead, Ohio	On bed.	44,200	10,450	2.4	150.	1-30	The "Corniferous."
White, Joliet, Ill.	On bed.	57,800	13,850	2.54	158.8	1-91	The "Niagara"
Bluish-drab, Lemont Quarry, Cook Co., Ill.	On bed.	47,200	11,200	2.645	165.3	1-89	
Sandstones.							
Purple sandstone, Fond du Lac, Wis*	On bed.	24,200	5,450	2.220	138.8	1-22	"Potsdam Sandstone."
Purple sandstone, Fond du Lac, Wis	On bed.	24,100	5,425	2.220	138.8	1-22	"Potsdam Sandstone."
Purple sandstone, Fond du Lac, Wis	On edge.	19,640	4,310	2.220	138.8	1-22	"Potsdam Sandstone."
Purple sandstone, Bass I., Wis	On bed.	21,000	4,650	2.040	127.5	1-15	"Potsdam Sandstone."
Purple sandstone, Bass I., Wis	On bed.	16,200	3,450	2.040	127.5	1-15	"Potsdam Sandstone."
Purple sandstone, Bass I., Wis	On edge.	16,350	3,487	2.040	127.5	1-15	"Potsdam Sandstone."

*These are probably from Fond du Lac, Minn.

Sand.

The St. Peter formation is excavated for mortar-sand by Jesse Schofield, Sec. 14, Caledonia, and by John Burns on Sec. 26. This white sand is delivered at Caledonia village for $1.25 per load, or occasionally for $1.50.

The St. Croix furnishes a similar sand near Mr. Kline's, Sec. 16, Union. These formations will supply a similar sand in any part of the county where they are accessible, the layers in the St. Croix, however, are about 200 feet below the top of the formation.

At Mr. Schofield's sand quarry, about a mile west of Caledonia, is a large mass of "lamellar calcite," lying on the slope of the St. Peter, and nearly covered by the loam. In that respect it is like a similar mass seen near St. Charles, in Winona county, in 1872, and mentioned in the report for that year, but it seems more firm than that. This appears like a firm, very compact rock, consisting of almost pure carbonate of lime, but somewhat colored. It is mainly massive, and striated, or laminated, but shows some crystalline grains. It weathers into undulating or wavy, smooth surfaces. There is another much larger mass, weighing many tons on the land of Mr. Willard, a short distance west. These masses can be burnt into a purely white quicklime of great strength.

The age and origin of this calcite involves an interesting problem. When that piece was found in Winona county, in 1872, it was referred hypothetically to the Trenton Green Shales, or to the worn-out Cretaceous that may have covered that country, making it of rock origin, either Lower Silurian or Mesozoic, but there is much reason to believe these calcite masses are not referable to the rock *in situ*, but are of atmospheric origin, being, in short, the remains of immense travertine deposits from limy water running down the St. Peter slope from springs that once existed but are now dry. They lie on the slope of the outcropping edge of the St. Peter, just below the Green Shales which shed all the water that works downward through the Upper Trenton limestone ; but they are also, so far as discovered, in regions where the Upper Trenton does not now exist, the only remaining portion of the Trenton being that which lies below the Green Shales. This is strikingly the case near Caledonia, where the Trenton is reduced to mounds and tables, capping the St. Peter sandstone, very far isolated from the main area of the Trenton. To suppose this calcite is due to springs caused by the Green Shales, a common phenomenon now in Fillmore county, is to require the former existence of the Upper Trenton, with a considerable thickness of strata, over all the re-

gion of Caledonia, and extending far enough north and east to furnish drainage surface sufficient to maintain such springs. This is not inconsistent with the history of geological changes, nor with the lapse of time since the Trenton was elevated to the condition of dry land. The present existence of isolated patches of the Lower Trenton, both in Minnesota and Wisconsin, can only be explained on the theory that the whole formation was once more largely spread in horizontal strata over those states, than at present. Then an extension of the Lower Trenton so as to embrace in one sheet of layers these isolated patches, is no more than enough to bring also the Upper Trenton into the region of these calcite masses. The present outlines, shape and position of the areas of the Lower Trenton, demonstrate that they are only the relics of once greater areas which have been eroded and removed slowly, and left as they are because they have been better protected against destructive agents. While Root river has been excavating the gorge in which it runs, 500 feet deep and two miles wide, the Trenton limestone, which at first may have extended as far northeast as to Hokah, has been slowly receding under the operation of denudation and surface drainage. These calcite masses, then, are relics of pre-glacial time, and perhaps of early pre-glacial time, since the last glacial epoch did not operate in Houston county so as to disturb the older surface.*

Brick.

The loam everywhere is suitable for making brick, which are uniformly red. The following establishments were seen:

Stephen Robinson, Money Creek; two miles south of the village

Fischer & Keller, Caledonia; began last year; burnt three kilns, and sold at $8.00 per thousand.

Brick were formerly made at La Crescent.

The Lutheran Society, at Spring Grove, manufacture on the spot a fine red brick from the loam taken out for foundations and basement of their large new church edifice.

Lime.

The Trenton and the St. Lawrence furnish all the quicklime made in Houston county. There are no extensive manufacturers,

* See the First Annual Report, p. 47.

but the common pot-kiln is found at a number of points, by which enough is made to satisfy the local demands.

Ole Timro, sec. 24, Money Creek	St. Lawrence.
Gilbert Nelson, Spring Grove	Trenton.
Michael Blasen, 1½ mile west of Caledonia	Trenton.
Peter Kreer, ne. ¼ sec. 29, Mayville	St. Lawrence.
John Gross, 1 mile nw. from Brownsville	St. Lawrence.
John Molitor, 1 mile east of Caledonia	St. Lawrence.
George Timansen, Spring Grove	Trenton.
Ole Tostenson, Spring Grove	Trenton.
Wm. E. Potter, LaCrescent	St. Lawrence.
Samuel Pound, sec. 12, Hokah	St. Lawrence.

Lead.

It is a common belief at La Crescent, held by Mr. Knapp, Mr. Day and others, that the lead enterprise at Dresbach, mentioned by Dr. Owen in his final report on the geology of Wisconsin, Iowa and Minnesota, was a speculating job, got up for the purpose of creating an excitement and selling land. The reputed discoverers were men from Galena, Ill., and the lead found is believed to have been brought from that place. The excitement soon died out, and all operations ceased the same season they began, and have never been revived. Whether this be true or not the rock, though not the same as that at Galena, is about the same as that in which are the lead mines in Missouri.

Earthworks.

At La Crescent are a great many so-called *Indian Mounds.* Many have been graded away, but a good many still exist. They are on the brow of the drift-terrace, or lower bench, and none are known on the upper, loam-terrace. They are, as usual, in rude rows, and about three feet high, some of them being four feet. When opened they have been found to contain human remains of men of large stature, and it is said that in grading for the railroad a copper skillet and other trinkets were found at the depth of 18 feet below the surface.

III.

PALÆONTOLOGY.

Notes on the fossils of the Trenton limestone in Minnesota.

Since the examination by Prof. James Hall, of the fossils of the Trenton, Black river and Birdseye limestones of New York, and the publication in 1846 of his large *pioneer volume* on the palæontology of the rocks of the United States, which makes the 1st volume of the New York State Palæontology, nothing so thorough as his work has been undertaken on the fossil contents of that geological horizon.

In Dr. Owen's report on the geology of Wisconsin, Iowa and Minnesota, which followed Prof. Hall's first volume, in 1851, a few species occurring at the falls of St. Anthony, and on Turkey river in Iowa, are described, and others are mentioned as identified at various other points in the northwest. The names applied are generally those of Prof. James Hall, and the identifications are based on those of the Trenton group of New York State.

In Foster & Whitney's Report on the Lake Superior Land District (1851) a few more species are described and figured by Prof. Hall, derived from the Trenton limestone in Michigan and Wisconsin.

In the First Canadian Decade (1859) by J. W. Salter, other species are described, particularly gasteropods, and there is also a full account of *Receptaculites occidentalis*, a genus which Prof. Hall first announced from the Trenton but failed to fully elucidate, owing to not having favorable specimens.

In the Third Canadian Decade (1858) Mr. Billings has named and figured a number of cystids from the Trenton rocks of Canada.

In the Fourth Decade (1859) the same eminent palæontologist describes the crinoids of the Trenton as found in Canada.

In 1861 was published by the legislature of Wisconsin a small

volume containing descriptions of a number of new species of fossils from the Trenton of that state by Prof. Hall, who was then State Geologist of Wisconsin. This contribution to the palæontology of the Lower Silurian was printed only in the legislative documents, and is very rare.

The Reports of the New York State Cabinet, containing the papers of the Curator, Prof. Hall, are many of them given largely to palæontology, and a number of them pertain to the Trenton limestone. These reports are issued annually, and now number 27.

In the Annual Reports of Progress of the Geological Survey of Canada, Mr. Billings also continued to add to our knowledge of the palaeontology of the Trenton, such material as was gathered in Canada. The reports for 1854, 1857 and 1858 contain matter relating to the Trenton. Subsequently to that he published his descriptions of fossils separately, and in 1865 was issued a fine volume on the Palæozoic fossils of Canada which was entirely the work of Mr. Billings, and contains figures of a number of Trenton species.

In 1863 appeared *The Geology of Canada*, which, however, only gives figures and names of species already described.

In 1868 was published the third volume of the publications of the Geological Survey of Illinois, which contains some descriptions of fossils from the Trenton and Galena formations, by Messrs. Meek and Worthen.

Meantime, in Tennessee, Prof. J. M. Safford had closely examined the fauna of the Trenton and Nashville series in that state, and without describing many new species he has given in his volume on the geology of that state much accurate information concerning its palæontology, as correlated to the same horizon in New New York state. This was published in 1869.

In 1874 appeared the first part of Vol. 2 of Palæozoic Fossils of Canada, by Mr. Billings, but it is mainly taken up with the Quebec Group.

By the aid of the foregoing works some progress has been made in the examination of the Trenton fossils of Minnesota. The specimens thus far examined are a part of those gathered by the Geological Survey of the State. The examination is far from complete. Indeed it has but just begun. Those have been named which are identifiable readily, leaving doubtful specimens, as far as the investigation has gone, to some future time when more pains can be taken to make sections and minute examinations. Moreover, there is a good collection of Trenton fossils in the cases

of the Minnesota Academy, and another in the Academy at St. Paul, while one of the best collections of Galena fossils that have ever been made is in the possession of Mr. Frank Wilson, at Mantorville, who has kindly loaned them to the Survey.

It is hoped that with the aid of these collections, after a while, a complete account of the Trenton fauna may be made out for the Northwest, and that the study of this formation—so long neglected—may be made more easy and attractive.

The following species have been identified already. This list, though very incomplete, is here given that it may be seen how far the work has gone:

Cephalopoda.

Endoceras angusticameratum. Hall.
Endoceras magniventrum. Hall.
Orthoceras multicameratum. Con.
Endoceras proteiforme. Hall.
Endoceras proteiforme. Hall. Var strangulatum. Hall.
Endoceras distans. Hall.
Lituites undatus. Con.
Ormoceras tenuifilum. Hall.
Conularia Trentonensis. Hall.
Orthoceras bilineatum. Hall.
Orthoceras junceum. Hall.

10 species.

Gasteropoda.

Maclurea magna. Hall.
Murchisonia bellicincta. Hall.
Murchisonia bicincta. Hall.
Murchisonia perangulata. Hall.
Murchisonia angustata. Hall.
Pleurotomaria umbilicata. Hall.
Pleurotomaria ambigua. Hall.
Pleurotomaria lenticularis. Con.
Murchisonia subfusiformis. Hall.
Maclurea Logani. Sal.
Rhaphistoma lapicida. Salter (?)

11 species.

Brachiopoda.

Strophomena alternata. Con.
Strophomena tenuistriata. Sow. (a variety.)

Orthis testudinaria. Dal.
Strophomena fluctuosa. Bill.
Discina Pelopea. Bill.
Rhynchonella capax. Con. (increbescens of Hall.)
Orthis plicatella. H.
Orthis subquadrata. H.(?)
Strophomena nitens. Bill.(?)
Lingula quadrata. Eich.
Orthis occidentalis. H.

Also undetermined species of Orthis Leptaena, Strophomena Chonetes, Lingula, Rhynchonella. and of the *Acephal*, Ambonychia.

11 species.

Polyp Radiates.

Petraia corniculum. H.
Chaetetes Lycoperdon. H.
Chaetetes petropolitanus. Pander.

3 species.

Crustacea.

Illaenus latidorsata. Hall (?)
Isotelus (Asaphus) gigas. Hall.

2 species.

Protozoa.

Receptaculites occidentalis. Sal.
Receptaculites Oweni. Hall.

2 species.

In addition to these there is a number of species that have been examined that have proved to be unidentifiable by the use of references accessible, and some of them may prove to be new to science.

Of the foregoing species the following pertain to the Lower Trenton or to the Green Shales that separate the Lower Trenton from the Upper, and may probably be found in the neighborhood of Minneapolis, or along the bluffs of the river below the Falls of St. Anthony:

Endoceras angusticameratum. Hall.
Endoceras magniventrum. Hall.
Endoceras proteiforme. Hall.
Endoceras distans. Hall.

Chaetetes Lycoperdon. Hall.
Chaetetes petropolitanus. Pander.
Rhaphistoma lapicida. Salter(?)
Petraia corniculum. Hall.
Orthoceras junceum. Hall.
Orthoceras multicameratum. Con.
Orthoceras bilineatum. Hall. (Record doubtful.)
Isotelas gigas. Hall.
Orthis testudinaria. Dal.
Rhynchonella capax. Con.
Lingula quadrata. Eich.

The specimens from the locality of Minneapolis have not yet been subjected to careful examination. There are known to be other species of brachiopods, graptolites and fucoids, besides gasteropods and corals.

The following have been identified from the Upper Trenton, not including the Galena:

Orthoceras multicameratum. Con.
Lituites undatus. Con.
Endoceras distans. Hall.
Receptaculites occidentalis. Sal.
Endoceras proteiforme. Hall. Var strangulatum. Hall.
Ormoceras tenuifilum. Hall.
Maclurea magna. H.
Maclurea Logani. Salter.
Pleurotomaria Lenticularis. Con.
Chaetetes petropolitanus. Pander.
Murchisonia subfusiformis. H.
Murchisonia bellicincta. H.
Receptaculites Oweni. H.
Rhynchonella capax. Con.

The following are known from the Galena within the limits of this State:

Endoceras magniventrum. Hall.
Endoceras proteiforme. Hall.
Receptaculites Oweni. Hall.
Petraia corniculum. H.
Conularia Trentonensis.
Strophomena alternata. Con.
Murchisonia bicicnta. H.
Isotelus gigas. H.

Murchisonia perangulata. H.
Murchisonia angustata. H.
Murchisonia bellicincta. H.
Pleurotomaria umbilicata. H.
Pleurotomaria ambigua. H.
Strophomena tenuistriata. H. (variety.)
Orthis testudinaria. Dal.
Strophomena fluctuosa. Bill.
Discina Pelopea. Bill
Orthis plicatella. H.
Orthis subquadrata. H.(?)
Strophomena nitens. Bill.(?)
Orthis occidentalis. H.

IV.

CHEMISTRY.

REPORT OF PROF. S. F. PECKHAM.

Prof. N. H. Winchell:

My Dear Sir :—I have the pleasure of reporting the chemical work on the Geological Survey for the past year as consisting of a complete analysis of the so-called, Russell Mineral Spring, in Minneapolis ; four specimens of coal and their ashes the serial numbers of which are 11, 12, 13 and 14 ; No. 15, a sort of clay, and a stone known as the St. Lawrence limestone, of which there were two specimens numbered 30 and 31. I also report the analyses made for Messrs. Kindred and Culver in the fall of 1875.

The process of analysis employed for the coals was the same as that used by myself for the analysis of some 25 specimens belonging to the Geological Survey of California. The specific gravity was first determined by sifting the dust from the finely granulated coal and weighing in a sp. gr. flask, after standing under water at least 12 hours. One gramme was then weighed in a platinum crucible and dried at a temperature of 215°–220° Fahr. until it ceased to lose weight. The loss is water.*

The residue was then heated over a Bunsen's burner for 3.5 minutes, and then over a blast lamp for the same length of time, and weighed. The loss was considered to be volatile combustible matter. The residue was burned to an ash and the ash weighed. The loss from combustion was considered to be non-volatile combustible material, or fixed carbon.

*The question has been raised whether or no this loss be water. Very carefully conducted experiments were made during my research upon the California coals, to ascertain if the coal was oxidized by prolonged heating at the temperature above mentioned. The amount of water escaping was absorbed by chloride of calcium and weighed. It exactly corresponded to the loss experienced when the experiment was conducted as described above, and no oxidation products could be detected.

In conformity with your wishes I also made a quantitative analysis of the ashes of each of these coals.

The coals are quite unlike. Nos. 11 and 12 are semi-cannel coals. No. 13 consists of a mass of clay containing carbonaceous matter. No. 14 consists of an earthy mass, chiefly silica containing fragments of mineral charcoal.

No. 11 is homogeneous and brittle, of a dull black color, and cracks in a dry atmosphere. When heated it is non-caking, the pieces retaining their form and size, and in this respect it resembles some of the cretaceous coals of the Pacific coast. The results of analysis are as follows:

Specific gravity	1.441	
Water	13.53	per cent.
Volatile combustible matter	54.11	"
Fixed carbon	29.49	"
Ash	2.87	"
	100.00	"

The ash contained—

Insoluble silicic acid, etc	3.698	per cent.
Soluble silicic acid	14.159	"
Sulphuric acid	23.363	"
Ferric oxide and alumina	23.419	"
Lime	7.592	"
Magnesia	16.055	"
Carbonic acid, chlorine, alkalies, etc	11.714	"
	100.000	"

The total amount of combustible matter in this coal is 83.60 per cent.

No. 12 in some respects resembled No. 11. It is a semi-cannel in appearance, very friable in dry air, and non-caking. The results of analysis are as follows:

Specific gravity	1.425	
Water	12.70	per cent.
Volatile combustible matter	38.32	"
Fixed carbon	45.61	"
Ash	3.37	"
	100.00	"

The ash contained—

Insoluble silicic acid, etc	8 338 per cent.
Soluble silicic acid	22.963 "
Sulphuric acid	19.674 "
Ferric oxide and alumina	20.006 "
Lime	16.353 "
Magnesia	3.946 "
Carbonic acid, chlorine, alkalies, etc	8.720 "
	100.000 "

The total amount of combustible matter in this coal is 83.93 per cent.

No 13 is a specimen of dark colored clay containing an unusual amount of organic combustible matter, not enough, however, to give it any value as fuel. It burns to a very light-colored ash consisting largely of alumina, and would therefore in all probabilty, make very good brick if sufficient sand were mixed with it. The results of analysis were as follows :

Specific gravity	1.968
Water, Volatile combustible matter, Fixed carbon	29.55 per cent.
Ash, consisting of clay	70.45 "
	100.00 "

The ash contained—

Insoluble portion, consisting of insoluble alumina and silicic acid	92.751 per cent.
Soluble silicic acid	.490 "
Sulphuric acid	.282 "
Ferric oxide and alumina	2.894 "
Lime	1.076 "
Magnesia	.348 "
Undetermined matters	1.159 "
	100.000

No. 14 consisted of a soft, siliceous rock, containing small fragments, grains and specks of mineral charcoal. The results of analysis are as follows :

Specific gravity	2.141
Water and combustible matter	26.54 per cent.
Ash	73.46 "
	100.00 "

The ash contained—

Insoluble matter, chiefly silicic acid	96.549 per cent.
Soluble silicic acid	0.836 "
Sulphuric acid	0.178 "
Ferric oxide and alumina	0.257 "
Lime	1.023 "
Magnesia	0.462 "
Undetermined matters	0.695 "
	100.000

No. 15 is a dull-green, amorphous mineral, unctuous and soapy to the touch. Fracture uneven, coarsely granular. Hardness 1.5. Easily cut with a knife, giving a smooth surface. Specific gravity 2.562. Lustre dull, waxy, with very minute pearly scales. Color mottled, dull-green to grayish-green, opaque, scales translucent. When wetted it absorbs water and softens, but does not become plastic.

In closed tube it gives water. B.B. infusible. Gives blue color with cobalt, which is indistinct from excess of iron. Is decomposed by hydrochloric acid, leaving a white insoluble residue containing only a trace of iron. The oxidation of the iron varies according to the extent of the exposure. The following are the mean results of three closely concordant analyses:

SiO_2	37.88 per cent.
Fe_2O_3	15.78 "
Al_2O_3	26.96 "
MgO	1.74 "
K_2O } Na_2O }	0.95 "
H_2O	15.88 "
	99.16 "

A trace of lime was not determined.

These results show the mineral to be allied to Fahlunite, var. Huronite of T. S. Hunt. See Dana's Mineralogy, Ed. 1870, p. 485.

It is doubtless one of the numerous decomposition products of a ferruginous Feldspar.

Nos. 30 and 31 are pieces of the St. Lawrence limestone. This stone consists of a hard, siliceous, magnesian limestone containing sufficient iron to give it an ocherous shade of color with yellowish streaks. It also contains angular grains of quartz and small grains of a green mineral quite uniformly distributed through the rock. These grains are of all sizes from that of a large pin's head to those of scarcely preceptible dimensions. They are irregularly spherical in form, sometimes slightly flattened, or elongated. Cold commercial hydrochloric acid dissolves all of the constituents of the rock except the grains of quartz and the green grains. By sifting and careful sorting, the largest of the green grains may be obtained quite pure. The specific gravity of these grains is 3.634—Hardness about 2.0. B. B. infusible becoming brown from oxidation of iron. In the closed tube gives water becoming more or less oxidized. The following are the mean results of three analyses :

SiO_2	48.20	per cent.
FeO	27.09	"
Al_2O_3	6.94	"
K_2O	7.54	"
Na_2O	1.02	"
H_2O	8.72	"

These characteristics and results give a variety of Glauconite not decomposed by hydrochloric acid. See Dana's Mineralogy, Ed. 1870, p. 462.

Russell Mineral Spring Water. This water flows from a spring in the cellar of the house at present occupied by Perkins Russell, Esq., on the corner of Fifth street and Fifteenth avenue S. E., in this city. The flow of the spring is very uniform throughout the year and the volume is copious, bubbling up in the center of a curbed area about four feet in diameter. On exposure to the atmosphere the water deposits sesqui-oxide of iron. No gas escapes from super-saturation. The water is very clear and sparkling, with a slight green color and the taste of a dilute solution of hydrosulphuric acid gas.

Analysis showed that one U. S. wine gallon of 231 cubic inches contains of,

		Grains.
Potasium chloride,	$K Cl$	0.170161
Sodium chloride,	$Na Cl$	1.226701
Calcium chloride,	$Ca Cl_2$	0.393765
Calcium carbonate	$Ca CO_3$	10.060996
Calcium sulphate,	$Ca SO_4$	0.867690
Calcium Phosphate,	$Ca_3 (PO_4)_2$	0.171380
Magnesium carbonate,	$Mg CO_3$	4.371058
Iron proto-carbonate,	$Fe CO_3$	0.169227
Manganese proto-carbonate,	$Mn CO_3$	0.032561
Silicic oxide,	$Si O_2$	1.393182
Organic matter,		0.208340
Sodium biborate,		A trace.
Potassium nitrate,		A trace.
Ammonium chloride,		A trace.
Calcium fluoride,		A trace.
Barium carbonate,		A trace.
Barium sulphate,		A trace.
Total solid matter,		19.065061
Specific gravity at 60° Fahr.		1.000638
Temperature,		45.5° Fahr.

At that temperature one gallon contains of

Carbonic acid gas,	CO_2	41.037432 C. inches.
Of which is combined to form bicarbonates,		25.651171 C. inches.
Leaving in solution,		15.386261 C. inches.

The water also contains an amount of hydrogen sulphide ($H_2 S$), varying in amount at different times from a trace to a few cubic inches per gallon.

These results give a water of somewhat peculiar character, yet not sufficiently remarkable in any respect to lead one to expect unusual results to follow its use. The amount of solid matter is small and consequently all of the ingredients present are found in small proportion; yet we find, on comparing these results with the analysis of other waters, that the amount of calcium phosphate present is relatively large. The reputation which the water has attained as a remedial agent, may be, in part, due to the presence of this salt, or it may be due to the peculiar combination presented by the simultaneous presence of phosphate of lime, proto-carbonate of iron and sulphide of hydrogen.

It may be said, however, that the causes producing certain physio-

logical effects are very obscure, and when these effects are observed to follow the use of complex mixtures dissolved in large quantities of water, but little satisfaction can be gained from theoretical speculations that attribute them to the presence of one or the other ingredient of the mixture. But little more can be said than that the water contains small quantities of substances that give, when found in large proportions, the specific characters to seltzer, chalybeate, and white-sulphur springs, and that its use in many instances has been attended with beneficial results.

In accordance with your request, that I should furnish you the results of the analyses that were made in the fall of 1875 for Messrs. Kindred and Culver, I submit the following:

I. Three specimens supposed to contain silver were sent to Dr. P. B. Rose to be assayed. The first two were from J. B. Culver, Esq., of Duluth, and were reported as not containing silver. The third specimen was from C. F. Kindred, Esq., of Brainerd. It was reported as containing "52.32 oz. of silver to the ton of ore, which at $1.30 per oz. = $68.01 per ton."

II. A sample of iron ore, supposed to contain tin, from the neighborhood of Duluth, was sent to Prof. E. W. Morley, of Hudson, Ohio, a gentleman of large experience on iron assays. He reported two assays as yielding iron, 16.19 per cent. and 16.17 per cent. "Tin not present in any appreciable quantity. The ore appeared to contain quite a notable quantity of Titanium. Titanium is now supposed to be injurious. * * The amount of iron in the ore is so small that iron produced from it could hardly compete with richer ores, even if flux and coal were both near at hand. One would not like to say the ore is valueless without knowing the relative amount of silica and calcium in the ore; but the probability that they are in such proportions as to render the addition of a flux needless, is very slight."

Another sample of iron ore from near Duluth, was sent Prof. Morley with instructions to determine the quantity of any thing he might find in it of commercial value. After giving the details of the process of analysis, he says: "You will see that everything of any commercial value is pretty thoroughly excluded. It is an iron—magnesium—sodium silicate; with not enough iron to make it of value as an iron ore."

The first mentioned iron ore resembles an iron ore found in the northern part of Rhode Island, where it occurs in a protruded mass, in some respects resembling porphyry.

Respectfully submitted,

S. F. PECKHAM,
State Chemist.

MINNEAPOLIS, Jan. 9, 1877.

V.

BOTANY.

The survey has received a hearty response to the following circular, which was issued in conformity with the instructions of the Regents, in the spring of 1876:

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

(BOTANY.)

To the Botanists of the State:

At the annual meeting of the Board of Regents, held in St. Paul in December, 1875, action was taken ordering the commencement of a thorough and systematic examination of the flora of the state. This was done in conformity to the law ordering a geological and natural history survey of the state, and placing it in charge of the Regents of the University. One clause of that law reads as follows:

"SEC 3. The natural history survey shall include, first, an examination of the vegetable productions of the state, embracing all trees, shrubs, herbs and grasses native or naturalized in the state; second, a complete and scientific account of the animal kingdom as properly represented in the state, including all mammalia, fishes, reptiles, birds and insects."

In the prosecution of this examination it is expected that the Regents will have the assistance of the botanists of the state, and it is for their information that the following suggestions are made concerning the collection and preservation of information, and especially of botanical specimens.

1st. Make as full notes as possible on the flora of your own locality, not only naming species, but mentioning peculiarities and variations of structure, habitat, color, and relative abundance. Recollect that there is no published text book that professes to give an account of the flora of the country west of the Mississippi in this latitude, and that you are very largely

an independent observer. Therefore repeated verifications of an observed variation or peculiarity, or of a species not named in the familiar text-books, should be made *before reporting such observation as a fact.*

2d. Collect and preserve as many specimens as possible. They will exemplify the local flora of your region, and will serve as duplicates for exchange with other portions of the state and with foreign botanists. The most valuable portion of your contribution to the survey will be, after all, the collections which you may make and forward for careful identification.

3d. It is the design of the Regents to collect together at the University, a complete representation of the plants of the state as ordered by the law, and to have them so arranged and exhibited that they can be seen for comparison by any of the botanists of the state that may wish to examine them.

4th. For aid in the study of the flora of the state, the following works will be useful:

Gray's *Manual of Botany.*

Torrey & Gray's *Flora of North America*, 2 vols., to *Lobeliaceæ.*

De Candolle's *Prodromus*, 18 vols., down to *Endogenae.*

U. S. Geological Exploration of the Fortieth parallel. Vol. V, Botany. (Watson.)

Pacific R. R. Reports.

Transactions of the St. Louis Academy.

Proceedings of the American Academy, Philadelphia.

Catalogue of the Plants of Minnesota, by I. A. Lapham, published in the Annual Report of the State Horticultural Society for 1875. Furnished by the Secretary of the Society.

Hayden's *Nebraska Plants.*

Hooker's Fl. Bot. Am., 2 vols.

Flora of Colorado, I vol., Porter & Coulter.

Nuttall's Genera, 2 vols.

Bentham's Genera, 4 parts.

5th. It is evident that there is no botanist, nor even any public library in the state that possesses the books necessary for the thorough study and satisfactory determination of the species of our flora. Within certain limits our flora can be studied, but the burden of our first efforts must be the collection of specimens. Their exhaustive study can only be done by experts, with the fullest facilities for comparison.

6th. The present design of the survey is to act as a means of communication between botanists of the state, to enable them to compare specimens, and as a depository for duplicates. To this end exchanges will be made with such as desire to compare species, and any aid or information will be rendered that it is possible to give. Lists of the local flora in different parts of the state should be made out as thoroughly as possible, to judge of the distribution of species. The areas that are covered with timber in the various counties, or townships, and the kinds of trees, should be stated. It is highly desirable that a local botanist be assigned to the working up of each county. For this purpose, the survey should be furnished with the

names of such botanists as are known to be interested in our state flora. Annual reports made by such local botanists would indicate the progress of the work.

N. H. WINCHELL.

THE UNIVERSITY OF MINNESOTA,
May 1st, 1876.

The survey has received several hundred specimens representing the flora of the state, and others have been gathered by Mr. Leonard and Mr. Herrick, assistants on the survey. Nothing systematic has been attempted in the way of identifications, but through the kindness of others, chiefly Mr. O. E. Garrison, of St. Cloud, and Dr. A. E. Johnson, of Minneapolis, valuable assistance has been rendered in determining our local flora.

FUNGI.

BY DR. A. E. JOHNSON.

Prof. N. H. Winchell:—I believe no attempt prior to this has been made to collect and list the Mycologic Flora of Minnesota. As a small contribution to the Natural History of Minnesota, I present the following list of plants, in the Mycologic Flora of our state, for such use as you may be pleased to make of it.

The list has been collected mainly from Hennepin county; some from Anoka, Ramsey and Wright counties.

I have placed the Gen. or Sub-Gen. before each species; as for example, Sub-Gen. 1. *Amanita.* Hence, in reading *Agaricus vaginatus*, the word *Amanita* should be supplied thus: *Agaricus* (Amanita) vaginatus. *Bull.* And so with all the species under each Gen. or Sub-Gen. Following the specific name of the species are initials or letters used by botanists to designate the name of the author of the species, and immediately following is the common name of the plant if it has received one; then follow such words as, wood, woods, ground, sticks, stumps, epiphytal, terrestrial, etc., indicating the habitat, and lastly the month or months in which the plant is found in our climate. If there is but one month named, the plant has only been observed in that month, but if two months are named, as June, Nov. the plant has been observed in both months and most always during the intervening months:

DIVISION 1. Sporifera.

FAMILY 1. Hymenomycetes.

ORDER 1. Agaricini.

SERIES 1. Leucospori. Spores white.

SUB-GEN. Amanita *Pers.*

GEN. Agaricus. *L.*

1. Agaricus vaginatus. *Bull.* Slick Amanita. Woods. August.
2. A. Ceciliae. *B. & Br.* Grey, ringless Amanita. Woods. Aug., Sept.
3. A. adnatus. *Smith.* Adnate-gilled Amanita. Woody places. Aug.
4. A. vernus. *Bull.* Spring Amanita. Woods, open places. June to Aug
5. A. phalloides. *Fr.* Stinking Amanita. Woods. August, Nov.
6. A. mappa. *Batsch.* Delicate Amanita. Under trees. Poisonous.
7. A. muscarius. *L.* Fly Amanita. Thin woods. Aug. & Sept. Poisonous.
8. A. excelsus. *Fr.* Tall Amanita. Woods. Aug. and Sept.
9. A. pantherinus. *D. C.* Spotted Amanita. Woods and open ground.
10. A. asper. *Fr.* Rough Amanita. Woods. June to Sept.

SUB-GEN. Lepiota. *Fr.*

11. A. procerus. *Scop.* Parasol mushroom. Woods. Aug. to Sept.
12. A. excoriatus. *Schæff.* Flaky Lepiota. Woods. May to Sept.
13. A. gracilentus. *Krombh.* Slender Lep. Ground. Sept. Edible.
14. A. acutesquamosus. *Wm.* Squarrose Lepiota. Ground. July.
15. A. clypeolarius. *Bull.* Fragrant Lepiota. Woods. Ju.
16. A. Americanus. *Peck.* Prairies. Aug. to Sept.
17. A. cristatus. *Fr.* Stinking Lepiota. Woods, fields. Aug.
18. A. naucinus. *Fr.* Large spored Lepiota. Woods. Aug. to Sept.
19. A. granulosus. *Batsch.* Granular Lepiota. Forests. July.
20. A. polystictus. *Berk.* Little Brown Lepiota. Ground. July.

SUB-GEN. Armillaria. *Fr.*

21. A. melleus. *Vahl.* Honey-coloured Armillaria. W. Aug to Sept.

SUB-GEN. Tricholoma. *Fr.*

22. A. vaccinus. *Pers.* Scaly Tricholoma. Ground, in woods. Sept.
23. A. crassifolius. *Berk.* Thick-gilled Tricholoma. Larch swamps.
24. A. varigatus. *Scop.* Variegated Tricholoma. Ground. June, July.
25. A. sulfureus. *Bull.* Sulphury Tricholoma. Woods. July, Aug.
26. A. gambosus. *Fr.* St. George's Mushroom. Grassy ground. June.
27. A. melaleucus. *P.* Changeable Tricholoma. Cleared ground. Sept.

SUB-GEN. Clitocybe. *Fr.*

28. A. nebularis. *Batsch.* Clouded Clitocybe. On ground in woods. Sept.
29. A. Adirondackensis. *Peck.* Smooth Clitocybe. Woods. Aug., Sept.
30. A. candicans. *Fr.* Whitish Clitocybe. Woods. Sept.
31. A. phyllophilus. *Fr.* Leaf-loving Clitocybe. Woods. Sept.
32. A. dealbatus. *P.* Ivory Clitocybe. Woods. July.
33. A. giganteus. *Fr.* Giant Clitocybe. Woods. Sept.
34. A. cyathiformis. *Fr.* Cup-shaped Clitocybe. Woods. Aug., Sept.
35. A. laccatus. *Scop.* Waxy Clitocybe. Woods. June-Oct.
36. A. cerussatus. *Fr.* White lead clitocybe. Larch. May.
37. A. radio-zonaria. *n. sp.* Radiated Clitocybe. Ground, wood. June.

A full description in Bulletin of the Minnesota Academy of Natural Sciences for 1876.

SUB-GEN. Pleurotus. *Fr.*

38. A. ostreatus. *Jacq.* Oyster Pleurotus. Trunks in woods. July.
39. A. seratinus. *Schrad.* Yellowish Pleurotus. Larch. May.
40. A. mastrucatus. *Fr.* Imbricated Pleurotus. On wood. June.
41. A. atrocœruleus. *Fr.* Blue-black Pleurotus. On wood. July.
42. A. sulfuroides. *Peck.* Pine logs, &c. Sept.
43. A. serotinoides. *Peck.* Trunks in woods. Nov.

SUB-GEN. Collybia. *Fr.*

44. A. radicatus. *Relh.* Rooting Collybia. Ground, stumps. July.
45. A. velutipes. *Curt.* Velvet-stemmed Collybia. Stumps. May.
46. A. confluens. *P.* Confluent Collybia. Woods. July.
47. A. cirrhatus. *Schum.* Cirrhate Collybia. June, September.
48. A. tuberosus. *Bull.* Tuberous Collybia. Ground, &c. Aug., Oct.
49. A. acervatus. *Fr.* Tufted Collybia. Woods. Aug., Oct.
50. A. xanthopus. *Fr.* Yellow-stemmed Collybia. Ground. July, Aug.
51. A. dryophilus. *Bull.* Wood Collybia. Epiphytal. June to Oct.
52. A. exsculptus. *Fr.* Sulphur-gill Collybia. Ground. Sept.
53. A. plexipes. *Fr.* Twisted Collybia. On trunks.
54. A. stipitarius. *Fr.* Fibrillose Collybia. Epiphytal. July to Aug.

SUB-GEN. Mycena. *Fr.*

55. A. praelongus. *Peck.* Epiphytal. Swamps. June to July.
56. A. paluster. *Peck.* Larch swamps. Sphagnum. June.
57. A. radius. *n. sp.* Pale-yellow Mycena. Ground. May.

See Bulletin of the Minn. Acad. of Natural Sciences. 1876.

58. A. strobilinus. *Pers.* Fir-cone. Mycena. Epiphytal.
59. A. purus. *P.* Amethyst Mycena. Larch swamps. June to July.

60. A. pauperculus. *Berk.* Little-stump Mycena. July.
61. A. sanguineolentus. *A. & S.* Stinking Mycena. June to Oct.
62. A. crocatus. *Schrad.* The Stainer. Woods. June to July.
63. A. epipterygius. *Scop.* Yellow-stem Mycena. July to Aug.
64. A. stylobates. *P.* Discoid Mycena. Epiphytal. Woods. Aug.
65. A. corticola. *Schum.* Bark Mycena. July, Aug.
66. A. capillaris. *Schum.* Capillary mycena. Leaves. Aug.

SUB-GEN. Omphalia. *Fr.*

67. A. pyxidatus. *Bull.* Variable Omphalia. Ground. July.
68. A. affricatus. *Fr.* Hairy Bog Omphalia. Ground. July.
69. A. muralis. *Sow.* Wall Omphalia. Ground. July.
70. A. umbilliferus. *L.* Common Omphalia. Ground. July. Sept.
71. A. rufulus. *B. & Br.* Reddish Ompahlia. Ground. July.
72. A. campanella. *Batsch.* Tawny Omphalia. Larch swamps.
73. A. chryseus. *Peck.* Logs in woods. August.
74. A. fibula. *Bull.* Button Omphalia. Ground. June, Oct.
75. A. gracillimus. *Weinm.* Delicate Omphalia. Epiphytal. Aug.
76. A. integrellus. *P.* Little-white Omphalia. Epi. Aug., Sept.

SERIES. 2. Hyporhodii. *Fr.*

SUB-GEN. Volvaria. *Fr.*

77. A. bombycinus. *Schæff* Silky Volvaria. Epiphytal. July, Aug.
78. A. volvaceus. *Bull.* Stove Volvaria. Ground. July, Aug.
79. A. Taylori. *Berk.* Taylor's Volvaria. Ground. Aug., Sept.
80. A. gloiocephalus. *Fr.* Umbonate Volvaria. Ground. June.

SUB-GEN. Chamæota. *Smith.*

81. A. cretaceus. *Fr.* Chalky Chamæota. Ground. Aug.

SUB-GEN. Pluteus. *Fr.*

82. A. cervinus. *Schæff.* Fawn Pluteus. Ground. May, Oct.
83. A. nanus. *P.* Mealy Pluteus. Logs in woods. Aug.
84. A. petasatus. *Fr.* Broad-capped Pluteus. Epiphytal. Aug.
85. A. leoninus. *Schæff.* Yellow Pluteus. On wood. Aug., Oct.
86. A. chrysophæus. *Schæff.* Dingy Pluteus. On wood. Aug.
87. A. phlebophorus. *Ditm.* Veined Pluteus. On wood. Aug.

SUB-GEN. Entoloma. *Fr.*

88. A. strictior. *Peck.* Ground. Sept., Oct.
89. A. sinuatus. *Fr.* Woods. Ground. Poisonous. July.
90. A. prunuloides. *Fr.* Plum-like Entolomia. Woods, ground. Sept.

91. A. helodes. *Fr.* Moor Entoloma. Ground, woods. Sept.
92. A. repandus. *Bull.* Repand Entoloma. Ground, woods. July.
93. A. ardociacus. *Bull.* Meadow Entoloma. Ground, woods. Sept.
94. A. sericellus. *Fr.* Silky Entoloma. Woods. Aug., Sept.
95. A. rhodopolius. *Fr.* Rosy Entoloma. Ground, woods. Aug., Sept.
96. A. costatus. *Fr.* Costate Entoloma. Ground. Sept.
97. A. cuspidatus. *Peck.* Swamps. Sphagnus marshes. Sept.

SUB-GEN. Clitopilus. *Fr.*

98. A. prunulus. *Scop.* Plum Clitopilus. Woods, ground. Season.
99. A. cretatus. *Berk.* Chalky Clitopilus. Woods, ground. Aug., Sept.
100. A noveborasensis. *Peck.* Dingy white Clitopilus. Ground. Aug.
101. A. Woodianus. *Peck.* On ground, and wood. Sept.
102. A. undatus. *Fr.* Waved Clitop. Aug., Sept.

SUB-GEN. Claudopus. *Smith.* Seem. Journal.

103. A. euosmus. *Berk.* Tarragon Clau. Wood. June.
104. A. depluens. *Batsch.* Ground Clau. Ground. Sept.

SUB-GEN. Leptonia. *Fr.*

105. A. chalybæus. *P.* Steel-blue Leptonia. Prairies. July, Sept.
106. A. incanus. *Fr.* Hoary Leptonia. Prairies. Dayton. Aug.

SUB-GEN. Nolanea. *Fr.*

107. A. pascuus. *P.* Pasture Nola. Wet prairies. June.
108. A. rufo-carneus. *Berk.* Red-brown Nola. Marshes. Aug., Sept.
109. A. Babingtonii. *Blox.* Babington's Nola. Woods. Sept.
110. A. conicus. *Peck.* On rotton wood. Swamps. Aug.
111. A. delicatulus. *Peck.* Delicate Nola. Larch swamp. Aug.
112. A. Clintonianus. *Peck.* Clinton's Nola. Swamps. Aug.

SERIES 3. Dermini. *Fr.*

SUB-GEN. Pholiota. *Fr.*

113. A. præcox. *P.* Spring Phol. Prairies. May.
114. A. comosus. *Fr.* Hairy Phol. Decaying trunks. Aug.
115. A. squarrosus. *Mull.* Scaly Phol. Trunks. Aug.
116. A. flammans. *Fr.* Yellow scaly Phol. Ground. June.
117. A. temnophyllus. *Peck.* Brownish Phol. Ground. June, July.

SUB-GEN. Hebeloma. *Fr.*

118. A. punctatus. *Fr.* Ground in woods. Sept.
119. A. crustuliniformis. *Bull.* Ring Hebeloma. Woods. Sept.

120. A. fastibilis. *Fr.* Ochrey Hebe. Woods. July-Oct. Common.
121. A. stellatosporus. *Peck.* Stellate Hebeloma. Ground. Sept.
122. A. griseo cabrosus. *Peck.* Rough Hebeloma. Popple groves. Sept.
123. A. illicitus. *Peck.* Smooth Hebeloma. Popple groves. Sept.
124. A. ascophorus. *Peck.* Viscid Hebeloma. Burned ground. Sept.
125. A. mutatus. *P.* Changeable Hebeloma. Ground. July, Aug.
126. A. pyriodorus. *P.* Pear-scented Hebeloma. Woods. Sept.
127. A. obscurus. *P.* Violet Hebeloma. Ground. July.
128. A. flocculosus. *Berk.* Flocculose Hebeloma. Ground. Sept.
129. A. deglubens. *Fr.* Peeling Hebeloma. Woods. Aug., Sept.
130. A. fastigiatus. *Fr.* Peaked Hebeloma. Woods. July.
131. A. rimosus. *Bull.* Cracked Hebeloma. Ground. June, Sept.
132. A. trechisporus. *Berk.* Rough-spored Hebeloma. Ground. Aug.
133. A. auricomus. *Batsch.* Golden-haired Hebeloma. Woods. July.
134. A. floculentus. *Poll.* Woolly Hebeloma. Ground. July.

SUB-GEN. Flammula. *Fr.*

135. A. polychrous. *Berk.* Reddish Flammula. Ground, wood. Aug., Sept.
136. A. gummosus. *Lasch.* Viscid Flammula. Wood. July.
137. A. sapineus. *Fr.* Bright-Spored Flam. Ground and wood. Aug.

SUB-GEN. Crepidotus. *Fr.*

138. A. mollis. *Schœff.* Soft Crepidotus. On wood. July-Oct.

SUB-GEN. Naucoria. *Fr.*

139. A. semiorbicularis. *Bull.* Half-round Naucoria. Dung. June.
140. A. vernalis. *Peck.* Decaying wood. June.
141. A. lignicola. *Peck.* Decaying wood. June.
142. A. erinaceus. *Fr.* Hedgehog Naucoria. Wood. Nov.

SUB-GEN. Galera. *Fr.*

143. A. ovalis. *Fr.* Oval Galera. Cow-dung. Aug.
144. A. tener. *Schœff.* Slender Galera. Dung. July-Oct.
145. A. sparteus. *Fr.* Meadow Galera. Mossy ground. June.
146. A. hypnorum. *Batsch.* Moss-loving Galera. July. Sept.
147. A. sphagnorum. *Pers.* Bog-moss Galera. July, Sept.

SUB-GEN. Tubaria. Smith. Journ., 1870.

148. A. inquilinus. *Fr.* Little Tubaria. On wood, swamps. June, Sept.
149. A. furfuraceus. *P.* Mealy Tubaria. Chips, wood. July, Sept.

SERIES 4. Praetellæ. *Fr.*

SUB-GEN. Psalliota. *Fr.*

150. A. campestris. *L.* Common Mushroom. Ground. August.
Var. pratensis. *Vitt.* Rich muck. Aug.
Var. silvicola. *Vitt.* Ramsey and Wright counties. Aug.
151. A. silvaticus. *Schæff.* Wood Psalliota. Woods. Aug.
152. A. Johnsonianus. *Peck.* Woods. Sept.

SUB-GEN. Pilosace. *Fr.*

153. A. eximius. *Peck.* Decaying logs in woods. Sept.

SUB-GEN. Stropharia. *Fr.*

154. A. stercorarius. *Fr.* Dung Stropharia. May, Sept.
155. A. semiglobatus. *Batsch.* Semiglobose Stropharia. June, Sept.

SUB-GEN. Hypholoma. *Fr. Hab.* Generally on stumps.

156. A. sublateritius. *Fr.* Brick-red Hypholoma. Sept.
157. A. fascicularis. *Hud.* Tufted Yellow Hypholoma. Sept.
158. A. lacrymabundus. *Fr.* Weeping Hyph. July, Nov.
159. A. velutinus. *P.* Velvety Hyph. Trunks. July.
160 A. perplexus. *Peck.* Ground about stumps. Sept.
161. A. phyllogenus. *Peck.* Fallen leaves. July

SUB-GEN. Psilocybe. *Fr. Hab.* Mostly on the ground.

162. A. limicola *Peck.* Aug., Sept.
163. A. spadiceus. *Schæff.* Bay Psilocybe. Wood. Ground. Aug.
164. A. cernuus. *Mull.* Nodding Psilocybe. Wood. Ground. Sept.
165. A. fœnisecii. *P.* Brown Psilocybe. Ground. Sept.

SUB-GEN. Psathyra. *Fr. Hab.* Ground. Wood.

166. A. mastiger. *Berk & Br.* Peaked Psathyra. Ground. Aug., Sept.
167. A. corrugis. *P.* Wrinkled Psathyra. Ground. Aug.
168. A. obtusatus. *Fr.* Obtuse Psathyra. Ground. June.

SERIES 5. Coprinarii. *Fr.* Spores black.

SUB-GEN. Panæolus. *Fr.* Mostly on dung.

169. A. separatus. *L.* Ochrey Panæolus. June, Sept.
170. A. leucophanes. *B. & Br.* Shiny-White Panæolus. May, Aug.
171. A. fimiputris. *Bull.* Dark-gray Panæolus. June, Aug.

172. A. campanuiatus. *L.* Campanulate Panæolus. June, Aug.
173. A. papilionaceus. *Bull.* Butterfly Panæolus. June, July.
174. A. solidipes. *Peck.* July.
175. A. fimicola. *Fr.* Dung Panæolus. June.

SUB-GEN. Psathyrella. *Fr.*

176. A. gracilis. *Fr.* Slender Psathyrella. Sept.
177. A. pronus. *Fr.* Stooping Psathyrella. Ground. Sept.
178. A. atomatus. *Fr.* Sprinkled Psathyrella. Manure. June, July.
179. A. disseminatus. *Fr.* Clustered Psathyrella. Woods. July, Sept.
180. A. odoratus. *Peck.* Manure heaps. May, June.

GEN. 2. Coprinus. *Fr.*

181. C. comatus. *Fr.* Shaggy Coprinus. Rich ground. Sept.
182. C. atramentarius. *Fr.* Inky Coprinus. Dung. June, July.
183. C. fuscescens. *Fr.* Brownish Coprinus. Wood. Juue, July.
184. C. picaceus. *Fr.* Magpie Coprinus. Ground. Sept.
185. C. similis. *B. & Br.* Striate Coprinus. Wood. Sept.
186. C. fimetarius. *Fr.* Shaggy-dung Coprinus. June, July.
187. C. tomentosus. *Fr.* Downy Coprinus. Dung. May, June.
188. C. miveus. *Fr.* Snowy Coprinus. May, June.
189. C. micaceus. *Fr.* Glistening Coprinus. May, Sept.
190. C. deliquescens. *Fr.* Deliquescent Coprinus. June.
191. C. lagopus. *Fr.* Hare's foot Coprinus. Dung. July.
192. C. radiatus. *Fr.* Delicate Coprinus. Dung. May, June.
193. C. ephemerus. *Fr.* Ephemeral Coprinus. May, June.
194. C. insignis. *Peck.* About roots of trees. July, Aug.
195. C. angulatus. *Peck.* Ground in woods. Aug., Sept.
196. C. plicatilis. *Fr.* Rich ground. June, July.
197. C. hemerobius. *Fr.* Collared Coprinus. July.
198. C. silvaticus. *Peck.* Ground. Sept.
199. C. semilanatus. *Peck.* Dung. Aug.

GEN. 3. Bolbitius. *Fr.* Manure, rich soil.

200. B. Boltoni. *Fr.* Bolton's Bolbitius. Dung. June, Sept.
201. B. fragilis. *Fr.* Fragile Bolbitius. Epiphytal. May, Aug.
202. B. titubans. *Fr.* Wavering Bolbitius. Ground. Forest. Open. Ju., Oct.
203. B. apicalis. *Smith.* Two-coloured Bolbitius. Ground. June, July.
204. B. nobilis. *Peck.* Noble Bolbitius. Ground. Woods. Sept.

GEN. 4. Cortinarius, *Fr.*

SUB-GEN. 1. Phlegmacium. *Fr.*

205. C. varius. *Fr.* Variable Cort. Ground. Woods. Aug., Sept.

206. C. cyanipes. *Fr.* Blue-stemed Cort. Woods. July, Aug.
207. C. russus. *Fr.* Ruddy Cort. Woods. Sept.
208. C. coloratus. *Peck.* Amongst moss. Larch swamps. Sept.
209. C. communis. *Peck.* Woods. Sept.
210. C. multiformis. *Fr.* Multiform Cort. Woods. Sept.
211. C. glaucopus. *Fr.* Brown-zoned Cort. Sept.
212. C. callochrous. *Fr.* Tawny-viscid Cort. Woods. Aug., Sept.
213. C. cœrulescens. *Fr.* Azure-blue Cort. Woods. Sept.
214. C. turbinatus. *Fr.* Top-shaped Cort. July, Sept.
215. C. scaurus. *Fr.* Club-footed Cort. Woods. Sept.
216. C. corrugatus. *Peck.* Woods. June.

SUB-GEN. 2. Myxacium. *Fr.*

217. C. collinitus. *Fr.* Smeared Cort. Woods. Sept.
218. C. sphærosporus. *Peck.* Woods. Sept.

SUB-GEN. 3. Inoloma. *Fr.*

219. C. violaceus. *Fr.* Violet Cort. Woods. Aug.
220. C. camphoratus. *Fr.* Strong-scented Cort. Ground. Sept.
221. C. callisteus. *Fr.* Stout Cort. Woods. August.
222. C. pholideus. *Fr.* Scaly Cort. Woods. Sept.
223. C. sublanatus. *Fr.* Woolly Cort. Woods. Sept.
224. C. lilacinus. *Peck.* Woods. Sept.
225. C. squamulosus. *Peck.* Scaly Cort. Woods. Aug., Sept.
226. C. asper. *Peck.* Newly cleared places. Sept.

SUB-GEN. Dermocybe. *Fr.*

227. C. anomalus. *Fr.* Thin-capped Cort. Woods. Sept. Oct.
228. C. spilomeus. *Fr.* Scaly-stemmed Cort. Woods. Sept.

SUB-GEN. Telamonia. *Fr.*

229. C. bulbosus. *Fr.* Bulbous Cort. Woods. Aug., Sept.
230. C. lignarius. *Peck.* Decayed wood. June.
231. C. limonius. *Fr.* Lemon Cort. Decaying pine. June.
232. C. hinnuleus. *Fr.* Fawn Cort. Woods. June.
233. C. psammocephalus. *Fr.* Little Tawny Cort. Woods. Aug., Sept.
234. C. illeopodius. *Fr.* Tan-colored Cort. Woods. June, Sept.

SUB-GEN. Hygrocybe. *Fr.*

235. C. Armeniacus. *Fr.* Peach Cort. Woods.
236. C. vernalis. *Peck.* Spring Cort. Ground. June.
237. C. castaneus. *Fr.* Chestnut Cort. Woods. Sept.
238. C. Reedii. *Berk.* Reed's Cort. Shores of lakes. June.

239. C. leucopus. *Fr.* White-stemmed Cort. Woods. May.
240. C. decipiens. *Fr.* Deceptive Cort. Woods. Sept.

GEN. Lepister. *Smith.* Sieem. Jour. 1870.

241. L. nudla. *Bull.* Amethyst Lep. Woods. Prairies. Aug. Sept.
242. L. personata. *Fr.* Purple-stemmed Lep. Ground. Aug. Sept.

GEN. Paxillus. *Fr.*

243. P. involutus. *Fr.* Involute Pax. Ground in woods. Aug. Sept.
244. P. strigosus. *Peck.* Hairy Pax. Ground, woods. Sept.

GEN. Hygrophorus. *Fr.* Terrestrial. Woods, on ground.

245. H. eburenus. *Fr.* Ivory Hygroph. Woods. Sept., Oct.
246. H. cossus. *Fr.* Goat-moth Hygroph. Woods. Sept., Oct.
247. H. cerasinus. *B.* Waxy Hygroph. Woods. Sept., Oct.
248. H. aromaticus. *B.* Aromatic Hygroph. Woods. Sept.
249. H. mesotephrus. *B. & Br.* Brown-disk Hygroph. Woods. Aug.,Sept.
250. H. hypothejus. *Fr.* Pine-wood Hygroph. Sandy soil. Woods. Sept.
251. H. olivaceo-albus. *Fr.* Olive Hygroph. Woods. Sept.
252. H. leporinus. *Fr.* Hare-colored Hygroph. Terrestrial. Sept.
253. H. pratensis. *Fr.* Pasture Hygroph. Open places, woods. Sept.
254. H. niveus. *Fr.* Snow-white Hygroph. Mossy ground. Aug., Oct.
255. H. ceraceus. *Fr.* Wax-like Hygroph. Woods. Sept., Oct.
256. H. miniatus. *Fr.* Vermillion Hygroph. Woods. Aug., Sept.
257. H. coniscus. *Fr.* Conical Hygroph. Terrestrial. Aug., Oct.
258. H. nitidus. *B. & R.* Amongst moss in wet places. Aug., Sept.

GEN. GOMPHIDIUS. *Fr.* Terrestrial mainly.

259. G. viscidus. *Fr.* Viscid Gomphidius. On wood. Aug.

GEN. LACTARIUS. *Fr.* Terrestrial. Mainly in woods.

260. L. torminosus. *Fr.* Woolly Lactarius. Aug., Oct.
261. L. cilicioides. *Fr.* Tomentose Lact. Sept.
262. L. turpis. *Fr.* Dirty Lact. July.
263. L. pubescens. *Schrad.* Pubescent Lact. Aug., Sept.
264. L. zonarius. *Fr.* Zoned Lact. Aug., Oct.
265. L. blennius. *Fr.* Slimy Lact. Aug., Sept.
266. L. pyrogalus. *Fr.* Pear-scented Lact. Aug., Sept.
267. L. plumbeus. *Fr.* Lead-coloured Lact. Aug., Sept.
268. L. chrysorrhæus. *Fr.* Yellow juiced Lact. July, Aug.
269. L. piperatus. *Fr.* Peppery Lact. July, Sept.
270. L. vellereus. *Fr.* Woolly-white Lact. July.
271. L. deliciosus. *Fr.* Delicious Lact. Aug., Oct.

272. L. pallidus. *Fr.* Pallid Lact. Aug., Sept.
273. L. theiogalus. *Fr.* Sulphur-juiced Lact. Aug.
274. L. cyathala. *Fr.* Cup-like Lact. Aug., Sept.
275. L. glyciosmus. *Fr.* Scented Lact. Aug., Oct.
276. L. serifluus. *Fr.* Thin-juiced Lact. Sept.
277. L. fuliginosus. *Fr.* Dingy Lact. July, Oct.
278. L. affinis. *Peck.* Viscid Lact. Sept., Oct.
279. L. volemus. *Fr.* Orange-brown Lact. July, Sept.
280. L. platyphyllus. *Peck.* Aug., Sept.
281. L. sordidus. *Peck.* Sandy soil. Sept.
282. L. griseus. *Peck.* Low ground. Aug.

GEN. Russula. *Fr.* Terrestrial. Usually late Summer and Autumn.

283. R. nigricans. *Fr.* Blackish Rus. July, Aug.
284. R. aduster. *Fr.* Scorched Rus. Sept., Oct.
285. R. delica. *Fr.* Whitish Rus. Woods. Aug.
286. R. furcata. *Fr.* Forked Rus. Woods. Sept.
287. R. sanguinea. *Fr.* Blood-red Rus. Woods. July.
288. R. rosacea. *Fr.* Rosy Rus. Woods. July.
289. R. sardonia. *Fr.* Changeable Rus. Woods. July.
290. R. depallens. *Fr.* Bleached Rus. Woods. July.
291. R. virescens. *Fr.* Greenish Rus. Woods. July, Sept.
292. R. lepida. *Fr.* Scaly Rus. Woods. July, Aug.
293. R. rubra. *Fr.* Red Rus. Woods. July, Aug.
294. R. fœtens. *Fr.* Fœtid Rus. Woods. July, Sept.
295. R. emetica. *Fr.* Emetic Rus. Woods. July, Oct.
296. R. fragilis. *Fr.* Fragile Rus. Woods. July, Aug.
297. R. integra. *Fr.* Entire Rus. Woods. July, Aug.
298. R. decolorans. *Fr.* Discolored Rus. Woods. Sept.
299. R. veternosa. *Fr.* Sleepy Rus.
300. R. nitida. *Fr.* Shining Rus. Woods. Sept.
301. R. alutacea. *Fr.* Tan-colored Rus. Woods. July, Aug.
302. R. lutea. *Fr.* Yellow Rus. Woods. August.
303. R. chamæleontina. *Fr.* Chameleon Rus. Woods. Sept.
304. R. marlæ. *Peck.* Woods. July, Aug.

GEN. Cantharellus. *Adams' Fung.*

305. C. cibarius. *Fr.* Edible Chantarelle. Woods. July.
306. C. aurantiacus. *Fr.* False Chant. Ground and wood. Aug.
307. C. umbonatus. *P.* Umbonate Chant. Ground. July.
308. C. tubæformis. *Fr.* Tubæform Chant. Woods. July.
309. C. infundibuliformis. *Fr.* Funnel-shaped Chant. Ground. July, Aug.
310. C. minor. *Peck.* Ground in woods. July, Aug.
311. C. dichotomus. *Peck.* Damp ground. Woods. July, Aug.

GEN. NYCTALIS. *Fr.* Gen. Hymen.

312. C. asterophora. *Fr.* Star-bearing Nyctalis. Dead Fungi. Sept.

GEN. MARASMIUS. *Fr.* Epiphytal. Terrestrial.

313. M. oreades. *Fr.* Fairy-ring. Champignon. May, Oct.
314. M. fusco-purpureus. *Fr.* Purple brown Maras. Woods. June, July.
315. M. Wynnei. *B. & Br.* Wynne's Maras. Leaves. June, July.
316. M. erythrophus. *Fr.* Pallid Maras. On ground and wood. July.
317. M. terginus. *Fr.* Clustered Maras. In woods on wood. June.
318. M. alliaceus. *Fr.* Onion-scented Maras. Wood. July, Aug.
319. M. rotula. *Fr.* Collared Maras. Ground. June, Oct.
320. M. androsaceus. *Fr.* Black stemed Maras. June, Sept.
321. M. insititius. *Fr.* Horny stemed Maras. Aug., Oct.
322. M. epiphyllus. *Fr.* Leaf Maras. Woods. June, Oct.
323. M. saccharinus. *Fr.* Granular Maras. Epiphytal. Woods. June, July.
324. M. spodoleucus. *B. & Br.* Stemless Maras. Epiphytal. Woods. June, Sept.
325. M. velutipes. *B. & C.* Woolly Maras. Woods. July.
326. M. plancus. *Fr.* Hairy Maras. Woods. June, Oct.
327. M. subvenosus. *Peck.* Leaves in woods. Aug., Oct.
328. M. campanulatus. *Peck.* Leaves in woods. Aug.
329. M. cæspitosus. *Peck.* Decaying branches, woods. June.
330. M. longipes. *Peck.* Among fallen leaves, woods. Aug., Oct.
331. M. glabellus. *Peck.* Amongst leaves, woods. July, Sept.
332. M. anomalus. *Peck.* Sticks, leaves in woods. July.

GEN. Lentinus. *Fr.* Generally on wood.

333. L. tigrinus. *Fr.* Tiger-spot Len. June, Oct.
334. L. Dunalii. *Fr.* Dunal's Len. June, Sept.
335. L. lepidius. *Fr.* Scaly Len. June, July.
336. L. cochleatus. *Fr.* Shell Len. June, July.
337. L. vulpinus. *Fr.* Strong-scented Len. May, Aug.

GEN. Panus. *Fr.* Epiphytal. Stumps.

338. P. torulosus. *Fr.* Twisted Pan. Sept.
339. P. conchatus. *Fr.* Shell Pan. May, Oct.
340. P. salicinus. *Peck.* On Salix discolor. Michx. Sept., Oct.
341. P. strigosus. *B. & C.* Aug.

GEN. Trogia. *Fr.*

342. T. crispa. *Fr.* Crisped Trogia. On dead branches. Sept

GEN. Schizophyllum. *Fr.*

343. S. commune. *Fr.* Common Schiz. On dead wood. The season.

GEN. Lenzites. *Fr.*

344. L. betulina. *Fr.* Birch Lenzites. Stumps. Perennial.
345 L. floccida. *Fr.* Flaccid Lenzites. Stumps. Sept., Oct.

ORDER II. Polyporei.

GEN. Boletus. *Fr.* Terrestrial.

346. B. elegans. *Schum.* Elegant Boletus. Woods. June, Oct.
347. B. flavus. *With.* Bright-yellow Bolet. Woods. July.
348. B. badius. *Fr.* Bay Boletus. Woods. Wright county. August.
349. B. striæpes. *Sec.* Striate Bolet. Aug.
350. B. chrysenteron. *Fr.* Red-cracked Bolet. Sept.
351. B. subtomentosus. *L.* Yellow-cracked Bolet. Woods. Aug.
352. B. pachypus. *Fr.* Thick-stemmed Bolet. Aug., Sept.
353. B. edulis. *Bull.* Edible Bolet. Woods. Aug.
354. B. æstivalis. *Fr.* Early Bolet. Woods. Esculent.
355. B. purpureus. *Fr.* Purple Bolet. Woods. Aug.
356. B. scaber. *Fr.* Shaggy Bolet. Woods. Aug. Esculent.
357. B. alutarius. *Fr.* Tan-colored Bolet. Woods. Aug.
358. B felleus. *Bull.* Bitter Bolet. Woods. Sept.
359. B. cyanescens. *Bull.* Sibthorp's Bolet. Woods. Aug.

GEN. Polyporus. *Fr.*

360. P. leptocephalus. *Fr.* White-pored Poly. On wood. June, July.
361. P. perennis. *Fr.* Perennial Poly. Ground, stumps. Aug., Oct.
362. P. Rostkovii. *Fr.* Rostkovius' Poly. Rotton wood. June, Sept.
363. P. elegans. *Fr.* Elegant Poly. Trunks, branches, woods. July.
364. P. quercinus. *Fr.* Oak Poly. Old oaks. June.
365. P. sulfureus. *Fr.* Sulphury Poly. Logs, stumps. June, Sept.
366. P. alligatus. *Fr.* Connected Poly. Base of stumps. June, Sept.
367. P. heteroclitus. *Fr.* Grand Poly. Ground. Wright county. Aug.
368. P. salignus. *Fr.* Willow Poly. On Willows. July, Nov.
369. P. chioneus. *Fr.* Soft white Poly. Roots of stumps. Aug.
370. P. cassius. *Fr.* Blue-gray Poly. On pine logs. July, Oct.
371. P. destructus. *Fr.* Destructive Poly. Larch, ground. July, Sept.
372. P. rutilans. *Fr.* Reddish Poly. Branches, woods. June.
373. P. adustus. *Fr.* Scorched Poly. Stumps.
374. P. hispidus. *Fr.* Hispid Poly. Living oaks. Perennial.
375. P. spumeus. *Fr.* Oozing Poly. Trunks, branches. July.
376. P. nigricans. *Fr.* Black-hoof Poly. Living birch. Perennial.
377. P. annosus. *Fr.* Imbricated Poly. Larch stumps. Perennial.
378. P. connatus. *Fr.* Connate Poly. Crab trunks. Miss R. A. Johnson.
379. P. hirsutus. *Fr.* Bristly Poly. Dead trunks. Woods. July.
380. P. versicolor. *Fr.* Common Zoned Poly. Stumps, &c. Persistent.

381. P. abietinus. *Fr.* Whitish Fir Poly. Larch. July.
382. P. contiguus. *Fr.* Contiguous Poly. Decayed wood, &c. June, Sep.
383. P. ferruginosus. *Fr.* Rusty Poly. Posts, &c. June, Sept.
384. P. Armeniacus. *Berk.* Buff Fir Poly. June.
385. P. incarnatus. *Fr.* Flesh-Colored Poly. Larch. July, Aug.
386. P. violaceus. *Fr.* Violet Poly. Poplar Larch. July, Aug.
387. P. medulla-panis. *Fr.* Crumb of Bread Poly. Wood. June, Sept.
388. P. obducens. *Fr.* Incrusting Poly. Rotten wood. Perennial.
389. P. vulgaris. *Fr.* Common-effused Poly. Dead wood.
390. P. vaporarius. *Fr.* Creeping Poly. Fallen branches.
391. P. glomeratus. *Peck.* On Acer saccharinum. *Wang.* Aug.
392. P. Gordoniensis. *B. & Br.* Gordon's Fir Poly. Decaying wood. Sep.

GEN. Trametes. *Fr.*

393. T. pini. *Fr.* Fir trunk Trametes. Pine trunks. Perennial.
394. T. odora. *Fr.* Small pored Trametes. Willows.

GEN. Dædalea. *Fr.*

395. D. unicolor. *Fr.* One-coloured Dædalea. Stumps. Trunks.
396. D. latissima. *Fr.* Effused Dædalea. On fallen dead branches.

GEN. Merulius. *Fr.*

397. M. tremellosus. *Schrad.* Tremellose Merulius. Sept.
398. M. corium. *Fr.* Leathery Merulius. Dead trunks.
399. M. malluscus. *Fr.* Thin Merulius. Dead wood.
400. M. rufus. *P.* Rufous Merulius. Dead oak branches.
401. M. serpens. *Fr.* Creeping Merulius. Dead wood. June, Sept.

GEN. Porothelium. *Fr.*

402. P. Friesii. *Mont.* Fries' Porothelium Pine wood.

ORDER III. Hydnei.

GEN. Hydnum. *Linn.*

403. H. repandum. *L.* Spreading Hyd. Ground. Aug., Sept.
404. H. zonatum. *Batsch.* Zoned Hyd. Ground. Woods. Sept.
405. H. tomentosum. *L.* Tomentose Hyd. Ground. Woods. July.
406. H. erinaceus. *Hull.* Hedgehog Hyd. Living Oak. Sept., Oct.
407. H. niveum. *P.* Snowy Hyd. Dead wood. Leaves. Sept.
408. H. farinaceum. *P.* Mealy Hyd. Decaying wood. July, Sept.

ORDER IV. Auricularini. *Fr.*

GEN. Cratorellus. *Fr.*

409. C. cornucopioides. *Fr.* Horn-like Cratellus. Ground.

GEN. Thelephora. *Fr.*

410. T. cæsia. *P.* Ash-gray Thelephora. Incrusting grass.
411. T. arida. *Fr.* Dry Thelephora. Decaying pine.

GEN. Stereum. *Fr.*

412. S. purpureum. *Fr.* Purple Stereum. Trunks. Perennial.
413. S. hirsutum. *Fr.* Hairy Stereum. Stumps. Peren.
414. S. acerinum. *Fr.* Maple Stereum. Living maple trunks.

GEN. Hymenochæte. *Lev.*

415. H. rubiginosa. *Lev.* Rubiginous Hymenochæte.

ORDER V. Clavarici.

GEN. Clavaria. *L.*

416. C. amethystina. *Bull.* Amethyst Clavaria. Sept.
417. C. fastigiata. *D. C.* Fastigiate Clavaria. Woods. Aug., Oct.
418. C. coralloides. *L.* White Coral Clavaria. Woods. Aug., Sept.
419. C. umbrina. *Berk.* Umber Clavaria. Woods. Aug., Sept.
420. C. cinerea *Bull.* Cinereous Clav. Woods. Sept.
421. C. cristata. *Holmsk.* Crested Clav. Woods. Sept.
422. C. rugosa. *Bull.* Wrinkled Clav. Woods. Sept.
423. C. Kunzei. *Fr.* Kunze's Clav. Woods. Sept.
424. C. aurea. *Schæff* Golden Clav. Open woods. Sept.
425. C. formosa. *Pers.* Beautiful Clav. Aug., Oct.
426. C. crocea. *P.* Saffron-yellow Clav. Decaying wood. May.
427. C. purpurea. *Mull.* Purple Clav. Woods. Sept.
428. C. inæqualis. *Mull.* Unequal Clav. Woods. Sept.
429. C. vermiculata. *Scop.* White-tufted Clav. Aug., Sept.
430. C. fragilis. *Holmsk.* Brittle Clav. Woods. Sept.
431. C. contorta. *Fr.* Contorted Clav. Branches. Aug.

GEN. Calocera. *Fr.*

432. C. glassoides. *Fr.* Soft Calocera. Decayed stumps. Sept.

ORDER VI. Tremellini.

GEN. Tremella. *Fr.*

433. T. fimbriata. *Pers.* Fringed Tremella. Dead branches. June.
434. T. frondosa. *Fr.* Large Pale Tremella. Ground. Aug., Oct.
435. T. foliacea. *P.* Foliaceous Tremella. Stumps. Aug.
436. T. lutescens. *Fr.* Yellowish Tremella. Old stumps. Aug., Sept.
437. T. mesenterica. *Retz.* Orange Tremella. Sticks. Aug., Oct.

438. T. vesicaria. *Bull.* Bladdery Tremella. Ground. Aug., Sept.
439. T. albida. *Hud.* Whitish Tremella. Logs. June, Aug.
440. T. intumescens. *Sow.* Contorted Tremella. Wood. July, Sept.
441. T. indecorata. *Somm.* Dingy Tremella. Dead willows. Aug.
442. T. tubercularia. *Berk.* Horny Tremella. Branches. Sept., Oct.
443. T. torta. *Willd.* Twisted Tremella. Oak. July, Sept.
444. T. epigæa. *B. & Br.* Ground Tremella. Ground. Sept.

GEN. Exidia. *Fr.*

445. E. glandulosa. *Fr.* Witches'-Butter Exidia. Oak branches. Aug.

GEN. Hirneola. *Fr.*

446. H. Auricula-Judae. *Berk.* Jew's-ear Hirneola. Wood.

GEN. Dacrymyces. *Nees.*

447. D. stillatus. *Nees.* Orange Dacrymyces. Pine logs.

GEN. Apyrenium. *Fr.*

448. A. lignatile. *Fr.* Wood loving Apyrenium. Decayed wood.

HYPOGÆI.

FAMILY II Gasteromycetts.

ORDER VII. Hypogæi.

GEN. Hymenogaster. *Tul.*

449. H. muticus. *B. & Br.* Cracking Hymenogaster. Sept.
450. H. luteus. *Vitt.* Yellow Hymenogaster. Woods. July, Sept.
451. H. decorus. *Tul.* Comely Hymenogaster. Woods. Aug. Sept.

PHALLOIDEI.

ORDER VIII. Phalloidei.

GEN. Phallus. *Linn.*

452. P. impudicus. *Linn.* Common Stink-horn. Sept., Oct.

TRICHOGASTRES.

ORDER IX. Trichogastres.

GEN. Tulostoma. *Pers.*

453. T. mammosum. *Fr.* Nippled Tulostoma. Ground.

GEN. Geaster. *Mich.*

454. G. fornicatus. *Fr.* Vaulting Geaster. Ground. Sept., Oct.
455. G. striatus. *D. C.* Striate Geaster. On sand.
456. G. Bryantii. *Berk.* Bryant's Geaster. Sandy soil.
457. G. hygrometricus. *P.* Hard-coated Geaster. Ground. Woods. Oct.
458. G. lageniformis. *Vitt.* Flask-like Geaster. Woods. Oct.

GEN. Bovista. *Dill.*

459. B. nigrescens. *P.* Blackish Bovista. Prairies. May.
460. B. plumbea. *P.* Lead-colored Bovista. Prairies. Common.
461. B. ammophila. *Lev.* Rooting Bovista. Woods. Sept.

GEN. Lycoperdon. *Tourn.*

462. L. giganteum. *Batsch.* Giant Puff-ball. Pastures. Oct.
463. L. cælatum. *Fr.* Collapsing Puff-ball. Prairies. Aug., Sept.
464. L. atropurpureum. *Vitt.* Purple-spored Puff-ball. Aug.
465. L. pusillum. *Fr.* Little Puff-ball. Prairies. June, Sept.
466. L. saccatum. *Vahl.* Elongated Puff-ball. Thickets. July.
467. L. gemmatum. *Fr.* Warted Puff-ball. Meadows. Prairies. Aug.
468. L. pyriforme. *Schæff.* Pear-shaped Puff Ball. Stumps. Sept.

GEN. Scleroderma. *P.*

469. S. vulgare. *Fr.* Common Scleroderma. Borders of woods. Aug.
470. S. bovista. *Fr.* Thin-coated Scleroderma. Aug., Sept.
471. S. verrucosum. *Pers.* Warty Scleroderma. Prairies. Aug.

GEN. Polysaccum. *D. C.*

472. P. olivaceum. *Fr.* Olive Polysaccum. Ground, woods. Aug.

ORDER X. Myxogastres.

GEN. Lycogala. *Mich.*

473. L. epidendrum. *Fr.* Stump Lycogala. July, Oct.

GEN. Reticularia. *Bull.*

474. R. maxima. *Fr.* Large Reticularia. Trunks, fallen trees.
475. R. atra. *Fr.* Black Reticularia. Pine logs. Aug.
476. R. umbrina. *Fr.* Umber Reticularia. Stumps. July.

GEN. Æthalium. *Link.*

477. A. septicum. *Fr.* Æthalium. Woods. Decaying wood.

GEN. Spumaria. *Fr.*

478. S. alba. *D. C.* White Spumaria. Living grass. June.

GEN. Ptychogaster. *Ca.*

479. P. albus. *Corda.* White Ptychogaster. On ground. July.

GEN. Diderma. *P.*

480. D. farinaceum. *Peck.* Invests fern stems in low woods.
481. D. Marlae-Wilsoni. *Clinton.* Sticks, woods. Aug.
482. D. globosum. *Fr.* Globose Diderma. Dead leaves. Sept.

GEN. Didymium. *Schrad.*

483. D. melanopus. *Fr.* Black-stemmed Didymium. Sticks. Aug.
484. D. connatum. *Peck.* Decaying *Russula.* Sept.
485. D. furfuraceum. *Fr.* Scurfy Did. Rotten wood. July, Aug.
486. D. squamulosum. *A. & G.* Scaly Did. Dead leaves, &c. Aug.
487. D. farinaceum. *Fr.* Mealy Did. Dead leaves. Aug.
488. D. pertusum. *Berk.* Pierced Did. Stumps. Oct.

GEN. Physarum. *P.*

489. P. pulcherripes. *Peck.* Rotten wood. July.
490. P. cæspitosum. *Peck.* Rotten wood. Aug.
491. P. atrum. *Fr.* Black Physarum. Dead Branches. Aug.

GEN. Angioridium. *Grev.*

492. A. sinuosum. *Grev.* Twisted Angioridium. Sept.

GEN. Craterium. *Trent.*

493. C. mutabile. *Fr.* Changeable Craterium. Bark. July.

GEN. Diachæa. *Fr.*

494. D. elegans. *Fr.* Elegant Diachæa. Dead leaves. Aug.

GEN. Stemonitis. *Gled.*

495. S. fusca. *Rath.* Brown Stemonitis. Dead wood. June.
496. S. ferruginea. *Ehrb.* Rusty Stemonitis. Dead wood. July.
497. S. ovata. *P.* Ovate Stemonitis. Rotten wood. June.
498. S. obtusata. *Fr.* Obtuse Stemonitis. Rotten wood. June.

GEN. Arcyria. *Hill.*

499. A. nutans. *Fr.* Nodding Arcyria. Rotten wood. June.

ORDER XI. Nidulariacei. *Tul.*

GEN. Polyangium. *Link.*

500. P. vitellinum *Ditm.* Egg-yellow Polyangium. Stumps.

FAMILY III. Coniomycetes.

ORDER XII. Sphaeronemei.

GEN Phoma. *Fr.*

501. P. ampelinum. *B. & C.* Dead grape vines. Woods. July.
502. P. exiguum. *Desm.* Little Phoma. Elder shoots. Aug.
503. P. glandicola. *Lev.* Acorn Phoma. Acorns. Sept,

GEN. Discella. *B. & Br.*

504. D. carbonacea. *B. & Br.* Black Discella. Dead twigs.

ORDER XV. Pucciniæi.

GEN. Phragmidium. *Link.*

505. P. mucronatum. *Link.* Rose Brand. Living Rose leaves. Aut.
506. P. gracile. *Greve.* Raspberry Brand. Rasp. leaves. Aut.
507. P. obtusum. *Link.* Strawberry Brand.
508. P. graminis. *Pers.* Corn mildew. Leaves of corn. Aut.
509. P. striola. *Link.* Sedge Mildew. Rushes. Autumn.
510. P. coronata. *Corda.* Coronated Mildew. Grasses.
511. P. vaginalium. *Link.* Knot-grass Brand. Aut.
512. P. primulae. *Grev.* Primrose Brand. Primroses. June.
513. P. variabilis. *Grev.* Variable Brand. Taraxacum. July.

GEN. Gymnosporangium. *D. C.*

514. G. juniperi. *Lk.* Living branches.

ORDER XVI. Cæomacei.

GEN. Tilletia. *Tul.*

515. T. caries. *Tul.* Bunt. On wheat filling the grains. Aut.

GEN. Ustilago. *Link.*

516. U. carbo. *Tul.* Corn smut. Autumn.
517. U. antherarum. *Fr.* Anther Smut. Lychens, &c.
518. U. violae. *B. & Br.* Violet Smut. Violet leaves. August.
519. U. occulta. *Preus.* Rye smut. On culms of rye.

GEN. Uredo. *Lev.*

520. U. Quercus. *Brand.* Oak-leaf Uredo. Sept.
521. U. bifrons. *Grev.* Twin-faced Uredo. On *Rumex.* Aug., Sept.

ORDER XVII. Æcidiacei.

GEN. Æcidium. *Pers.*

522. A. euphorbiæ. *Pers.* Spurge Cluster-Cups. May, June.
523. A. urticæ. *D. C.* Nettle Cluster-Cups. June.

FAMILY IV. Hyphomycetes.

ORDER XVIII. Isariacei.

GEN. Isaria. *Fr.*

524. I. arachnophila. *Ditm.* Spider Isaria. Dead spiders.
525. I. citrina. *P.* Lemon-colored Isaria. Decaying fungi. Aug.
526. I. intricata. *Fr.* Intricate Isaria. Decaying fungi. Sept.

ORDER XIX. Stilbacei.

GEN. Tubercularia. *Tode.*

527. T. granulata. *P.* Granulate Tubercularia. Dead branches.

DIVISION II. Sporidiifera.

FAMILY VI. Physomycetes.

ORDER XXIV. Mucorini.

GEN. Ascophora. *Tode.*

528. A. elegans. *Corda.* Elegant Ascophora. Fowls' dung.

GEN. Mucor. *Mich.*

529. M. ramosus. *Bull.* Branched Mucor. Decaying fungi. Aug.
530. M. Mucedo. *L.* Common Mucor. Decaying fruits.
531. M. caninus. *P.* Dog's dung Mucor. Dung of dogs.

FAMILY VII. Ascomycetes.

ORDER XXVIII. Elvellacei.

GEN. Morchella. *Diel.*

532. M. esculenta. *Pers.* Common Morel. Woods. May, June.

GEN. Helvella. *Linn.*

533. H. gigas. *Kromb.* Large Helvella. Ground, woods. Spring.
534. H. crispa. *Fr.* Pallid Helvella. Ground, woods. Early Summer.
535. H. sulcata. *Afz.* Sulcate Helvella. Ground, woods. Oct.

GEN. Verpa. *Swartz.*

536. V. digitaliformis. *Pers.* Finger-shaped Verpa. Wood.

GEN. Spathularia. *P.*

537. S. flavida. *Prs.* Yellow Spathularia. Woods. July.

GEN. Leotia. *Hill.*

538. L. lubrica. *Pers.* Slimy Leotia. Woods. Sept.

GEN. Geoglossum. *P.*

539. G. viride. *P.* Green Geoglossum. Decayed wood.
540. G. glutinosum. *P.* Glutinous Geoglossum. Woods.

GEN. Peziza. *Linn.*

541. P. macropus. *Pers.* Long-stemmed Peziza. Ground. July.
542. P. badia. *P.* Large Brown Peziza. Pond margin. July.
543. P. aurantia. *Fr.* Orange Ground Peziza. June.
544. P. lutea-nitens. *B. & Br.* Bright Yellow Peziza. Ground.
545. P. fibrillosa. *Curr.* Woolly Orange Peziza. Oct.
546. P. repanda. *Wahl.* Spreading Peziza. Gound. June.
547. P. trachycarpa. *Curr.* Rough-spored Peziza. Woods.
548. P. leiocarpa. *Curr.* Smooth-spored Peziza. Ground.
549. P. cupularis. *L.* Scolloped Peziza. June.
550. P. subhirsuta. *Schum.* Hirsute Peziza. Ground.
551. P. humosa. *Fr.* Ground Peziza. Woods.
552. P. scutellata. *L.* Shield-like Peziza. Woods. May, Sept.
553. P. unicisa. *Peck.* Ground in woods. Sept., Oct.
554. P. echinosperma. *Peck.* Ground in woods. June.
555. P. rubra. *Peck.* Burnt ground. June.
556. P. tiliae. *Peck.* Dead branches. Tilia Americana. July.
557. P. coccinea. *Jacq.* Carmine Peziza. Wood. Nov.

ORDER XXXI. Sphæriacei.

GEN. Valsa. *Fr.*

558. V. pulchella. *Fr.* Beautiful Valsella. Cherry and birch.

With three or four exceptions, the plants constituting the foregoing list of *Fungi*, have been found by the writer.

Respectfully contributed,

A. E. JOHNSON.

MINNEAPOLIS, January 1st, 1877.

VI.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

In accepting the position of Ornithologist on the Geological and Natural History Survey of the state to which I have been appointed by the Board of Regents, I desire to express to you and the Board my appreciation of the honor thus conferred upon me.

When first proposed to me to undertake this work, its objects were so accordant with my inclinations that I had only to harmonize its requirements with the exacting duties of my profession, to enter enthusiastically upon it. This our mutual arrangements have enabled me to do more satisfactorily than I had hoped. I therefore permit myself to expect to have something to report to you at the end of another year appropriate to an embodiment in the permanent records of your comprehensive work.

To do this I must be permitted to rely upon the co-operation of not only yourself and the other members of your staff, but of the Board, and all collectors temporarily or permanently associated with the survey.

I have had sufficient experience in the work before me to realize the necessity of aid from reliable sources, and this department of your survey has been so long delayed that it must be rigorously prosecuted if it shall keep its place alongside of the others in the years to come. I do not commence it, however, entirely *de novo*, having had some nineteen years observations in which I have accumulated some notes on birds in my vicinity, with occasional explorations into other sections as fully represented by them. The rapid settlement of the state has changed the relative representation of this class of its fauna very materially, and the increasing extent of the cultivation of the soil for varied productions is at present not only changing the aggregate numbers of birds that come here to breed, and those that permanently reside here, but

the relative proportions of species, which shows the importance of early attention to this department of the zoology of the state.

The earliest information on this subject that I have been able to get has been obtained through interviews with persons connected with the army or trappers and traders, stationed at the several military posts at a very early day. Of course this has been meagre, and unsatisfactory because, to a large extent, it has been unreliable. After sifting it as carefully as possible I find about fifty to sixty species that are known to be territorial and aboriginal.

The first approximation towards a listing of species was made by Henry Patton in connection with Owen's geological survey of Wisconsin, Iowa and Minnesota, in 1848–9. As he did not record the locality, or any of the circumstances of his observations, his list I regret to say is but little more valuable than the foregoing, as it is impossible to ascertain what portion of the ninety-five species he gives were obtained within our own special province. It is not a little remarkable that in the several explorations by the national government preliminary to the location of our great transcontinental railroad, made upwards of twenty years ago, while ample provisions were made for collecting the birds along the various lines of exploration in every other instance, that from St. Paul to the Rocky Mountains had none. From thence to the Pacific the collections were as abundant and the reports as full as on any other route embraced in these extensive explorations. But in subsequent railroad surveys—in 1870, I think,—along the line of the Northern Pacific, Mr. Tripp reported a list of 138 species observed, which only recently came to my notice in the Proceedings of the Essex Institute of Massachusetts. Excepting the few mentioned, my own notes of observation, published by the Minnesota Academy of Natural Sciences in 1874, had antedated them so far as this section was involved.

There have been occasional observations noted by persons visiting or passing through the state, which have been preserved, that are reliable.

During the last year—1876—several species hitherto unknown here have been identified, making at the present time a list of about two hundred and seventy-five species, embracing one hundred and sixty-one genera, in thirty-eight families under six orders.

This comprises nearly the entire history of the ornithology of Minnesota, up to the present time, so far as my knowledge extends.

Very respectfully yours,

P. L. HATCH.

Minneapolis, Jan. 10, 1877.

VII.

ENTOMOLOGY.

REPORT OF ALLEN WHITMAN.

SAINT PAUL, MINNESOTA,
December 23d, 1876.

Prof. N. H. Winchell, State Geologist:

SIR:—I have the honor to present the following report upon the Rocky Mountain Locust,* as it has appeared in and near Minnesota during the year 1876. At the time of my appointment (in May) to make this report, through the State Geological Survey, there was a hope, and apparently a reasonable one, that the coming summer would close our present opportunities for observing the destructive species of locust, at least as far as our state was concerned. The insects were found to be hatching in a region covering the whole or parts of five or six of our southwestern counties, in a strip of country reaching from Madelia westward

* The name "Rocky Mountain Locust" is expressed or implied throughout this report. I suppose that every one knows that it is the *Caloptenus Spretus*, or the "grasshopper," that is referred to. Although the name "hopper" holds its place in popular usage, by force of its brevity and euphony, the use of the word locust can occasion no ambiguity, at least in Minnesota. In regard to the latter name, an old etymology is still often repeated, which has done duty long enough. The word *locust* (Latin, *locusta*,) is not derived from the Latin *locus-ustus*, a *burnt place*, and that for half a dozen reasons. The root of the word (*loc*) is probably found in the Greek root *lak* (in *lasko*, *e-lak-on*,) and in the Latin *loqu-or*, referring in this case to the chirping or shrilling sound of some insect called *locusta*. Its form is confirmed by such Latin words as *robustus*, *venustus*, &c See *Fick*, *Vergleichendes Woerterbuch der Indogermanischen Sprachen*. *Part IV. Root* (3.)

across the state, and into two of the eastern counties of Dakota. A few were also found in the northern part of the state in Clay county, and in a few scattered spots in Dakota along the Red river. No other hatching-ground nearer than Colorado was known, and there was reason to believe that the amount of damage resulting from their presence here would be comparatively small, and a fair probability that their swarms would be so scattered and so diminished during the summer, that the injury would, for the present, end with the flying season. Under these circumstances, it seemed best to make such additions and corrections to the Report of the Grasshopper Commission of 1875, as the experience of the present year should furnish. But as the season has advanced, and events have multiplied themselves, the subject has assumed, both in extent and urgency, a new and continued importance. Following close upon the attack of 1874, we have a new locust invasion, surpassing all former ones in the amount of territory visited, in the magnitude of the invading swarms, in their repeated comings, and in the length of their combined stay. In addition to the losses inflicted upon the crops during the last four summers, amounting to at least eight millions of dollars, we find the evil still confronting us as in 1873, and while we have gained something by our four years' experience, we have also lost something by the disheartenment which four successive years of damage necessarily bring. To meet in any such report as this the demands of a subject so extensive and important, or the expectations of the large number of people who are so deeply interested in it would be simply an impossibility, but I should be glad if anything contained in it could add to the knowledge necessary for intelligent action, or to the hopefulness which we may reasonably entertain in regard to the locust problem in the long run. Such as it is, the report is the result of several visits to the southwestern counties during the spring and summer, of replies to circulars sent to nearly every infested town in the state, and of a large amount of correspondence addressed freely to various points in Minnesota, Dakota, and elsewhere. To compile such information as could be collected from all these, and from hundreds of items published in our state papers during the summer, has been a work of a good deal of time and trouble. The practical value of the results of work of this kind seldom corresponds to the amount of trouble incurred, but this is simply the fault of the subject.

GENERAL VIEW OF LOCUST INVASIONS.

Taking into consideration the whole cultivated region from

Manitoba to Texas and from the Rocky Mountains to the Mississippi, there have been in the series of thirteen years from 1864 to 1876, but four, (or at most five) years when some portion of this area was not attacked by locusts, coming in from somewhere outside of the cultivated area. In other words there have been no less than nine locust invasions, (differing much in extent and degree, but still occurring,) in the Mississippi and Red River valleys during the last thirteen years. And these nine attacks stand against some seven or eight recorded appearances of destructive locusts in the same territory during the 46 years preceding, from 1818 to 1864. Again we have on the one hand the sudden appearance of the immense swarms which are said to have overrun a vast extent of territory on both sides of the Rocky Mountains in 1855, the gradual disappearance of their progeny in the course of the next three years, apparently without furnishing material for subsequent invasions, and their continued absence for the next six years. On the other hand we have, since 1864, a series of attacks occurring at intervals of one, two, or at most three years, and apparently of late an annual vibration between the country lying along the mountains and the lower cultivated regions, each in its turn becoming a breeding-ground. The causes of the increase and continuance of the evil of late years lie outside the range of common observation. That they do not result entirely from an increase of acreage under cultivation, is to be inferred from the locust history of other countries, and from the facts that while Central America has suffered from the same evil at least as far back as 1514 (Bancroft's Native Races of the Pacific Coast, vol. v., page 601,) and Mexico and California at least as lately as 1855, the exemption of these countries since the latter date has been as noticeable as the repeated devastation of our own vicinity. As for any analogy to be derived from the locust history of European countries the books are not at hand in this state to furnish the exact chronology of the evil; but from such a source as I have at hand, the record of Germany for the last four centuries shows intervals of exemption from injury for eight, twelve, sixteen, forty (1763—1803,) or even fifty (1636—1686) years, and again no less than fourteen years of injury between 1727 and 1755, and among these series of three, four, or even five successive years of damage, as in the five years from 1727 to 1731, and again from 1746 to 1750.*

* These dates are taken from a work entitled, Die Kleinen Feinde der Landwirthschaft, by Prof. H. Nordlinger, Stuttgard, 1855, furnished by the kindness of Gustav Kyllander, Esq., of Severance, Sibley county. For a

The locust problem still presents a great deal upon which nothing like complete information has been furnished. Even in regard to the locust as it appears in our own State, not only does the farmer ask many questions, to which the entomologist can as yet give no decisive answer, but even in the practical economy of the locust question opinions are still at variance, where experience should, by this time, have brought some degree of unanimity. When it comes to the exact origin of our invading swarms, their manner of increase from year to year before leaving their native regions, their growth, habits, and movements in those regions, how far eastward those regions may or do extend, the causes of the repeated appearance of migrating swarms, or their continued absence for years or even decades, no one can at present offer in answer much more than a mere show of probabilities. It is evident that the whole question is becoming too urgent to wait for private investigation to solve it. The claims which an agricultural population of at least thirteen States and Territories may justly urge upon the National Government in this regard, have been fully set forth during the past season ; but purely in the interest of science, if for no other reason, we might fairly ask that some portion of the sums annually devoted to national discovery might be expended upon the further elucidation of a subject which touches us so nearly and so powerfully. Having at hand the time, the place, and the opportunity, we might at least attempt the solution of some questions which the Old World has been obliged to leave unanswered for a thousand years. We might, perhaps, learn enough of the causes of locust invasions to know in what years such invasions would become probable, and enough of their origin to say whether prevention is possible or impossible.

THE EVIL AS IT APPEARS IN MINNESOTA.

The growth and habits of the young locust as it appears in the cultivated regions, have been so fully described of late years, (particularly in the seventh and eighth annual reports of the State Entomologist of Missouri, Prof. Ch. V. Riley,) that it seems im-

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systematic and connected view of the locust evil in general see a paper contained in the Report (for 1876) of the Hon. Commissioner of Statistics of Minnesota, Dr. J. B. Phillips. Notice is particularly called to a chronological table published therein. It will be seen that there is no state or territory west of the Mississippi that is not in the "grasshopper regions," and no year since 1863 that has not been a locust year. The year 1871 should be included in the table, for reasons stated in this report.

possible to add much that can contribute to that practical end which the farmer has in view, the protection of his crops from the locusts which hatch in his immediate vicinity. If anything practical is still to be expected in this direction it ought to come from those who are brought face to face with the young locust, and are obliged to act upon knowledge gained upon the spot. Enough has been learned already to make it certain that almost any community may, by enlisting all the forces at its disposal, effect a measurable saving of its crops, and that the evil, if it could be confined to the locusts that hatch here, might be practically eradicated in a few years at most. But there is a growing apprehension in the minds of the people of Minnesota, brought about mostly by a consideration of events occurring in our own state only, and that too only within the last four years, that we are more liable to locust invasions than other states; that the locust evil may become a permanent one here even without reinforcements from abroad, and that its area may gradually extend until it covers regions still unknown to it. This apprehension is increased by the fact that the invasion of the present year has reached, (to the south of St. Paul,) about one degree of longitude farther east than it has ever been known to extend before. It is possible that Minnesota may, from its geographical position, suffer from locust invasions more frequently in the long run of fifty or a hundred years than Kansas or Manitoba, though a history of the last twenty years shows no special preponderance in favor of either state; it is possible that its cold climate, and the high and dry soil of its southwestern counties may furnish a more congenial and permanent home to the swarms that breed here, though the events of the last four years, when fairly considered, show that even here there is a constant decrease in the numbers of such swarms as remain; and finally the history of the whole Mississippi Valley shows that the Rocky Mountain Locust is confined on the east by a tolerably well defined limit which up to the present time, neither invading swarms, nor their progeny have essentially altered. Upon all these points entomologists are repeatedly called to express their opinions, which have been freely and in most cases cautiously given; and these opinions are in turn repeatedly called into question by those who persist in mistaking opinion for prophecy, or in applying a general rule to a limited area, or to a particular year. But it is evident that there is still room for the study of the physical character of the locust, and of the geographical, geological, climatic or other causes by which it is influenced.

HISTORY OF PAST INVASIONS.

Until within the last four years the migratory species of locusts has been so infrequent and transient a visitor in Minnesota, that the details of its former visits are almost forgotten. There is no definite knowledge of any such visit down to the year 1855, unless the ravages committed in the Red River Settlement in 1818 and 1819 may be said to concern this State. But the statement of Capt. Jonathan Carver in 1766, in regard to the large swarms which "infest these parts and the interior colonies" shows the occasional presence of the migratory locust, although it is hard to say exactly what localities are referred to. But late in July, 1856, invading swarms came from the Northwest into the Upper Mississippi Valley, and gradually spread along the river during the season, much the same as they have done in the past summer, and reaching nearly the same limits. The injury was, of course, felt most severely along the Mississippi and the cultivated region adjacent, but the locusts are said to have appeared along the Minnesota River, in the Yellow Medicine country, and at various points in the northwestern counties of the State. It is probable that the northwestern part of the State was swept over by migrating swarms during the summer, much the same as in the present year. But few traces of these were seen in the following year, except along the Upper Mississippi, where the damage was even greater than the year before. A general flight took place in July, and the direction of the departure was to the south and southwest generally, and was, perhaps, the occasion of the injury done in Iowa that year.

Again, in 1864, swarms appeared early in July, along the Upper Minnesota river, and spread eastward gradually during the season, and reached about as far east as in 1874, *i. e.*, to the third tier of towns in Le Sueur county. Scattering swarms also visited Manitoba in the same year, and probably some portions of these reached Northwestern Minnesota, for we hear of slight appearances of them in the Red River and the Sauk Valleys in 1864 and 1865. But the greater portion of the injury was done in the Minnesota Valley, and was followed by a general departure to the southwest in 1865. The injury in Colorado also was very severe in the same years, but there seems to have been no large movement to the eastward, such as occurred later, in 1866 and 1867.

It seems very likely that the swarms which entered Minnesota in 1864 were hatched at no great distance, and were the offspring of swarms that had alighted in eastern Dakota in the preceding

year. This may perhaps be inferred from the following letter of the Rev. S. R. Riggs, missionary at the Sisseton Indian Agency, dated Sept. 9, 1875:

"In 1863, it will be remembered, that on Gen. Sibley's expedition to the Missouri we met with the *ravages* of the grasshoppers in various parts of Dakota, particularly, as I remember, near Skunk Lake (in Minnehaha county) where the large grass had been eaten to the bare stalks, and our animals fared badly." He adds:

"In 1865, I visited a camp of Dakota scouts, near the 'Hole in the Mountain,' at the head of the Redwood. That was in the month of August. The valley of the Minnesota clear out to the Coteau was so full of grasshoppers as to make it unpleasant traveling. For the next four years, I traveled every summer on the Missouri River, coming over to and from Minnesota. Every season I met with grasshoppers at some point on the east side of the Missouri. In 1867, and also in 1868, we found them near Fort Randall. In 1869, in August, we met them above Fort Sully, near Grand River. In all these cases, they were only in small battalions, and appeared to have come there from other parts."

Again, in 1871, slight and scattering swarms of locusts appeared in Stearns, Todd, Douglas, Pope, Otter Tail, Becker and Polk counties, and perhaps in others. In all these counties they were in sufficient numbers to make themselves noticeable, and in some cases crops were injured, or a few eggs laid; but the occurrence would have been mostly forgotten by this time if it had not been brought to mind by more recent events.

The invasion of 1873 was something unusual in its character from the earliness of its arrival, the direction from which it came, and from the fact that it was the beginning of a visitation which has been prolonged to the present time by what, judging from former years, would appear to be unusual circumstances. Each summer since 1873, instead of being the scene of a general departure of the hatching swarms as in former years, has seen portions of these alighting but a few miles from where they were hatched, (generally in the next range of counties, and sometimes in other parts of the same county,) and depositing eggs for another brood. In addition to these, new swarms coming in from the northwest in 1874 and again in 1876, have added greatly in the area of devastation in both these years, and in the latter year to the area of egg-deposit.

MINNESOTA AS A BREEDING GROUND OF THE LOCUST.

Without saying anything for the present about the new coming

swarms, the history of those that have bred inside the State since 1873 has been as follows: They reached the southwestern corner of the state about the first of June, 1873, brought by a wind that had been blowing freshly from the southwest for several days. During June and July, they spread themselves over the whole or portions of fourteen different counties, lying adjacent to each other, and throughout all this area locusts were found to be hatching in 1874. On acquiring wings, these flew northward early in July, and portions of them alighted in the range of counties next beyond those they had already occupied, leaving vacant the ground they had covered on hatching. By the 15th of July they had entered Blue Earth, Nicollet, McLeod and Renville counties. By the latter date, new swarms had begun to pour in from the northwest, and passed over the western counties to the southward. That these additional swarms did not add much to the stock of eggs deposited by our own brood is probable, for two or three reasons; first, because their progress, so far as it could be traced, was entirely across the state, and even across most of western Iowa, before laying eggs; and secondly, because the principal hatching-ground of 1875 was precisely in those counties which had been already occupied by our own stock in 1874 (before the arrival of new comers) with some slight additions to the eastward. Eggs were also laid, later in the season, in scattered spots in some of the northern counties, and in six towns in Meeker county, by swarms coming in from the northwest about the first of August. But the greater portion of the locusts hatched in 1875 were found along the Minnesota River, and these on flying moved southward, and alighted in the range of counties next beyond those they had just occupied, where they remained and deposited eggs during July and August. Of the swarms hatched from these last spring (1876) some flew away to the southward early in July, while others flew northward, some alighting along the Minnesota, and others moving still further north. Other swarms also came from the west, from the Red River valley, into several of the northern counties, and were probably a portion of those that hatched along the Red River. By the 10th of July all these had made their appearance in thirteen counties besides those in which they were hatched, but generally in small and scattered bodies, and in only two or three towns in a county; they were most numerous in Renville, Douglas, and Otter Tail counties.

The object of the preceding paragraph is to show that it is probable that the locusts which hatched in Minnesota last Spring were to a considerable extent the descendants of the swarms

which entered the State in 1873. However unimportant it may seem, it has a certain value if it enables us to judge of the effect upon the Rocky Mountain locust resulting from a four years' continuous breeding in our climate.

DEGENERATION.

So much has been said of late years of the tendency of the migratory locust to "degenerate" in the more easterly and southerly portion of the area visited by it, and this theory has been considered by our people so complete a failure, that it is worth while to state exactly what the theory is, and how truly it applies to our State. It might have been submitted at the start that opinions based upon a consideration of events still occurring, and more or less liable to be modified by new circumstances, should not be pressed too far nor too literally; and it was just that in judging as to the correctness of these opinions, that they should have been fairly stated. I give them in the briefest form in which I find them: "There is nothing more certain than that the insect is not autochthonous in West Missouri, Kansas, Nebraska, Iowa, or even Minnesota, and that when forced to migrate from its native home, from the causes already mentioned, it no longer thrives in this country." (Riley's Seventh Annual Report, p. 165.) It will be noticed that Dakota and Colorado are not included in this list; that Minnesota is to some extent excepted, and that, though not directly stated in the sentence quoted, the application is to swarms breeding one year after another in the regions mentioned, and not to such fierce hordes as have swept down upon us from the northwest in the summers of 1874 and 1876. The discouraging events of the last four years have served to confuse the question, and it is no wonder that our farmers, seeing the considerable numbers that have remained to breed here from one year to another, with the intolerable numbers that have been added in two out of four seasons, should come to believe that Providence has given over one half of our state to be henceforth the perpetual home of the locust. We have a series of occurrences so different from those of Missouri, Kansas and Nebraska, that it seems hard to account for them on any basis of mere accident or of which way the wind happens to blow when our swarms are ready to migrate.

The winds which sweep clean away the hatching swarms of the more southern states carry our own but a few miles from their birth place. It is evident that they are not detained here merely

by abundance of food, for the swarms of Kansas and Missouri leave behind them fields as rich as ours; nor by force of winds, for the same winds that bring down upon us invaders born hundreds of miles away, and carry them across our state and into more southerly regions, might also carry with them the broods of our own hatching. I believe it is not as yet fully known what connection there may be between the migrations of the locust and its season of egg-laying, but it seems that some cause for the fact that portions of our swarms remain here to breed can be found in an early stage of egg-laying. Here again we have a difference between our own broods, and not only the new swarms that come in upon us from the mountain regions, but also those which leave the more southerly regions and fly to the northwest on acquiring wings. As for the latter, in the flight from the Missouri Valley northward in 1875, Prof. Riley was able to learn of no case of their depositing eggs, nor were the hatching grounds, (outside of Minnesota,) of last spring found to be anywhere in the vicinity of those of 1875; as for the swarms that have descended upon us during the summer, I have not been able to learn of any deposit of eggs whatever in any of their stopping places on their way toward this state, and even on arriving here it was evident in most cases that they had not yet reached the season of egg-laying. Between the 17th and the 31st of July there was a gradual movement, apparently of new-comers, across the state towards Iowa, and the egg-laying did not become general until about the latter date. Between the first and sixth of August other swarms came in, and these again in most cases did not begin to lay until a week or more after their arrival. Still others came in later, and the laying was kept up until late in September and was seen to occur in October, or as long as the locust remained alive. On the other hand our own stock were seen in 1875 to be laying within eight days after their flight commenced and in the places where they first alighted, and during the past season the laying had already begun on the third of July and by the tenth had become general in the western part of Nicollet county, within a few miles from their hatching-ground, and within two weeks from the time when the flying began. This early period of laying may be of itself a sufficient cause for portions of our swarms remaining here, while the less mature pass on.

NATURAL DECREASE FROM ONE YEAR TO ANOTHER.

But though portions remain, there is no increase in their num-

bers from one year to another. So far from holding its own, the locust has seen its breeding grounds decrease from nearly fourteen counties in 1873, to some seven and a half counties in 1874, and about five and a half counties in 1875; and in this latter area though able to inflict serious damage in many places (owing chiefly to the small acreage planted) they were in other places noticeably fewer than in former years.

This continuous decrease has resulted from several causes, and the first of these is the early stage of laying just alluded to, by means of which considerable numbers of locusts have hatched out during the last two autumns, and have died without reproducing themselves. In this connection, the state of Minnesota has an advantage over more southerly regions, in the fact that we are situated nearer to the breeding-grounds of invading swarms. Of these the earlier comers are more likely to pass over us before reaching the full period of their development, while the later comers are cut off by our earlier frosts; and of the eggs which are left with us, being deposited earlier in the season, more are likely to hatch in the fall and become harmless. On the other hand, the invaders are more likely to mass their forces in more southerly states, reach them in full maturity, and remain later in the season, while the eggs, being deposited later than ours, remain mostly unhatched until spring. These considerations enable us to understand why certain counties in Missouri, where the locusts hatched in 1875, presented in May such a picture of devastation and desolation as Minnesota has never seen in all its locust experience.

But while becoming prematurely developed, (if this is a correct expression of the facts as stated,) the locust had also become shorter lived. One year ago, there was hardly such a thing as a Rocky Mountain locust to be found in Minnesota by the first of September. The swarms that had hatched along the Minnesota River in the spring, and had alighted but a few miles further to the south in July, had almost totally perished in August, without extending the territory of their occupation more than the width of one county beyond the area which they covered on alighting. And in this connection we owe more to the Tachina maggot than many are willing to allow. But of the invading swarms of the present year, though large numbers of the bodies of the dead could be found in the fields early in September, (something unusual, from the fact that heretofore they have hardly ever been found at all,) large numbers remained alive until they were killed by frost, and even then died with eggs unlaid.

Still another effect of naturalization during the last four years

is an apparent change in character, slight in itself, but showing what the tendency would be if the locust were to continue to breed here. While it has lost some portion of its inclination or its ability to migrate, it has also lost somewhat of its gregarious character. This was shown by the young locusts last spring, moving over the fields in scattered bodies, or in no bodies at all, a peculiarity so noticeable as to attract the attention of the farmers; by the movements of the swarms on leaving their hatching-grounds, in small squads and in various directions; and by the fact that where they alighted first they left their eggs promiscuously here and there in the grain fields, instead of in bodies and in selected spots as heretofore. There was no general flying from their hatching-ground in large bodies, mostly in one direction, as was the case in 1874 and 1875. By the last week in June they began to leave some places so imperceptibly that their departure could hardly be seen, though their numbers were noticeably diminished. For the first ten days of July, small squads went careering up and down, south of the Minnesota river, and wherever there was anything like a movement of large bodies they seem to have left the state to the northwest, west, and southwest. In the meantime, others had spread themselves northward towards the North Pacific Railroad, and had alighted here and there in numbers sufficient to do considerable damage. But, judging from the occurrences up to the 10th of July, had it not been for new-comers, next year would have seen the insects so few and so scattered as to be incapable of great damage, and they might become, in a year or two, as flitting and as unnoticeable as the Red-Legged Locust that breeds with us every year.

Probably this is all that can be made of the "degeneration" of the locust so far as observed in Minnesota. It had not become so impaired in strength nor so diminished in numbers as not to prove a serious evil wherever it alighted or laid eggs. It was however decreasing in numbers, and gradually becoming less capable of reproducing itself. Something might perhaps be added in regard to changes in color and appearance; while the locusts which hatched in Minnesota last spring had when fully developed something of the darkness and dullness of old age, the brightness and fierceness of the fresh invaders was apparent to every one.

The facts stated show the general tendency, but there is a more vital question than the tendency of the locust to degenerate here. How long the state will continue to be one of the breeding-grounds of the locust, is simply how long new hordes will continue to sweep over us and leave here fresh seeds of future devastation.

Nothing is more certain than that we might, by general and continued effort, practically eradicate the offspring of almost any one year's invasion; nothing is more probable than that in almost any season, the whole body of our hatching swarms might be utterly swept away from our midst by favorable winds; and finally, if we may judge from the last four years, our breeding-swarms would decrease gradually from one year to another, and if not reinforced from abroad would finally become so few and so scattered as to be harmless.

ANNUAL DEPARTURE OF THE LOCUSTS.

Besides the causes of decrease already mentioned, still another has been found in the impulse which moves the locust to leave its birthplace on acquiring wings. The considerable numbers that have remained behind each year, have created the impression that none were gone, and that the locust had become a permanent appendage of the state. But a collection of various items for the last three years, together with letters received from the eastern tier of counties in Dakota, shows that considerable numbers have left the state, generally to the northwest in 1874, and in various directions during the past summer. But, with Dogberry, we have been content to "take no note of him, but let him go, and thank God we were rid of a knave." It is only within the last year or two that it has become fully apparent that the final destination of these departing swarms is an important consideration, and one which serves to complicate the locust question more deeply than ever.

Whether or not it is a general rule that the locusts on acquiring wings seek the direction from which their parents had come in the preceding year, (a rule which the experience of Minnesota fails to substantiate,) it is at least certain that in 1875 "the main direction taken by the insects that rose from the lower Missouri valley country was northwesterly." (Riley's 8th Ann. Report, p. 105.) These swarms were traced by Prof. Riley, moving northerly from the end of May, through June and into July, and passing various points in Dakota, Wyoming and Montana.*

* He adds (page 108) "nor can I learn of any instance where these swarms that left our territory deposited eggs." The different case of our own breed of locusts, laying eggs within two weeks after the flying commences, is remarkable. But I am informed by Captain J. S. Poland, commanding at Standing Rock, that a swarm from the south alighted near that post, July 4th, 1875, and deposited considerable quantities of eggs between the 4th and the 18th of July.

They passed northward over Bismarck at various times between June 6th and July 15th. (Same report, p, 86.) But a still more definite statement as to the final destination of these northward moving swarms is found in an editorial of the Winnipeg *Standard*, of August 19, 1876, entitled "Locust Flights." It is there stated that in 1875,

"The locusts which hatched in Missouri, Kansas and Nebraska, in an area of 250 miles from east to west, and 300 miles from north to south, took flight in June, and invariably went northwest, and fell in innumerable swarms upon the regions of British America, adjoining Forts Pelly, Carlton and Ellice, covering an area as large as that they vacated on the Missouri River. They were reinforced by the retiring column from Manitoba, and it seemed to be hoping against hope that the new swarms of 1876 would not again descend upon the settlements in the Red River valley. Intelligence was received here that the insects took flight from the vicinity of Fort Pelly on the 10th of July, and then followed a fortnight of intense suspense."

There is of course in all this a failure to connect by any direct chain of continued observations the swarms that left the Mississippi valley in 1875 and those which finally disappeared in the region of the mountains and in British America; still less is it shown that those swarms were the parents of those which are known to have hatched in the same regions in 1876, or even that those which are known to have hatched there were those which descended upon the lower country in July and August. But there is at least a strong series of probabilities.

A great deal has been said within the past two years about the practical help which the general government may perhaps find itself able to extend to the people of the Mississippi valley by attacking the locust in its native breeding-places, and it has been considered possible that some means might eventually be discovered of preventing or at least mitigating such inroads as that which has just ended. But if the events of 1875 and 1876 have any such connection as is claimed for them in the preceding paragraph, if the more northern and western breeding-grounds of the locust are recruited from the lower cultivated regions in alternate years, the problem of how to give practical help to the farmer will be greatly simplified. It would be hard to imagine a method of extirpating the swarms or the eggs of a hurrying insect from an extended area, or perhaps several such areas, of mountains and deserts, the resort of wild beasts and savages, where only armed bands can maintain a foothold; and on the other hand it would be hard for the government to find a time better fitted to begin the exter-

mination of the locust, than when the mountain region must be measurably depleted of its stock, nor a place better situated for the warfare than a region where, with any fair assurance of conquering a peace, every inhabitant stands ready to do battle.

STARTING POINTS OF INVADING SWARMS IN 1876.

Besides the region named in the article above quoted from the Winnipeg *Standard*, various parts of Montana are known to have been considerable hatching-grounds during the past spring. In the Bismarck *Tribune* of June 14th is found the following, which is quoted because it gives an idea not only of the place but of the nature of a breeding-ground:

"IN THE FIELD, NEAR ROSEBUD BUTTES, May 29, 1876.

"As we move westward the grazing improves, and here in the Little Missouri Valley the season is at least a month in advance of the season on the Missouri. This would be a splendid grazing region, were the water good. The grass is heavy and nutritious, but the water is strongly impregnated with alkali. Millions of locusts are just now making their appearance in this region. Too young to fly or do much harm, in a few days, should the winds favor them, they will sweep down upon the defenceless agriculturalists on the border, doing untold damage."

Officers who passed over the country between the Little Missouri and the Yellowstone rivers during the spring, state that at various points in that region young locusts were found in immense numbers. Shortly before the 23d of July, migrating swarms of locusts appeared in the vicinity of Gen. Crooks' camp; "myriads of grasshoppers filled the air, appearing like an immense drifting snow-storm, trending toward the southeast, and apparently taking advantage of a northwest wind to favor their flight to the same fields that they have effectually devastated for two consecutive seasons." (Extract from a letter of July 23d, quoted in the *Pioneer-Press and Tribune*.)

MOVEMENTS OF SWARMS OUTSIDE OF MINNESOTA.

It is difficult to show any eastward movement across Dakota of these swarms that hatched in Montana. At Standing Rock, the movement was from the north. On the 19th of July, quite a large number were observed coming from the north, and by the 26th had about all disappeared from the vicinity of that station. Capt. Poland states that the main body appeared to pass to the west of

that station, moving south. No eggs were laid at Standing Rock, or in the immediate region. At Fort Sully, as shown by the records of the Signal Observer, the locusts appeared at various dates from the 14th to the 30th of July, and again from the 10th of August till September 2d ; but whenever the direction of their flight is given, it is to the northwest. No eggs were known to be deposited there. At Lower Brule Agency, on the 29th of July, an immense swarm alighted from a westerly direction, and flew again to the northwest, after remaining five days. At different times during the month of August, small swarms, coming from a westerly direction, alighted and died there. No eggs deposited. At Yankton, the course was generally south, through the flying-season.

It is probable that both in 1874 and 1876 the swarms that came into this state, at least in the earlier part of the season, were hatched in or near British America. This is to be inferred from the direction of their coming, the fact that we know of extensive hatching-grounds in British America in both these years, and that we know of no nearer hatching-ground. There is here also a failure to connect Minnesota with any known breeding-place by any continuous observations. But it is known at least that at Bismarck swarms passed south at various times during July, 1876. At Jamestown, (on the N. P. Ry., east of Bismarck,) a large swarm coming from the northwest on the 12th of July, dropped and remained until the 24th when they left, going south. On the 14th of August a very large swarm passed over southward without alighting. At Worthington, D. T., (still farther east, on the Northern Pacific Railroad,) the first flight appeared from the south on the 25th of June, stayed about 24 hours and on a change of wind went south. For the next six weeks locusts passed over that station in various directions.

At Fort Totten, "in the summer of 1875, grasshoppers hatched in the vicinity of the post, took wing in June, and left in the beginning of July. In 1876, there was no hatching, but they came and departed without doing material damage. They always go and come with the wiud. They came about the middle of July, and left in about four days; came again two weeks afterwards and left without depositing any eggs. Swarms generally came from the northwest. They often pass over in large numbers without doing damage."

L. C. HUNT,
Lieut. Col. 20th Inf.

ENTRANCE OF INVADING SWARMS.

The rate at which swarms have been pouring into the state du-

ring the summer, may be judged from notes taken at points along the western line of the state of Minnesota, and from the eastern tier of counties in Dakota. I give them in regular succession, from Pembina southward:

Pembina, D. T., Aug. 31, 1876.—"No locusts hatched near here, and no eggs now deposited."—W. R. Goodfellow.

July 8.—"Grasshoppers first observed to-day. They could scarcely be seen with the naked eye, but by using colored eye-glasses they were made plainly visible. They were in great numbers, flying very high, far above cumulus clouds, and in a northeasterly direction."

July, 9.—"Grasshoppers flying northeast.

July 11.—"Grasshoppers, flying high, and moving southeast, were observed in great numbers."

July 12.—"Grasshoppers still appear moving south-southeast, flying very high; can scarcely be seen with the naked eye"

July 13.—"Grasshoppers still continue to be seen moving south by east."

July 17.—"Grasshoppers noted to-day, moving southeast, in greater numbers than heretofore, and flying considerably lower. None have as yet alighted."

July 20.—"Grasshoppers continue to fly over this place, moving from the northwest."—Records of the Signal Observer, J. Kabernagle.

Grand Forks, Grand Forks county, D. T. (nearly opposite Crookston) Aug. 28, 1876.—"A few locusts were hatched here and flew to the southeast early in July.

"A few lit on the 9th of July. They came from the north before alighting, but on the 8th the same grasshoppers flew north and returned next day, a few alighting, and all left on the 10th, without doing any injury—direction southeast.

"From the 10th, all through the month of July, when the weather was fine and clear, and the wind from the north or northwest, more or less of them flew over, moving in a southerly or southeasterly direction. But in no instance have I seen very heavy clouds of them until the 4th and 5th of August, when I was out on the head waters of the Turtle and Big Sault, from thirty-five to forty miles west and northwest of this place, I saw them moving in a southeasterly direction, in thicker and heavier clouds than I ever before saw grasshoppers flying. On the evening of the 5th it rained, and a considerable portion of them fell, and rose next day, moving in the same direction as before. And, strange to say, they rose without much sunshine, as the day was cloudy, and the sun showed itself only at intervals, and that for a few minutes at a time. I never saw them move before except upon a clear, sunshiny day, with a wind favorable to the direction in which they wanted to move. None lit near the Red River at this time.

"I do not think that any eggs have been laid here by those alighting in July, nor by those alighting on the 5th of August, west of here thirty-five or forty miles."—Hector Bruce.

Crookston, Polk Co., Minn., Sept. 2, 1876.—"On July 10th and 11th, swarms of 'hoppers came from the southwest, and lit at Crookston and vicinity, remaining two and a half days, and without doing any damage worth noticing; they were pairing. They got up on the third day, and went northeast. Three days later, a large swarm passed over us, going east of southeast, coming from the north. July 31st, a few lit here from the west, but doing no damage. August 10th, a few straggling ones came from the north, until August 15th, when they disappeared, going south."—Ross and Walsh.

Caledonia, Traill Co., D. T., (a few miles south of Crookston,) Aug. 30th, 1876.—"No locusts hatched here in the spring, nor were any eggs deposited They began to fly over about July 5th, generally going south or southwest, and for ten days there was hardly a day but what we could see some flying, most always going south."—Ara Sargeant.

Fargo, Cass county, D. T., Aug. 31, 1876.—"A few locusts were hatched here, and flew northeast on acquiring wings. A large swarm alighted on the 18th, and remained two days, without doing much damage. During the last half of July, and until August 5th, extensive swarms were passing over this county. Their destination was determined by the direction of the wind, either northwest or southeast.

"I cannot learn that any eggs have been laid here this season."—A. J. Harwood.

Breckenridge, Minn., Sept. 27, 1876.—"Grasshoppers hatched here from May 23d onward.

June 27.—"First seen flying to-day, few in numbers, going with the wind, from northwest to southeast, between 11 A. M. and 2 P. M.

July 4.—"Flying in great numbers this forenoon from 9 to 11:30, going from the north with the wind.

July 11.—"Hoppers coming down in swarms this forenoon, and flying from the north.

July 12.—"Hoppers left to-day, going south, as there was a strong wind blowing from the north all day.

July 19.—"Hoppers flying from the northwest to-day, in millions. Seen first about 9 A. M., and kept going until sundown; largest swarm seen yet, and looked like a great drift of snow.

July 22.—"A few hoppers seen to-day, flying between 10 A. M. and 3 P. M., from the north, slowly.

July 23.—"Hoppers flying from 9 A. M. to 5 P. M, from the north and northeast, but not in great numbers as on other days, none of them coming down.

July 24.—"Hoppers returning to-day, coming from the southeast, flying with the wind; began moving about 10 A. M. and till 4 P. M. None came down.

Aug. 1.—"Hoppers have appeared again in millions, coming from the north; are destroying the crop in Minnesota and Dakota. But few of them are rising to-day, as the weather is cloudy.

Aug. 3.—"Hoppers still remain, and are destroying everything, crop, vegetables and grass. A few seen flying during the entire day, from the southeast.

Aug. 6.—"Hoppers began to leave about 10 A. M., going southwest; wind very light, and from the west. First seen depositing eggs to-day.

Aug. 7, 9, 10, and 12.—"Hoppers seen flying in small numbers from the southeast; still remain here, depositing eggs."—From the Records of the Signal Observer, M. L. Hearne, M. D.

Wahpeton, Richland Co., D. T., (opposite Breckenridge,) Aug. 30, 1876.—"A few locusts hatched here; so few that the dates of their hatching or departure was unnoticed. Eggs were laid only in scattering spots, after August 1st. They left before the egg-laying was finished."—D. Wilmot Smith.

Sisseton Agency, D. T., (opposite Big Stone Co., Minn.,) Aug. 12, 1876.—"In the upper portions of the Reservation, twenty-five miles north of the Agency, a small quantity of grasshoppers were hatched, in the latter part of May, and destroyed several grain fields and gardens. At different times in the month of July, we saw them flying over, sometimes in large numbers. Only a few straggling ones came down. The direction has generally been from a point south of southwest.

"On Sabbath, the 30th of July, we had a visitation all over the Reserve. They came down like snowflakes in winter, and covered the earth. Garden vegetables, especially beans and onions, were eaten up to the roots. Corn was pretty much destroyed, and potatoes and oats were very much damaged. The wheat was generally ripe, and but little eaten. They commenced leaving about twenty-four hours after they came, but it was the last of the week before we were free from them. They left on the same line on which they came, going towards the northeast or east of northeast. They were probably the same that have lately visited Herman and Morris, on the St Paul & Pacific Railroad. I understand they were quite as thick to the west of us, twenty miles, as here."—Rev. S. R. Riggs.

[These swarms appear to have reached Ortonville, Big Stone county, about the first, Herman on the third, and Morris on the fifth of August. They came eastward from the James river. The settlers along the James river state that no locusts were hatched there, and that all that appeared there during the season came from the northwest.]

Gary, Deuel Co., D. T., (Opposite Yellow Medicine Co., Minn.) Dec. 8th, 1876. "No locusts were hatched in this county last spring. The first flying swarm appeared in the latter part of June, flying northwest and did no alight. July 20 a very large swarm came from the southwest and went northeast; a few stopped and remained about 24 hours.

"August 15, they flew very thick, the largest swarm I ever saw. They came from the northwest and flew southeast. This swarm, as near as I can learn, was about 20 miles wide. [This probably furnished a portion of the swarms which reached Le Sueur, Mankato, and other points to the east and southeast on the 18th of August.] August 19th a swarm flew from north to south. August 24th a small swarm passed from northwest to southeast; and again in the same direction on the the 30th of August. On September 4th, 5th, 7th, and 9th small and scattering squads flew over to the southeast."—H. H. Herrick.

Medary, Brookings Co., D. T., (opposite Lincoln Co., Minn.,) August 30, 1876.—"The hoppers hatched last spring in this county and the northern half of Moody county. These became fully developed from the 25th of June to July 1st, and on the days between those dates they left in great clouds. The favorable winds for them seemed to be from north, northwest or northeast. They seemed inclined to go southwest.

"From July 1st until now the hoppers have been seen flying overhead nearly every day, moving with the wind, most numerous always with northerly wind. These alighted only once or twice in July, but only in small numbers, and remained only a short time.

"On Saturday, July 22d, very dense clouds passed over, (some so low as almost to darken the atmosphere,) with a northeast wind. They were going west. I have since learned that they rose from Minnesota, from the State line eastward.

"On Saturday, August 5th, very great swarms passed from west to east. At that time many alighted on the prairies, but not many in the settlement. The next morning, Sunday, I drove from Medary to Oakwood, about 18 miles north, and when about half way, I could see, for a distance of thirty miles up and down the valley of the river, dense clouds of hoppers rising. I have since learned that they extended more than 40 miles south of here, and I know more than 20 miles north, making a belt more than sixty miles wide.

"These I note as remarkable displays of hoppers. They could be seen every day, in what any reasonable man would call sufficient numbers. No eggs were laid in this county so far as heard from."—Rev. G. S. Codington.

Flandrau, Moody county, D. T. (opposite Pipestone county, Minn.) Sept. 12, 1876.—"A few hoppers hatched here, but did little damage, and flew to the south and southwest with the army which came over in July.

"The first flying over came about the 21st of July, from a northeast course, and that was the time they visited our crops and made a general raid. Since that time to the first of September, they have been flying more or less, but have done no great harm.

August 6.—"They passed over in large swarms to the southeast. These did us little harm. They have laid eggs to a limited extent in our county."—M. D. L. Pettigrew.

It will be seen from this that swarms from some source or other began to cross the state line to the eastward on July 8th, at Pembina, and that, as a general rule, the date of arrival of large swarms becomes later in the season the farther southward the point of arrival moves. And all these are only the incomings of swarms noticed at prominent points on the border; how many more have crossed or recrossed at other places where there was no one to report their comings, can only be guessed at from the immense clouds that have rolled over the state, passing and repassing each other to the south and east, from the 20th of July to the first week of September. At least one large swarm, in addition to those already recorded, must have entered somewhere to the northwest of Douglas county, shortly before the 18th of August. But whatever form or continuity these bodies may have had before reaching the state, it was soon lost after their arrival. It is not easy to trace them, even from one county to another, as they passed over ground already occupied by earlier comers. All we can say is, that there were extensive movements in certain directions, on certain days.

MOVEMENT OF SWARMS WITHIN THE STATE.

The movement of the various swarms of our own hatching early in the season has been already given. By the 10th of July the counties to the south of the Minnesota river were generally free from locusts, and had begun to congratulate themselves on their delivery. Between the 10th and the 20th the locusts had begun to increase largely in numbers in the northern counties, but the fact that additions had already begun from abroad was not generally known. The greater portion of these had begun to move southward by the latter date and passed various points between Lac qui Parle and Madelia on or soon after July 20th. They passed gradually along over the counties that had been injured during the spring by our own stock, and by the first of August had reached the southern line of the state and many had passed on into Iowa. As they moved along, portions remained behind here and there, but there was no extensive deposit of eggs until they reached the southern half of the lower range of counties in the state. It seems probable that these bodies also brought with them to the southward, parts of our own hatching swarms that had flown northward early in the month. But by the twentieth of the month the locusts had mostly disappeared from along the lines of the Saint Paul and Pacific, and

the Saint Paul and Sioux City Railroads, and there were congratulations once more that "the hoppers were gone." A line showing the eastern limit of their raids at this date would pass, generally speaking, along the eastern boundary of Todd county, through Stearns, Meeker, the eastern part of McLeod, through Sibley, Nicollet, and the northwest corner of Blue Earth, and in Martin county as far east as Fairmont.

Between the end of July and the sixth of August, new swarms had been collecting in Otter Tail, Grant, Stevens, and Big Stone counties, and in some of the eastern counties of Dakota; and on the latter date, a wind from the northwest gave these an opportunity they had apparently been waiting for, and there was a general flying to the east and southeast, over a large portion of the western half of the state. In the southwestern counties, where the new-comers could be traced directly back to Dakota, there was very little alighting, and they mostly passed over into northwestern Iowa. By this raid of the sixth of August, the area of visitation was extended eastward to St. Cloud, into Wright and Le Sueur counties, and across Blue Earth and Martin counties. After the sixth of August, clear weather and favorable winds, at various dates, carried the line still further eastward, as on the eleventh, the fourteenth, and especially on the eighteenth of August, when large swarms flew over Elk River, Monticello, Glencoe, Shakopee, Blakeley, Belle Plaine, Le Sueur, Mankato, and Blue Earth City, and one flight was seen as far east as Hastings. During the week ending August 26th, they were seen flying over or alighting at various times in Rice, Waseca, Steele, Faribault and Freeborn counties, and are said to have appeared over Rochester. By the first of September they had added Waseca, Freeborn, Carver, and portions of Hennepin, Sherburne, and Benton counties to the "grasshopper regions," and some slight additions to the eastward have been made since the latter date.

The comparatively slow rate of progress to the eastward through the season is surprising, considering the long distances which the locust is supposed to travel, and the impression which one receives from seeing a swarm passing in one direction through an entire day. It is easy to imagine that such flights must have come immediately from British America or Montana, and that they will shortly reach Wisconsin and Illinois. But the locust, as it appears in our state, moves (with perhaps rare exceptions,) by day only and often for only a few hours in the day, and a halt for the night is easily prolonged by head winds or cloudy weather into a halt for several days; nor do the swarms move continually

eastward, although the line of encroachment is continually moving in that direction. In one case at least, a body that had moved easterly over a county on the 24th of August, returned directly west one week later. (Freeborn County *Standard*, editorial, Aug. 31, 1876.) There is no knowledge that any swarm has (in Minnesota) reached the Mississippi river south of Hastings.

But the general direction of movement since the twentieth of July has been to the southward and eastward. The experience of the summer has shown that the Big Woods offer no impassible barrier. Hitherto, the incoming swarms have reached about as far east (but not in great numbers) as Lake Washington, in Le Sueur county, longitude 16° 50′ (nearly) west. They have reached this point toward the end of August, when impaired in strength and activity. But the invasion of the past summer has been characterized by the incoming of fresh and still active swarms late in August, and these have been carried by winds blowing freshly from the west, as far east as Mower county, longitude 16° west. It may be proved in future that the eastern limit of invasion is determined solely by the extent to which winds prevail from the west, together with the length of the season during which the locust retains its full activity and strength. The connection between the movements of the locust and the prevailing direction of the winds, seems likely to receive more attention than has hitherto been paid to it. While the timbered country of the northeastern part of the State has been but little infested, to any great distance east of the Mississippi, it may be said that that portion of the state does not lie in the direct line of invasions. There is nothing to show that swarms purposely turn aside from the heavily timbered regions and go elsewhere, although in partially timbered sections they alight mostly in the open farms. But, having once entered the timber, their progress is soon ended, and no more fortunate destination could be selected for our departing swarms than Northeastern Minnesota. Locusts have been quite numerous about Brainerd throughout the summer, since early in July, and their numbers were perceptibly increased on the sixth of August, apparently brought in by a strong wind from the southwest; but these evidently found their progress impeded by the timber, for they did not extend to any distance east of Brainerd, along the Northern Pacific Railroad, nor did they lay eggs extensively about Brainerd.

The connection between flying movements and the direction of the winds may be shown by the following diary kept by Lieut. R. B. Plotts, of Elk township, Nobles county:

July 5.—"Light wind; first flight came from the northeast, and commenced to settle down about 10 A. M.; attacked gardens first of all. They remained here till Sunday, the 9th, when in a brisk breeze from north-northwest, a light rain the night before, they flew from early in the morning till after sundown, and lit heavily south of me.

July 10.—"Wind southeast; flew heavily to the west, the highest appearing to sheer off southwest. Got a heavy light from those east of me.

July 13.—"Late in the afternoon wind suddenly veered to northeast, and they started immediately. Nearly all left me.

July 15.—"Wind north, veering to the east. Not a very heavy flight to the west.

July 16.—"Wind south-southeast. Still going west.

July 17.—"Wind east, trending north, showery. Before the showers commenced, could be seen going west. That ended the first raid. No more flying over till

July 20.—"Second raid came in on a west-northwest wind, and lit at night.

July 22.—"Wind north-northeast, heavy flight, and coming down all day.

July 23.—"Wind northeast, haling east. Heavy flight; came down heavily, and covered everything nearly.

July 24.—"Wind varying from north-northeast to east. Coming and going all day; some commenced laying eggs, which was kept up till this raid all left us.

July 27.—"Wind from north and east. Heavy flight, and most of them left here.

July 29.—"An east wind took all this raid away, the upper current being to the southwest. No more flights until

Aug. 6.—"Light wind from northwest. Another heavy raid came in. These remained till

Aug. 10.—"When wind again came from the northwest, and it rained. As soon as the shower was over and before the sun shone out, the hoppers started in heavy flight.

Aug. 12.—"The red mites were first noticed doing much damage to the eggs.

Aug. 13.—"Another showery day, and immediately after the rain they started south.

Aug. 14.—"Wind from north and north-northeast. They started early and before the sun came out, although it was quite cool; about all of this raid left.

Aug 16.—"Very cloudy, with variable winds. Suddenly, while it was quite dark with clouds, the hoppers jumped up and flew off southwest; the very first puff of wind from the northeast, and they all left here.

Aug. 18.—"Wind again from the north. A very heavy flight passed over, high up in the air. None alighted. Red mites disappearing.

Aug. 23.—"Wind hauling to westward, and some few stragglers flew as near south as they could.

Aug. 24.—"Wind northwest. Grasshoppers very high and heavy flight to the southwest.

Aug. 25.—"Wind northwest Heavy flight to the southwest, very high.

Aug. 31.—"Showery for several days before; wind suddenly north-northwest, and by 10 A. M. many grasshoppers were flying. By noon, in the upper air and almost indistinguishable, was a heavy body going southwest. None lit here.

"On the dates intermediate between those given the wind was very light, and there were no flights, except perhaps short ones, from one part of a field to another.

"When the directions of flight are not expressly stated, they correspond almost exactly with the direction of the wind."

AREA OF THE PRESENT DEPOSIT OF EGGS.

A line showing the eastern limit of the area where eggs are now deposited in Minnesota would include (very nearly) the western tier of towns in Mower county, the western part of Steele, Rice, and Scott counties, the whole of Carver, the western part of Hennepin, along the river, (and in many places thickly in the timber farms,) in Sherburne and Benton counties, the southern part of Todd county, then westerly including Otter Tail, the southwestern part of Becker, and portions of Clay counties. To the south and west of this line the locusts have had possession of more or less of the state from the fourth of July to the first of October, and it would be difficult to specify with any exactness especially in the eastern part of this area, where eggs are most or least thickly laid. But the counties along the Red river from Glyndon to Lac qui Parle are comparatively free from eggs, unless in the eastern portions, and again many towns from Madelia westward in Watonwan, Cottonwood, Murray, Redwood, and the whole of Lyon and Lincoln counties are almost entirely free from eggs.

The accompanying map will show the areas of egg-deposit for the last four summers, but the lines must not be construed too exactly. They are intended to cover generally the outside limits. As for the limit of the deposit during the present year, it is impossible to draw it exactly, and no doubt a few locusts will be found hatching in many spots next spring which lie to the east of this line. Late in the season, considerable numbers passed over Owatonna to the eastward, some over Mantorville, and possibly a few over Rochester, and these, perhaps, will be found to have alighted and laid eggs somewhere in the southeastern counties. On our borders eggs are laid in the southwestern counties of

MAP OF MINNESOTA

PUBLISHED FOR THE

STATE GEOLOGICAL & NATURAL HISTORY SURVEY

SHOWING

The Areas where eggs were deposited by the Rocky Mountain Locust in 1873-4-5-6.

1877

MINNESOTA.—CENSUS OF 1875.

COUNTY.	POPULATION.	COUNTY.	POPULATION.	COUNTY.	POPULATION.
Aitkin,	205	Houston,	16,566	Ramsey,	36,333
Anoka,	5,709	Isanti,	3,901	Redwood,	2,982
Becker,	2,256	Jackson,	3,566	Renville,	6,876
Benton,	1,974	Kanabec,	301	Rice,	20,622
Big Stone,	305	Kandiyohi,	8,083	Rock,	1,561
Blue Earth,	20,942	Lac qui Parle,	1,428	St. Louis,	3,517
Brown,	9,815	Lake,	161	Scott,	12,394
Carlton,	495	Le Sueur,	13,237	Sherburne,	3,018
Carver,	13,033	Lincoln,	413	Sibley,	8,884
Cass,	239	Lyon,	2,543	Stearns,	17,797
Chippewa,	2,977	McLeod,	8,651	Steele,	10,739
Chisago,	6,046	Martin,	6,738	Stevens,	786
Clay,	1,451	Meeker,	8,626	Swift,	2,269
Cook,	215	Mille Lacs,	1,300	Todd,	3,818
Cottonwood,	2,870	Morrison,	2,722	Traverse,	100
Crow Wing	1,031	Mower,	13,682	Wabasha,	17,206
Dakota,	17,360	Murray,	1,329	Wadena,	210
Dodge,	10,045	Nicollet,	11,525	Waseca,	9,994
Douglas,	6,319	Nobles,	2,750	Washington,	14,751
Faribault,	11,131	Olmsted,	20,946	Watonwan,	4,024
Fillmore,	28,337	Ottertail,	9,174	Wilkin,	528
Freeborn,	13,189	Pembina,	203	Winona,	27,385
Goodhue,	28,500	Pine,	795	Wright,	13,775
Grant,	1,191	Polk,	937	Yellow Medicine,	2,484
Hennepin,	48,725	Pope,	4,075	Total population,	597,407

REFERENCES

- Capitol
- Incorporate Cities
- Towns & RR. Stations
- Postoffices
- finished R.R.
- Proposed R.R.
- County Boundaries
- State Boundaries
- 1873
- 1874
- 1875
- 1876

Level of the Lake is 600 feet above the Ocean.

Par. of Lat 43°30'

Dakota as far north as Rock Co., Minnesota, and in Iowa as far east as Mower county.

PLACES WHERE EGGS ARE DEPOSITED.

These eggs have been deposited, as a general rule, in the vicinity of cultivated fields, and in each township the extent of the deposit is measured, in some degree, by the amount of land under cultivation. It is not presumable, at least, that wild prairies or lands lying far distant from tilled fields, are extensively filled with eggs. The locust is attracted and held by the growing crops, and it seems to be something more than a mere coincidence that the area devastated by the young in the spring does not become a laying-ground in the summer; this is especially true of the present year, and the same strip of country where the locusts hatched in the spring, and where the little that was planted, was mostly consumed by them, is at present exactly that portion of the infested area that is now most nearly free of eggs, although the deposit is abundant enough in the counties to the north and south of it. Nor do the prairies, when covered with grass, present many favorable situations for the deposit of eggs. The experience of the summer would seem to show that almost any bare, sunny spot, where the earth is hard enough or moist enough to retain the shape of a hole, is selected by the locust when she is ready to lay. To what extent the prairies in general are filled with eggs, cannot be told, of course, until the time of hatching arrives, but in the vicinity of cultivated fields the wild prairie has received its share of eggs. Throughout the whole area already given, with the exceptions named, there is hardly a town where the deposit was not so extensive by the first of October as to form one of the most serious of all considerations for next year's crop. These eggs are laid sometimes in ground so hard as to resist the point of a knife-blade, sometimes in sand-heaps so soft that the next shower washes off the sand and leaves the egg-cones standing like pegs in the ground; on knolls high and clear of all moisture, on sand-bars in the rivers, and in flats so low as to be overflowed by the next rain. But the most favorable spot of all, everywhere, is new breaking. Grain fields have generally suffered most damage on the sides nearest to new breaking, and, conversely, in new breaking more eggs are laid on the sides nearest to grain fields. In some counties, a large amount of new breaking has been done by non-residents, and will furnish a fruitful source of evil next spring. Of circulars sent to nearly all the infested towns to ascertain the extent to which eggs

were deposited during the season, the following, from Blue Earth county, is a sample of all, as to the extent of the deposits, and the spots where they are situated:

Beauford.—"All over the town; not much in the stubble, but on all bare spots, such as sheep-pastures, between the rows of corn and potatoes, gardens, all places that were clean of weeds, river bottoms, where fed close, timothy stubble and road sides."—J. S. Larkin.

Butternut Valley.—"It would be difficult to run down a spade and turn the dirt anywhere in stubble, corn, potato fields, meadow, or road, without finding eggs. It seems as twenty to one before, and they destroyed everything."—Samuel D. Shaw.

Ceresco.—"Over the whole township, very thick in most places."—J. M. Mead.

Jamestown.—"They have deposited their eggs on nearly every farm in this township."—A. P. Davis.

Judson.—"They have laid eggs very extensively, especially on new breaking and roads, some in the stubble, grass, prairie and corn lands."—Humphrey H. Jones.

Leray.—"Eggs are laid on every clear, dry place in the town; mostly in corn fields, potato fields, gardens, and in the highway."—Ira B. Reynolds.

Lime.—"In the flats along the Minnesota river they are thicker than in the timber, but along the roads, and in old pastures, they are so thick that nobody can have an idea, unless he has seen it himself."—Jacob Born.

Mapleton.—"There is not a farmer but claims that every favorable spot on his farm is thoroughly peppered."—J. E. Brown.

Medo —"All timothy pastures, all new breaking, in the roads, and in some stubble to a limited extent—from 6 to 10 acres in each quarter."—B. F. Steadman.

Rapidan.—"Every favorable place is well filled; roadsides, tame pastures, and new breaking thickest, corn fields next, and stubble fields and unbroken prairie least."—James B. Swan.

Shelby.—"All along the highways and especially on all new breaking and old pastures, corn fields and prairie lands that are eaten out by pasturage, and in fact there is no such thing as exception from them."—Thomas J. Cross.

South Bend.—"Eggs are deposited in every rood of dry ground in the township."—D. P. Davis.

Sterling.—"In some places the eggs are stuck in very thick, but in the fields generally the eggs cannot be very thick. Still, in the aggregate there are very many, being everywhere, even in the timber."—N. A. Hunt.

Vernon Center.—"Eggs are deposited all over the township, and in some places very thick, seemingly no room for more, and in other places (wheat stubble,) not so many."—E. W. Washburn.

The laying this year seems to surpass that of former years not only in the area filled, but in the numbers deposited everywhere. This could hardly fail to be the case when the laying commenced early in July and was prolonged into September, and when some towns received deposits from two, three, or even four different bodies. Where new breaking was harrowed in the fall the eggs often appeared strewn on the surface as thickly as grain is sown; e. g., "I have just dragged a new piece of breaking, and the eggs were as thick as wheat sown at the rate of one and a half bushels per acre; but I think they are thicker on breaking than anywhere else. (S. S. Clevenger, town clerk of Bismarck, Sibley Co.)

TIME OF DEPOSITING EGGS.

The time when eggs have been deposited this year has been stated already. The time when, or rather the age at which the Rocky Mountain Locust deposits its eggs, is a different question. The same species has laid eggs in Kansas, this year, as late as the 13th of November, and may continue to lay in Texas as late as the first of December. (Riley's 7th Ann. Report, p. 192.) If the mission of the locust is to lay eggs once and die, what could be the time or place of birth of those insects which have apparently just reached maturity by the first of December? Although it has been considered possible that these are a second brood whose parents were hatched in the preceding April or May in Texas or Colorado, there is no knowledge of the time or place of any such second hatching. If these late laying swarms are such as those which come down from the Snowy Range in Colorado, in the latter part of August (vide N. C. Meeker, quoted in Riley's 8th Ann. Report, p. 84) it must be admitted that the mountain-born broods are a longer-lived and more vigorous race than any bred in Minnesota. Besides this, among the swarms which have come in upon us this year, many were found dying as late as October, containing eggs.

That the Rocky Mountain Locust lays eggs twice or three times in a lifetime, has been the result of some guess-work among our farmers, who considered it necessary in order to account for facts as they saw them. I give the result of a single experiment.

On the 25th of June, I shut up in wire gauze cages nine pupæ of the Rocky Mountain Locust. The bottoms of the cages were filled with earth packed hard, and the insects appeared to thrive in confinement. By the second of July they had all become perfect insects. By the 8th of July they commenced coupling, and were seen repeating the act for several days. On the 15th and 16th two of the females went through the form of depositing eggs, and I marked the place of deposit on the edge of the cage. The coupling was repeated again as before, until the third of August. At that date the coupling ended, and the locusts became almost inactive, and were seen to eat very rarely afterward.*

On the 14th of August one of the males died; the female died on the 9th of September, and was found to contain fourteen full sized eggs, but I found on examining the cage that there was also a full sized egg-cone where she had already appeared to deposit on the fifteenth of July. Of the rest of the Rocky Mountain Locusts the males were caged with some female Red-Legged Locusts caught in my garden, and although the two species did not seem inclined to have much commerce with each other, I saw one pair coupling. These observations are very slight and imperfect, but are given for whatever they may be worth. That the male dies first may be inferred not only by the above experiment, but from the fact that in September it was common to find many pairs coupled, of which the female was alive, but the male had died without releasing himself.

PARASITES AND ENEMIES.

The various insect enemies of the Rocky Mountain Locust have been described sufficiently for common information by Prof. Riley on pp. 44-46 of the "Report of the Proceedings of a

* The early part of this coupling season was one of the greatest activity on the part of these insects; they dashed themselves against the wire of their cages as though all space would be too small to contain them; there would be a flash of the wings, extended and closed again in an instant, or that movement of the hind legs known as "fiddling," which seemed to be a well known signal between the male and female. In cages, where several pairs were confined together, the male, while in the act of coupling, would repeat this movement, if brushed against by another.

Conference of the Governors of several Western States and Territories, at Omaha, Nebraska, in October, to consider the Locust Problem." As the descriptions are further illustrated by figures, and as the pamphlet is intended for public distribution it may serve to prevent some of the confused knowledge about these parasites and enemies which has heretofore prevailed to a considerable extent. The amount of help which may be expected, or has already been received, from these enemies of the locust is, in *limited areas*, even greater than Prof. Riley would assign to them. There are farms where in loose, mellow soil it is now almost impossible to find eggs, yet but a short distance away eggs may be found in abundance in hard ground. There was also great difference in the different flying swarms in regard to the presence of the internal grub. While in some places hardly a locust (one out of five,) could be found that was not affected by some internal parasite, in others they were almost entirely free from them. Mr. W. C. Ralls, of Le Sueur, examined 624 locusts between the 7th and 10th of September, and in 9 of these the grub was found, and in 10 the hair-worm. It would be well if we could add to this help which is given without expectation of bounty or relief, the help which might have been added by thousands of prairie-chickens killed during the fall. When a whole community stands in need of every form of assistance that man and nature can render, it is worse than useless to throw away the help, however slight, that any willing instrument is ready to contribute.

DAMAGE TO CROPS.

The form and substance which this report might have been expected to assume early in the season, have changed considerably under changing circumstances. The various means of contending with the locust have been set forth generally and in detail during the past four months; and the amount of damage which has been inflicted upon the crops, while it might have been ascertained with some precision in five or six counties, has become a different matter when combined with severe losses by drouth, and extending over thirty-five or more counties. The exact amount of loss in so many different counties, varying as it does from almost total loss of the grain crops to slight injury to gardens and late corn, can not be arrived at with any less efficient machinery than that of the Commissioner of Statistics, to whom the whole of this portion of the subject properly belongs.

Of grain, the oats and barley have, as usual, suffered the most; in Raymond, Stearns county, where the locusts were most numerous from the 23d of July to the 20th of August, "the Lost Nation wheat was only slightly damaged, while the Fife wheat was ruined." (So stated by L. B. Raymond, Esq.) The same fact was noted by P. Hoffman, Esq., of Westport, Pope county; but it is not known how generally the rule will apply.

Corn and potatoes have escaped with less damage everywhere, though corn attacked in the silk has been ruined. Peas are never specially mentioned except to note their escape from injury. ("On the whole, we consider peas and potatoes the best crop to raise."—S. S. Gillam, Big Bend, Cottonwood county.) Sorghum is almost locust proof so far, both against the young and old. Flax, tobacco and beans are generally mentioned to note their almost total destruction. Farms lying on the east side of lakes have often suffered less than others, both in this state and Dakota. In some cases farms situated in the timber have been passed over altogether; in others they have yielded 5 to 10 bushels to the acre, while crops on the prairies in the same town have been failures; on the other hand, rarely the timbered portions of a town have suffered more severely than the prairie farms.

PRACTICAL METHODS OF CONTENDING WITH THE YOUNG LOCUST.

The different means of contending with the locust both in the egg and the unfledged state, have been set forth so fully and so often within the last two years, that they ought by this time to have reached, in some form or other, the hands of every reading man in Minnesota. The report of the commission appointed by Governor C. K. Davis in 1875, (of which some 5,000 copies were printed,) the proclamation of Governor J. S. Pillsbury, issued August 30th, 1876, containing the gist of all the known methods of locust warfare, and the many and oftentimes excellent amplifications and details of these methods, as they have appeared in the state newspapers during the summer, cover the whole ground so far as it is known. Finally the Report of the Proceedings of the Omaha Convention repeat, in twelve excellent pages, the whole subject once more, and a reprint of these in the newspapers of those counties where the evil is new and comparatively unknown, ought to leave no further lack of information.

It ought also to be understood that these sources contain all that has so far been made public on the subject, and that the farmer must for the present defend his crops by these means or

not at all. We are so accustomed to the comprehensive methods of farming by machinery that it is hard for us to come down to the petty exercise of individual exertion which the European peasant would consider only a regular portion of his daily existence. But whatever may be the success of various machines and applications which are now in preparation, but not to be disclosed at present, there is as yet no labor-saving contrivance, capable of being applied over large areas, which can accomplish anything like a universal destruction of the young locust, and the general law of labor holds good, that a man's success is measured by the earnestness of his own endeavor. Even the difficulty which results from sparseness of population may be overcome in some little measure; where a few farmers in a township where eggs are laid have determined to sow a small acreage and to defend it to the best of their abilities, something may be gained by combining and sowing in partnership, or side by side, the fields that would otherwise be distributed over a township. Of course there are objections and difficulties to any such method of proceeding, but they are at least no greater than those already presented in the mere fact that the locust is present. On the other hand the advantages would be great; half a dozen families acting in concert and in the defense of one large field would accomplish far more than by any disjointed efforts; it would be far easier to defend the four sides of one large field than the twenty-four sides of half a dozen smaller ones; and lastly the single field would have a smaller number of locusts in the aggregate to contend against, and insects hatched at a distance from it might never reach it before flying; at least it is certain that fields lying within three miles of the hatching grounds of last spring, remained untouched until the flying season.

WHAT MAY BE DONE BY ENERGY AND PERSEVERANCE.

Although it is impossible for me to add at present anything to the many and various methods of locust-warfare that have been repeated so often, it may be of some value to show what has been or may be done with those already known. It was not as a mere form of speech that the conference at Omaha concluded with these words:

"That our consultation with each other and with those who have tested the matter, has resulted in the firm conviction that by proper efforts, concerted action, and a vigorous and determined warfare against them, the young grasshoppers which may be

hatched out next year, or any subsequent year, can be successfully fought and our crops saved; that we are not without remedy, but we may protect our crops against them if we will but make use of the means within our reach."

The conditions of success here noted, "proper efforts, concerted action, and vigorous and determined warfare," have never yet been applied in Minnesota. The truth of the above quotation, is shown by the fact that where even individuals, contending not only against the locusts hatched about them, but against those which the concerted action of their neighbors should have rendered harmless, have defended their crops with perseverance and determination through a whole season, they have in the end received a return which justified both their usual and their extra labor. Even the most petty means of defence, if kept up persistently through a whole spring, will often effect a saving of a considerable portion of the crop. The town of Lime, in Blue Earth county, one-half of a government town, in 1875 turned out its whole population to battle with the young locusts with brooms, switches, and every weapon they could lay hands on, and returned an average crop of 12 2-3 bushels of wheat, 36 bushels of oats, and 36 bushels of corn to the acre. The town reported no damage from locusts, and the return was about the average crop for the whole county, and a fair yield.

Charles Pelzel, of Milford, Brown county, by spreading tar over strips of building paper, and placing these along the sides of his fields, saved most of his crop, while those of his neighbors were badly damaged. The paper was re-spread with tar as often as it became covered with young locusts. On 25 acres of wheat he saved 223 bushels, and on eight acres of oats 400 bushels. All this was at a cost of $3 for tar.

Mr. N. V. McDowell, of Bigelow, Nobles county, who has fought the locusts persistently ever since they came in 1873, by 10 days' extra labor in hauling and burning straw, saved a fair crop on 55 out of 70 acres cultivated, but his exertions were rendered useless by the raids of July and August. Even after these he was able to harvest five bushels of wheat to the acre on early sowing.

The only crop of small grain harvested in the town of Holly, Murray county, this year, was by Mr. J. M. King. He writes:

"I put in about 50 days' labor for one man. I caught 100 bushels in my net, and destroyed as many more by scattering straw over their hatching grounds and burning them. I also put to flight swarms and droves of them after they began to fly by use of bags nailed on to from 25 to 50 feet of pole or board, with which I trailed back and forth across my fields, at times

driving them like sheep, and at other times not making much impression. I saved 450 bushels of wheat from 52 acres, but firmly believe that if we had had a favorable season, the hoppers would have hurt it but little; but the dry weather, coming as it did, seemed to kill it."

The following experience is also worthy of being recorded:

"Mr. S. W. Danforth, of Madelia, Watonwan county, after having once resolved (in 1874) that he would put in no crop whatever should the locusts deposit eggs on his farm a second time, resolved once more in 1876 that he would determine whether he or the locusts should be master of his farm. On the north side of his wheat field was a prairie ridge where the locusts hatched in the spring. These, while very young, began to come into the field on the north, and had reached it before being discovered. He began by burning them with straw on the edge of the field and on the adjoining prairie, constructing a ditch along the side of the field at the same time. Smaller ditches were also made inside the field to stop those which had already entered. When young, they were also delayed by simply harrowing over the soil and presenting a rough surface for them to crawl over. Seven or eight days were spent in this way, and after the ditch was finished, it turned away the locusts so completely that the work was considered done, and the crop saved. On the western edge of his field was a strip of prairie grass, 40 rods wide, and beyond this some stubble and old corn grounds, belonging to a neighbor. Here the locusts hatched out abundantly. About a week after work was done on the north side of the field, these had crossed the strip of prairie and entered the field from the west before being noticed. As soon as they were discovered, he got all the help he could and made a ditch as fast as possible. This stopped them for nearly a week, and then they began to cross it. He hitched a horse to a plank and walked him up and down in the ditch, and this turned them aside for a while. There was a cloudy day on which the locusts rested, but when the sun came out they were ravenous, and there was no stopping them. They crossed the ditch, and filled the straw-fire so full as to extinguish it. He called in his neighbors to see what would happen to them if the locusts were allowed to keep on in their course, and five or six turned out with teams, hauling straw. With this they burned over a strip three or four rods wide and a hundred rods long, along the edge of the field. But in spite of all his efforts, the locusts had made their way into his wheat, and by this time he had finished a catching-net. The next day, in five hours, he caught from 15 to 20 bushels. This was continued daily, until 75 or 80 bushels had been caught, and it was not necessary to use it, except as occasion demanded on certain days, or in certain spots where the locusts were thickest. This work was so effectual that there should have been (except for drouth) a fair crop of wheat, or at least half a crop all over the farm, except where the burning was done. This demonstrates the possibility of one farmer's fighting two farmers' locusts, and still saving half a crop."

CATCHING-MACHINES.

Many other isolated cases of persistent and partially successful efforts in saving crops from the young locusts have occurred this year; I mention these because they have been reported more fully than others. It also shows what can be done with machines in the later part of the season, and what might have been done by attacking the locusts in their hatching-grounds instead of waiting for them to approach the grain. The coming spring seems likely to test what can be done with catching-machines. Not only are several elaborate ones patented or prepared for use when the time comes, but many farmers are already preparing such machines after their own fashions. To those who are deterred by cost or by lack of a model, it should be said that an efficient machine can be made at a cost of a few poles or strips of board, a pair of wheels, a few yards of stout canvas, and just sufficient ingenuity to construct a long, open-mouthed bag to run over the fields with its lower edge near the ground, and running back in the rear to a sack to contain the locusts that are caught. Mr. King's net was such, and captured from two to eighteen bushels per day, depending on the size and age of the locusts.

Mr. Danforth's machine consisted of two wheels, connected by an axle 20 feet long and six inches in diameter; this was made of a stout pole obtained from the woods, and it was necessary that it should be so large and strong, for the loads of young locusts captured were sometimes so heavy as to bend even this badly. Across the top of this axle two poles, of about the same diameter as the axle, were fastened, running back nearly to a V some eight or ten feet behind the middle of the axle, and extending forward and opening out in front of it. The front ends of this V was steadied by a cross-piece. This was the frame-work. The net was made of about 40 yards of cotton cloth, cone-shaped, in front about 18 feet wide, from one side to another along the axle, and six or eight feet high from the ground to the top of the net. This net narrowed back about seven feet until it was some five or six feet in diameter, and terminated in a stout canvas bag three or four feet long, closed with a string at the rear end. The heavy loads of locusts caught (sometimes 500 pounds) made it necessary to have a support for the net and bag, and for this purpose a triangular floor-work of boards was made, the front end supported from the axle, and the hind end from the hind end of the V poles, and running as near the ground as possible. The lower edge of the net in front was kept close to the ground by a piece of light scantling fastened

to the edge of the cloth, and rising and falling over uneven surfaces. The horses were hitched to the ends of the axles, outside of the wheels, their breasts extending forward nearly to the front ends of the V poles, where they were fastened by the head. The net sloped backward at the top in front, and when the machine was in motion a man stationed on the axle with a broom gave the locusts as they entered the net a start toward the rear end. Just where the cone terminated in the oblong bag, a large piece of canvas had been cut out and wire gauze inserted, and the locusts moved towards this on getting into the net, attracted by the light. The only outlay in constructing this machine was for the 40 yards of cotton cloth. This net captured from eight to twelve bushels of pupæ per day when first used, and the amount diminished daily till the 24th of June, when about two bushels were taken.

Mr. Andrew Webster, of Norseland, Nicollet county, had, in 1875, about 230 acres of wheat sown. The locusts began to hatch about May 17th, and he commenced at once to destroy them by burning with straw. As it was impossible to protect the whole of his crop with the help at hand, he selected a field of fifty acres to defend, and burned all the locusts that hatched near it. This continued until June 11th, when the straw was exhausted, and the locusts had begun to come in from the adjoining fields. Two catching-nets were then rigged up, (of the usual form,) attached to axles fourteen and sixteen feet long, each drawn by one horse moving at a fast trot. The amounts caught were: From June 11th to 17th, (part of the time with one net,) 121 bushels; with both nets, June 17th, 37 bushels; June 19th, 20 bushels; June 21st, 77 bushels; June 22d, 63 bushels; June 23d, 45 bushels; June 24th, 71 bushels; June 26th to 28th, 128 bushels; June 29th, 59 bushels; June 30th, 28 bushels; July 1st, 18 bushels, when the work was discontinued, as the locusts had begun to fly, and had become too scattered to be caught easily. The catching was done along the edge of the field, and between the hours of five and ten P. M. It required the labor of four men and four horses during these hours. The whole number of bushels caught was 667, and, on threshing, 658 bushels of wheat were harvested from the fifty acres.

DITCHING.

The experience of Minnesota in regard to ditching, in 1875, was so successful, and so strongly and fully confirmed by the testimony of reliable men, that the experiment should have seemed worthy

of a more extended trial than it has received this year. But few ditches have been dug, but these, even when left to take care of themselves, have generally served as a barrier during the earlier half of the season. A ditch, to be effectual, needs care and watching; when its sides have been washed down by repeated rains, and it becomes a mere curved surface, it is a very slight barrier indeed. The time and trouble of constructing such ditches as these, would be spent better otherwise.

CONTENDING WITH WINGED LOCUSTS.

Here and there during the past season have been cases of one farmer or a few farmers in a township who were able to save some portion of their crops from the flying swarms. The number of cases where this has happened is in some twenty-five or thirty out of the whole number of towns in the state that have been invaded. When there has been any success at all it has generally been early in the season, and over small patches of garden or cornfields. There are towns where farmers have smudged, roped, discharged fire-arms, and rattled tin pans, until straw stacks and patience were exhausted; and all to no avail. Others have worked hard smoking and roping their fields, supposing all the while that they were accomplishing something, only to find in the end that they were worse off than neighbors who had done nothing. Others, who have had plenty of straw at hand, have, by firing it at just the right moment, managed to save a field. But the uselessness of all such attempts has generally been too apparent to encourage any hope of even a chance of success.

BURNING PRAIRIES.

The amount of help which may be received from burning the grass on the prairie at the time of hatching, seems likely to be well tested next year, as the efforts to preserve the grass have so far been generally successful. The exact amount of help that can be derived from a general burning must vary much, with differing circumstances, from one year to another, and the opinions as to its value differ greatly. To those who believe that the whole region of uncultivated prairie in the western part of the state is extensively dotted with eggs, nothing could seem more important than a general preservation of the grass, difficult or impossible as this may be. There is no question whatever as to the value of preserving it in all cultivated neighborhoods, or in all regions

that are interspersed with farms. And yet even in these it is difficult to select a time for burning which will not allow the escape of some portions of those already hatched or of those still unhatched. But even if the help falls a great deal short of general destruction it is still a help; even if no insects are hatched on the prairie they often hop away in large numbers off the bare fields into the prairie grass, and may be destroyed in large quantities. In addition to this, where the grass is burned late in the spring it gives place to a growth of young and tender grass which often serves to entice the locusts away from the crops. In Watonwan county last year only about one half of the grass was saved through to May or June, in Cottonwood county less than one half, in Redwood, Murray and Lyon counties, hardly any. Wherever it was fairly tried in Cottonwood county, those who had charge of attending to the preservation and firing of it are strongly convinced that efficient service was rendered by it.

PLOWING AND HARROWING.

The prevention of the eggs from hatching by deep plowing or by surface harrowing has been urged in the Report of the Omaha Conference, and none too strongly. While there is much difference of opinion in regard to deep plowing, there is strong testimony to show that where the eggs are turned under to the depth of ten inches they either never hatch at all, or come forth so late as to be incapable of harm, appearing sometimes after the corn has reached the height of three or four feet, sometimes as late as the end of August. But if there is any point in the whole subject where opinions seem to be unanimous, it is in regard to the value of harrowing up the eggs in the fall, and exposing them to the influence of weather, birds and other enemies. In this connection the general harrowing of new breaking and plowing of roadsides that have been done by many farmers, or by townships, cannot fail to be of benefit. That this work should commence in our climate as soon in the fall as there is any assurance that the egg-deposit is ended, is evident from the consideration that the longer the egg is exposed to the above mentioned influences the more sure its destruction is likely to become, and from the fact that in many places the ground became frozen before the work of harrowing was nearly finished.

THE NEED BOTH OF STATE AND OF INDIVIDUAL EXERTION.

It will be fortunate if science and national discovery shall finally

be able to dispel for us some of the uncertainties which beset the locust problem in general. It is the doubt in regard to the future and the fear that each year may prove more disastrous than its predecessor, that give the evil more than its real magnitude and paralyze hands that are not otherwise accustomed to refuse labor. To simplify the conditions of the problem as far as possible, to determine how far the goings and comings of a fitful insect hurrying destructively over thousands of miles of grain fields, and sowing everywhere the seeds of future devastation, may be foreseen or prevented, is an object worthy of the highest science and the most liberal enterprise. But the help that can come from any such source must necessarily be long in action and slow in results. With all our uncertainties, we have one certainty before us in the immediate future; it is that of a great and wide spread injury which only prompt, efficient, concerted and continued effort can remedy. We cannot offer to do less than to render at once by ourselves and to ourselves a portion of that help which we ask a broader knowledge and enlarged means to render unnecessary in the future. The state of Minnesota has already taken the lead in the proposal of a conference upon the locust subject, which, if the results correspond in any fair measure to the objects proposed, will end in more definite knowledge and more efficient action throughout all the region that has been overrun for so many years. The state may fitly supplement the action of the conference by determining once for all just what can be done with the evil when it has taken root here. It is no longer a question that that is a state matter which concerns more or less intimately forty-four out of seventy-one counties.

But the matter does not end with the state. After all that can be done by legislation, success depends purely upon how much each man is willing to do with his own hands. Without united effort to meet the evil wherever it occurs, and with every means or instrument that lie at our disposal, without a determination to plow and sow and defend, each and every man on his own domain, nothing will be done that is worth legislating about. No effort is worth securing that does not recognize the need of the broadest possible exertion, or offer the largest possible assurance of ultimate success.

BOUNTY.

The conference at Omaha, while recognizing the necessity for united action, both of the state and of every individual through-

out the present infested regions, resolved "That it will be wise and politic for the legislatures of each of the states and territories most deeply interested in the locust question, to enact a state bounty law," etc. As there is in the minds of many a grave doubt as to the expediency of offering any bounty at all which shall take the form of a specified amount to be paid per bushel for locusts, and as it will be difficult to enact any law which shall be equally adapted to the thickly settled counties and the thinly settled frontier, I have included in circulars to the different towns the question, "If a bounty were offered in your township, next spring, for the destruction of locusts, could it be made to any extent successful in saving crops?" and "How small a price per bushel would accomplish the purpose?" The farmers ought to know at least as well as any one the capabilities of their own communities, and it is some proof of the sincerity with which they have made their replies, that in counties where the locust is comparatively unknown, it is answered that they are unable to give an opinion; in the sparsely settled counties, the fear is often strongly expressed that such a bounty would be useless for the purpose stated; while in those counties where the locusts have hatched of late years or where the bounty system has already been applied, it is considered that a bounty per bushel would undoubtedly accomplish the object named. The amount is generally placed at one dollar per bushel, seldom more, and often one-third or one-fourth of that amount; and while one dollar per bushel might be none too great a price per bushel for locusts immediately after hatching, it is certain that in a very few days a much smaller amount would more than equal it.

By referring to the experience of Mr. Andrew Webster, already given, it will be seen that from the 11th of June to the first of July, even ten cents per bushel would have been a paying bounty, when added to the crop that was saved by the exertions made in catching. With the improved machines and contrivances for capturing that are being brought forward at this date (Jan. 30, 1877) it is certain that the state need not offer a larger bounty, at the utmost, than ten cents per bushel after the tenth of June. If the locusts exist in sufficient numbers to do great injury after that date, a few cents per bushel added by counties, or by towns, to the amount given above, will make a bounty that will amply repay labor, to say nothing of the saving in crops. It would be also an improvement, both in convenience and exactness, if a bounty were offered per pound, instead of per bushel. It is no pleasant matter to measure a few bushels of locusts that have been standing for a

day or two under a hot June sun, and the hurry of an unpleasant task may be a cause of inaccuracy in measurement; but the measure in pounds of almost any quantity of dead locusts can be obtained at once, with ease and accuracy.

CONCLUSION.

In conclusion it remains to thank the many persons, both known and unknown to me, who have so kindly replied to my circulars and letters of inquiry during the season. The writers are so many that it is impossible to name them, but they have helped greatly to give this report whatever value it may have. This value must necessarily appear different to different readers; many will miss what they expected to find, or find what may appear of comparative little value. But I have endeavored to compile from all available sources what might be of benefit to our citizens and at the same time worthy of appearance in a report upon the Natural History of the State; I have tried to show not only the requirements of the present year in meeting the locust evil as we find it upon us now, but also the connection between one year and another. But whatever the value of the report may be, the State should provide fitting means for the continuance of similar (or better) efforts during the year 1877. Not only is an enterprise of this sort, if properly conducted, always a worthy one in any State which labors under an evil of such magnitude, but the help which a national commission may derive from assistants acting under its direction in every one of the States now infested may be of great value, and will help to bring completeness to a task which any commission will find too widely extended to reach with personal observation. There is no need to regret the trifling sums which have so far been expended upon "grasshopper investigations," nor to begrudge the few hundred dollars that will enable us to do what little we can in aid of that scientific inquiry for which we now ask of the National Government competent maintenance and the best learning that America can supply.

Respectfully submitted.

ALLEN WHITMAN.

GEOLOGICAL MAP OF HENNEPIN COUNTY, MINN.

By N.H. Winchell.
1876.

REFERENCE

Mill
Roads
Rail Roads
Timber
Swamp
Creeks

EXPLANATION OF COLORS.	
Trenton	
St. Peter	
Lower Magnesian	

DAYTON
HASSAN
CHAMPLIN
CORCORAN
MAPLE GROVE
BROOKLYN
GREENWOOD
CRYSTAL LAKE
INDEPENDENCE
MEDINA
PLYMOUTH
ROBBINSDALE
MINNETRISTA
EXCELSIOR
MINNETONKA
RICHFIELD
EDEN PRAIRIE
BLOOMINGTON
HIGH PRAIRIE
ANOKA
CHAMPLIN
OSSEO
MINNEAPOLIS
HOPKINS STA.
EDEN PRAIRIE STATION & P.O.
SHAKOPEE
HAMILTON
Bloomington Ferry
ST. P. & S.C. R.R.
ST. PAUL & MISSISSIPPI R.R.
BRANCH RIVER
CROW RIVER
MINNESOTA RIVER
LONG LAKE
WAYZATA BAY
LOAM
SAND

T120N.
T119N.
T118N.
T117N.
T116N.
T29N.
T28N.
T27N.

RXXIV W 5 P.M.
RXXIII W 5 P.M.
RXXII W 5th P.M.
RXXI W 5th P.M.
RXXIV W 4th P.M.
RXXIII W 4th P.M.

HENNEPIN COUNTY
ANOKA COUNTY
RAMSEY COUNTY
SCOTT COUNTY
DAKOTA COUNTY

VIII.

THE GEOLOGY OF HENNEPIN COUNTY.

Situation and Area.

Hennepin county lies west of the Mississippi river, and in the angle formed by the Minnesota and the Mississippi. It extends thirty miles north and south and about the same distance east and west, but its form is more that of a square with rounded corners. Its aggregate area is 354,904. 96 acres, as follows, by towns. This tabulated statement was furnished by Mr. F. E. Snow, under the direction of Sur. Gen. J. H. Baker, St. Paul.

Surveying Statistics of Hennepin County, Minnesota.

Township.	Range.	TOWNSHIP LINES. When Surveyed.		SUBDIVISIONS. When Surveyed	Acres.	Remarks.
27	23	.....	.....	.....	.....	Frac'l Ft. Snell. Res'n.
28	23	N. & W.	July, 1853.	August, 1853.	1,804.67	" " "
29	23	N. E. S. W.	Oct., 1847.	Oct. Nov., 1847.	3,126.94	East of Miss. River.
29	23	S. & W.	July, 1853.	July, 1853.	434 02	West of Miss. River.
27	24	N. E. W.	July, 1853.	August, 1853.	14,251 79	Frac'l Minn.R.& Res'n
28	24	N. E. S. W.	July, 1853.	August, 1853.	19,671.79	Frac'l Ft. Snell. Res'n.
29	24	N. & E.	Oct., 1847.	Nov., 1847.	5,674.58	East of Miss. River.
29	24	N. E. S. W.	July, 1853.	July, Aug., 1853.	16,268.72	West of Miss. River.
115	21	E.	July, 1853.	Sept., 1854.	1,374.75	Frac'l Minn. River.
115	21	N. & W.	Sept., 1854.	.....	.....	
116	21	E.	July, 1853.	Oct., 1854.	8,674.30	Frac'l Bal. 4th P. M.
116	21	N.	Oct., 1853.	.....	.....	
116	21	S. W.	Sept., Nov., 1854.	.....	.....	
117	21	E.	July, 1853.	Nov., 1854.	9,654.96	Frac'l Bal. 4th P. M.
117	21	S.	Oct., 1853.	.....	.....	
117	21	N. & W.	Nov., 1854.	.....	.....	
118	21	S. & E. Frac'l	July, 1853.	Oct., 1855.	13,654.25	Frac'l Bal. 4th P. M.
118	21	N. S. W.	May, 1855.	.....	.....	
119	21	N. S. W.	May, 1855.	July, 1855.	20,274.59	Frac'l Miss. River.
120	21	S. & W.	May, 1855.	July, 1855.	3,371.20	Frac'l Miss. River.
115	22	N. E. W.	Sept. Oct. Nov., 1854.	Oct., 1854.	62.95	Frac'l Minn. River.
116	22	N.	Oct., 1853.	Oct., 1854.	19,769.41	Frac'l Minn. River.
116	22	S. E. W.	Nov., 1854.	Oct. Nov., 1854.	.....	
117	22	S.	Oct., 1853.	Nov., 1854.	21,877.28	
117	22	N. E. W.	Nov., 1854.	.....	.....	
118	22	N. E. S. W.	May, 1855.	August, 1855.	21,487.87	
119	22	N. E. S. W.	May, 1855.	Sept., 1855.	21,639.66	[& Crow Rivers.
120	22	N.	Oct., 1853.	Sept., 1855.	16,823.03	Estimated Frac'l Miss.
120	22	S. E. W.	May, 1855.	.....	.....	[& Crow Rivers.
121	22	S.	Oct., 1853.	Sept., 1855.	202.30	Estimated Frac'l Miss.
121	22	W.	May, 1855.	.....	.....	
117	23	S.	Oct., 1853.	Nov., 1854.	12,312.62	
117	23	N. E. W.	Nov., 1854.	.....	.....	
118	23	N. E. S. W.	May, 1855	July, 1855.	21,599.26	
119	23	N. E. S. W.	May, 1855.	June, July, 1855.	22,980.48	
120	23	S. E. W.	May, 1855.	Oct., 1855.	16,533.32	Est'd Frac'l Crow Riv.
121	23	E.	June, 1855.	July, 1855.	22.00	" " " "
117	24	S. & W.	Oct., 1853.	June, 1855.	18,729.09	
117	24	E.	Dec. 1854.	.....	.....	
117	24	N.	May, 1855.	.....	.....	
118	24	W.	Oct., 1853.	June, 1855.	21,463.03	Est'd Frac'l Crow Riv.
118	24	N. E. S.	May, 1855.	.....	.....	
119	24	N. S. E.	May, 1855.	June, 1855.	13,841.54	Est'd Frac'l Crow Riv.
120	24	E. & S.	May, 1855.	Oct., 1855.	444.50	" " " "

Total surveyed area.....347,928.90 acres.

The following is the area of the unsurveyed portion of the Fort Snelling Reservation, as estimated by Mr. F. E. Snow:

Tp. 27, Range 23..... 760.00 acres.
Tp. 27, Range 24..... 464.44 acres.
Tp. 28, Range 23.....4,334.24 acres.
Tp. 28, Range 24.....1,417.38 acres.

Total.....6,976.06 acres.

Natural Drainage.

Nearly three-fourths of the boundary of this county is formed

by rivers. The Mississippi is along the northeast, the Minnesota is along the south and southeast, and Crow river runs along the northwest. It has numerous lakes of clear water, and small streams that flow from the central or southwestern portions outward, in nearly all directions, but no large streams enter the county, except where the Mississippi intersects the city of Minneapolis. Lake Minnetonka is a large and irregular expanse of water, in the southwestern part of the county, with high shores and knolls of drift on all sides, navigable for small steamers of which there are already five on the lake. The frequency of lakes throughout the county is one of its most noticeable features. They are generally surrounded by high drift hills, and have deep water, and gravelly shores. Steamers ply on the Mississippi above the Falls of St. Anthony, and also below, though the rapids below the Falls, extending about a mile, and the rapids at Meeker's Island, about three miles below the Falls, prevent the general navigation of the river within the limits of the county. The Minnesota river is also navigable throughout its extent in Hennepin county. In the north central portion of the county are several extensive marshes, about the headwaters of some of the streams running north, and extending along their valleys.

The Surface Features.

The most of the county has an undulating or rolling drift surface, and a nearly level general contour. The Mississippi river has modified the drift in a wide belt of country along both sides, but especially on the west side, within Hennepin county, making the surface nearly flat, with a lighter, or more sandy soil. This belt of flat land, on the west side, is markedly set off from the rolling portion of the county by a line which nearly coincides, through Dayton, Champlin and Brooklyn, with the supposed boundary line between the St. Peter sandstone and the lower magnesian formation. In the northern part of Crystal Lake this line changes its direction, and approaches rapidly toward the river, entering the corporate limits of the city of Minneapolis in Sec. 16. It then strikes nearly south, running along the west side of Lakes Calhoun and Harriet; then east toward the river, keeping on the east of Lakes Amelia and Mother, after passing which it strikes rapidly toward the west and southwest to Sec. 33, in Richfield township, when it turns nearly south; and in Sec. 16, Bloomington, it coalesces with a similar line which follows the Minnesota river. The belt of land thus set off, is generally flat and often sandy or

gravelly with only an occasional knoll of hardpan drift. At some depth below the surface the hardpan drift is uniformly met with in all excavations. This flat tract is, in its widest parts, six miles across from east to west. The narrowest point is in N. Minneapolis where it is less than a mile across. A similar flat belt runs along the east side of the river in Anoka and Ramsey counties. This land is at the present time never reached by even the highest freshet stage of the river. There is *within* the flat tract, along the river, a flood-plain level, subject to annual overflow. If ever the river operated over this belt so as to affect its topography, it must have been at a time when it was of vastly greater volume than at present, and probably during the period of recession of the ice of the last glacial epoch, and while the material of the drift was itself being deposited. This tract is underlain in some places by a laminated clay, which, when burned for brick, makes the well-known "Milwaukee brick" which are of a light buff or cream color.

The elevation of the county above the ocean is, perhaps on an average, about one thousand feet. The following points have been determined.

Elevations in Hennepin County.

	Above the Ocean.
St. Anthony Junction, St. P. & P. R. R.	829 feet.
Mississippi (low water) at Nicollet Island	791 feet.
Minneapolis Junction, St. P. & P. R. R	821 feet.
Mississippi (low water), half a mile below St. Anthony Falls	711½ feet.
Self's Lake (water), St. P. & P. R. R	842 feet.
Wayzata Station, St. P. & P. R. R	922 feet
Lake Minnetonka (water)	913 feet.
Long Lake Station, St. P. & P. R. R	940 feet.
Anoka, (opposite Champlin,) St. P. & P. R. R	869 feet.
Minneapolis Depot, M. & St. P. R. R	816 feet.
Minnehaha Creek, (bottom,) M. & St. P. R. R	792 feet.
Minnehaha Creek, grade of M. & St. P. R. R	806 feet.
Minnehaha Station, M. & St. P. R. R	802 feet.
Fort Snelling Station, M. & St. P. R. R	712½ feet.
Bottom of Minnesota river, at crossing of M. & St. P. R. R	663 feet.
Bridge at crossing of Minn. R. at Ft. Snelling, M. & St. P. R. R.	708½ feet.

Elevations on the Minneapolis & St. Louis R. R.

FURNISHED BY COL. J. B. CLOUGH.

[East from Minneapolis.]	Above the Ocean.
Crossing of St. P. & P. R. R., near St. Anthony Junction	828 feet.

140 "stations" east of crossing,* (cut of 7 feet,)	938 feet.	Rolling surface.
220 "stations" east of crossing, (cut of 16 feet,)	913 feet.	
240 "stations" east of crossing, (track,) Robinson L.	906 feet.	
240 "stations" east of crossing, water surface, Robinson L.	898 feet.	
265 "stations" east of crossing, (cut of 7 feet)	917 feet	
300 "stations" east of crossing, (track,) Bennett L.	885 feet.	
300 "stations" east of crossing, water surface, Bennett L.	883 feet.	
300 "stations" east of crossing, bottom, Bennett L.	863 feet.	
308 "staitons" east of crossing, clay ridge, (cut 20 feet,)	888 feet.	
320 "stations" east of crossing, track, (cut 18 feet,)	897 feet.	
405 "stations" east of crossing, track at Owassa L.	888 feet.	
405 "stations" east of crossing, bottom Owassa L.	871 feet.	
405 "stations" east of crossing, water surface Owassa L.	878 feet.	
415 "stations" east of crossing, track, (cut 17 feet,)	897 feet.	
Tamarack Swamp, ("no bottom,") track	873 feet.	

[NOTE.—This swamp seems to consist of a mass of floating peat, grass-roots, &c., supporting small tamarack trees. Three piles were driven (spliced), each 60 feet long, making 180 feet, without reaching solid foundation. The track was then supported on a raft consisting of logs, slabs and brush thrown on the surface, and remains so still.]

465 "stations" east of crossing, track	873 feet.	Rolling.
465 "stations" east of crossing, water, (30 ft. piles driven)	869 feet.	
600 "stations" east of crossing, track, (ground on either side 30–50 feet higher)	931 feet.	
650 "stations" east of crossing, White Bear flats	923 feet.	
670 "stations" east of crossing, Junc. of L. S. & M. R. R.	917 feet.	
White Bear Lake, (water,) cannot be far from	913 feet.	

[NOTE.—The depot at White Bear may be six or ten feet higher than the grade at this Junction.]

[South from Minneapolis.]

Minneapolis & St. Louis Depot, Minneapolis, cor. 2d street and 4th avenue	816 feet.
Crossing of Hennepin avenue, foot of Bridge street, at the old suspension bridge	803 feet.
St. Paul & Pacific Depot, Minneapolis	821 feet.

[The line, to Cedar Lake, follows the valley of Basset's creek.]

Cedar Lake, (track)	855 feet.
Cedar Lake, (water surface)	852 feet.
Bass Lake, (track)	876 feet.
Bass Lake, (water surface)	868 feet.
Divide between Bass Lake and Minnehaha creek	908 feet.
Divide between Bass Lake and Minnehaha creek, (nat. sur.)	920 feet.
Marsh at Minnehaha creek, (track)	885 feet.
Marsh at Minnehaha creek, (surface of marsh)	880 feet.

* One "station" equals one hundred feet.

Crossing of Minnehaha creek, (track)..... 897 feet.
Crossing of Minnehaha creek, (water)..... 885 feet.
Divide east of Hopkins Station, (cut 14 feet)..... 918 feet.
Divide between Hopkins Station and Shady Oak, (cut 18 feet)... 901 feet.
Shady Oak Lake, (track)..... 900 feet.
Shady Oak Lake, (water surface)..... 898 feet.

[Piles were here driven 78 feet, to a hard bottom, which now support the track; water 20 feet; the rest mud, "or something else." Soundings at first indicated but 20 feet of water; but in filling, the bank settled at least 40 feet further; after two months' work at filling, with little visible progress, the builders had to resort to pile-driving.]

Mud Lake, (track)..... 893 feet.
Mud Lake, (water)..... 890 feet.

[Rolling Surface.]

Elevation between Mud Lake and Glen Lake marsh, (cut 8 feet). 913 feet.
Glen Lake marsh, (track)..... 898 feet.
Glen Lake, (surface of marsh)..... 895 feet.

[At Glen Lake marsh, after the track was built it sank, and was entirely lost, a lake being formed. Then piles were resorted to, with a depth of 50 feet, for a distance of 250 feet.]

Divide 1,000 feet west of Glen Lake marsh, (cut 18 feet)..... 908 feet.
Rolling descent to—
Island Lake, (track)..... 893 feet.
Island Lake, (water surface)..... 881 feet.
Divide 1,000 feet west of Island Lake, (track; no cut)..... 903 feet.

[On the east side of the line hills rise 75 or 100 feet higher, the road running through a gap; on the west side hills rise 30 or 40 feet. At 1,500 feet further south the road passed through a ridge of gravel and red clay (mixed) in which was found a piece of native copper weighing 78 pounds. This was a cut of 30 feet.]

Purgatory creek crossing, (track)..... 844 feet.
Purgatory creek crossing, (ground)..... 823 feet.
Purgatory creek crossing, (bottom)..... 820 feet.

[Piles were driven here 36 feet without finding a hard bottom.]

Eden Prairie Station, (8 feet cut)..... 873 feet.
Divide between Eden Prairie Station and Lake Bradford, (cut 8 ft.) 891 feet.
Lake Bradford, (track)..... 863 feet.
Lake Bradford, (water)..... 855 feet.
Elevation at county line, (Hennepin and Carver; track)..... 865 feet.
Elevation at county line, Hennepin and Carver, (Nat. Surface).. 895 feet.

[At 1,000 feet west of the county line is a cut of 40 feet.]

Ravine 2,000 feet west of last cut, (track)..... 836 feet.

[Trestle work is built here 75 feet high, and 450 feet long; stiff clay on the west side of the ravine and sand on the east side. Sudden changes occur in the drift in going down to the Minnesota valley.]

One mile further on, ravine, (track)	791 feet.
One mile further on, ravine, (bottom)	726 feet.
Foot of the Minnesota river bluffs, near Chaska	742 feet.

[Then comes a quaking, or peaty, marsh for 3,000 feet.]

Crossing of Hastings and Dakota R. R., Chaska	716 feet.
Carver Station, (12 feet fill)	710 feet.
Minnesota river crossing, (track)	716 feet.
Botton of Minnesota river, (Carver)	678 feet.
Water in Minnesota river, (Carver)	683 feet.
Sioux City Junction	753 feet.

Description of the towns of Hennepin county.

In the following notes on the various towns of the county the magnetic variation given is that recorded by the U. S. Surveyors on the township plats:

TOWNS 27 AND 28, R. 23 W. OF 4TH PRIN. MER. (*Fractional.*) *E. parts of* RICHFIELD *and* MINNEAPOLIS.

These embrace the bluffs of the Mississippi and Minnesota rivers south of Minneapolis, and a narrow strip of level and prairie land along the west side of those rivers above the point of their confluence, not exceeding two miles in width.

T. 29, R. 23 W. OF 4TH PRIN. MER. (*Fractional.*) *E. part of* ST. ANTHONY.

This is a belt of one mile wide embracing six sections, and lies mostly on the east side of the Missitsippi river. It is all included within the prairie land that characterizes the Mississippi valley, except about a mile square in its northern portion, which is rolling and wooded.

T. 27, R. 24 W. OF 4TH PRIN. MER. (*N. of the Minnesota.*) *E. part of* BLOOMINGTON.

By far the larger portion of this town is prairie, lying in the northeastern portion. Along the southern side the bluffs of the

Minnesota river are rarely rocky, but usually turfed and frequently timbered. The bottom lands sometimes embrace large water areas, and are very wide, the bluffs running from one-half mile to a mile from the river channel. The timber is generally light, except a small area in the northwest corner of the town. The town has several small lakes in the uplands.

T. 28, R. 24 W. OF 4TH PRIN. MER. *Central part of* RICHFIELD *and northern part of* MINNEAPOLIS.

The central and northern portions of this town are rolling, and contain numerous lakes, such as Wood, Grass, Mother, Amelia, Calhoun, Harriet, Diamond, Pearl, Rice, Duck and Mud. This rolling tract is crossed by Brown Creek (now known as Minnehaha Creek). Toward the northeast and southeast are patches of level prairie.

T. 29 N., R. 24 W. OF 6TH PRIN. MER. *E. part of* MINNEAPOLIS.

This town embraces the city of Minneapolis, on both sides of the river, and the Falls of St. Anthony. The largest part of the town is flat, and the southeastern portion contains prairie belts, particularly on the west side of the Mississippi river, within the ancient drift bluffs of the river. The western portions, and a small area in secs. 1 and 12, are rolling and timbered, with lakes. There are also small areas of swamp, the largest being east of the Mississippi river in secs. 12, 13 and 24. Bassett's Creek breaks the surface in the central part of the town on the west side of the river, entering the Mississippi about a mile above the Falls. Mag. var. 9°, 39′ to 11°, 20′.

TOWNS 115 AND 116 N., R. 21 W. OF 5TH PRIN. MER. (*Fract.*) *W. part of* BLOOMINGTON, *and S. W. part of* RICHFIELD.

This embraces a little prairie tract in the southern portion, and several lakes in the northern, but it is mostly undulating and timbered. The Minnesota bluffs bound it on the south, but they are not rocky. They rise about 150 feet above the river. In the northern portion are some high drift-knolls. Anderson lake is the principal body of water. Mag. var. 10° to 12°, 30′.

TOWNS 117 AND 118 N., R. 21 W. 5TH PRIN. MER. (*Fractional.*) CRYSTAL LAKE, *with parts of* MINNEAPOLIS *and* RICHFIELD.

This is entirely a wooded and undulating or rolling tract, run-

ning N. and S., about 2½ miles wide, and east to the Mississippi north of Minneapolis. It has small marshy areas, and one irregular patch of prairie northwest of Minneapolis city. Mag. var. 10°, 5′ to 11°, 53′.

T. 119 N., R. 21 W. 5TH PRIN. MER. BROOKLYN.

This town is altogether level, except in the southwest corner, and is mainly one of prairie. The scattered timber is small. Palmer Lake is in Sec. 26, and through it runs Shingle creek, which is accompanied by some marsh. The Mississippi river forms the eastern boundary, but the bluffs are low and consist of drift only. A belt of heavier timber skirts the river in the northeastern portion of the town. Mag. var. 10° 45′ to 12° 39′.

T. 120 N., R. 21 W. 5TH PRIN. MER. *E. part of* CHAMPLIN.

There is a small area lying on the Mississippi river, having a variety of surface, flat prairie, timbered bottom land, and lightly timbered upland.

T. 116 N., R. 22 W. 5TH PRIN. MER. EDEN PRAIRIE.

While this town is mainly rolling or hilly, with lakes and some marshes, and heavily timbered, it took its name from a flat prairie which lies in the southern portion, bordering on the Minnesota river, including the bottom land and a belt about a mile wide north of the bluffs. Mag. var. 10° to 13° 57′.

T. 117 N., R. 22 W. 5TH PRIN. MER. MINNETONKA.

This town is wholly wooded and rolling, some parts being hilly. It also has small areas of marsh, intervening between the drift hills, and occasional lakes, the largest body of water being a part of Minnetonka Lake, from which flows Little Falls creek, (known now as Minnehaha creek,) and crosses the center of the town easterly. Mag. var. 10° 9′ to 14° 45.

T. 118 N., R. 22 W. 5TH PRIN. MER. PLYMOUTH.

This is also a rolling and timbered town, with several lakes and tamarack swamps. Medicine Lake in the S. E. corner is the largest body of water. Mag. var. 11° 21′ to 14° 45.

T. 119 N., R. 22 W. 5TH PRIN. MER. MAPLE GROVE.

The town is entirely rolling and wooded, except a small portion in sections 1, 12 and 13, which is an extension of the Brooklyn prairie. It is crossed by a small creek running N. through the center, and by its tributary in the N. W. It contains several fine lakes. Mag. var. 9° 45' to 12° 38'.

T. 120 N., R. 22 W. 5TH PRIN. MER. DAYTON, *and W. part of* CHAMPLIN.

This town resembles the last, but borders on the Mississippi river, which has drift-banks that rise about 100 feet above the river. Crow river also touches it on the north. Mag. var. 9° 45 to 12°.

T. 117 N., R. 23 W. 5TH PRIN. MER. EXCELSIOR, *and part of* MEDINA, *and part of* MINNETONKA.

About one-half of this town is covered with water, pertaining to Lake Minnetonka. The rest is rolling and heavily timbered, with occasional marshes. Mag. var. 11° 15' to 13° 12'.

T. 118 N., R. 23 W. 5TH PRIN. MER. *N. part of* MEDINA.

This town is much diversified with lakes, marshes, and a rolling surface. It is entirely wooded. Mag. var. 10° 20' to 13° 12'.

T. 119 N., R. 23 W. 5TH PRIN. MER. CORCORAN.

A wooded, rolling town, with frequent small marshes and two or three lakes. Mag. var. 10° 40' to 11° 45'.

T. 120 N., R. 23 W. 5TH PRIN. MER. (*S. of Crow River.*) HASSAN.

This is a wooded, rolling town, similar to the last, but has Crow river along its northern boundary. Mag. var. 9° 13' to 11° 30'.

T. 117 N., R. 24 W. 5TH PRIN. MER. MINNETRISTA.

This is a rolling timbered town embracing a part of Lake Min-

netonka, and several smaller lakes, as well as numerous marshes. Mag. var. 10° 40' to 13° 12'.

T. 118 N., R. 24 W. 5TH PRIN. MER. INDEPENDENCE.

This is a rolling timbered town, dotted with small marshes and lakes. Mag. var. 10° 5' to 12° 30'.

T. 119 N., R. 24 W. 5TH PRIN. MER. (*S. of Crow River.*) GREENWOOD.

Crow river, which crosses this town, separates Greenwood from Wright county. It is in every respect similar to those already described. Mag. var. 10° 25' to 10° 12'.

Soil and Timber.

The most of the county has a close, clay soil of a grayish color. This is particularly the case in the heavily wooded portion. At least three-quarters of the county are embraced under this description. The soil of the eastern quarter of the county is more sandy. The change from clay to sand, while in general taking place along the boundary line already defined under the head *Surface Features*, still is not always abrupt. It is always accompanied by a change of timber species. In the clay land are found sugar maple, elm, bass, butternut, and a variety of others, while in the sandy or loam covered portions are found only oaks and aspens which generally are also quite small. The belt containing this small, sparse timber runs north and south across the eastern portion of the county covering the eastern part of Maple Grove, the eastern part of Plymouth, the western part of Minneapolis and the central portions of Richfield and Bloomington, with isolated areas in Minnetonka and Eden Prairie. This feature in the forest of the county gradually dies out toward the east, and most noticeably after passing the boundary between the rolling surface and the flat land along the Mississippi ; the country becoming nearly a continuous and open prairie. Throughout this belt of sparse and small timber there are occasional large bur oaks on the uplands, and also occasionally gigantic black oaks, with charred trunks, in clusters, having no other company than an undergrowth of oak bushes. There are also, in the bottom land along some of the ravines, occasional trees of elm or bass. The eastern boundary of the heavily tim-

bered rolling area, with a distinctively clay soil, strikes the Mississippi river about three miles southeast of Dayton.

The following species of trees and shrubs are known to grow in the county. The trees are named in the estimated order of abundance:

American Elm. Ulmus Americana, L. (*Pl. Clayt.*) *Willd.*
Bass. Tilia Americana, L.
Sugar Maple. Acer saccharinum. *Wang.*
Red Oak. Quercus rubra. *L.* (*?*)
Butternut. Juglans cinerea. *L.*
Bur Oak. Quercus macrocarpa. *Michx.*
Red Elm. Ulmus fulva. *Michx.*
Soft Maple. Acer rubrum. *L.*
Bitternut. Carya amara. *Nutt.*
White Ash. Fraxinus Americana. *L.*
Black Oak. Quercus tinctoria. *Bart.* (*?*)
Ironwood. Ostrya Virginica. *Willd.*
Black Ash. Fraxinus sambucifolia. *Lam.*
Wild Plum. Prunus Americana. *Marsh.*
June-berry. Amelanchier Canadensis. *Var.* Botryapium. *Torr. & Gr.*
American Crab-Apple. Pyrus coronaria. *L.*
Aspen. Populus tremuloides. *Michx.*
Tamarack. Larix Americana. *Michx.*
Box Alder. Negundo aceroides. *Mœnch.*
Great-toothed Poplar. Populus grandidentata. *Michx.*
Black Cherry. Prunus serotina. *Ehr.*
Cottonwood. Populus monilifera. *Ait.*
Water Beech. Carpinus Americana. *Michx.*
Willow. (*Salix.*)
Hackberry. Celtis occidentalis. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.* (*?*)
White Oak. Quercus alba. *L.*
Red Cedar. Juniperus Virginiana. *L.*
White Pine. Pinus Strobus. *L.*

A few trees of white pine occur on Minnehaha creek, and at Dayton.

Shrubs and Woody Vines.

Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Bittersweet. Celastrus scandens. *L.*
Frost Grape. Vitis cordifolia. *Michx.*
Hazel. Corylus Americana. *Walt.*
Smooth Sumac. Rhus glabra. *L.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*

Wolf-berry. Symphoricarpus occidentalis. *R. Br.*
Black-cap Raspberry. Rubus occidentalis. *L.*
High Blackberry. Rubus villosus. *Ait.*
Red Raspberry. Rubus strigosus. *Michx.*
Choke Cherry. Prunus Virginiana. *L.*
Thorn. Cratægus coccinea. *L.*
Rose. Rosa lucida. *Ehr.*
Prickley Ash. Zanthoxylum Americanum. *Mill.*
Staghorn Sumac. Rhus typhina. *L.*
Wild Rose. Rosa blanda. *Ait.*
Round-leaved Cornel. Cornus circinata. *L'Her.*
Common Elder. Sambucus Canadensis. *L.*
High-bush Cranberry. Viburnum Opulus. *L.*
Black Currant. Ribes floridum. *L.*
Alternate-leaved Cornel. Cornus alternifolia. *L.*
Panicled Cornel. Cornus paniculata. *L'Her.*
Red-osier Dogwood. Cornus stolonifera. *Michx.*
Speckled Alder. Alnus incana. *Willd.*
Sheep-berry. Viburnum Lentago. *L.*
Elder. Sambucus pubens. *Michx.*
Honeysuckle. Lonicera parviflora. *Lam.*
Honeysuckle. Lonicera ciliata. *Muhl.*
Yellow Honeysuckle. Lonicera flava. *Sims.*
Kinnikinnick. Cornus sericea. *L.*
Dwarf Cornel. Cornus Canadensis. *L.*
Prickly wild Gooseberry. Ribes Cynosbati. *L.*
Smooth wild Gooseberry. Ribes rotundifolium. *Michx.*
Ninebark. Spiræa opulifolia. *L.*
Meadowsweet. Spiræa salicifolia. *L.*

THE GEOLOGICAL STRUCTURE.

The only rocks seen in actual outcrop within the county are those belonging to the Trenton limestone, and the St. Peter sandstone; but the Shakopee limestone (of the Lower Magnesian formation) is seen in outcrop at Shakopee, on the opposite side of the Minnesota river, and must exist in the immediate bluffs of the Minnesota river in the southwestern portion of the county. It is very likely also that large areas of the Cretaceous formation exist within the county, though its presence is only known by the abundance of Cretaceous *debris* that is found in the drift throughout the county. The geology of the county then may be embraced in the following list of formations:

1. The Drift and the loess loam.

2. The Cretaceous.
3. The Green Shales and Trenton Limestone.
4. The St. Peter Sandstone.
5. The Shakopee Limestone (of the Lower Magnesian.)

The respective areas of the Trenton, St. Peter and Lower Magnesian, are represented on the accompanying colored map of the county, so far as those areas can be ascertained or estimated. It must be borne in mind that there are no outcrops of rock in the county except along the valley of the Mississippi river, and that hence the boundary lines as laid down are not intended to express anything more than an approximation to their actual positions.

The Shakopee Limestone.

The reader is referred to earlier reports for the details of lithology and special characters of this limestone. It is sufficient here to say that it is named from the city of Shakopee, in the Minnesota valley, where it was first recognized as a different limestone from that along the bluffs of the Mississippi river below Hastings; and that it is the uppermost member of the *Low. Magnesian* series. It lies just below the sandstone which is seen at the Falls of St. Anthony, and is known as the "Kasota stone" among builders when wrought at Kasota, a few miles above Shakopee, in the Minnesota valley. It is strictly *an arenaceous dolomite* of a buff color varying to pinkish, or "fawn-colored," as described by Featherstonhaugh. Its thickness is about seventy feet. There is no known outcrop of it within the limits of Hennepin county, but it certainly underlies a belt of territory running northward from Shakopee and Bloomington, toward Dayton, through the central part of the county. Were it not for the heavy covering of drift, it might be expected in outcrop about the shores of Minnetonka Lake.

The St. Peter Sandstone—Its Area.

This well known formation is seen in the bluffs of the Mississippi river at and below the Falls of St. Anthony to the mouth of the Minnesota, and exists also in the Minnesota river bluffs for several miles above Fort Snelling; though, for reasons which pertain to the history of the Minnesota river and its age as compared with that of the Mississippi in this vicinity, it is but rarely exposed in the bluffs of that river above Fort Snelling.

The slopes from the upland to the river level, along the Minnesota, are uniformly smoothed over by the drift, and are turfed or wooded; but the descent from the upland to the river along the Mississippi, above Fort Snelling, is perpendicular and rocky, the river running in a canon-like gorge. Owing to a dip of the rocks toward the east, the St. Peter sandstone is brought above the level of the Mississippi at points above the Falls of St. Anthony, within the immediate river valley. On the east side of the river it outcrops along Main street, and is struck by digging wells at points further north and east. It underlies a belt of country running north and south across the county, next east of that of the Shakopee, which is probably about six miles wide. In the vicinity of the Falls of St. Anthony the St. Peter is also caused to be the surface rock by the cutting through of the over-lying Lower Trenton by the ancient drainage-courses of the Mississippi, or of its tributaries. Thus there is a break in the continuity of the Trenton where Bassett's creek enters the Mississippi, above the falls. That stream runs at no point over the Trenton limestone, but over the St. Peter sandstone. The valley in which it lies was cut by some more powerful force than the creek itself, and perhaps by the Mississippi river before the last drift epoch. At that time the Mississippi must have reached the Minnesota valley at some point above Fort Snelling, without running over the Trenton limestone at all, and hence without causing any falls. The width of the St. Peter area in the immediate river valley, *above the falls*, as compared with that in the same valley *below the falls*, considered in connection with the Bassett's-creek St. Peter area, clearly points to the ancient continuation of the Mississippi valley southward by the way of Bassett's creek, to the Minnesota, instead of by way of Fort Snelling. There is another break in the overlying Trenton on the east side of the river, leaving the St. Peter as the surface rock, in a low tract of land in the First Ward, northwest from the Cemetery. This low area is crossed by the Branch Line of the St. Paul & Pacific railroad longitudinally. This area of the St. Peter becomes quite narrow near the St. Anthony Junction, but rapidly widens out toward the south and east, so far as can be judged from the topographical features and from information gathered from dug wells. Just how far this St. Peter area extends south under the extensive peat marsh which covers a large tract in that direction, it is impossible to say; but the Trenton replaces it, at the surface, within a mile, since it occupies the river bluffs uninterruptedly from Fort Snelling to the

Falls of St. Anthony, and since Tuttle's brook passes over it in joining the Mississippi near the University.

Its Lithological Characters.

The outward, and also the chemical, characters of this sandstone, in Minnesota, are, so far as seen, remarkably constant and simple. It is white, "saccharoidal," friable, non-fossiliferous, (or almost so,) and consists almost entirely of pure quartz sand. It contains not enough lime to act as a cement, and hence can almost everywhere be excavated even with the fingers. On exposed surfaces, as along the bluffs of the Mississippi, where dripping water passes over it, the grains become more firmly cemented together by deposition of carbonate of lime and iron oxide, and its delicate whiteness is lost. Indeed, wherever water in the smallest quantity is allowed to trickle through it, a deposit of iron oxide is invariably seen, since rarely, if ever, is any surface water found entirely free from that impurity.

The thickness of the St. Peter at the Falls of St. Anthony is 164 feet as developed by a drilled well sunk at E. Minneapolis in 1874-5; but that is considerably more than it is accredited with at points further south. At Chatfield, in Fillmore county, it is 122 feet in thickness, and in the S. W. part of Houston county it is but 75-80.

The St. Peter, operating in conjunction with the overlying Trenton limestone, is the immediate cause of a great many waterfalls. The Falls of St. Anthony are caused by the passage of the Mississippi from the limestone on to the sandstone. The latter, worn away at the foot of the fall by the retro-action of the water, leaves the limestone projecting to fall down in heavy blocks as fast as it becomes too feeble to support further its own weight. This protecting cap of limestone extends but a few rods above the present brink of the falls; and had it not been that vigorous measures were taken a few years since for its protection, it is very probable that ere this the falls themselves would have disappeared, or changed to a foaming rapid, thus destroying, or greatly damaging, one of the most important water-powers of the world. The first alarm was occasioned by the effect of the water of the river in running through an artificial tunnel in the underlying St. Peter sandstone, and the collapsing of large areas of the limestone. The water was immediately excluded from the tunnel, the sandstone behind the waterfall was protected from the retro-action of the water, and a wall or dike of concrete or *beton* was constructed

under the river in the sandrock, and below the limerock, crossing the Mississippi a short distance above the brink of the falls. This wall of concrete has a width of four feet and extends downward from the limerock to below the bottom of the river, below the falls. The chief object of this dike is to cut off all streams of water from running in the St. Peter and so perforating it and eroding it as to cause the downfall of the limerock. A number of such streams, some of considerable size, were found to be passing through the sandrock, having entered it from the river at points above the limit of the limerock. Being under considerable hydrostatic pressure their force of erosion on the sandrock was greater than ordinary surface streams of the same size. One such stream, or sheet, of water was struck by Mr. Franklin Cook, in sinking a drilled well into the sandrock at a point within the gorge some distance below the falls, when the water rose at once above the surface and has continued to flow ever since.

No fossils have been taken from this sandstone in Hennepin county; indeed, the only trace of organic structure known to have been found in it, in the entire northwest, consists of a species of *Lingulepis*, obtained in Fillmore county, and described in the report on that county, in 1875.

The Trenton Limestone.

This formation, as it occurs in Minnesota, comprises three main parts. The lowest, only, can be seen generally in Hennepin county, though that next above exists also, and is struck in wells at some distance back from the river. Those parts are—

The Upper Trenton.
The Green Shales.
The Lower Trenton.

The *Green Shales* are often called *soapstone*, but they do not contain the mineral constituents of soapstone, and should not have that name. They are about 20 feet in thickness, but being rather soft and easily covered up, they are hid by the overlying drift or loam at nearly all points along the river bluffs. Within the shales are often thin lenticular layers of very fossiliferous crystalline limestone, the upper and lower surfaces of which are literally covered with fossils in a fine state of preservation, but firmly bound to the limestone layers. There are also fossils distributed through the shales themselves, which, on the weathering of the shales, wash out in perfect preservation. *Orthis Lynx*, *Rhyn-*

chonella capax and *Chaetetes Lycoperdon*, are the most common in such conditions; but on the slabs of limestone that weather out of the shales are often a great many minute fossil forms of encrusting corals, as well as other species of brachiopods. The Green Shales may be seen at Finn's Glen, about three miles below the Falls of St. Anthony, on the east side of the river, where a little stream enters the Mississippi.

The *Lower Trenton* is tpyically that which occurs at the Falls of St. Anthony, and thence in the bluffs of the Mississippi to St. Paul. It has generally the following alternation of parts in descending order:

1. Impure limestone.....9–12 feet.
2. Calcareous shale.....4– 6 feet.
3. Argillaceous limestone..... 15 feet.

The above are the main distinctions as seen in Hennepin county. The characters of No. 1 are not always uniformly distributed through the whole thickness designated, but they are apt to fade out downward being replaced by some of the characters of No. 2; which also exhibits a tendency to pass gradually into the rock of No. 3. On the other hand, there is very generally a thin stratum of shale exactly like the most of No. 2, under the limerock, and lying on the St. Peter sandstone.

The following more special section will show the alternations referred to, as they appear at the quarry of E. Malony, on the east side of the river, below the University, at Minneapolis:

Section of the Trenton below the University.

No. 1.—Impure limestone, crystalline, rough to the touch, hard, but splitting to thin lenticular chips under the weather. This is of a blue color within, but on exposed surfaces becomes a dirty buff. The grain is close, except for the cavities resulting from absorbed fossils. The fragments into which the stone weathers out are brittle and somewhat sonorous. It is very fossiliferous especially with *Strophomena deltoidea*. It also has frequently, associated with this, *Strophomena*, a species of *Orthis*, which is perhaps *costalis*, species of *Murchisonia*, *Leperditia*, *Edmondia*, and occasionally of *Asaphus*. Thickness not fully exposed; seen about ..... 8 ft.

No. 2.—Similar to the last, but gradually becoming more impure with shale, the fossils being gathered more into sheets or layers, making mere calcareous belts..... 2 ft.

No. 3.—Green shale, calcareous, weathering blue, with but few fossils. Occasionally is found a large specimen of *Endoceras magniventrum*, H., in this shale, the form only being preserved, surrounded by a thin black film of bituminous matter.....4 ft. 8 in.

No. 4.—The last passes gradually into a calcareous shale resembling the well-known building rock of this place, in which still there are few distinguishable fossils. This stone is sometimes used for rough walls, or in protected positions. It is markedly set off from the rock below by a projecting shoulder formed by the upper portion of No. 5.....2 ft. 4 in.

No. 5.—The building stone of this place, and St. Paul. This stone is rather too argillaceous to be a reliable building material, yet is extensively used. The shale is intimately disseminated through the calcareous layers, without showing regular lamination, yet causes a mottled or blotched color over the surfaces when cut or broken. The darker spots are shaly; the lighter ones are more purely calcareous. The color of the whole is blue, which makes it have the appearance of strength and durability when placed in a structure. The fossil remains in this member are apt to be comminuted, so as to be wholly undistinguishable, yet sometimes large specimens of *Endoceras magniventrum*, H., are found in the layers. Rarely also, on separating the layers in quarrying, a rock-surface is disclosed that is eminently fossiliferous with forms of *Rhynchonella capax*, *Orthis*, and other brachiopods and incrusting corals. This is the principal and most constant member of the *Lower Trenton*. Thickness about..... 15 ft.

No. 6.—Blue shale, parting conchoidally under the weather, lying on the St. Peter sandstone. Seen..... 2 ft.

Total..... 34 ft.

The section exposed at the quarries on the east side of the river, at Minneapolis, is essentially the same as the foregoing, viz.:

No. 1.—"Gray rock"..... 8 ft.
No. 2.—"Soft stone," (shale)..... 6 ft.
No. 3.—"Blue stone"..... 14 ft.
No. 4.—Slaty clay..... 2 ft.
No. 5.—White sandrock to the river. .....25 ft.

About one block above the railroad bridge over the Mississippi, at Minneapolis, the line of strike of the limerock from the north

runs down to the river, but probably crosses the river considerably further down—but a short distance above the Falls. On both sides of the river, above the Falls, the strike diverges from the actual river channel, and passes inland, nearly parallel, however, with the river, and extends some miles northwest ; but below the Falls the line of strike is very near the river, and indeed constitutes the bluff of rock which encloses the gorge. The valley occupied by Bassett's creek is wider and deeper cut in the rock than that of the Mississippi below the Falls, as may be seen more clearly by consulting the accompanying map, but the line of strike of the limerock, along the creek, and along the river above the mouth of the creek, is covered by the loam deposit, which is not the case below the Falls to Fort Snelling. Below Fort Snelling the Mississippi bluffs are again covered and masked by the loam. Above the Falls the line of the edge of the limerock forms a terrace ascent facing the river, and about one-half a mile from it, and can be traced by this means on the west side of the river northward to Shingle creek, where it bears westwardly away from the river, along the south side of the creek and becomes lost by reason of the prevalence of the drift ; on the east side, at about the same distance from the river, it runs northwardly across the blocks of the Second Ward and diagonally northeastwardly across the blocks of the First Ward, and returns upon itself toward the Junction of the St. Paul & Pacific R. R. Further east another area of the Low. Trenton approaches the river, and its line of strike forms a similar terrace which extends northward to the line of Anoka county and beyond. It is exposed and worked in one or two quarries situated exactly on the Anoka county line, northwest of Sandy Lake, near the railroad. It is evident from its weathered condition and stained color, although still buried under the loam, that it has been subjected, at this point, and also all along the terrace-like ascent that it forms, on either side of the river, above the falls, to the action of water, and alternating sub-ærial agencies, for a long period of time, and that perhaps it was the water of the river, in times prior to the glacial epoch that stained and shattered it. Indeed it is with some difficulty recognizable, as the same rock that forms the falls at St. Anthony, without a knowledge of its stratigraphical continuity ; this is especially true of the quarries near Sandy Lake on the east side of the river.

There is a gentle dip in the layers of Lower Trenton at Minneapolis toward the southeast. At the lower, or iron, bridge it is very slight, hardly perceptible ; at the falls it is about an inch in one hundred feet ; it increases soon to three or four inches in one

hundred feet, and at Central Avenue, on the east side of the river, it is about five feet in one hundred feet. This dip causes the rock to rise from under the river and into the river banks, finally running in the country, as already stated, half a mile or more from the river, and more than fifty feet above it. The dip of five feet in one hundred at Central Avenue is a little away from the river, so that sewers will not empty themselves unless they are run at variance with the dip. It does not continue of the same amount but decreases northwardly, else the layers could not lie at the level they occupy where quarried at points in the north part of the city. This change may be gradual, or there may be a fault, or break, at some point in E. Minneapolis, north of Central Avenue. The St. Peter sandrock is exposed, above the level of the river, above the falls, near the upper bridge, in E. Minneapolis; and on the west side of the river, at the mill-pond at Shingle creek, two miles north of the limits of the city.

On the west side of the river the strike of the limerock, above the falls, leaves the river-bank about halfway between the railroad bridge and the mouth of Bassett's creek, sweeping round on the south side of the creek so as not to cross it, nor to be visible in its banks. It is quarried in the lumber yard opposite Boom Island, but turns from their rapidly toward the west and south, barely extending north of Sixth Avenue, North. It re-crosses the railroad between Fourth and Fifth streets, and follows the line of the road, but a block or two south of it, to the crossing of Hawthorne Avenue where it turns abruptly to the eastward, and southward along the north side of the lake in the Seventh Ward; but whether it continues in the same direction further than Nicollet Avenue, or bears more to the southward is unknown. The "hardpan" ridge crossing the south end of the Seventh Ward indicates the proximity of the strike of the Lower Trenton along the south side of the same lake, which would require an abrupt change of direction, again to the westward, or the existence of a separate area of Trenton rock lying toward the southwest. On the north side of Bassett's creek is another Trenton area, the eastern edge of which enters the city limits from the north, about one block east of Lyndale Avenue in a southwestward course, crosses Lyndale Avenue between Twenty-third and Twenty-fourth Avenues N., passes through blocks 5, 6, 7, and 8 toward the south, and again across Lyndale Avenue between Sixteenth and Seventeenth Avenues N. It crosses Plymouth Avenue two blocks east of Lyndale, and on reaching the valley of the creek it turns westward,

but its location cannot be further definitely traced owing to the prevalence of the drift, and the fact that the surface becomes one of a generally rolling character. It is tolerably certain that it does not cross the valley of Bassett's creek, but sweeps round by the west and north and unites with itself along the south side of Shingle creek, about two miles north of the city limits.

The intimate connection which the features and position of the Lower Trenton areas bear to the Post-Tertiary, about the Falls of St. Anthony, has led to a more careful study of history of the drift, and some further allusion to this formation will be found under the head of *The Drift.*

The Cretaceous.

Although the Cretaceous *in situ* has not been seen in Hennepin county, it deserves to be named among the formations of the county on account of the important and conspicuous part it takes in the composition of the drift, and the strong probability that it does exist in horizontal strata below the drift in much of the western portion of the county. There is no portion of the county in which pieces of lignite from the Cretaceous have not been discovered; and throughout the rolling area, where the drift is a close clay, the color of the whole mass is frequently perceptibly tinged with green. Not infrequently pieces of green shale a foot or more in diameter are met with along the cuts by the roadside particularly in the western part of the county—disintegrated and ready to separate on the least disturbance. These of course could not have been far transported by the drift forces. The drift itself is greatly thickened by Cretaceous debris, and *is conspicuously free from foreign stones and boulders of a more enduring nature.* No other Cretaceous debris than pieces of green fissile shale and of black lignite has been recognized, and from these no fossils have been taken.

Seventeen years ago there was some excitement in the vicinity of Dayton over a reported discovery of coal, about two miles west of the village, in Wright county, by a man named Charles Williams. Upon visiting the place, the excavation was found to consist of two shafts sunk in the drift, now nearly refilled. About the place the drift thrown out shows nothing but drift clay with pebbles of all kinds and colors. One is said to have been about eighty feet deep. The general belief now is that all the coal that was found was brought for the purpose from St. Paul, as the

owner, after vainly attempting to sell his land, placed a heavy mortgage on it and abandoned the country, allowing the sale of the land for the mortgage. There is certainly now no evidence of the existence of coal, or lignite, in the vicinity, though there are traces of the Cretaceous in the drift which points to the near proximity of its layers. There is also a reported exposure of "slate" in a ravine a mile or so beyond, but it could not be found.

NOTES ON THE DEEP WELL DRILLED AT EAST MINNEAPOLIS, MINN., IN 1874—1875.

(*From the Bulletin of the Minnesota Academy of Natural Sciences for* 1875.)

BY N. H. WINCHELL.

NATURAL SURFACE OF GROUND.				
1	42		Sand.	42
2	28	Blue.	Limestone.	70
3	164	White.	Sandstone.	234
4	102	Red.	Limestone.	336
5	16	Gray.	Limestone.	352
6	116	White.	Sandstone.	468
7	128	Blue.	Shale.	596
8	82	White.	Sandstone.	678
9	170	Blue.	Shale.	848
10	9	Sandy.	Limestone.	857
11	130	White.	Sandstone.	987
12	∞	Sandy.	Marl.	995
13	79	White.	Sandstone.	1074
14	57	Red.	Marl.	1131
15	200	Red.	Sandstone?	1421

The accompanying diagram of the strata passed through, with the designations of the strata, was furnished by Col. J. B. Clough, City Engineer, in whose charge the work was put by the City Council when money was appropriated to aid the enterprise. This occurred at the depth of about 1,000 feet.

No. 1. This sand is the well-known *loess loam* of the Mississippi bluffs. Though it is represented here as having a thickness of 42 feet, it shows less than one-half that thickness along the river bluff opposite the site of the well, less than 15 rods distant. It is here underlain by a heavy deposit of boulder-clay drift. It is presumable that this boulder-clay, which is itself rather sandy, was penetrated without the knowledge of the workmen, since it is seen to extend as far from the river as the site of the well along Central Avenue and on other streets, and is struck uniformly over the East Division of the city in digging wells at the depth of ten to twenty feet.

No. 2 is the *Lower Trenton Limestone*, embracing some layers of green shale, and is that which causes, in conjunction with the St. Peter sandstone (No. 3,) the Falls of St. Anthony.

No. 3 is known as the *St. Peter Sandstone*. Its thicknes, as here developed, is greater than observed at any other point in Minnesota. It is generally accredited with a thickness of about 125 feet, but here shows 164

feet. It is a purely white sand with very slight cement and very little variation in texture or grain.

No. 4 is known as the *Shakopee Limestone*. It has been placed as the uppermost member of the great Lower Magnesian Formation of Dr. D. D. Owen, but perhaps the St. Peter should be regarded as the uppermost member of that formation. Its color here appears to be nearly the same as seen at Kasota, where it is largely wrought and sold under the name of *Kasota Stone*. Its thickness, 102 feet, is greater than has been observed at any other point

No. 5 is designated a *gray limestone*, with a thickness of 16 feet. It is a new feature in the lithology of the Lower Magnesian, and may belong to the Shakopee.

No. 6. Below the *gray limestone* is a white sandstone, similar to the St. Peter above, with a thickness of 116 feet. This can be identified as the *Jordan Sandstone*, so named from Jordan village on the Minnesota river, above Shakopee, where it was first recognized as a distinct portion of the Lower Magnesian.

No. 7, which is here denominated a *blue shale* having a thickness of 128 feet, has not before been recognized as a distinct portion of the Lower Magnesian. It occupies the place, in order of stratification, of the St. Lawrence Limestone, but is not so thick.

No. 8 is likewise an unknown stratum.

No. 9, in like manner, has never before been discovered. It is highly probable that, taken together, Nos. 7, 8, 9 and 10 are the actual equivalents of the St. Lawrence Limestone in point of stratification, modified in character and increased in thickness by proximity to the ancient Laurentian belt that lies but few miles further north. This would indicate the early origin of the Minnesota spur of the old Laurentian belt or nucleus of North America, as a shore line along which shale and sand were accumulated at the same time that limestone was being formed at points more remote in deeper water.

No. 10 pertains to the same horizon, and bears a stronger resemblance to the St. Lawrence.

Nos. 11, 12 and 13 represent the St. Croix Sandstone, but it is of less thickness than where seen in the Mississippi bluffs.

No. 14 may represent the "Lingula flags," or the upper portion of the Potsdam Sandstone.

No. 15 was rather clayey to be designated, unqualifiedly, a sandstone. It is undoubtedly the upper portion of the great series of marls and sands that characterize this horizon in Minnesota, as made known by Dr. Owen, and by him and others referred to the

age of the Lower Potsdam Sandstone of New York. It seems to be the same formation in which the salt well, drilled at Belle Plaine, stopped at the depth of 710 feet, though much less compact than where it is exposed at the surface in southwestern Minnesota. It is the same formation as the rock that embraces the well-known "pipestone" or *Catlinite* of Minnesota.

THE UNIVERSITY OF MINNESOTA,
Minneapolis, May 25, 1876.

The Drift.

In Hennepin county this deposit appears under still other features than those reported from more southern counties, and considerable light is thrown on the history of that interesting epoch of geological history. Three important facts respecting it can now be considered pretty clearly established.

1st. There are two distinct glacial or hardpan deposits in Hennepin county.

2d. The limit of the ice and moving drift of the latter was, toward the east, not far from the present line of the Mississippi, between Minneapolis and Fort Snelling, passing between Minneapolis and St. Paul.

3d. The Falls of St. Anthony have receded, since the last glacial epoch, or since the retirement of the lake-like expanse of water that filled the Mississippi valley, reducing the river more nearly to its present size, only from the mouth of the Minnesota, at Fort Snelling, a distance of about nine miles.

The facts on which these conclusions are based may be grouped under three heads, as follows:

1*st.* *Detailed observations on the composition of the drift.*
2*nd.* *The geographical distribution of the different parts.*
3*rd.* *The gorge below the falls.*

1. *Detailed observations on the composition of the drift in the vicinity of the Falls of St. Anthony.*

Section 1. *At the Falls of St. Anthony, near the river.*

The drift-bank has been considerably excavated near McAlester College on the east side of the river for use in the repairs on the Falls by the United States Engineers. As the point of excavation

MAP OF THE VICINITY OF THE FALLS OF SAINT ANTHONY

Intended to illustrate the Surface Geology,

by N. H. Winchell.

Scale - One Inch = One Mile. 1876. The Geological and Natural History Survey of Minnesota.

Explanation.

- Railroads
- Supposed line of bluff of the Mississippi before the last glacial epoch.
- Strike of the lower Trenton
- Trenton and Sand stone bluff.
- Supposed strike of the low Trenton
- Drift Hills.
- Area of the older drift clay.
- Area of the later drift clay.
- Area of the brick clay.
- Gray Gravel and Sand.

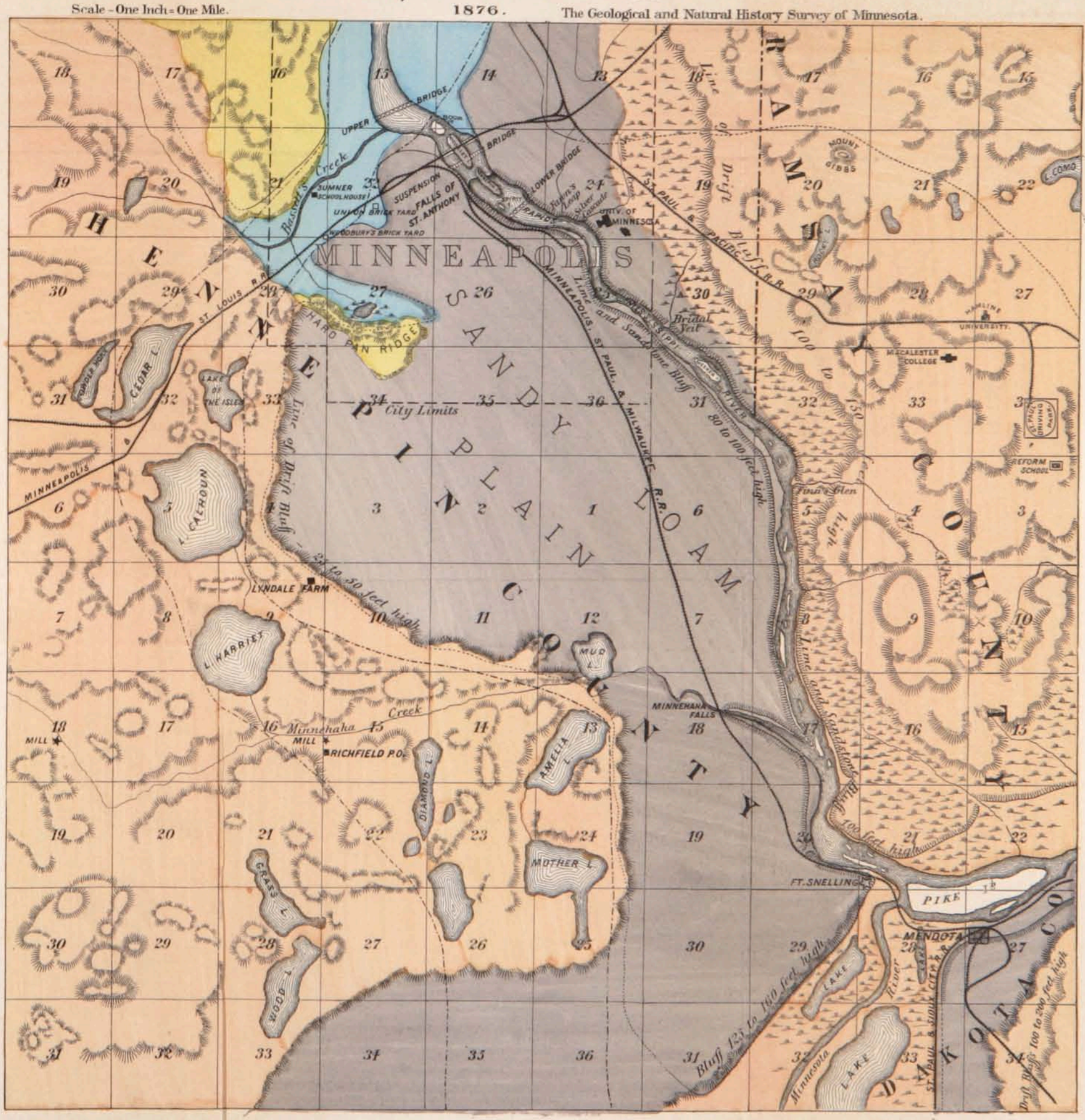


PHOTO ENG. CO. N.Y.

changes, thus successively revealing different parts of the bank, the nature of the whole may be ascertained. A common general section is as follows:

No. 1.	Loam	3 ft. to 6 ft.
No. 2.	Stones and boulders, rounded, sometimes with a considerable thickness of sand	5 ft. to 15 ft.
No. 3.	Red hardpan clay, with stones and boulders, lying on the rock	10 ft. to 20 ft.

In a few places along this excavation the color of No. 3, is not so distinctly red or copper-colored. It seems to be lighter, as if it had been mingled with hardpan of a later date which in much of the county is seen to overlie the red hardpan. This shading of color pertains only to the upper portion of the deposit. There are also places along the same bank where the light-colored or gray hardpan was deposited in considerable quantities, and still remains, and as the bank recedes a little from the river this light-colored hardpan occupies the inner and lower portion of the main slope in such a way as to hide the red entirely, and give a false impression of its having replaced it. In other places it is seen to lie directly on the red.

By further and more detailed examination of the same bank the foregoing No. 2 is seen to become separated into two or three pretty constant parts. It is sometimes clayey, and of a gray color. It is sometimes entirely made up of gravel and sand with belts of boulders, the alternation of parts being in general expressed by the following:

Section 2. Detailed Section at the Falls of St. Anthony, near the river.

1.	Loam	3 to 6 feet.
2.	2 (a). The gray sand and gravel	0 to 10 feet.
	2 (b). The gray stones and boulders	1 to 10 feet.
	2. The gray hardpan	0 to 6 feet
3.	3 (a). The red sand and gravel	0 to 10 feet.
	3 (b). The red stones and boulders	1 to 2 feet.
	3. The red hardpan	10 to 25 feet.

There are three main parts or members. No. 1 is never wanting. No. 2 is always seen as far as this excavation is concerned, but its subordinate parts are not always all present. Very often 2 (a) and 2 (b) are the only portions seen; and in other places 2

(a) is wanting, the only thing that separates No. 1 from No. 3 being No. 2 (b). Of No. 3, the red sand and gravel may be absent, but in no case has the line of red stones and boulders been found wanting. The red hardpan, No. 3, is the most conspicuous portion of the whole, and is always present, rising sometimes by alternations with No. 2, (gray hardpan to near the top of the bluff.) There is in that case always a loam (No. 1) overlying, and a similar mixture of red stones and boulders with gray, immediately overlying the red hardpan. The gray hardpan at this point is quite unimportant as a member of the bank, but it is found to embrace very large boulders, not only of granite, but also of the Lower Trenton formation. Its color is very marked in contrast with the red hardpan. The stones in it have the appearance of glaciation. The *red hardpan at this place has not been seen to embrace a piece of the Lower Trenton.* Its boulders are usually small, rarely exceeding ten inches in diameter, while the bulk of it has only stones, less than four inches in diameter, and of a red color and quartzitic composition. "Greenstone" as a boulder is also common in the red hardpan. The iron in it, which causes the color, is *peroxide, non-hydrated.* The iron in the gray hardpan is *hydrated.*

The drift surface on the bluffs along the northeast side of the river, at Minneapolis, shows no gray hardpan. The bluffs rise about one hundred feet, average, higher than the top of the foregoing section and consist, so far as seen, of red clay and gravel. Toward the southeast, where the St. Paul and Pacific R. R. passes out of the valley of the Mississippi, the characters of the gray and red are mingled at first in an overlying stratum of gravel and sand, but before reaching St Paul the gray has entirely disappeared so that in the bluffs at that place the drift is all red clay, or sand, gravel and boulders derived from red clay, the whole having a characteristic prevailing red color. There are places where the shales of the Trenton have stained the drift clay at St. Paul, but those are low in the valley and near the river. The country generally at St. Paul and thence to Stillwater, on the St. Croix river, fifteen miles east, on the Wisconsin boundary, is everywhere covered only with the red drift. This statement is made without regard to the loam which is found very generally over this portion of the state. Within the valley of the Mississippi at St. Paul the upper portion of the drift is affected by the mingling of gray and red. The following observations, made in St. Paul, belong to this general class of facts.

Section 3. On Sibley street, in St. Paul.

No. 1.	Loam	2 feet.
No. 2.	Stones and gravel, mostly limestone, also boulders, large stones, sloping to the SE. and E	12 feet.
No. 3.	Sand and gravel in beds irregularly alternating with No. 2. Some beds of gravel are two feet thick	10 feet.
No. 4.	Stones and gravel. In this are some northern boulders and limestone pieces, also pieces of green shale; the large stones sloping E. and SE	20 feet.
No. 5.	Red sand, horizontally and somewhat obliquely stratified, often fine and clayey	8 feet.
No. 6.	Red hardpan, seen	12 feet.

No. 6 above is often of the color of common red brick, and is very hard and compact. The stones in it are apt to be small. The upper portion at least shows in some instances a kind of lamination which still holds stones and is very sandy. In other places it passes into No. 5 gradually. But there is a very sudden and marked transition from No. 4 to No. 5, showing plainly a distinct deposit and a different origin. The iron in No. 4, and all above is hydrated, giving the whole a yellowish-gray, or olive cast, but although No. 5 consists of sand, and will admit water as freely as No. 4, it has only the red color of non-hydrated peroxide of iron. Hence the cause given for the color of the iron and of the drift (and generally accepted) as in Ohio, in contrasting the upper and lower portions, is not applicable here. Nos. 2, 3 and 4 make substantially one great deposit, and may come from the disintegration, under glacial water, of the usual clayey drift-sheet in the act of deposition—as the whole locality is in a low spot in St. Paul where the Trenton is broken down by some great drainage force. The boulders and stones in No. 6 are generally of metamorphic rock, there being but very rarely a piece of limestone. What pieces there are of limestone are of some foreign formation not evidently of the Lower Trenton. The stones in No. 4 are nine-tenths of them from the Lower Trenton.

Descending from Sibley street toward Wacouta street, and so toward the general centre of the tributary valley in which these excavations are made, Nos. 2, 3 and 4 gradually taper out and become no thicker than three feet, and other deposits replace them uncomformably thus.

Section 4, between Wacouta and Sibley streets, St. Paul.

No. 1.	Loam	2 to 4 feet.
No. 2.	Horizontally stratified yellow clay, varying to blue near the bottom, with no stones nor gravel	2 to 6 feet.
No. 3.	The same as Nos. 2, 3 and 4 of the last section, diminishing in thickness from 25 feet to 2 feet where it runs under the above No. 2, towards the lower portion of the valley	25 ft. to 2 feet.
No. 4.	The same as No. 5 of the last section, red and clayey, showing oblique stratification along the right of the cut, but horizontal along the left; at the extreme right hand passing downward into No. 5—the red hardpan	10 feet.
No. 5.	Stony, red hardpan, seen	5 feet.

No. 2 becomes, at the crossing of Wacouta street, about 16 feet thick, and continues horizontally bedded, but with a gentle, general slope toward the N. E. or toward the centre of the valley. Its lower portion also changes to a quicksand. The gravel and sand of No. 3, of the last section, lie sometimes on No. 5 without the intervention of No. 4. The limestone masses, as well as the granite boulders in No. 3 have their angles rounded and decomposed, some masses even falling to pieces in the process of digging, though this is of course due largely to the quality of the rock. They are all water-worn and stained, rather than glaciated. The limestone masses are generally changed in color through and through, as if having been water-soaked in contact with air, or alternately in contact with air and water, for a great many years. They are not blue and fresh as water-soaked specimens are from a quarry, nor so well preserved as masses seen along the gorge below the Falls of St. Anthony. There are spots below Wacouta street where this member (No. 3) becomes clayey, making a gray stony hardpan, resembling that which covers the western part of Hennepin county, but still very gravelly and stony. This character does not rise above the lowermost two feet, so far as seen in the excavations on Wacouta and Sibley streets. Below Wacouta street the thick clay (No. 2 of the last section) is seen lying *below* a layer of stones and gravel, and this position can be traced in the opposite bank to some distance above Wacouta street, the clay gradually becoming thinner till it allows the overlying gravel and stones to come into contact with those of No. 3, the only remaining difference between the upper and lower parts being then a dif-

ference in *throw*, or slope, of the larger stones, as noted in *Section* 3. It is supposed to be the equivalent of the brick-clay at Minneapolis, at Lake Minnetonka and at Carver, though it does not everywhere make brick of the same color. It lies directly on the gravel and stones of No. 3, with a sudden transition, indicating some great and sudden change in the force depositing the material, followed again by a revival of the former drainage force, giving origin to the overlying course of stones and gravel. It is wholly embraced within the period of deposit of the gray or later drift.

The exposures within the Mississippi valley at St. Paul may be summarized in a general way as follows :

Section No. 5. *Summarized section of the drift within the valley at St. Paul.*

1.	Loam.	3 to 10 feet.
2.	2 (a). Gray sand, gravel and stones	0 to 10 feet.
	2 (b). Fine, laminated blue brick-clay	0 to 16 feet.
	2 (c). Gray sand, gravel and stones	20 feet.
	2. Gray hardpan	2 feet.
3.	3 (a). Fine, laminated red sand or clay, the *Tripoli* of Stillwater	0 to 10 feet.
	3 (b). Red hardpan	10 to 20 feet.

Outside of the valley of the Mississippi near St. Paul, and within the limits of the city, the general aspect of the drift is red, particularly toward the east, the red hardpan, or its product, the red sand and gravel, rising to the tops of the bluffs, the foregoing No. 2, of the general section, being absent. The red hardpan is sometimes locally modified, and is largely converted by wash and drainage to a coarse sand, as seen in the cuts near the St. Paul and Pacific Junction with the West Wisconsin Railroad. Along the north bluffs of the river this character prevails, overlain by a thickness, usually not great, of No. 1.

At three-quarters of a mile below the University the drift at the rim bank consists as follows :

Section 6. *Three-quarters of a mile below the University.*

1.	Loam	5 feet.
2.	Gravel and gravelly clay	20 feet.
3.	Red hardpan to the rock, perhaps	15 feet.

At Minneapolis, near the west end of the lower bridge, the drift

consists apparently of gray hardpan, 7 feet, without any trace of the older red drift. The same is true at the stone quarries about a quarter of a mile further S. E.—thus in more detail at the quarries.

Section 7. At Bank's Arenson's quarry, Minneapolis.

1.	Loam	3 feet.
2.	Gravel and stones, the latter being mostly granitic, but with a few pieces of limestone, varying to	12 feet.
3.	Stony, gray hardpan clay	

Section 8. Corner of Washington avenue and Sixth avenue, north, Minneapolis.

1.	Loam, stratification not evident; apparently passing downward into brick-clay	2 to 4 feet.
2.	Brick-clay	1 to 4 feet.
3.	Fine sand, lying unconformably under the last	1 to 4 feet.

No. 1 contains calcareous concretions as large as peas and walnuts. It cannot be said to merge certainly into No. 2, but it seems to. The stratification of No. 2 fades out gradually upward, while the texture and composition continue somewhat into No. 1, becoming also yellow, or at last rich brown or black when it is termed soil. No. 2, as seen in this exposure, consists of a long synclinal, the axis running nearly north and south, toward the west, so lifted as to disclose what it lies on, (No. 3.) It is quite calcareous, showing concretionary lumps, and coatings, and also at a point on Fifth street, fresh water species of shells—though the cut there may be more nearly the equivalent of No. 1. This section shows that the source of the water which spread the brick clay was toward the west, and that the bottom on which it was spread was one of stratified fine sand which increased toward the west. This is near the descent to Bassett's creek, and over the St. Peter sandstone, (the Trenton having been broken down,) and that stream or its valley, had something to do, probably, with the sudden transition seen here from sand to brick clay. Although there is at one point in this cut an agreement in direction between the strata of the sand and those of the clay, yet on close inspection it appears that the clay came on suddenly.

At the yard of the *Union Brick Company* (Baxter, Woodward and M'Nair) the clay is yellow, with some beds of fine white sand to the depth of about eight feet, when it begins to show blue.

Upward here it becomes a clayey loam. The strata have a wavy outline, synclinals and anticlinals following each other twice in about 14 rods, rising and falling six feet.

At Woodbury's brickyard, which is about half a mile west of the Union Brick Company's, within the valley of Bassett's creek, the clay is underlain by a quicksand which furnishes water that rises to within twelve feet of the surface. The clay is about forty feet in thickness and contains thin layers of sand, interlaminated, which becomes white on drying. The upper portion gradually becomes yellowish by exposure and the hydration of the iron, the lower portion being blue. There are also in it calcareous concretions and a few large *Unio* shells which are very fragile. This clay seems to occupy the valley of Bassett's creek generally. At the Sumner School house, which is in the valley of this creek, north of Woodbury's yard, after drilling through this clay, over 100 feet, an artesian overflow of water was obtained.

Passing across Bassett's creek, on Western avenue, and ascending the bluffs on the west side of the creek, the drift is found to consist of the red gravelly hardpan, covered by a light loamy soil. The surface is rolling, with frequent springs and numerous lakes.

At Richfield P. O., Minnehaha creek runs about 35 feet below the general level of the country, and the banks are composed of gravelly, gray or yellow clay. No red clay can be seen. But at the school house in Richfield, Sec. 18, on Minnehaha creek, the well, dug, disclosed the red drift clay some feet below the surface. At the Edina Mills there is a bank of drift, composed of clay and gravel of the usual gray color, containing many pieces of the Trenton limestone.

On the NW. ¼ of Sec. 8 (S.) Crystal Lake, a cut in the Osseo road shows the gray and red hardpan as follows:

Section 9. *NW.* ¼ *Sec.* 8 (*S.*) *Crystal Lake.*

1. Gray or yellowish hardpan, with few Cretaceous pieces, and some boulders..... 8 feet.
2. Red hardpan passing into red sand and gravel below..... 6 feet.

The red passes into the yellow by a series of blotches interchanging one with the other, as if coarsely mixed. Even between the blotches there is a sudden change of color. When the line of union is not broken up into blotches the change of color is abrupt. The late, or gray hardpan is more calcareous than the older. The appearance of the red drift is, as if there had been a lake, or at least a low spot in it, prior to the deposition of the gray.

In Sec. 16, Eden Prairie, a cut by the road shows the red drift, on a low level, but five or six feet above the creek, while in the higher portions the gray only is seen.

Near the mill at Minnetonka City the old red drift can be seen in a little excavation by the road, on a level with and near the creek. It is overlain by a course of stones and gravel, in which appears a piece of the Trenton, and that again by the great deposit of the gray hardpan generally over the country.

The drift knolls at Wayzata are of the brown hardpan, but occasionally show the red at low levels where cut by the roads.

About the west end of Lake Minnetonka the drift is very clayey and has a great proportion of Cretaceous materials. The water of wells is very hard.

The ridge which enters the corporate limits of Minneapolis (Sec. 27) is a spur from the main drift-bluff running along the west side of the river. The most of it, within the limits of the city, is of gray hardpan and gravel, with variations toward the west and northwest toward the red hardpan, of which there is a considerable area extending to and beyond Cedar Lake.

Sec. 36, Champlin. The rolling land begins gradually, the timber changing also gradually. The rolling land is stony, clayey or gravelly, with patches of sand as revealed in wells, and some places of stratified clays near the flat country. The stones are mostly granitic, but have among them, also, numerous large masses of light-colored, fine-grained dolomite, which are burned for quick-lime. The ridges are said to run generally S. W. and N. E., but are very irregular, with depressions and cross-ridges. Water is easily got in wells at about 40 feet—sometimes in 15 or 20.

At the mouth of Elm creek, near Champlin, the bank is exposed by a recent wash, disclosing the composition of the plain on which are Osseo and Brooklyn. The upper portion of the bank, including the loam, is 18 feet, and consists of coarse sand, with gravel and pebbles obliquely stratified, the whole of a light brown color. The lower portion—25 feet—consists of red hardpan which continues down to the level of the water of the Mississippi.

In traveling the river road from Champlin to Dayton, a very noticeable change occurs in the nature of the surface drift, before reaching the latter place. It becomes lighter colored, shaly or ashy, with pieces of slate. About a mile below Dayton a large freshet wash by the roadside, where a creek enters the Mississippi river, shows an exposure of about 35 feet of pebbly clay of a light, gray color, with pieces of slate, and an occasional boulder near the bottom, underlain by a sand of the same color, 20 feet thick,

varying to very fine or clayey, stratified, which, washing out easily, causes the downthrow of large masses of the clay, both in the creek gorge and along the river bluff. No red drift is visible. The surface about is rolling, with occasional boulders.

At Dayton the general character of the surface is of the gray, or ashen, slaty, rolling hardpan. Along the bank of Crow river the drift is exposed in a good section.

Section 10. *At Dayton.*

1.	Stratified fine sand and clay	10 feet.
2.	Blue drift hardpan	25 to 30 feet.
3.	Red drift hardpan	8 to 10 feet.

In No. 2 are many fragments of Cretaceous slate, sidorite, iron concretions, (covered with gravel and cemented by iron rust,) granitic pebbles, and (Devonian ?) limestone masses which have supplied a great deal of quick-lime, and an occasional large granite boulder. In No. 3 are a great many small greenstone and quartzite stones, and but few that are large, also many granitic stones. Along the bank of the river a piece of native copper about the size of a hickory-nut was found by James Ream.

At the old bridge on Sec. 18, Hassan, or a few rods below it, on the right bank of Crow river, is a deposit of coarse crag, three feet thick, comprising the pebbles and stones that were washed out of the old red hardpan. It dips a little to the east, and shows as a persistent layer for 30 or 40 rods, causing a terrace in the surface of the alluvium of the flood plain, and rising, at the bridge, about 18 feet above the river, beyond which it seems to strike inland and is lost. It also appears on the opposite side of the river above the bridge. In the opposite direction it finally runs down to the level of the river, eastward, and disappears. It has been used by Mr. Hoag for underpinning for his house.

About the lakes (Mother, Amelia, Calhoun, &c.,) the country is rolling, but is less so toward the southeast part of that tract; indeed the rolling area gradually dies away into the plain in some parts of Richfield so that its eastern margin is not so marked. On the plain the soil and the subsoil is gravelly or sandy, very rarely stony. The same is true of the rolling tract about Diamond Lake. There are no stones in the fields nor about the lake shores. This seems to indicate the agency of water rather than of ice in piling up these outer knolls, and in spreading the gravel of the plain. Minnehaha creek has a gravelly bottom all the way below Richfield, at least.

Through sections 20 and 19, in the southern part of Bloomington, the hardpan drift, on the north side of the Ferry road, rises above the flat on which the road runs, with the appearance of a terrace, and is wooded with oaks, aspens and ironwood. For some distance the terrace-like level on the surface of the hardpan is about half a mile north of the road, and rises about 40 or 50 feet. It is stony with occasional boulders, becoming more rolling further north.

At Bloomington Ferry the river runs near to the hardpan bank on the north side. The bank rises 140 feet above the water in summer. This is about the average, the top of the hardpan being of irregular outline. This includes the "terrace" of hardpan mentioned in sections 20 and 19. That terrace appears to approach the river here. The surface farther back is still higher, and indeed continues to ascend with an irregular contour. The hardpan is yellowish brown or gray, and gravelly near the top, but also has afforded some large granite boulders, that now lie in the street near the ferry, and others that are on the beach below the ferry. The Minneapolis and Chaska brick-clay is seen also at the ferry, and some years ago supplied a red brick seen in the house of Mr. Chadwick. Within a mile and a half, toward Eden Prairie, the surface rises apparently about 100 feet higher.

The well of Mr. J. Miller, N. W. ¼ sec. 9, Crystal Lake, was dug March, 1875, by Mr. J. G. Sommers, who gives the following section:

Section 11. *N. W.* ¼ *Sec.* 9, *Crystal Lake.*

1.	Loam	1 foot.
2.	Yellow hardpan, with little stones	5 to 6 feet.
3.	"Blue black clay" with no stones nor bedding; "one solid mass." This had sticks at different depths, and small pieces of Cretaceous coal, but positively no stones. Small quantities of water were met at 15 feet below the surface, and again at 25 feet	45 feet.
4.	Sand, boulders and gravel, all mixed; clean, with no clay. Some of the boulders being very large	3 feet.
5.	Light clay (even lighter than No. 2) with small stones but no boulders; nothing red about it	19 feet.
6.	Mixed stones and gravel; cemented	1 foot.
7.	Sand with water	2 feet.
8.	Blue limerock; rough, not polished nor scratched; depth of well	76 feet.

At Charles Grotjann's old brickyard, in Upper St. Anthony, the clay contains lumps and concretions of clay, and also the usual limy concretions. The most interesting feature at this point is the jamming and folding to which this otherwise regularly laminated brick-clay has been subjected. There is a thrust-up place near the river, at the brickyard, which shows these laminations crumpled and broken, with a sudden transition upward into gravel and sand, which is unconformably stratified. This might possibly have been done by floating ice in the river at some earlier stage of the valley when the river may have covered this level which is 15 or 18 feet higher than the usual freshet rise of the water. Yet it hardly seems attributable to that cause, since it is not only covered with the loam, which is referable to that last high stage, in undisturbed continuity, but is so deeply within the bank that crowding ice could hardly reach it. The terrace flat of Upper St. Anthony, underlain by the brick-clay, is 25 feet higher than the river.

The highest drift knolls in the neighborhood of Minneapolis are in Anoka county, about Sec. 24 Manomin, in the neighborhood of Sullivan's and Moore's lakes, but east of them. They are of red drift clay, with gravel and granitic boulders, yet *the boulders are not so common* as might be expected from the fact that these areas suffered the exposure and surface drainage incident to the last glacial epoch. The soil is clayey, and loamy, but between the bluffs and the river are extensive sandy flats. Little wet spots, even lakes and swales which never become dry, lie between these knolls. These hills continue SE. toward Bower's Lake in Ramsey county. The high hill north of and near Bower's Lake is 130 feet higher than the NE. corner of Moulton's Nursery, which may be taken as an average height for the hardpan drift bluffs along the east side of the river. From the Nursery to the foundation of the University is a further descent of 110 feet; thence to the river at the University 137 feet, making a total descent from the high knolls at Bower's to the river below the falls, in the rapids near the University, of 377 feet.

On section 12, Crystal Lake, near the mouth of Shingle creek, in digging a well for Mr. J. Kesler, Mr. O. E. Spear found a stick as large as his wrist in a blue clay, (the brick-clay) that had no stones nor gravel, about 18 feet beneath the surface.

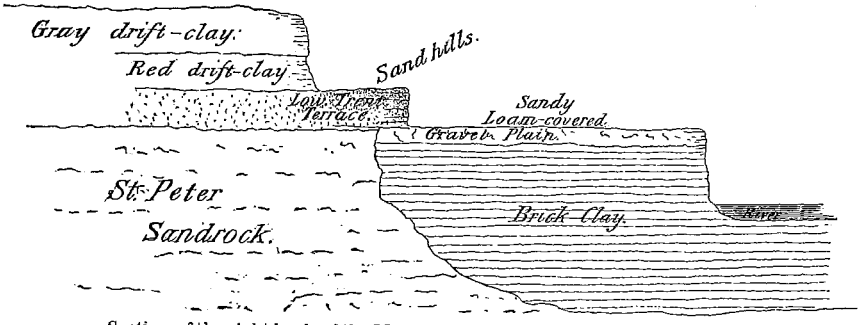
On the N. E. $\frac{1}{4}$ sec. 12, Crystal Lake, at Peterson and Swansen's brickyard, this same clay is manufactured into cream colored brick. It is obtained in the immediate river-bank, and runs appa-

rently beneath the river. It is blue, stoneless and horizontally stratified.

Section 13. *N. E.* ¼ *Sec.* 12, *Crystal Lake, at Peterson and Swansen's Brickyard.*

1.	Loam	3 feet.
2.	Sand, gravel and pebbles; stratified; sometimes rusty	4 to 6 feet.
3.	Brick-clay; blue; horizontally bedded	15 feet.
4.	Slope to the river; apparently clay	15 feet.

An ideal section of the right bank of the river at this place, (near the mouth of Shingle creek,) would be as shown by the following diagram. This is based on the observed exposures of the various parts in such topographical positions as indicate its correctness :



Section of the right bank of the Mississippi near the mouth of Shingle Creek.

The above figure represents the brick-clay as lying immediately on the St. Peter sandstone, because at that point no drift-clay can be seen to lie between them. It is more probable, however, that a deposit of drift-clay, perhaps both the red and the gray, runs below the brick-clay, as seen at St. Paul; or at least that such a deposit ante-dated the brick-clay, though sudsequently perhaps entirely swept away.

Further information concerning the drift was sought for in developments of the common wells throughout the country. The following table shows the result:

Wells in Hennepin County.

Owner's Name.	Location.	Feet in the drift.	Feet in the rock.	Total Depth.	Remarks.
N. O. Phillips	NW. ¼ Sec. 6, St. Anthony	20	..	20	Water comes from the clay; fails in dry season.
D. D. Moore	SE. ¼ Sec. 6, St. Anthony	40	..	40	Clay nearly 40 feet; then coarse sand; little water.
D. D. Moore	" "	40	..	40	No water.
Frank Thery	" "	87½	..	87½	"Blue clay" 24 feet; then red clay sand and gravel; good water.
—— Wilson	Hoyt's Addition to St. Anthony	15	..	15	All sand; then struck the rock, which is smooth like a floor.
Crystal Lake House	Sec. 10, Crystal Lake	30	..	30	No rock; good water; near the river.
Jesse N. Richardson	Richfield P. O.	68	..	68	Gravel and gravelly clay; good water.
—— Rankin	Eden Prairie Station	43	..	43	Sand and coarse sand; good water.
John Brown	Near Bloomington Ferry	88	..	88	Clay and sand; good water.
John Scofield	Four or five miles E. of Bloomington Ferry.	53	..	53	Good water.
—— Marville		75	..	75	Clay and hardpan 50 feet; sand and clay alternating.
—— Clark	¾ mile N. of Highland Park	52	16	68	Clay and sand; drilled in lime rock.
N. Palmer	Gale's 2nd Addition, Minneapolis	26	19	45	26 feet boulders and clay; then in limerock.
Fred Wagner	No. 1200 N. 23rd St., Minneapolis	25	19	44	
—— Bailiff	4 miles E. of Bloomington Ferry	56	..	56	First 25 feet all sand.
Wm. Knight	SE. ¼ Sec. 10 Crystal Lake	14	..	14	Sandy loam; good water.
C. H. Sanborn	NW. ¼ Sec. 5, Crystal Lake	40	..	40	Good water.
All wells in	Osseo, and Brooklyn generally	12–14	..	12–14	Flat country; good water.
Wm. Schmidt	Sec. 36, Champlin	45	..	45	Sandy knoll.
Mathias Zopli	Sec. 36, Champlin	20	..	20	Ten feet of good water.
Ferdinand Schmidt	Sec. 1, Maple Grove	44	..	44	Twelve feet stratified clay and sand; good water.
Fonduck House	Champlin	33	.	33	Got water at 8 feet above a "dark clay" (red clay ?)
Wells at	Champlin, generally	25–33	..	25–33	Good water.
—— DePuy	Sec. 12, Hassan	17	..	17	All clay; seeps.
Peter Hill	SW. ¼ Sec. 4, Minneapolis	22	.	22	Gravel and sand; near a tamarack swamp.
David Corban	NE. ¼ Sec. 12	70	..	70	Nearly all clay; water in sand; rose 25 feet.
Joseph Hennesey	SW. ¼ Sec. 29, Maple Grove	16	..	16	In clay.
Thomas Hennesey	" "	15	..	15	In clay.
Martin Devery	SW. ¼ Sec. 28, Maple Grove	65	..	65	Blue clay; water in sand.
Wells generally at	Maple Grove	15–25	..	15–25	In blue clay; no knowledge of any red clay.
Crystal Lake House	SE. ¼ Sec. 6, Crystal Lake	40	..	40	Sand nearly all the way; then clay.

Wells in Hennepin County.—Continued.

Owner's Name.	Location.	Feet in the drift.	Feet in the rock.	Total Depth.	Remarks.
Frank Paul	SW. ¼ Sec. 31, Richfield (E)	75	..	75	40 feet loam; the rest clay; no rock; no water.
Frank Paul	" "	27	..	27	Saud all the way; no rock; no water.
Frank Paul	" "	53	..	53	No rock, nor water.
Wm. Franchou	NW. ¼ Sec. 31, Richfield	53	11	46	11 feet in lime rock; then white sand, and good water.
F. X. Brousseau	Sec. 14 Bloomington	27	..	27	Sand; near the river bluff; water on clay.
J. Stansfield	NW. ¼ Sec. 14, Richfield	56	..	56	Some clay, but mostly gravel; good water.
T. Vessey	Sec 5, Bloomington	56	..	56	Near the river; in the bluffs.
E. M. Snow	Long Lake	14	..	14	Mostly sand and gravel; then blue clay; good water.
May and Co	Long Lake	60	..	60	Mostly hardpan; water "irony."
Medina Mills	Long Lake	175	..	175	Gravel and sand; then blue clay; good, soft water.
D. E. Priest	Sec. 23, Minnetrista	25	..	25	Yellow clay hardpan and sand; "hard" water.
Jacob Schleh	St. Bonifacius, Minnetrista	36	..	36	18 ft. yellow clay; 18 ft. blue clay hardpan and sand; good water in gravel.
J. Metz	" "	36	..	36	" " " " " "
J. Miller	NW. ¼ Sec. 9, (S.) Crystal Lake	56	20	76	Loam, yellow clay and blue clay 56 feet; contained sticks; struck the limerock.
R. S. Lee	Highland Park, Minneapolis	27	..	27	Clay, sand, clay, sand; good water.
Lambert Negley	19th St., bet. 20th and 21st Aves., N	45	..	45	Sand all the way to white sand rock.
—— Halsey	19th St., bet. 20th and 21st Aves., N	37	8	45	Eight feet of limerock.
John Eagle	Cor. 20th St., and 21st Ave., N	20	25	45	Limerock 15 feet; saudrock 10 feet.
—— Parker	Christmas Ave. and 23rd St	39	9	48	Clay; struck rock at 39 feet.
John Hooper	NE. ¼ Sec. 8 (SE.) Crystal Lake	?	..	?	Strack the limerock.

2. *Geographical distribution of the different parts.*

(a). *The red hardpan.*

This, which from its position must be regarded the oldest of the different parts, is found exclusively in the eastern part of the county, and thence eastwardly to St. Paul, and through Washington county to Stillwater. It seems to be the principal deposit, rising from immediate contact with the indurated rocks to the surface of the country. It is locally modified by the loss of its clay, so as to consist almost entirely of coarse sand and gravel, or, in other places, of stones and boulders. Along the main valleys, as at St. Paul and at Stillwater, its upper portion, to the thickness sometimes of twenty feet, consists of very fine clay, which yet seems to contain a large per cent. of silica, (nearly 75 per cent. according to Prof. Peckham,) the whole derived doubtless from the gentle washing of the red hardpan. This fine red clay has been referred to in a former report as possibly pertaining to the Cretaceous. Its color is due to non-hydrated ferric oxide. The red hardpan also appears on the west side of the river at the surface of the drift, and constituting its principal mass, in the western part of the township of Minneapolis, in the rolling tract that embraces lakes Calhoun and Cedar; also northwardly to Bassett's creek; also, with some modifications in much of the townships of Richfield, Eden Prairie and Minnetonka. As a loam covers much of this part of the county it is not possible to define the exact limit of its distribution. There is a rolling belt of small timber, (oaks and aspens,) that extends north and south across this part of the county, which seems nearly to coincide with the superficies of the old red drift clay on the west side of the river. In general that is the timber that characterizes it on the east side of the river. Even within this area on the west side of the river there are spots where the color of the hardpan is modified toward the gray color; and other places where there are important deposits of gray hardpan overlying the red. This is particularly the case in the northern part of Minneapolis, and in Crystal Lake townships, covering the locality at which the Mississippi seems to have been deflected from its old channel. The extensive flat in eastern Minneapolis, Richfield and Bloomington townships is also underlain by this red hardpan, but it is also supplied with extensive superimposed gravel deposits, as well as with patches of unmodified gray hardpan. The gray hardpan may be seen in the immediate bluffs of the river in some cases, both on the west and on the east sides, within the

limits of the city of Minneapolis, but the red is found to lie nearly everywhere, under this flat as the lowest portion of the drift. The red extends under the gray hardpan an unknown distance westward. It is seen in deep valleys and excavations along the central portions of the county, but with decreasing frequency toward the west and northwest, until nothing is known of it, at least within the limits of Hennepin county.

(b) *The Gray Hardpan.*

This covers the greater part of the county, gradually becoming thinner toward the east and southeast. Within the valley of the Mississippi it extends at least to St. Paul, found in the depressions between the rock bluffs, or in the lower depressions in the old drift-surface. In those areas, however, not embraced within the river valley, nothing has been seen of the gray hardpan as far east as St. Paul. The gray hardpan, or the gravel, sand and stones that result from its modification, seems to be spread generally over the upper flats and terraces that exist, from different causes, along the river below the Falls of St. Anthony. It begins to be mingled with the red drift, and finally to cover it entirely, within the limits of Minneapolis. The conspicuous ridge of hardpan within the city, (sec. 27,) is of a gray color, but it blends with the main river bluffs toward the northwest, along the west side of Bassett's creek, and loses its distinctive characters. The gray color, however, prevails on the north and east side of the creek, through a rolling tract of country, and into Crystal Lake township—and thence, uninterruptedly, northwestwardly. The gray hardpan surface is specially characterized by heavy timber, particularly after passing out of the valley of the Mississippi, and thus beyond the area liable to its modified conditions. It is observable that the eastern line of the Big Woods, properly so-called, (i. e. comprising large trees of Sugar Maple, Bitternuts, Elm, Bass, Oaks, &c.,) nearly coincides with the eastern line of the unmodified gray hardpan, and approaches the Mississippi river at Champlin, actually reaching the river bluffs a few miles below Dayton. This line may be said to run, in general, from the eastern end of Lake Minnetonka to Champlin. Whatever gray hardpan is found to the east of that line, or to the southeast, speaking generally, seems to have been mingled with the red, and to have lost much of its clay. It is hence often converted to a gray gravel and sand, and is in many places replaced by red hardpan or by red gravel and sand. A gray gravel which varies to a hardpan, is spread out over the flat on which Minne-

apolis stands. This is covered by the loam, and is underlain by the red hardpan.

(c) *The Brick-Clay.*

This is found particularly within the valley of Bassett's creek, and, above its mouth, in the valley of the Mississippi. It very rarely rises above the level of the top of the Trenton terrace, but has a thickness, as shown by the well sunk at the Sumner School house, of over 100 feet in some places. A similar clay, supposed to be of cotemporaneous origin, is seen embraced between deposits of gravel and boulders, at St. Paul, as shown by the general section at that place, and lying above the gray hardpan. A similar stratified clay is found at Lake Minnetonka, and at Carver, in the valley of the Minnesota.

The general distribution of these parts, in the vicinity of Minneapolis, is shown by the accompanying map, but a great many details, and exceptions are disregarded.

At Banks Arenson's quarry, on the west side of the river, nearly opposite the State University, the gray hardpan, which is stripped off the rock for quarrying, lies over a glaciated rock-surface, the marks running N. NW. and S. SE. While these marks correspond with the general direction of the river at this point, their regularity and persistence over a large surface preclude their having been caused by the action of the water of the river. The quarry has also been worked back from the line of the strike of the bluffs, and this stripping is about four rods back from the old line. The marks are also immediately overlain by a stony hardpan which is of the last glacial epoch, being olive-colored or earthy, not red like that which lies on the rock generally on the east side of the river.

Glacial striæ on Hennepin Island, above the paper-mill, run 32° West of North, by compass.

When the rock-surface was exposed for the City Market, it was not striated, but polished and scratched promiscuously.

The rock-surface is said to be glaciated on Nicollet Island, but no opportunity has been afforded of taking the direction.

According to Col. J. B. Clough, of Minneapolis, a piece of native copper weighing 70 pounds was taken from the drift in a R. R. cut, on the Minneapolis and St. Louis R. R., about 13 miles S. W. of Minneapolis, in 1872.

A piece weighing about two pounds was found in the fall of 1874, in grading the streets of Minneapolis.

Mr. W. D. Hurlbut has also found several pieces in the drift near Rochester, in Olmsted county.

3. *The Gorge below the Falls.*

From the Falls to Fort Snelling the gorge between the rock bluffs is about a quarter of a mile in width, and the rock has a freshly-broken appearance, the large fragments thrown down by the action of the water, as the falls receded, still existing in the talus along the bluffs. Throughout this distance (nine miles) the rocks lie horizontal, hence the recession, so far as it depends on that element, has been of uniform rate. The hight of the bluff above the river remains also nearly the same throughout this entire distance, increasing a little perhaps near Fort Snelling. The relative length of time during which the rocks of this gorge have been exposed to atmospheric forces, compared to that of the bluffs below Fort Snelling, or to that in the ancient valley now occupied by Bassett's creek, is indicated by the depth to which they have been weathered or stained. It is well known that the same rock may present different colors from the effect of atmospheric agents. The Lower Trenton, for instance, is blue within, when freshly quarried at fresh exposures. That is the color it has in all the quarries below the falls at Minneapolis, and which it shows in deep quarrying at St. Paul. This color is met with either immediately at the surface, as at the Falls, or within an inch or two of the surface as at Fort Snelling. When weathered long, the stained coating becomes thickened. The stone then is either rusty-buff, or yellowish and dirty, resulting from the oxydation and hydration of the iron which it contains. This color may penetrate to the depth of several feet, depending on the porosity of the rock, and the length of exposure. At quarries above the falls of St. Anthony, near the mouth of Bassett's creek, this stained condition is found to penetrate the whole Lower Trenton, the rock at the same time having become more easily separable along some of its bedding planes, and also more firmly cemented by the permeation of the iron through the more shaly parts. The same change is visible in the old river bluffs above the falls where the Lower Trenton is wrought on the east side of the Mississippi, opposite the mouth of Shingle creek, and to a considerable extent in the quarries in Upper St. Anthony.

The gorge below Fort Snelling, where the Minnesota and the Mississippi unite, is about a mile wide, between the rock-bluffs; and the Minnesota above Fort Snelling has the same width between

the rock-bluffs. Besides the aspect of greater age, as indicated by the greater change of color in the rock below Fort Snelling, the bluffs themselves are smoothed and the rock hid by drift and loam since the action of the river ceased. The top of the rock along the gorge above the fort is surmounted with a thickness of drift gravel and clay, which shows a section, as cut by the river, continuous, perpendicularly, with the rock-bluff itself. This thickness of drift is nearly uniform from the Fort to the Falls, and indicates the spreading of the drift before the recession of the Falls; but below Fort Snelling (with a single exception, to be noted,) the rock-bluff is generally hid by a subsequent accumulation of drift. The same is true of the bluffs of the Minnesota above the Fort. This subsequent accumulation is so abundant above the Fort along the Minnesota, that the strike of the Trenton limestone is totally hid within less than a mile.

The direction of the Mississippi changes at Fort Snelling, making a right angle, from S. E. to N. E., but the change is caused by its entering the wide gorge which runs in that direction. The wide valley in which the Minnesota runs is out of proportion with the amount of water which it carries, but its valley continues of the same width, and in the same direction beyond the confluence of the Mississippi, the valley taking the latter name.

Below Fort Snelling, opposite the mouth of the Minnesota, is a low, long, alluvial island, (Pike Island,) running to a point downstream. The existence of this island, which lies in the wide gorge, and which must have been formed since the excavation of the gorge, points directly to some force not now existing; since the joint action of the two streams uniting, instead of accumulation, would be the reverse under normal conditions. If the volume of the two rivers were to be increased so as to have sufficient momentum to move the substructure of Pike Island, the result would be the gradual destruction and removal of the island, instead of its increase. The retardation of the current causes it to drop sediment, but when two streams unite, the current is not retarded, but generally by reason of closer confinement in a proportionately narrower channel, it is increased.

The right bank of the Mississippi, just below the confluence of the two streams, shows, for about half a mile, a fresh erosion of the rock-bluff similar to that of the bluffs above the fort, the current of the river having been driven against that bank so as to undermine the limerock and cause its downfall. This is opposite the point at which the Mississippi enters the wide gorge. Pike

Island lies alongside of it, and between it and the debouchure of the Mississippi into the wide gorge.

Above the mouth of Bassett's creek the Mississippi runs between rock-bluffs of the same kind as those below Fort Snelling. They are about a mile apart and show all the above named indications of greater age. They, however, rise but about thirty or forty feet above the river, and are buried under the loam, or under the drift and loam. This old valley continues southwardly by way of Bassett's creek, and its course, as supposed, is expressed on the accompanying map of the region, drawn on a scale of one inch to one mile. This old valley was cut down into the St. Peter sandstone over one hundred feet, since it has been drilled into at the Sumner Schoolhouse in Minneapolis without striking rock, to even a greater depth than that.

From the foregoing facts the following interesting history may be read. It is believed that the glacial theory of L. Agassiz, and nothing but that, will explain the grand changes which this history relates.

Prior to the last glacial epoch the Mississippi river did not run over the Trenton limerock at all, but passed, in a wide, deep valley, similar to that which it now occupies below Fort Snelling, by way of the valley of Bassett's creek, and lakes Calhoun, Harriet and others, along the western side of the Trenton area, and joined the Minnesota at some point above Fort Snelling, but probably between Shakopee and Fort Snelling. The country was then covered with the drift of an older glacial epoch, and was probably timbered with species of trees the same as those now living.

As the last glacial epoch approached, the transport of drift material was from the northwest. After the closing of the northward outlet of the Winnipeg waters by the accumulated ice and the perpetual winter, they were drained southwardly through the valley of Big Stone lake and Lake Traverse, into the Minnesota valley, and thence into the Mississippi, past the site of Fort Snelling. Their volume was augmented not only by the proper volume of the Minnesota itself, but by the dissolution of the ice of the glacier that gradually crept over the state from the north, and northwest, as it arrived in latitudes too genial for the existence of ice.

The land ice not only disrupted the old drift surface and distributed its material as it moved on, but also gathered a great deal of

the bed-rock itself, particularly of the Cretaceous. This Cretaceous debris, being abundant and easily transported, gave its own shaly color to the drift with which it was mingled, and even stamped on the clay of this drift period a peculiar and characteristic quality, thus rendering it easily distinguishable from the older drift which was of a red color and charged with small red or green stones, with few granite boulders. The later drift contains more numerous large granite boulders than the older. Round the southern limit of the land ice, the old red drift was thrown up into hills and ridges and shoved into old valleys, and locally mixed with, or covered by, the gray drift of the later period.

In the valleys, particularly those having a southward drainage, the gray drift was transported most freely and distributed most widely, partly by the agency of the abundant water. The Minnesota was much larger than the Mississippi, and the Mississippi was much larger than it is now. Large quantities of floating ice would also pass down these streams, carrying from the glacier, stones and gravel, distributing them on the then flood-plains, the now gravelly terraces of the Mississippi.

The margin of the ice did not extend across the Minnesota into Dakota county.—At least it did not obstruct the Minnesota river so as to permanently divert it from its course, and certainly did not reach far south of that river, since the isolated outliers of the St. Peter, (as Castle Rock,) round whose bases the older drift lies, were not destroyed. The ice choked up the old valley of the Mississippi below the mouth of Bassett's creek, and filled it with drift clay, the river itself being, at the acme of the cold, reduced to smaller dimensions by the contraction of the field drained, and by the changed topography of the country toward the north. The river was thus forced to pass round the eastern foot of the ice further to the southeast, a lake of standing water perhaps covering the valley which it had abandoned, and setting back into a portion of the valley still occupied. This water, fresh from the glacier, was very muddy, and gave origin to the brick-clay that lies in its old valley, as shown by the accompanying map showing the surface geology.

The Mississippi, thus forced out of its old channel, after rising to the level of the limerock of the Lower Trenton, ran *over* the rock, to reach the same valley again by plunging over the precipice at Fort Snelling, thus giving birth to the Falls of St. Anthony. In reaching that point it had crowded on to the old drift bluffs along the east side of the river, driving them, by erosion, further toward

the east, while the old valley itself served to retard, and even to limit, the transportation of the drift clay toward the east.

Later, as the volume of the river increased by the dissolution of the ice and the opening of the tributary valleys as it withdrew, the waters spread over the whole area from the line of the old drift bluffs on the east, to the recently made moraines along its west banks, receiving and distributing not only gravel and sand over the whole broad valley, as at Minneapolis, but also large quantities of the gray hardpan clay.

It was at this time that Pike Island began to form; and also that the current of the Minnesota was carried, by the added momentum of the Mississippi, against the opposite bluffs below Mankato, so as to produce new exposures of the sand and limerock.

The Falls must have begun at Fort Snelling near the acme of the cold, as the effect of the ice is not important at any points south or east of the mouth of Bassett's creek. They have occupied the interval of time elapsed since then in receding to their present position. Were it possible to establish a unit of recession for a calculation, the length of that interval could be computed. The rate has been much greater since the construction of dams and mills, diverting the water, or concentrating it at points; and hence the data of recession since the permanent occupancy of the region, are valueless for this purpose. The only other means of estimating the rate of natural recession is to employ the statements of the early travelers who have described the Falls. Their discoverer was Father Louis Hennepin. In returning from his captivity among the Dakotas, he saw the Falls in July, 1680, and briefly describes them as follows: "This fall is forty of fifty feet high, divided in the middle by a rocky island of pyramidal form."

"In ascending this river ten or twelve leagues, navigation is interrupted by a fall, which we named in honor of St. Anthony of Padua, whom we had chosen as patron of our enterprises. This fall is 50 or 60 feet in hight, and has an island of rock, in the form of a pyramid, in the middle of the chute." (See the Amsterdam edition of Hennepin's works, 1704, chapter 44, p. 319.) A translation of Hennepin's narration is found in the *Historical Collections of Louisiana, Part IV*, in which he gives "40 or 50" feet as the hight of the fall.

In the London edition of Carver's journal, 1778, p. 69, Carver thus describes the Falls of St. Anthony, as he saw them in 1766: "This amazing body of waters, which are above 250 yards over, form a most pleasing cataract; they fall perpendicularly about 30 ft., and the rapids below, in the space of 300 yards more, render

the descent considerably greater. * * * * * * In the middle of the falls stands a small island, about 40 feet broad, and somewhat longer, on which grew a few cragged hemlock and spruce trees; and about half way between this island and the eastern shore is a rock lying at the very edge of the fall in an oblique position, that appeared to be about five or six feet broad, and 30 or 40 long. * * * * At a little distance below the falls stands a small island, of about an acre and a half, on which grow a great number of oak trees, every branch of which, able to support the weight, was full of eagles' nests."

The engraving accompanying this description is that seen in *Winterbottom's America*, and is reproduced in *Harper's New Monthly Magazine for October*, 1875, and wrongly attributed to Father Hennepin. Carver's original engraving shows an island above the falls, which is omitted in the copy in Harper's. Carver states on the engraving that the breadth of the fall is about 600 feet. This engraving shows an insignificant island just in the brink of the falls, extending neither below nor above the falls, and an apparently detached block of limerock lodged on the brink between it and the eastern (or northern) shore. In the stream below the falls is represented a larger low island, not rocky, but alluvial, nearly circular, and covered with timber.

Lieut. Z. M. Pike visited the falls of St. Anthony Sept. 30, 1805. His journal, published in London in 1811, is entitled: *Exploratory Travels through the Western Territories of North America in* 1805–6–7. He says of the falls: "The Falls of St. Anthony did not strike me with that majestic appearance which I had been taught to expect from the descriptions of other travelers. On an actual survey I find the portage to be 260 poles, but when the river is not very low, boats ascending may put in 31 poles below at a large cedar tree, which would reduce it to 229 poles. The hill on which the portage is made is 69 ft. ascent, with an elevation at the point of debarkation of 45°. The fall of the water between the point of debarkation and of re-loading is 58 feet; the perpendicular fall of the chute is 16½ feet; the width of the river above the chute 627 yards, below 209. In high water the appearance is much more sublime, as the great quantity of water then forms a spray which in clear weather reflects from some positions the colors of the rainbow, and when the sky is overcast, covers the falls in gloom and chaotic majesty."

Major Stephen H. Long visited the Falls of St. Anthony in a six-oared boat in 1817. His journal, which was not published till 1860, and then by the Minnesota Historical Society, gives a more

minute description of the Falls than that of any of his predecessors. The courtesy of Rev. E. D. Neill renders it possible to give a transcript from this rare document.* "The perpendicular fall of the water at the cataract, as stated by Pike in his journal, is sixteen and a half feet, which I found to be true by actual measurement. To this hight, however, four or five feet may be added for the rapid descent which immediately succeeds the perpendicular fall within a few yards below. Immediately at the cataract the river is divided into two parts by an island which extends considerably above and below the cataract, and is about five hundred yards long. The channel on the right side of the island is about three times the width of that on the left. The quantity of water passing through them is not, however, in the same proportion, as about one-third part of the whole passes through the left channel. In the broadest channel, just below the cataract, is a small island also, about fifty yards in length and thirty in breadth. Both of these islands contain the same kind of rocky formation as the banks of the river, and are nearly as high. Besides these there are immediately at the foot of the cataract two islands of very inconsiderable size, situated in the right channel also. The rapids commence several hundred yards above the cataract, and continue about eight miles below. The fall of the water, beginning at the head of the rapids, and extending two hundred and sixty rods down the river to where the portage road commences, below the cataract, is, according to Pike, fifty-eight feet. If this estimate be correct the whole fall from the head to the foot of the rapids, is not probably much less than one hundred feet. But as I had no instrument sufficiently accurate to level, where the view must necessarily be pretty extensive, I took no pains to ascertain the extent of the fall. The mode I adopted to ascertain the hight of the cataract was to suspend a line and plummet from the table rock on the south side of the river, which, at the same time, had very little water passing over it, as the river was unusually low."

Beltrami in 1823† thus describes the Falls: "Seated on the top of an elevated promontory, I see, at half a mile distance, two great masses of water unite at the foot of an island which they encircle, and whose majestic trees deck them with the loveliest hues, in which all the magic play of light and shade are reflected on their brilliant surface. From this point they rush down a

*Voyage of a six-oared skiff to the Falls of St. Anthony in 1817, by Major Stephen H. Long, T. E., U. S. A.

† A Pilgrimage in Europe and America, leading to the discovery of the sources of the Mississippi and Bloody river. J. C. Beltrami. London, 1828. Vol. 2, p. 205.

rapid descent about 200 feet long, and, breaking against the scattered rocks which obstruct their passage, they spray up and dash together in a thousand varied forms. They then fall into a transverse basin, in the form of a cradle, and are urged upward by the force of gravitation against the side of a precipice which seems to stop them a moment only to increase the violence with which they fling themselves down a depth of twenty feet. The rocks against which these great volumes of water dash, throw them back in white foam and glittering spray ; then plunging into the cavities which this mighty fall has hollowed, they rush forth again in tumultuous waves, they once more break against a great mass of sandstone forming a little island in the midst of their bed, on which two thick maples spread their shady branches."

Keating, who narrates Maj. Long's Expedition in 1823, says, (Vol II, p. 306.)

"On the 6th of July we walked to the falls of St. Anthony, which are situated nine miles (along the course of the river, seven by land) above the fort. The first glimpse which we caught of the fall was productive of disappointment, because it yielded but a partial view, but this was amply redeemed by the prospect which we obtained of it when the whole fall opened itself before us. We then discovered that nothing could be more picturesque than this cascade. We had been told that it appeared like a mere mill-dam, and we were apprehensive lest a fall of sixteen feet would lose all its beauty when extended upon a breadth of several hundred yards; but we soon observed that this was by no means the case. The irregular outline of the fall, by dividing its breadth, gives a more impressive character. An island, stretched in the river both above and below the fall, separates it into two unequal parts, the eastern being two hundred and thirty yards wide, and the western three hundred and ten. The island itself is about one hundred yards wide. From the nature of the rock, which breaks into angular, and apparently rhomboidal, fragments of a large size, this fall is subdivided into small cascades, which adhere to each other so as to form a sheet of water unrent, but composed of an alternation of retiring and salient angles, and presenting a great variety of shapes and shades; each of these forms in itself a perfect cascade, but when taken together in one comprehensive view they assume a beauty of which we could have scarcely deemed them susceptible. * * * * * * * * * Concerning the hight of the fall, and breadth of the river at this place, much incorrect information has been published. Hennepin, who was the first European who visited it, states it to be fifty or sixty feet high. It

was this traveler that gave it the name which it now bears, in honor of St. Anthony of Padua, whom he had taken for the protector of his discovery. He says of it, that it 'indeed of itself is terrible, and hath something very astonishing.' This hight is, by Carver, reduced to about 30 feet; his strictures upon Hennepin, whom he taxes with exaggeration, might with great propriety be retorted upon himself; and we feel strongly inclined to say of him, as he said of his predecessor, 'the good father, I fear, too often had no other foundation for his accounts than report, or at least a slight inspection.' Pike, who is more correct than any traveler whose steps we have followed, states the perpendicular fall at sixteen and a half feet; Major Long measured it in 1817, with a plumb line, from the table rock from which the water was falling, and found it to be the same. Mr. Colhoun measured it while we were there with a rough water level, and made it about fifteen feet. The difference of a foot is trifling, and depends upon the place where the measurement was made; but we cannot account for the statement made by Mr. Schoolcraft, that the river has a perpendicular pitch of forty feet, and this so late as fourteen years after Pike's measurement. The same author states the breadth of the river, near the brink of the fall, to be two hundred and twenty-seven yards, while Pike found it to be six hundred and twenty-seven yards, which agrees tolerably well with a measurement made on the ice. Messrs. Say and Colhoun obtained an approximate admeasurement of five hundred and ninety-four yards; this resulted from a trigonometrical calculation, the angles having been measured with a compass that was small and not nicely graduated, and the base line having been obtained under unfavorable circumstances. Below the fall the river contracts to about two hundred yards. There is a considerable rapid both above and below; a portage of two hundred and sixty poles in length is usually made here; the whole fall, or difference of level between the place of disembarking and reloading, is stated by Pike to be fifty-eight feet, which is probably very near the truth; the whole fall to the foot of the rapids, which extend several miles down the river, may be estimated as not far short of one hundred feet."

Mr. G. W. Featherstonhaugh says (*Report of a Geological Reconnoissance made in* 1835 *from the seat of government to the Coteau de Prairie:*) "An island about 450 yards long divides the Mississippi into two parts at the Falls of St. Anthony, which have a very irregular outline, owing to the soft sandstone being washed out unequally in places, and the superincumbent strata of limestone falling down in large blocks; these are piled up in large quantities

on the bed of the river immediately at the foot of the falls. That part of the river on the north side of the island is about two hundred and twenty yards in width. There is a very fine smooth section of the rocks here to the water, about 90 feet. I should think the fall would not average more than twenty feet. * * * * * On the south side of the river the line of the falls is a very irregular curvature, and measures about 450 yards to the island. The hight of the fall does not appear so great on this side, owing perhaps to the bed of the river being so much choked up with the fallen slabs. It is a wild rocky scene, but deficient in interest as a waterfall on account of its want of hight."

Data.

From these descriptions the following data may be eliminated:

Hennepin, 1680—Pyramidal island in the middle of the fall. Hight of fall 50 or 60 feet (or "40 or 50 feet.")

Carver, 1766—Width of river 250 yards (or "about 600 feet;") hight of the fall 30 feet; a small island in the middle of the fall 40 feet broad and "somewhat longer," with hemlock and spruce trees, and another of an acre and a half a little below the falls, with great quantities of eagles' nests; an island also above the falls; an oblique rock in the brink of the falls half way between the island and the east shore, "about five or six feet broad and thirty or forty long."

Pike in 1805—Portage 260 poles; waterfall 16½ feet; width of river above the falls 627 yards; below 209.

Long in 1817—Island 500 yards long divides the cataract and river above and below the falls; channel on the west side three times that on the east side; one-third of the water descends the east channel; waterfall 16½ feet. In the broadest channel, just below the cataract is a small island, 50 yards by 30; both islands rocky, with the same formations as in the banks, "and nearly as high;" two others of inconsiderable size immediately at the foot of the falls, both in the right channel.

Beltrami in 1823—Only distinctly mentions an island in the falls, and an island of sandstone below, with maples.

Keating in 1823—Island in the river both above and below the fall, separating it into two unequal parts, the eastern 230 yards wide, the western 310; the island is 100 yards wide; total width of river at the falls about 594 yards, with rough data; below the fall the river contracts to about 200 yards.

Featherstonhaugh in 1835.—Island 450 yards long divides the

fall unequally ; east channel 220 yards wide, west channel 450 ; fall 20 feet average.

* In 1856, just before the erection of permanent mills, and the diversion of the water so as to disturb the recession, the falls on the west of the island were, in general terms, abreast of the saw-mill of Farnham and Lovejoy. They had a bend upward in the center of the channel, and a sweep downward near the west shore. Their ends were nearly opposite each other. The total width of the river, including Hennepin island, was 1,700 feet at the falls. Putting together the statements of the earliest settlers, the downward sweep of the falls along the east side of the west channel met the island about 100 feet below the lowest portion of the flat undisturbed portion of the limerock on which Farnham and Lovejoy's milldam is erected, the mill itself having originally been erected in a little notch or jog in the falls, partly on the limerock and partly below the falls, close on the shore of the island. Since then the falls in the west channel have receded about 500 feet, hastened by these artificial means ; the falls on the east side, having been more protected, have not receded any perceptible amount.

Considering all these statements, and adjusting their descriptions with each other and with the known position of the Falls in 1856, before the permanent improvements for milling were made, the following conclusions may be made out :

Hennepin saw the falls in 1680, when Spirit island divided them, and their hight was much greater than now. The river gorge is 1,350 feet wide across Spirit island. The confinement of the water in this narrower channel caused the greater hight of the fall.

Carver saw the falls in 1766, just as they were leaving Spirit island and entering on Hennepin island. The "oblique rock" seen was the submerged toe, or lower, rocky end of Hennepin island. No doubt the river completely surrounded the visible part of Hennepin island, *above the brink of the falls ;* the rock, which is its substructure, only showing a small area in the fall. The rhomboidal masses, into which the limerock is cut by pre-existing jointage flaws, would very likely cause an oblique fracture along the brink, as piece after piece fell, as fully detailed by Keating in 1823 in describing the west channel. The width of the whole channel at this point, stated by Carver as about 600 feet, is 1400 feet by careful measurement. The island which Carver's engraving shows above the falls must be intended for Hennepin island which now divides the fall, but is very much out of the right position—even to

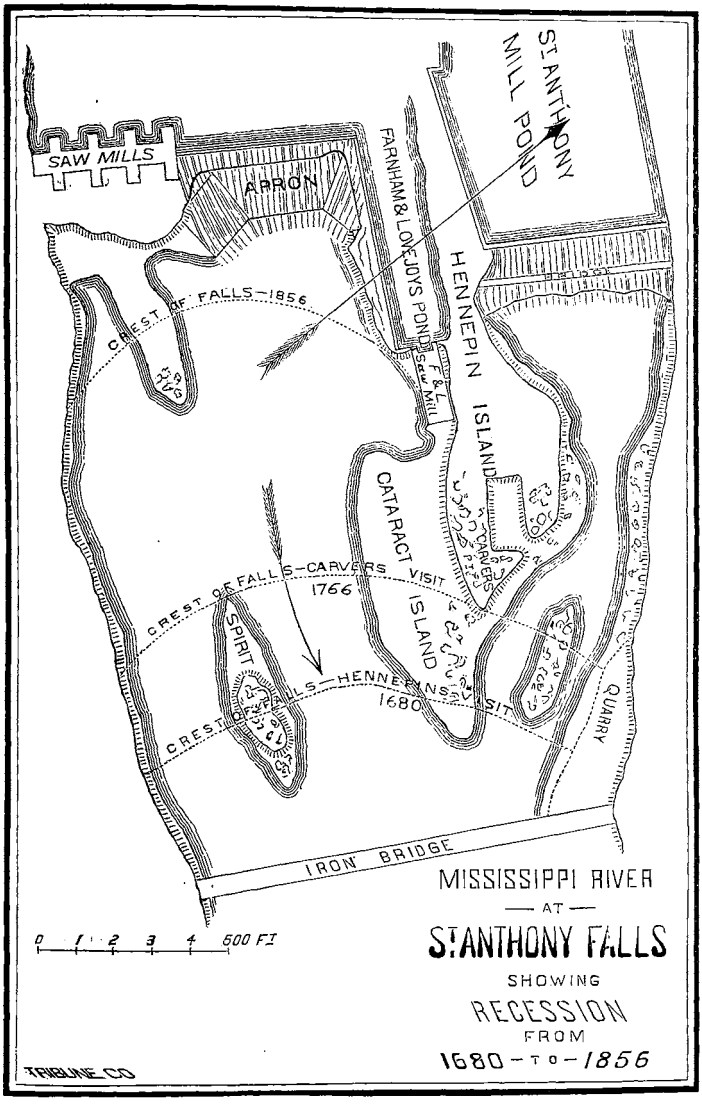
* These statements are made on the authority of Messrs. Chute, Dr. A. E. Johnson and Mr. S. W. Farnham.

represent any island. The island which his engraving shows in the brink of the falls was the upper end of Spirit island, while the low island below the falls, on which he mentions great quantities of eagles nests, can be no other than the lower end of the same island,* the narrow limerock having fallen away in the intervening space, making really (if his engraving shows correctly at this point) two parts, or islands, each being rocky. His engraving is the copy of his pencil-sketch, made probably from memory after he had left the place, and the representation of an island as *low*, which ought to have been *high* and rocky, rendered somewhat necessary to avoid the hiding of the falls, and engraved in London, would be no unexpected error, and would hardly be regarded an imperfection by any but a geologist or a professional artist. It is possible also, if his sketch was made after he left the place, *that there was really but one island of the whole.* His attention had been directed during his stay to *the island with the eagles' nests*, about which he speculates at some length in his journal, and to *the island dividing the falls.* When he came to make his sketch he represented both prominent ideas without regard to the exact manner in which they were topographically related or united; and finding that a continued *high* island would hide the west channel, (his view being from the east bank) which would materially interfere with the general effect of his illustration, he so reduced the hight of the lower portion of the island as to make it appear like another island; the engraver then perpetuated the *appearance*, not knowing the facts. Whichever hypothesis be correct, it is not possible for the island represented in the brink of the falls, to have been Hennepin island. Besides the general agreement of the whole account with the accounts of future travelers, on the supposition of its having been Spirit island, and the statement that it was *in the middle of the falls*, Carver's engraving shows *two men in the act of portage of a canoe along the east shore*, below the falls; showing that the view presented was intended to represent the *principal fall*, (if not the whole,) while the channel on the east of Hennepin island is now, and always has been, since it began, about one-third that on the west side. Thus Carver's description, aided by his very imperfect illustration, fixes the position of the falls in 1766 at the very foot of Hennepin island.

When Lieut. Pike arrived in 1805 probably nothing remained of Spirit island in the brink of the falls, though he gives no description of the falls themselves.

In 1817, when Major S. H. Long first visited them, Hennepin

*Spirit Island (what was left of it) in 1856, was still the abode of eagles.


SAW MILLS
ARRON
FARNHAM & LOVEJOYS POND
ST. ANTHONY MILL POND
HENNEPIN ISLAND
CREST OF FALLS—1856
Saw Mill
CATARACT ISLAND
CREST OF FALLS—CARVERS VISIT 1766
SPIRIT
CREST OF FALLS—HENNEPINS VISIT 1680
QUARRY
IRON BRIDGE
0 1 2 3 4 500 FT
MISSISSIPPI RIVER
— AT —
ST. ANTHONY FALLS
SHOWING
RECESSION
FROM
1680 — TO — 1856
TRIBUNE CO

island divided them unequally, and Spirit island was wholly below the falls, and is described as high and rocky, with the same formations as are seen in the banks of the river. This statement demonstrates the incorrectness of Carver's engraving in this particular. If Carver did not see that high, rocky island, it never could have got there, where it exists still, between his visit and that of Long.

In 1823, Keating and Beltrami saw the falls in pretty much the same position as Long in 1817.

Again, Featherstonhaugh, in 1835, repeats the same general description.

There has been no published careful measurement of the river from Fort Snelling to St. Anthony Falls, but a lining of the map constructed by Gen. G. K. Warren, with the U. S. township and section lines represented, makes the distance almost exactly eight miles. Prof. Rhame has made for the survey a series of triangulations and chain measurements at the falls, and in the gorge below, with the view of finding the distance the falls have receded since Carver's visit to 1856, and also since Hennepin's discovery. A line across the river gorge through Spirit island may represent the position of the falls at the time of their discovery; another across the foot of Hennepin island with an upward curve in the west channel will represent Carver's line of the falls, and another, one hundred feet below the limerock on which stands Farnham and Lovejoy's mill-dam, may represent them in 1856. It is evident that the interval between Carver's time and 1856, is the most reliable datum, the statements of Hennepin not enabling us to determine *at what point* in Spirit island the falls were when he first saw them. Still, for the purpose of comparison, a point has been assumed as that at which they were when abreast of Spirit island at the time of Hennepin's visit, and Prof. Rhame has taken measurements from it. That point is about the middle of the undisturbed limerock of the island, and 415 feet above the line of the upper end of the piers of the lower bridge immediately below, in a large re-entrant angle in the undisturbed limerock on the east side of the island, which angle runs from the top of the limerock to the bottom. The interval between Hennepin's line and that of Carver is 300 feet, between that of Carver's and that of 1856, is 606 feet, making the whole recession since Hennepin 906 feet.

Conclusion.

Between Hennepin, 1680, and 1856, are 176 years; the recession in that time was 906 feet, or an average of 5.15 feet per year.

The time needed at that rate to recede from Fort Snelling would be 8,202 years.

Between Hennepin and Carver are 86 years; the amount of recession was about 300 feet, or 3.49 feet per year. The time needed at that rate to recede from Fort Snelling would be 12,103 years.

Between Carver in 1766, and 1856, were 90 years; the recession in that interval was 606 feet, or 6.73 feet per year; at that rate it would take 6,276 years to recede from Fort Snelling.

The average of these three results is 8,859 years. Still, the exactness of the datum between Carver and 1856, is such that the actual time of such recession is probably more nearly expressed by taking that only into the calculation. This brings the glacial period to a much more recent date than some other means of calculation; but it is probable that no other datum so exact for such a calculation has ever before been used.

The only elements of possible error in this calculation are:—changes in the volume of the river, and incorrect statement for the length of the gorge between the falls and Fort Snelling.

In regard to the first of these elements of uncertainty, it is true that the river may have been larger during the first portion of its occupancy of this channel, on account of the proximity of the glacial ice, and the recession hence more rapid than during the latter; yet the width of the gorge between the rock-bluffs does not perceptibly change from Fort Snelling to the present position of the falls. Indeed, the widest portion of this gorge seems to be where the falls are at the present time. Again, the *datum* for the calculation is all taken from the latter portion of the time involved, and would more than balance any error in the opposite direction. It is not altogether certain, moreover, that an increase of the volume of water would hasten the recession. The rate of recession is dependent on the rapidity of the undermining of the limerock by the retro-action of the falling water on the loose sandrock. While the increased momentum of the water, incident to an increase of volume, would *highten* the falls, by digging deeper into the sandrock, it would by that very change remove further from the limerock the retro-action of the falls, and hence would leave a quantity of undisturbed sandrock to support longer the limerock. In regard to the second element of uncertainty, it would be found that the gorge, if measured carefully, is a little longer than eight miles rather than less.

If the occurrence of our winter in aphelion, caused by the precession of the equinoxes and the revolution of the line of the

apsides, about 11,300 years ago, was the cause of our last glacial period, the greatest *effect* of those causes which had their greatest *force* at that time, was probably felt at a considerably later date, as suggested by Prof. Rhame, in the same manner as the greatest heat of summer is not felt at the same time when the causes which produce it have their greatest activity.

This subject has been treated of by Dr. E. Andrews, in a paper read last year before the Chicago Academy of Sciences, but the writer has only seen a telegraphic newspaper notice of it. The same data employed by Dr. Andrews were furnished the writer by Mr. J. L. Gillespie, of the U. S. Engineers' office, St. Paul, and are employed and extended in the data foregoing.

The reader is referred to the Report of the Chief of Engineers, 1875, Part I, p. 385, for Gen. G. K. Warren's *Essay concerning important physical features exhibited in the valley of the Minnesota river, and upon their signification.*

Neill's history of Minnesota from the French Explorations to the present time.

Father Hennepin's works, published at Paris, Utrecht, London, Amsterdam, and other cities, to the number of twenty-two editions, from 1683 to 1742.

Historical collections of Louisiana, Part IV, contains original narratives of Hennepin and others relative to the early exploration of the Mississippi river, translated into English.

Three years' travels throughout the interior parts of North America. Jonathan Carver, 1766-7-8.

Voyage in a Six-oared Skiff to the Falls of St. Anthony in 1817. By Major Stephen H. Long. Collections of the Minnesota Historical Society.

Narrative Journal of travels from Detroit northwest through the great chain of lakes to the sources of the Mississippi river, in 1820. H. R. Schoolcraft.

Narrative of an expedition to the Sources of the St. Peter, Lake Winnepeek, &c., in 1823, under Major S. H. Long; by W. H. Keating.

Geological Reconnoissance made in 1835 *from the seat of government to the Coteau de Prairie.* G. W. Featherstonhaugh.

Material Resources. Fuel.

There is a large annual cut of cord-wood from the timbered portions of Hennepin county, which finds market at Minneapolis and St. Paul. This comprises sugar maple, iron wood, oak, bass, elm

and soft maple. The price per cord varies with the stringency of the money market. During the past year hard wood has brought five and six dollars per cord. Osseo is an important primary wood-mart; but large quantities are hauled by the first owners directly into Minneapolis. The county is generally heavily wooded, the thinly wooded and prairie portions being along the valleys of the Mississippi and Minnesota rivers, in the southeastern portion.

Building Stone.

The quarries on the east side of the river, most accessible, are owned by the St. Anthony Falls Water Power Company, and are leased by them to various parties, mainly to Patterson and Baxter.

The quarries on Hennepin island are turned over to the Government for use in the tunnel, but are owned by the St. Anthony Falls Water Power Company.

The quarries on Nicollet island are owned by Eastman and Company and are worked by Henry and Abrams.

The Mississippi and Rum river Boom Company have opened some quarries near 13th street north on the east side of the river, and take from the old river bluffs, back from the river, a thin and weathered stone for their piers. There are also a great many openings in the upper portion of the E. Division, by parties owning lots that cover the brink of the Trenton terrace. In these cases attention was called to the rock generally in making excavations for cellars.

The quarries below the University a short distance, furnished the stone for the older portion of the University building. The rest of the building was constructed from quarries on Nicollet island. Quarries are now wrought below the University near the "Old Cheever Landing," by Edward Maloney, and Mr. Malone.

The quarries on the west side of the river are owned by various parties, the whole being cut up into lots according to the city subdivisions. Banks Arenson, Andrew Ernson, Michael Delaney, Holscher and Weeks, Henry Wax and George McMullen own those below the falls opposite the University.

Three-fourths of a mile below these are quarries opened by Franklin Cook and Edward Murphy.

Quarries in Sec. 32, Bloomington, are owned by H. T. Welles and by Mr. Neuser.

The stone taken from these quarries is, in general, an aluminous blue limerock, without much variation in characters. It is true that there are two or more different, distinct, strata, with different

qualities of rock, as described in giving the sections of the Lower Trenton, but the great bulk of the building stone is taken from the same stratum, about 15 ft. in thickness, which is the persistent stratum occupying the immediate brink of the Falls of St. Anthony. The rock of this stratum varies only with the degree of exposure to which it has been subjected, so far as it is seen in Hennepin county.

In the upper part of the city, along the bluffs of the old river, as in the quarries opposite Boom island, and on the county line of Anoka county, this rock is very different, to a considerable depth, from that taken out below the falls. It shows the effects of very long weathering, probably dating from pre-glacial times. These differences are all accounted for by the known effect of water and iron, with the aid of time, on the shale with which the Lower Trenton is permeated. The thin sheets of shale, which appear as dark belts of irregular and crooked direction on the newly-cut face of a "dimension stone," begin to decompose after the lapse of a number of years, causing a shattering and splitting of the whole mass. When the change takes place under the surface of the earth, but where the natural surface waters get free access, the iron that always accompanies such water, aided by the pyrites of the rock itself, gives a rusty and dirty, or yellowish color to the rock to a considerable depth. This is marked sometimes by the slow decomposition of the limestone itself, and by the sprinkling of sand or loam that covers the rock. In the face of these changes it is no wonder that a great many who have not watched them closely should be firmly persuaded that the different aspects could not be assumed by the same rock.

Stone sells from 50 cents per perch of 16½ feet (for "gray rock") to 65 cents. This is for rough, non-dimension stone. For range rock, ("blue stone,") water table, 75 cents to $1.00 per foot, cut; uncut 15 to 18 cents per foot.

Brick and Pottery.

There is a small pottery establishment in upper St. Anthony, owned by Louis Kampf, the clay being taken from the Mississippi bank adjoining. The jars are light-colored, but not cream-colored.

The following brick-yards were noted in Hennepin county:

Peterson and Swansen, N. E. ¼ Sec. 12, Crystal Lake, above the mouth of Shingle creek. The brick made here are cream-colored; except, if poorly burnt, the topmost tier of the kiln has a reddish color. They are molded in water. Although this is the first year

this yard has been opened, it will turn out about 700,000. Delivered in Minneapolis these brick sell for $8.00 per thousand ; at the yard for $7.00 per thousand. Mixed wood costs $2.25 to $2.50 per cord.

The Union Brick Company, (Baxter, Woodward and McNair,) Minneapolis, have made two and a half millions the present season (1876 ;) generally burn five millions per year. Sell for $9.00 per thousand, average price. Soft wood (basswood) costs $3.25 to $3.50 per cord ; mixed wood (all kinds except hard maple and basswood) costs $3.75 to $4.00 per cord delivered at the yard. For a description of the clay the reader is referred to the drift-sections preceding. The brick are cream-colored.

Daniel Woodbury's yard is a short distance above the Union Brick Company's yard, within the valley of Bassett's creek, and he uses the same general deposit of clay, but perhaps encounters more calcareous matter in the form of concretions and bivalve shells. His brick are cream-colored, and also reddish. Mixed wood costs here $3.25, delivered ; makes 400,000 per year, selling at $8.50 per thousand, or $9.00, according to the haul.

At Dayton, brick are made by Medorre Arseno, his yard being the same as that occupied 21 years ago by Lyman Dayton, situated on the north side of Crow river. The brick, which sell for $8.50 per thousand, at the kiln, are generally of a cream color, but those from the outside of the kiln are tinged with red. Two or three kilns per year are made here. Mixed wood is worth $1.50 per cord ; hard wood $2.00.

In Upper St. Anthony the old brick-yard of Charles Grotjann has been closed. The brick made were red, and were not readily saleable.

Geo. Erhardt has opened a new yard at the N. end of Lake Calhoun, and sells red brick at $8.00 per thousand, or $8.50 delivered.

Quick-lime.

There has been some lime burnt from the Lower Trenton at Minneapolis, but nothing is being done at the present time. There is one old pot-kiln, below the falls, within the river gorge, built of lime-rock, owned by ———

Levi Guia burns lime from boulders at Dayton. His kiln has been erected eleven years, and is emptied sometimes to the number of six times per year. He sells at Anoka, Princeton, Elk River, Monticello and Dayton, and sometimes at Minneapolis, from $1.50

to $1.75 per barrel. Another establishment of the same kind is run at Frankfort, in Wright county, by Mr. Burnings, and another at Otsego by Mr. Ingleson.

Mills and Water-powers.

The following extracts, from the Annual Report of the Minneapolis Board of Trade for 1876, by C. C. Sturtevant, secretary, convey a correct idea of the importance of the water-powers of Hennepin county, and particularly of the Falls of St. Anthony;

"The vast water power which has given to Minneapolis her pre-eminence as the great manufacturing centre of the Northwest, and is destined to make it the chief commercial city of the State, is furnished by the Mississippi river, which has a fall of 82 feet within the city limits. The volume of water passing over these falls and rapids at the ordinary stage has been estimated by competent engineers at 120,000 horse-power. Most of it can be used with the present improvements with from 40 to 60 feet head, and the entire flow is available for manufacturing purposes. The first practical use made of this power was in 1848, when a dam was built from Hennepin island to the east shore, and four saw mills erected on it. It was not till 1857, however, that the present substantial improvements were fairly inaugurated. On the 26th of February, 1856, the St. Anthony Falls Water Power Company was chartered by the Territorial Legislature, and on the 27th of the same month and year the Minneapolis Mill Company was chartered. Both charters are perpetual, the former controlling the water from the centre of the channel on the west side of Hennepin island to the east shore, the latter from the same point to the west shore.

"Robert Smith, of Alton, Illinois, was the first president of the Minneapolis Mill Company, and in 1857, W. D. Washburn, Esq., was appointed secretary and agent. The same year C. H. Bigelow, of Lawrence, Mass., a civil and hydraulic engineer, made surveys and submitted plans for improving the water-power of the Mill Company. The construction of the dam and opening of the canal, commenced in September, 1857, and the dam was completed in January, 1858. The first flouring mill (the Cataract) was built by Eastman and Gibson the same year.

"The appliances for controlling and utilizing the water-power of this company consist of a low or waste dam built on the ledge, commencing in the center of the channel of the river and connecting with the dam of the St. Anthony Water-Power Company,

thence running down stream diagonally toward the westerly shore 400 feet; thence a high dam again down the stream, parallel with the shore 500 feet, forming a pond above the mills; thence at right angels 400 feet to the pier at the head of the canal, upon which last portion is built the block of saw mills. With this dam a head of 13 feet is obtained, and a sufficient supply of water is directed to the canal, while the large proportion of the water passes over the low dam and is wasted on the falls.

"The canal is excavated along the shore 350 feet to a point opposite the brink of the fall, of a width narrowing from 80 feet to 55 feet, and below this point 500 feet further of a uniform width of 55 feet, and carrying a depth of 14 feet of water.

"The mills located upon the property improved by the Minneapolis Mill Company are as follows:

(1.) *Upon or near the canal and supplied with water therefrom.*

Sixteen Flouring Mills, 181 runs of stone.
One Woolen Mill.
One Cotton Mill.
One Iron Works.
One Railroad Machine Shop.
One Planing Mill, Sash, Door and Blind Factory.
One Paper Mill.
One 300,000 bushel Grain Elevator.
One Machine Shop.
One Mill-furnishing Shop.
One Carding Mill.

(2.) *Upon the dam of the Company:*

Seven Saw-mills, having nine gangs, seven double circulars, and other appropriate machinery; daily capacity 900,000 feet.

(3.) *Upon the river bank above the canal, and discharging water through the First street tunnel:*

One Saw Mill.
One Planing Mill.
One Machine Shop.
The City Water Works.

"The total amount of power utilized by the Company is about 4,500 horse power.

"The present officers of the Company are Gen. C. C. Washburn, President; R. J. Baldwin, Treasurer; William D. Hale, Secretary and Agent; C. C. Washburn, D. Morrison, W. D. Washburn, R. J. Baldwin and C. J. Martin, Directors.

"The improvements of the St. Anthony Falls Water Power Company consist of a dam from the east shore to Hennepin island, 400 feet up the shore of Hennepin island, 650 feet from head of island, west 200 feet, thence diagonally to the dam of the Minneapolis Mill Company, 600 feet; total length of dam, 1,850 feet. The Company has sold eight saw-mill sites on the dam in the east channel, which, together with two flouring mills, one machine shop, and other mills, renting power for manufacturing purposes, utilize about 1,300 horse power under varying heads.

"The whole water-fall on the Company's lands is 69 feet. In all further developments it will be the aim of the Company to use the water under a head of from 40 to 60 feet, voiding the water through a tunnel, or tail-race, now excavated in the sand-rock under the limestone ledge.

"The original improvements, made at an early day, amounting to some twenty mills, of different kinds, were destroyed, mainly by fire, some eight years since, and have been replaced by substantial structures. The Company are now in a condition to utilize to the highest capacity the power controlled by them, and it offers to manufacturers a field unsurpassed in the Northwest.

"The present officers of the company are Richard Chute, President; Samuel H. Chute, Agent; Ernest Ortman, Treasurer.

"In addition to the mills located on the power controlled by these companies there is one large paper mill and one double saw mill in operation. By the above it will be seen that only a small portion of this vast water-power is now in use, while the improvements of these companies have rendered the whole flow of water available."

* * * * * * * * * * *

"The permanency of this water power is now established beyond a question. There was a time when fears were expressed that the ledge which forms the falls might at some future day be swept away by the action of the water; but all apprehensions of such a catastrophe are at an end. The Government in providing for the improvement of the navigation of the river above, aided by the water power companies and the city, has now completed such works as render the falls secure for all future time."

Flouring Mills in operation in Minneapolis in 1876.

	Name.	When Built.	Number Runs of Stone.	Name of Firm.
1.	Cataract	1859	10	D. R. Barber and Son.
2.	Union	1860	5	Darrow and Dibble.
3.	Arctic	1861	5	Hobart, Shuler & Co.
4.	Pillsbury	1865	11	C. A. Pillsbury & Co.
5.	Minneapolis	1865	9	Crocker, Fisk & Co.
6.	Washburn B	1865	11	Washburn & Hazard.
7.	Dakota	1867	6	S. S. Brown & Co.
8.	Zenith	1871	6	Day, Rollins & Co.
9.	City	1862	5	J. C. Berry & Co.
10.	North Star	1870	5	H. J. G. Crosswell.
11.	Holly	1872	4	W. F. Cahill & Co.
12.	Empire	1872	9	C. A. Pillsbury & Co.
13.	Palisade	1873	11	L. Day & Sons.
14.	Washburn A	1873	41	J. A. Christian & Co.
15.	Galaxy	1874	12	W. P. Ankeny.
16.	Anchor	1874	12	C A. Pillsbury & Co.
17.	Hennepin	1875	6	Mills, Thompson & Co.
18.	Humboldt	1875	6	Bull, Newton & Co.
19.	Phœnix	1876	5	Stamwitz and Shober.
20.	Pettit and Robinson	1876	15	Pettit and Robinson.

"The product of the foregoing mills for the year 1876 was as follows:

	Product.	Value.
Flour, barrels	1,135,160	$6,810,960
Bran, tons	50,945	509,450
		$7,320,410

"The total shipment of flour, in car lots, from Minneapolis by rail during the year 1876, amounts to 1,000,676 barrels. A large quantity is shipped in small lots, and sent out by teams, while the city consumption amounts to 40,000 barrels. There were also 50,000 barrels in store in the city. These several amounts make up the difference between the production and the shipment.

Lumber Mills in operation in Minneapolis in 1876.

Owner.	Lumber.	Shingles.	Lath.
Morrison Bros.	13,597,000	1,645,000	2,565,000
J. Dean & Co	14,128,164	6,955,000	1,650,850
Pettit & Robinson	8,000,000	3,500,000	850,000
Minneapolis Lumber Co	17,000,000	5,000,000	.....
J. B. Bassett	8,500,000	3,000,000	2,000,000
Eastman and Bovey	10,200,000	3,000,000	1,300,000
Farnham & Lovejoy	23,500,000	.....	.....
O. C. Merriman	19,936,404	2,701,750	2,319,500
Minneapolis Mill Co., two mills	12,557,537	2,580,500	2,818,000
Elias Moses	8,000,000	3,000,000	2,000,000
F. P. Clark	11,500,000	.....	2,000,000
McMullen & Co	2,000,000	10,000,000	.....
F. G. Mayo	3,850,000	4,600,000	450,000
Todd, Haven, Leavitt & Co	9,500,000	4,500,000	500,000
W. C. Baker, Assignee	13,752,172	4,522,000	1,406,000
Lee Brothers & Co	500,000	5,000,000	.....
Wm. H. Eldred	.....	23,000,000	.....
Jno. Gains	8,000,000	2,000,000	1,500,000
	184,521,277	85,004,250	21,359,350

"The production of lumber was the first manufacturing industry introduced into Minneapolis, and has added more largely to the population of the city than any other branch of business. The first mill was erected in 1848, but all the original mills built have given place to new and improved structures. At this time there are eighteen sawmills and one shingle mill in the city. Nearly all the saw mills have shingle and lath mills attached. The lumber product is distributed through the states of Minnesota, Iowa, Missouri, Kansas, Nebraska, and the territory of Dakota. The most of it is shipped by rail, although a small portion is rafted below the falls and floated down the Mississippi river to St. Louis and other points."

Mills in operation in Hennepin County outside the city of Minneapolis.

Pratt and Baird, Richfield P. O.; custom and ship to Minneapolis; 4 runs of stone; seven feet head; dam in Minnehaha creek.

Craik and Sons, Edina Mills (also known as the Red Mills;) dam in Minnehaha creek; 13 feet head; 4 runs of stone; custom and ships at Minneapolis.

Metz and Peacka, below Minnehaha Falls; dam in Minnehaha creek; 11 feet head; two runs of stone; custom.

Baxter and Northway, Champlin ; Champlin Mills ; two runs of stone ; Elm Creek power ; fall 16 feet ; shipping and custom.

Weitzel and Hurlbut, Dayton ; Dayton Mills ; Crow river power ; fall 9 feet ; five runs of stone ; ships at Itasca.

Henry Weitzel, sec. 10, Maple Grove ; Maple Grove Mills ; Elm creek power ; 12 feet fall ; two runs of stone ; custom.

McAfee and company, N. W. ¼ sec. 21, Bloomington ; Bloomington Mill ; 26 feet head ; three runs of stone.

Balm Brothers, sec. 26, Eden Prairie ; Eden Prairie Mills; two runs of stone.

Minnetonka Mill Company, Minnetonka City ; Minnetonka Mills ; dam in Minnehaha creek ; 12 feet head ; seven runs of stone ; shipping.

Herrick, Douglas & Co., on Minnehaha creek ; Globe Mills ; eight feet head ; four runs of stone ; shipping.

Medicinal Waters.

Some of the springs of the county have a local repute for medicinal qualities. The Chalybeate Springs of Minneapolis consist of a copious discharge of water from the top of the shale layer between the main calcareous members of the Lower Trenton in the bluff of the river. They are situated just below the falls, on the east side of the river. The overlying layer of limerock is parted along some planes and allows the water to enter it, but the shale is nearly impervious, and sheds it. The water is not originally from the rock, but is the drainage from the drift, and the bog swamp east of St. Anthony. It probably derives its iron from the ferriferous drift of the bluffs east of St. Anthony; passes into the swamp, deposits, after evaporation, a considerable iron as a bog iron ore, and carries on what it does not leave in the swamp, penetrating the gravelly and sandy drift between the swamp and the river bank. The iron is deposited as a peroxide on the rock over which the water runs. The taste of the water is very pleasant, and is similar to that of a number of wells, which afford Chalybeate water, situated further back from the river and on the margin of the swamp. Although this water is known as Chalybeate, from the copious deposit of iron it gives on exposure to the air, yet the quantity of iron present is very small.

On analysis Mr. S. Dana Hayes, of Boston, has said: "When heated it evolves gas ; after some evaporation it becomes opalescent, and finally deposits a precipitate, while it becomes more and more alkaline. It has the chemical character, and is strictly an

alkaline mineral water, resembling well-known waters found in the northern part of Vermont, and in Germany and elsewhere in Europe." Mr. Hayes gives the following

Analysis.

"One United States gallon, or 231 cubic inches, contains nineteen and eighty-four hundredths grains of solid dry mineral matter, consisting of:

Potash	1.257
Soda	1.900
Sodium	.060
Lime	5.394
Magnesia	1.589
Ammonia	Trace
Alumina	Trace
Protoxide of Iron	.028
Sulphuric acid	.117
Chlorine	.104
Silicic acid	.645
Carbonic acid, combined	8.106
Crenic acid, organic	640
Total	19.840

"These elements are probably combined in the water forming the following salts and compounds:

Carbonate of potash	Sulphate of potash.
Carbonate of soda	Silicate of soda.
Carbonate of lime	Chloride of Sodium.
Carbonate of magnesia	Crenate of iron, etc.

"All the corbonates named exist in the state of bicarbonates; and the gases present are carbonic acid, oxygen and nitrogen; the water containing three and three-tenths volumes of mixed gases in one hundred volumes of water. The aeration of this water renders it a pleasant beverage, and prevents the sense of heaviness after it has been drank in quantities. Beside the alternative medicinal qualities possessed by this water when taken internally, it will be found beneficial in hot and cold baths, especially in certain cases of skin disease. And it may be bottled and kept, retaining all its virtues for months without material alteration."

The Russell Mineral Spring, situated near the margin of the

same swamp, is described by Prof. Peckham on page 61, of the general report for 1876. This water has nearly the same chemical composition as that above mentioned, and within less than a grain the same total solid matter per gallon, deposits on exposure a peroxide of iron, and is probably from another drainage course from the same general reservoir—the peat marsh lying between the river and the drift bluffs, on the east side of the river.

At points a little further down the river, near the University, the water that runs down the bluff from springs issuing near the top of the bluff, deposits a calcareous tufa, which, in favorable circumstances, has become several feet thick. When the spattering water falls on moss, which often grows in such damp spots, it covers the moss with a film of carbonate of lime which, by gradually increasing, imprisons the moss, killing it, but takes its form and even its name, the moss itself gradually oxidizing and passing off in the air, as grass decays on the prairie. The deposit—loose and spongy—is then known as "Petrified Moss."

The "Great Medicine Spring," an old resort for the Indians, is situated a few miles west of Minneapolis, on the land of Mr. Wales. It also is chalybeate, but its exact chemical qualities are not known.

Earthworks.

Hennepin county presents a rich field for the anthropologist, a field, however, which has not been much explored. In the survey of the county artificial mounds were seen in a number of places; the following were noted:

There are two large mounds on the south bank of Crow river, at Dayton, forty feet across and about ten feet in hight.

Four are on Mr. Aaron Hoag's land, sec. 18, Hassan.

There is another large mound on James Ream's land, two miles above Dayton, on the north side of the river.

There are a great many mounds along the Minnesota river, above Fort Snelling; two or three on sec. 1, Bloomington; one is on the road near Mr. Van Ness', near the line between sections 1 and 12, Bloomington They occur on Mr. Brosseau's land, sec. 14, and frequently, along the bluff, further up, as far as Shakopee at least.

There is a large mound on sec. 27, Eden Prairie, visible for some distance across the prairie.

There is a mound on S. E. ¼ sec. 1, Minnetonka, near Wayzata.

At Mound City, at the western end of Lake Minnetonka, are

"about 40" mounds on Sec 24, Minnetrista. A number of others are on Nobles island, near the same place ; others are on N. Saunders' farm near Halstead's Bay, Sec. 22. There are others at Excelsior, on P. M. Gideon's land, Sec. 28.

Some at Palmer's lake have been opened by members of the Minnesota Academy of Natural Sciences, and their contents described by Dr. A. E. Johnson. A fine specimen of a shin-bone, characteristic of the Mound-Builders was taken from a mound at Palmer lake.

On the land of James Shaver, NW. ¼ Sec. 17, Minnetonka, are a great many mounds. In the summer of 1875 a number of these were located by chain and compass by a party from the Minnesota Academy of Sciences. They were found to lie on the bluff and knolls overlooking the water of the lake, following the higher land, without regard to direction or relative position. No plan or order was discernable, though about 20 were carefully surveyed. They vary in height from two or three feet to five or six, and from ten feet in diameter to forty. There are in that neighborhood fifty or more within the area of a quarter-section of land.

Eight mounds of the same kind are seen on Widow Ferguson's land, Sec. 23, Excelsior, also overlooking the lake. Others are on NW. ¼ Sec. 11, Medina, land of Albert Johnson ; and on Samuel Barto's, Sec. 7, Minnetonka ; a large one is on the first high point east of Gale's island, on Big island.

IX.

REPORT ON THE GENERAL MUSEUM.

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY; FOR THE YEAR 1876.

By N. H. Winchell, Curator.

During the Fall of 1875 the cases designed for the Museum were completed so far as they had been contracted for, and during the Christmas vacation they were filled by the display of the Ward Casts. Another larger case was immediately built in the same room for the reception of the mounted mammals. Thus three sides of the room were occupied with suitable cases. In the center were placed some of the larger of the casts, including the Glyptodon, and the Mastodon, on pedestals. The Megatherium is also designed for this group, but has not yet been unboxed. It became evident at once that the room, even if supplied with all the cases it could contain, was too small to accommodate the collections on hand. The Regents have concluded therefore to carry out the original plan and to devote the other large room, across the hall from the first, to a strictly geological and mineralogical cabinet, reserving the first mainly for zoological specimens.

Several boxes of fossils belonging to the survey were opened and carefully studied and labeled during the summer, but owing to the lack of suitable cases they were retained in the geological laboratory. Mr. Herrick labeled the shells on exhibition that were purchased of H. T. Woodman, and collected about a hundred native birds. These are not mounted, but are skinned and stuffed.

The Museum has had large accessions during the year through donations and purchases at the Centennial Exhibition. Some of these specimens have been catalogued and labeled, as may be seen

by the accompanying statement, but the most of them have not. The principal donors were the following:

The Geological Survey of Canada, through A. R. C. Selwyn, Director.
The Central Pacific R. R. California.
The Pennsylvania Diamond Drill Company.
The Wisconsin Geological Survey, through Mr. E. T. Sweet.
The Pacific Guano Company.
The Kentucky Geological Survey, through John R. Proctor, Secretary of the Survey.
Tennessee Centennial Commission, through Gen. J. T. Wilder.
The Land Department of the Little Rock and Fort Smith R. R.
The Selma, Rome and Dalton R. R. Alabama.

Some minerals also were purchased at favorable rates of Mr. Herbert R. Saunders and of Prof. A. E. Foote.

The most important addition to the mineralogical collections made during the year was in the purchase of the entire cabinet collection of Mr. Geo. F. Kunz, of Hoboken, N. J. This has not been received yet at the University, and is not enumerated in the following catalogue. In general it embraces a complete set of zinc and iron ores, and species, so far as they can be got in the locality of Franklin and Ogdensburg, N. J.; also a collection prepared by the late Charles Clifton, for Owen's college, England; also a general series of mineral species in excess of the foregoing zinc and iron compounds amounting to at least 125 species, with many duplicates. Fifteen boxes of this collection have been received. There are still about twenty more. No systematic attempt has been made to catalogue the zoological specimens. The following is a list of the geological and mineralogical specimens so far as they have been examined and labeled:

CATALOGUE OF THE GEOLOGICAL AND MINERALOGICAL SPECIMENS OF THE MUSEUM, TO DECEMBER 31, 1876.

Serial No.	Obtained. When	Obtained. Whence.	Name.	No of Specimens.	Locality.	Formation.	Collector and Remarks.
1	1869 ?	Dalmellington Iron Com., Ayrshire, Scotland	Black band Iron-stone	1	Ayrshire, Scotland	Coal Meas.	Prof. G. Campbell.
2	"	" "	" " " " calcined	1	" "	"	" "
3	"	" "	Iron ore	1	" "	"	" "
4	"	" "	Core from drill ?	2	" "	"	" "
5	"	" "		1	" "	"	" "
6	"	" "	Calamites sp. ?	2	" "	"	" "
7	"	" "	Lepidodendron sp. ?	1	" "	"	" "
8	"	" "	Lepidodendron sp. ?	1	" "	"	" "
9	"	" "		1	" "	"	" "
10	"	" "		1	" "	"	" "
11	"	" "	(Conchifers)	7	" "	"	" "
12	"	" "	No. 1 Pig Iron	1	" "	"	" "
13	"	New Commock, Ayrshire.	Lammark Cannel Coal	1	" "	"	" "
14	"	Dundee, Scotland	Shark's tooth	1	Dundee, Scotland		" "
15	"	Dalmellington, Scotland	Iron ore. (Haematite) with quartz	4	Ayrshire, Scotland		" "
16	"		Cinnabar	2	Europe		" "
17	"		Iron pyrites	5	"		" "
18	"		Pyritiferous conglomerate. (Auriferous)	3	"		" "
19	"		Iron ore. "Parkside"	1	Whitehaven, Eng		" "
20	"		Chert, flinty	1	Whitehead, Ireland.		" "
21	"	Rome, Italy	Samples of the building-stone of ancient Rome, Palaces about the Forum and Palatine Hill	20			" "
22	"		Orthis and Strophomena	3		Trenton	" "
23	"		Ormoceras tenuifilum, Hall. (Cephalopod)	2		" ?	" "
24	"	H. P. Van Cleve	Endoceras magniventrum, H. "	1	Mendota, Minn	Trenton	
25	"		Leptaena deltoidea. Con	1	Minneapolis	"	Records doubtful.
26	"		Calcite	Many		Metamorphic.	No records of any kind.

Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
27	.....	.....	Amygdaloid with Epidote.....	1	.....	Metamorphic.	No records.
28	.....	.....	Amygdaloid with Epidote.....	2	.....	"	" "
29	.....	.....	Calcite as a segregated vein in Argillite.	1	.....	"	" "
30	.....	.....	Calcite in Argillite (or Jasper).....	1	.....	"	" "
31	.....	.....	Porphyrytic Granite.....	1	.....	.....	" "
32	.....	.....	Franklinite.....	1	Franklin, N. J.....	.....	" "
33	.....	.....	Syenite.....	1	.....	.....	" "
34	.....	.....	Marble (rosy).....	1	.....	.....	" "
35	.....	.....	Quartzite.....	1	.....	.....	" "
36	.....	.....	Mica Schist.....	1	.....	.....	" "
37	.....	.....	White Sandstone.....	1	.....	.....	" "
38	.....	.....	Grit.....	1	.....	.....	" "
39	.....	.....	Conglomerate.....	1	.....	.....	" "
40	.....	.....	Marble (reddish).....	1	.....	.....	" "
41	.....	.....	Marble (white).....	4	.....	.....	" "
42	.....	.....	Hydromia Slate	1	.....	.....	" "
43	.....	.....	Catlinite.....	1	Pipestone Co., Minn..	Potsdam.....	" "
44	.....	.....	Syenite ?.....	1	St. Cloud.....	.....	Seems to contain only Labordorite and Quartz.
45	.....	.....	Granite ?.....	1	.....	.....	No records of any kind.
46	.....	.....	Calciferous Sandrock.....	1	.....	Lower Mag ...	" " "
47	.....	.....	Gypsum	2	Fort Dodge, Iowa....	.....	" " "
48	.....	.....	Gneiss.....	1	.....	.....	" " "
49	.....	.....	Grit	1	.....	.....	" " "
50	.....	.....	Pyrites and Chert.....	1	.....	.....	" " "

Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
51	.....	.....	Quartz in Greenstone.....	1	.....	.....	No records of any kind.
52	.....	.....	Saccharoidal marble.....	1	.....	.....	" "
53	.....	.....	Serpentine rock, (Ophiolyte.).	1	.....	.....	" "
54	1872	J. F. Kenworthy...	.....	4	.....	Hamilton.....	Records in doubt.
55	"	" ..	.....	2	.....	"	" "
56	"	" ..	.....	17	.....	"	" "
57	"	" ..	.....	4	.....	"	" "
58	"	" ..	.....	10	.....	"	" "
59	"	" ..	.....	7	.....	"	" "
60	"	" ..	.....	1	.....	"	" "
61	"	" ..	.....	1	.....	"	" "
62	"	" ..	.....	7	.....	"	" "
63	"	" ..	.....	1	.....	"	" "
64	"	" ..	.....	2	.....	"	" "
65	"	" ..	.....	1	.....	"	" "
66	"	" ..	.....	56	.....	"	" "
67	"	" ..	.....	1	.....	"	" "
68	.....	.....	Haematite (botryoidal),.....	1	.....	.....	No records whatever.
69	.....	.....	Galenite.....	23	.....	.....	" "
70	.....	.....	Calcite.....	2	.....	.....	" "
71	.....	.....	Pyrite.....	9	.....	.....	" "
72	.....	.....	Pyrite and Galenite.....	1	.....	.....	" "
73	.....	Dr. Stoneman	Glass quartz.....	2	.....	.....	Records doubtful.
74	.....	"	Strophomena alternata. Con.	1	.....	Trenton.	" "
75	.....	"	Strophomena alternata. Con.	1	.....	"	" "

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
76			Lead	1		Trenton ?	Records doubtful.
77		Dr. Stoneman	Cyathophylloids	3		"	" "
78		" "	Chaetetes sp.?	2		"	" "
79		" "	Chaetetes Lycoperdon. H.	7		"	" "
80		" "	Chaetetes sp.?	1		"	" "
81		" "	Crinoid stems	3		"	" "
82		" "	Orthis lynx	1		"	" "
83		" "	Resembles in shape Pleurotomaria subconica.	2			Has not the proper surface markings.
84		" "	Murchisonia ventricosa. H. (or perangulata.)	1			Records doubtful.
85		" "	Drusy Quartz	1			" "
86		" "	Native Copper	1			" "
87		" "	Barite	2			" "
88		" "	Selenite	1	Kansas		" "
89		" "	Endoceras angusticameratum. H.	1		Trenton	" "
90		" "	Fossiliferous Limestone	1		"	" "
91		" "	?	1			" "
92		" "	Quartzite pebble	1			" "
93		" "	Conglomerate	1			" "
94		" "	Strophomena sp.?	2			" "
95		" "	Strophomena sp.?	3			" "
96		" "	Strophomena sp.?	3			" "
97		Prof. Beardsley	"Variegated marble"	1	West Rutland, Vt		
98		" "	"Traprock"	1	Mt. Holyoke, Mass.		
99		" "	New Red Sandstone	1			
100		" "	Conglomerate. New Red Sandstone	1	Mt. Holyoke, Mass.		

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
101	.....	Prof. Beardsley.....	"Jasper".....	1	W. Rutland, Vt.....	.....	.....
102	.....	" "	"Chalcopyrite"	1	S. Hampton, Mass...	.....	.....
103	.....	" "	"Copper Pyrites".....	2	" " ...	.....	.....
104	.....	" "	Chalcopyrites and Chrysocolla.....	1	? ...	.....	.....
105	.....	" "	"Serpentine".....	1	Chester, Mass.....	.....	.....
106	.....	" "	"Margarite".....	5	" "	.....	.....
107	.....	" "	"Muscovite and Quartz".....	1	?	.....	.....
108	.....	" "	"Soapstone with Garnets".....	1	Chester, Mass.....	.....	.....
109	.....	" "	"Garnets" in Soapstone.....	1	" "	.....	.....
110	.....	" "	"Talc".....	1	" "	.....	.....
111	.....	" "	"Steatite".....	1	" "	.....	.....
112	.....	" "	"Emery".....	1	" "	.....	.....
113	.....	" "	"Hornblende".....	1	" "	.....	.....
114	.....	" "	"Serpentine".....	1	" "	.....	.....
115	.....	" "	"Emery Mine".....	1	" "	.....	.....
116	.....	" "	"Corundum".....	4	" "	.....	.....
117	.....	" "	"Corundum".....	1	" "	.....	.....
118	.....	" "	"Galena".....	2	S. Hampton, Mass...	.....	Lead Mines at S. Hampton.
119	.....	" "	"Talcose Schist".....	2	" " ...	.....	.....
120	.....	" "	Calcite on opalescent and drusy Quartz.....	1	" " ...	.....	.....
121	.....	" "	Quartz.....	2	" " ...	.....	.....
122	.....	" "	Calcite and (actinolite ?).....	1	" " ...	.....	.....
123	.....	" "	.....	1	" " ...	.....	.....
124	.....	" "	"Galena".....	.....	" " ...	.....	.....
125	.....	Burdett Thayer.....	Large crystal of Quartz.....	.....	Near Montreal, Ont..	.....	.....

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
126	Oct. 1872..	Geol. Sur	Endoceras magniventrum. Hall	3	Mantorville.....	Galena.....	N. H. Winchell.
127	"	W. D. Hurlburt.. ...	Endoceras magniventrum. Hall....	1	Near Rochester.....	"	"
128	"	"	. . ..	1	"	"	"
129	"	Geol. Sur.....	....	1	Mantorville.....	"	"
130	"	" "	.....	1	Mantorville ?	Trenton ...	"
131	"	" "	Orthoceras multicameratum. Con.	1	Pettit's Mill.....	" ...	"
132	Sept. 1875	" "	Endoceras magniventrum. Hall....	9	Sec 7, Viola, Olm. Co.....	Galena	M. W. Harrington.
133	"	W. P. Farrell.....	Endoceras proteiforme. Hall.....	2	NE¼, Sec. 32, Dover, Olm. Co..	"	M. W. Harrington.
134	Oct 1875.	John Kleckler.. ...	Lituites undatus. Con.....	1	2 ms. N.E. Spring Valley.....	Trenton ...	N. H. Winchell.
135	Sept. 1875	Geol. Sur....	Endoceras magniventrum. Hall....	1	Sec. 7, Viola, Olm. Co	Galena....	M. W. Harrington.
136	"	" "	.....	2	. ...	" ...	"
137	Oct. 1875.	" "	Endoceras magniventrum. Hall....	2	Fountain, Fill. Co.....	Trenton ...	N. H. Winchell.
138	"	John Kleckler	Endoceras distans.....	1	2 ms. N.E. Spring Valley.....	" ...	"
139	Oct. 1872.	Geol. Sur..... ...	Endoceras magniventrum. Hall....	1	Mantorville	Galena.....	"
140	Oct. 1875.	John Kleckler	. ...	1	2 ms. N.E. Spring Valley.....	Trenton ...	"
141	"	" "	.....	1	" " "	" ..	"
142	Sept. 1875	Geol. Surv.....	Endoceras magniventrum. Hall....	1	Olmsted Co.....	" ...	M. W. Harrington.
143	"	Rev. H. P. Satchwell.	....	1	Salem, Olm. Co.....	" ...	" (Quarry of John Vosburg.)
144	"	Geol. Surv.....	Endoceras proteiforme Hall.....	4	Cascade, Olm. Co.....	" ...	" (Jenkins' Quarry.)
145	Jan. 1876	S. H. Chute.....	Endoceras magniventrum. Hall....	2	Minneapolis, E.....	" ...	N. H. Winchell (From green shales.)
146	.....	W. P. Farrell.....	Receptaculites sp.?	1	N.E.¼, Sec. 32, Dover, Olm. Co.	Galena.....	M. W. Harrington.
147	1875.....	Geol. Surv	Receptaculites Oweni. Hall.....	3	Sec. 7, Viola, Olm. Co	"	"
148	1875.....	" "	....	1	Fillmore Co.....	"	N. H Winchell.
149	1875.....	Geo. Shepard.....	....	1	"	"	"
150	1875.....	Geol. Surv.....	Receptaculites occidentalis. Sal ...	1	Jordan, Fillmore Co	Trenton ...	"

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
151	Oct. 1875	Geol. Surv.	Chaetetes ?	2	Chatfield	Trenton	N. H. Winchell.
152	Sept. "	" "	Receptaculites Oweni. Hall	2	Sec. 17, Rochester, Olm. Co.	Galena	M. W. Harrington.
153	" "	" "	Receptaculites Oweni. Hall	1	" " "	Galena	"
154	Oct. "	" "	'Receptaculites globularis. H." (After M. & W.)	1	Chatfield	L. Trenton	N. H. Winchell. (Ill. Rep., Vol. III, p. 301.)
155	Sept. "	" "	Endoceras proteiforme. Var. strangulatum. H.	1	Cascade, Olmsted Co.	L. Trenton	M.W. Harrington. (Jenkins' q'ry.)
156	Oct. "	" "		1	Sec. 20, Beaver, Fill. Co.	Devonian	N. H. Winchell.
157	Sept. "	" "	Receptaculites Oweni Hall	1	Sec. 17, Rochester, Olm. Co.	Galena	M.W.Harrington. (Garrick's q'ry.)
158	" "	" "	Receptaculites. sp. ?	1	" " "	Galena	" "
159	" "	" "	Ormoceras tenuifilium. Hall	2	" " "	Gray Limestone.	" (below Garrick's q.)
160	" "	" "	Receptaculites. sp. ?	1	" " "	Galena	" (Garrick's q'ry)
161	" "	" "	Receptaculites Oweni. Hall	4	" " "	Galena	" "
162	" "	" "	Petraia corniculum. Hall	1	" " "	Galena	" "
163	" "	" "	Illaenus latidorsata. Hall ?	1	" " "	Galena	" "
164	" "	" "	Receptaculites Oweni. Hall	1	Olmsted county	Galena	" "
165	Oct. "	" "	Maclurea magna. Hall	1	Weisbach's Mill, Fill. Co.	Trenton	N. H. Winchell.
166	July "	" "	Maclurea magna ?	1	Northfield ?	Shakopee	"
167	Sept. "	" "	Receptaculites occidentalis. Sal. ?	2	Mantorville, Dodge Co.	Galena	S. Wilson.
168	" "	" "	Conularia Trentonensis. Hall	1	" " Wilson's quarry.	Galena	The longitudinal striæ are not quite like the figures of Hall, Plate 59. M. W. Harrington. (Upper layer.)
169	" "	" "	Receptaculites. sp. ?	1	Rochester, Olmsted Co	Galena	M. W. Harrington.
170	Oct. "	" "	Chaetetes. ?	1	2 miles N. E. Spring Valley.	Trenton	N. H. Winchell.
171	ept. "	" "		2	No. 7, Viola, Olm. Co.	Galena	M. W. Harrington.
172	" "	" "		1	" " "	Galena	"
173	Oct. "	" "	Productus. ?	4	Spring Valley	Galena. ?	N. H. Winchell.
174	Sept. "	" "	Strophomena. sp. ?	1	Garrick's quarry, Rochester	Galena	M. W. Harrington.
175	Oct. "	" "		1	Etna, Fillmore Co	Drift	N. H. Winchell.

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
176	1875	Geol. Sur.	Murchisonia bicincta. Hall. ..... Isotelus gigas. Hall. Orthis?..... Streptelasma corniculum. H. Leptaena? Murchisonia perangulata. Hall..... Murchisonia angustata. H.....	2	Rochester, (Garrick's quarry.).	Galena.....	M. W. Harrington.
177	"	"	Rhynchonella sp. ?.....	1	" "	"	" "
178	"	"	Murchisonia bellicincta. Hall	1	" "	"	" " Shows no siphuncle.
179	"	" "	Non-septate, portion of an orthoceras shell.	1	" "	"	" "
180	1872	" "	Strophomena deltoidea. Con.....	1	Minneapolis.	Trenton....	N. H. Winchell.
181	"	" "	" recta. Con.....	2	St. Charles.....	" ...	N. H Winchell. Cast of the interior of the concave or ventral valve with the crenulated striæ of the dorsal valve preserved on the margin. Pal. Foss. p. 130.
182	1875	" "	" alternata. Con.....	1	Rochester, (Garrick's quarry.)	Galena.....	M. W. Harrington.
183	"	" "	Pleurotomaria umbilicata. Hall.....	1	" "	"	" "
184	"	" "	" ambigua. Hall..... (or umbilicata.)	1	" "	"	" "
185	"	" "	.....	8	Fillmore County.....	Trenton....	N. H. Winchell.
186	"	" "	.....	1	" "	"	" "
187	"	" "	Orthis ?.....	1	" "	Galena.....	" "
188	"	" "	.....	1	Spring Valley.....	"	" "
189	"	" "	.....	1	Fillmore County	Trenton....	" "
190	"	" "	.....	1	" "	"	" "
191	"	" "	.....	1	" "	"	" "
192	"	" "	.....	1	" "	"	" "
193	"	" "	Strophomena sp. ?	1	" "	"	" "
194	"	" "	.....	1	" "	"	" "
195	"	" "	.....	1	" "	"	" "
196	"	" "	Pleurotomaria lenticularis. Con.....	1	" "	"	" "
197	"	" "	Orthoceratite ?.....	1	" "	"	" "
198	.....	" "	.....	1	Spring Valley	"	" "
199	.....	" "	Strophomena deltoidea. Con.....	3	Minnehaha	"	" "
200	.....	" "	.....	1	"	"	" "

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
201	.....	Geol. Surv.....	Strophomena deltoidea. Con.....	1	Minnehaha	Trenton....	N. H. Winchell.
202	.....	" "	Edmondiea subtruncata. Hall ?.....	2	"	"	"
203	.....	" "	Strophomena deltoidea. Con...	2	"	" ...	"
204	1875.	" "	" tenuistriata, Sow. (allied to)	2	Sec. 17, Rochester, Olmsted Co	Galena....	M. W. Harrington.
205	"	" "	Receptaculites ?.....	1	" "	"	M. W. Harrington.
206	"	" "	Chaetetes Sp, ?.....	1	Finn's Glen, Minneapolis.....	Trenton....	N. H. Winchell.
207	"	" "	Petraia corniculum. Hall.....	1	Sec. 17, Rochester, Olmsted Co	Galena.....	M. W. Harrington.
208	"	" "	....	1	" "	"	"
209	"	" "	Strophomena tenuistriata ?..... Phacops rana ?	1	" "	"	"
210	"	" "	.....	1	High Forest.....	.....	....
211	"	" "	Chaetetes petropolitanus. Pand..	1	2 miles N. E. Spring Valley...	Trenton....	N. H. Winchell.
212	"	" "	....	1	" " " " ...	"	"
213	"	" "	Endoceras distans. Hall.....	1	" " " " ...	"	"
214	"	" "	....	1	Spring Valley.....	Galeua.....	"
216	"	" "	Pleurotomaria umbilicata. Hall,.....	1	St. Anthony	Trenton....	"
217	"	" "	....	1	Rochester, (Garrick's Quarry)	Galena.....	M. W. Harrington.
218	Oct. 1872.	" "	Murchisonia subfusiformis. Hall.....	1	Mantorville, (Pettit's Mill) ...	Trenton....	N. H. Winchell, (compare 343 and 255.)
219	"	" "	....	1	" " " " ..	" " ..	M. W. Harrington.
220	Sept. 1875.	" "	Orthis, Leptaena nucleata (?)..... Productus. Atrypa. 428 and 299.	1	Sec. 22, Bloomfield	Galena ?...	N. H. Winchell.
221	.....	" "	.....	1	Chester, Iowa.....	Devonian..	"
222	.....	" "	....	1	" "	" ..	"
223	.....	" "	....	2	" "	" ..	"
224	....	" "	....	1	" "	" ..	"
225	Oct. 1875.	" "	....	1	" "	" ..	"

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
226	Oct. 1875	Geol. Surv		2	Forreston, Iowa	Galena	N. H. Winchell.
227	"	" "	Spirifer. Productus and Leptaena nucleata?.	1	Spring Valley	" ?	"
228	"	" "	Strophomena sp.?	1	Fillmore County	Trenton	"
229	"	" "	Spirifer sp.?	1	Spring Valley	Galena?	"
230	"	" "	"	1	" "	"	"
231	"	" "	Orthis testudinaria. Dal	1	" "	Galena	"
232	"	" "	Strophomena fluctuosa. Bill	1	" "	"	"
233	June, 1873	" "	Cyclonema?	1	Finn's Glen, Minneapolis	Trenton	"
234	"	" "	Spirifer sp.?	1	Spring Valley	Galena?	"
235	Oct. 1875	" "	Productus sp.? (distorted.)	1	" "	" ?	"
236	"	" "	Orthis testudinaria. Dal	1	" "	Galena	"
237	"	" "		1	" "	"	"
238	"	" "	Spirifer and Productus	1	" "	Galena?	"
239	"	" "		1	Chatfield	Trenton	"
240	"	" "		6	High Forest		"
241	"	" "	Orthoceras, with remains of trilobites	2	Holden, Goodhue Co.	Trenton	"
242	"	" "		2	" "	"	"
243	"	" "		1	" "	"	"
244	"	" "		1	" "	"	"
245	"	" "		3	" "	"	"
246	"	" "		1	" "		"
247	"	" "		1	" "		"
248	"	" "		3	Sec. 20, Beaver, Fillmore Co.	Devonian	"
249	"	" "		5	" "	"	"
250	"	" "		2	" "	"	"

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
251	Oct. 1875	Geol. Surv.	Maclurea Logani. Sal.....	14	Lime City, Fillmore Co.....	Trenton....	N. H. Winchell.
252	July 1876	" "	.....	1	Holden, Goodhue Co.....	"	" "
253	Oct. 1875	" "	Maclurea magna. Hall.....	1	Lime City, Fillmore Co.....	"	" "
254	" "	" "	.....	1	" "	"	" "
255	" "	" "	Murchisonia subfusiformis. Hall?....	1	" "	"	" " compare 343 & 318
256	" "	" "	Receptaculites occidentalis. Sal.....	1	" "	"	" "
257	" "	" "	Receptaculites Owẽni. Hall.....	1	" "	"	" "
258	" "	" "	.....	3	" "	"	" "
259	" "	" "	Chaetetes Lycoperdon. Hall	37	Fillmore, Fill. Co., (Shepherd's quarry).....	"	" "
260	Sept. 1875	" "	Fragment of trilobite shield?.....	1	Mantorville.....	Galena.....	M. W. Harrington.
261	" "	" "	Strophomena sp.?.....	1	"	"	" "
262	" "	" "	" fluctuosa. Bill.....	1	"	"	" "
263	" "	" "	Discina Pelopea. Bill.....	1	"	"	" "
264	Sep. 1875	" "	.....	2	Olmsted Co.....	Trenton ...	" "
265	Oct. 1875	" "	.....	2	Sec. 26, Bloomfield, Fill. Co.....	Galena.....	N. H. Winchell.
266	" "	" "	Rhynchonella capax. Con. (increbescens of Hall.) Has the internal markings of Atrypa but the shape of a Rhynchonella. ? (Eatonia ?).....	.....	Fillmore, Fill. Co.....	Trenton ...	" "
267	" "	" "	.....	24	Spring Valley.....	Galena?....	" "
268	" "	" "	....	1	Sec 26, Bloomfield.....	"	" "
269	" "	" "	.....	1	Sec. 30, Forestville, Fill. Co.....	Trenton....	" "
270	" "	" "	Same as No. 267, (shows a number of fragments).....	2	Spring Valley.....	Galena?....	" "
271	" "	" "	Slab with Strophomena sp.?.....	1	Mantorville, Dodge Co.....	Trenton ...	M. W. Harrington.
272	" "	" "	Orthis testudinaria. Dal....	Indefinite	Spring Valley.....	Galena.....	N. H. Winchell.
273	" "	" "	Orthis plicatella. Hall.....	1	" "	"	The dorsal beak is but slightly more prominent than that of the ventral valve. The casts of the interior of the dorsal valve are not with a "subquadrangular visceral impression" Pal. N. Y. I., p. 126.
274	" "	" "	" subquadrata. Hall. ?	Indefinite	" "	"	
275	" "	" "	Strophomena nitens, Bill?..	3	" "	" ...	The areas seem not to form an angle greater than 90°.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
276	Oct. 1875	Geol. Surv.	Petraia. ?	1	Spring Valley	Galena	N. H. Winchell.
277	" "	" "	Cast of an Orthis. (not subquadrata.)	1	"	"	"
278	" "	" "	Orthis Plicatella. Hall. (v. 273.)	2	"	"	"
279	" "	" "		4	"	"	"
280	" "	" "	Leptaena nucleata. (v. 220)	2	Sec. 22, Bloomfield	" ?	"
281	" "	" "	Chaetetes. (Or Bolboporites, Geol. Can., p. 124.)	3	Minneapolis	Trenton	"
282	" "	" "	Chaetetes Lycoperdon. Hall	1	"	"	"
283	" "	" "	Rhynchonella capax. Con.	1	"	"	"
284	Sept. "	" "	Murchisonia bellicincta. Hall	1	Sumner tp., Fillmore Co.	"	Geo. Ten Eyck. (N. H. W.)
285	" "	" "	Pleurotomaria. sp. ?	1	" "	"	" "
286	" "	" "	(Resembles Macrocheilus.)	1	" "	"	" "
287	" "	" "	Strophomena alternata. Con.	1	" "	"	" "
288	" "	" "	Maclurea Logani. Sal. (with a Strophomena attached).	1	" "	"	" "
289	" "	" "		1	Wasioja, Dodge Co.	Galena	M. W. Harrington.
290	" "	" "	Orthis. sp. ?	1	Rochester. (Garrick's q.)	"	"
291	" "	" "	Lingula quadrata. Eich	2	Olmsted Co	Trenton	W. D. Hurlburt.
292	" "	" "	Chaetetes. (And a fucoidal fragment.)	5	Sec. 25, Cascade, Olm. Co.		M. W. Harrington.
293	" "	" "		2	Mantorville, Dodge Co.	Galena	" (Upper layers Wilson's quarry.)
294	" "	" "		1	" "	"	M. W. Harrington.
295	" "	" "		1	" "	"	"
296	" "	" "		1	" "	"	"
297	" "	" "	Strophomena fluctuosa. Bill	1	" "	"	N. H. Winchell—Has a part of a pygidium of a trilobite.
298	Oct. "	" "		1	High Forest		N. H. Winchell.
299	" "	" "	Atrypa ? Eatonia ? (v. 220 and 428)	2	Sec. 22, Bloomfield	Galena ?	"
300	" "	" "		1	" "	"	"

Catalogue of the Geological and Mineralogical Specimens of the Museum to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
301	1875.....	Geol. Surv.	Productus ?..... ...	1	Sec. 22, Bloomfield, Fill. Co.	Galena ?.....	N. H. Winchell.
302	"	" "	....	2	Forestville, Fill. Co	Maquoketa.....	" (S.E. qr. Sec. 20.)
303	Oct. 1875	" "	.....	1	Lime Springs, Iowa.....	Niagara.....	"
304	"	" "	Orthoceras multicameratum. Con.	1	Minneapolis.....	Trenton	"
305	"	" "	Murchisonia bellicincta. Hall.....	1	Sec. 2, Forestville, Fill. Co..	"	"
306	"	" "	Pleurotomaria umbilicata. Hall....	1	" " " ..	"	"
307	"	" "	....	1	Sec. 21, " " ..	"	"
308	"	" "	....	1	Lime Springs, Iowa	Niagara.....	"
309	"	" "	Lingula Cobourgensis. Bill..... ...	1	Chatfield, Fillmore Co.....	Trenton	"
310	"	" "	Chaetetes petropolitanus. Pander...	1	Rochester.....	"	W. D. Hurlburt.
311	"	" "	.....	2	Spring Valley	Galena ?.....	N. H. Winchell.
312	"	" "	Orthis occidentalis. Hall? v. 220...	1	" "	" ?.....	N. H. Winchell—Resembles Leptaena nucleata H. of the Oriskany. (Ill Rep. III. p. 393, Pl. 8, fig. 8.)
313	June, 1873	" "	Chaetetes sp. ?	Indefinite	Finn's Glen, Minneapolis...	Trenton	N. H. Winchell. (Probably not a Cha-
314	Oct. 1873	" "	Productus?.....	1	Spring Valley.....	Galena ?.....	[etetes.) "
315	"	" "	.....	1	" "	"	"
316	"	" "	.....	1	" "	Niagara.....	"
317	"	" "	.....	1	" "	"	"
318	"	" "	Petraia corniculum. Hall.....	1	Minneapolis....	Trenton	"
319	"	" "	Petraia? sp.?	1	"	"	"
320	"	" "	Edmondia ventricosa. Hall.....	4	"	"	"
321	"	" "	....	6	"	"	"
322	"	" "	... .	3	"	"	"
323	"	" "	....	3	"	"	"
324	"	" "	....	5	"	"	"
325	"	" "	.....	1	"	"	"

Serial No.	Obtained. When	Obtained. Whence.	Name.	Number of Specimens.	Locality.	Formation.	Collector and Remarks.
326	1876.	Geol. Surv...		2	Minneapolis	Trenton...	N. H. Winchell.
327	"	" " ..		2	"	"	"
328	"	" " ..	Atrypa. ?.....(v. 220)	1	"	"	"
329	"	" " ..		1	Spring Valley	.....	J. Kleckler.
330	1873.	" " ..	Chaetetes Lycoperdon. Hall	Indefinite.	Finn's Glen, Minneapolis	"	N. H. Winchell.
331	"	" " ..		6	" "	"	"
332	"	" " ..	Murchisonia bicincta. Hall	1	" "	"	"
333	"	" " ..	Pleurotomaria subconica. Hall	1	" "	"	"
334	"	" " ..		4	" "	"	"
335	"	" " ..		1	" "	"	"
336	"	" " ..		3	" "	"	"
337	"	" " ..	Bellerophon bilobatus. Sow	2	" "	"	"
338	"	" " ..	Endoceras magniventrum. Hall	2	Rochester, Olmsted Co	"	N. H. Winchell, Whitcomb's Quarry.
339	1872.	" " ..		11	" "	"	N. H. Winchell, Whitcomb's Quarry.
340	"	" " ..	Isotelus gigas. Hall. Asaphus platycephalus. Stokes	1	" "	"	N. H. Winchell, Whitcomb's Quarry.
341	"	" " ..	Murchisonia bellicincta. Hall	1	Pettit's Mill, Mantorville	"	N. H. Winchell.
342	"	" " ..	Chaetetes petropolitanus. Pander	3	" "	"	"
343	"	" " ..	Murchisonia subfusiformis. Hall ?	1	" "	"	"
344	"	" " ..	Receptaculites occidentalis. Salter ?	2	Sec. 16, Pleasant Grove, Olm. Co	"	"
345	"	" " ..	Strophomena filitexta. Hall. (Dorsal valve)	1	" " "	"	" as described by Billings (i. e. changing the name of the valve.)
346	"	" " ..		2	Rochester, Olmsted Co	"	N. H. Winchell.
347	"	" " ..		1	Sec. 16, Pleasant Grove, Olm. Co	"	"
348	"	" " ..		2	" " "	"	"
349	"	" " ..	Murchisonia bicincta. Hall	1	" " "	"	"
350	"	" " ..		2	" " "	"	"

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	Number of Specimens.	Locality.	Formation.	Collector and Remarks.
351	Oct. 1872	Geol. Surv.....	.....	2	Pettit's Mill.....	Trenton....	N. H. Winchell.
352	"	" "	.....	1	Pleasant Grove.....	" ..	"
353	"	" "	Strophomena deltoidea. Con.....	1	St. Anthony	" ..	"
354	"	" "	Pleurotomaria umbilicata. Hall.....	1	Rochester, Olmsted Co	" ..	"
355	"	" "	Murchisonia bicincta. Hall.....	1	"	" ..	"
356	"	" " ...	.....	3	Pleasant Grove.....	" ..	"
357	"	" "	Chaetetes Lycoperdon. Hall(or stenopora fibrosa. Gold.)	4	Pettit's Mill	" ..	"
358	"	" "	Slabs of Trenton (fossiliferous).....	10	" "	" ..	"
359	"	" "	Receptaculites Oweni. Hall.....	4	Near Rochester, Olmsted Co.	Galena	"
360	"	" "	Has the same as 371, which may not be Strophomena...	1	" " "	"	"
361	"	" "	Ambonychia bellistriata. Hall?.....	1	" " "	Trenton....	"
362	"	" "	.....	1	" " "	Galena	"
363	"	" "	Murchisonia bellicincta. Hall.....	1	" " "	"	"
364	"	" " ...	Petraia corniculum. Hall.....	1	" " "	"	"
365	"	" "	.....	1	" " "	"	"
366	"	" " ...	Ambonychia?.....	1	" " "	"	"
367	"	" "	Isotelus gigas. DeKay. (Caudal shield.).....	1	" " "	" ...	"
368	"	" "	Endoceras magniventrum. Hall.....	1	" " "	"	"
369	"	" "	Strophomena fluctuosa Bill.....	1	" " "	"	"
370	"	" " ...	Rhynchonella capax. Con	3	Finn's Glen, Minneapolis	Trenton....	"
371	"	" "	Strophomena (tenuistriata? v. No. 204.)	1	Near Rochester, Olmsted Co.	Galena	"
372	"	" "	" "	1	" " "	"	"
373	"	" "	" "	1	" " "	"	"
374	"	" "	Orthis testudinaria. Dal.....	12	St. Charles.....	Trenton....	"
375	"	" "	Orthis testudinaria. Dal. Strophomena deltoidea. Con. Asaphus platycephalus. Rhynchonella bisulcata. Hall.	1	" "	" ..	"

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	Number of Specimens.	Locality.	Formation.	Collector and Remarks.
376	Oct. 1872...	Geol. Surv.....	.....	1	St. Charles..... ...	Trenton....	N. H. Winchell.
377	" " ...	" "	.....	1	"	" ...	" "
378	" " ...	" "	Strophomena deltoidea. Con.....	1	"	" ...	" "
379	" " ...	" " ...	.....	1	"	" ...	" "
380	" " ...	" "	Atrypa reticularis.....	1	" ?.....	" ...	" "
381	" " ...	" " ...	.....	1	"	" ...	" "
382	" " ...	" "	.....	3	"	" ...	" " Cast of the interior of the
383	" " ...	" "	Strophomena (sp. unidentifiable)(v. 391.) Graptolithus, Lingula. Strophomena, Orthis....	1	Mantorville.....	Galena	" " [convex valve.
384	" " ...	" "	Orthoceras? and Pentremites.? (v. Fauna Silurienne. p. 106, fig. 60).....	1	"	"	" "
385	" " ...	" " ...	Strophomena alternata. Con	1	"	"	" " may be alternistriata. Hall.
386	" " ...	" "	Graptolithus. sp. nov	1	"	"	" "
387	" " ...	" "	Strophomena sp.?	1	"	"	" " cast of the interior of
388	" " ...	" "	Fragment of trilobite shield?.....	1	"	"	" " [convex valve.
389	" " ...	" "	Strophomena sp.?.....	1	"	"	" "
390	" " ...	" "	.....	1	"	Trenton....	" "
391	" " ...	" "	Strophomena (sp. unidentifiable) (v. 383).....	1	"	Galena	" "
392	" " ...	" "	.....	1	"	Trenton. ..	" "
393	" " ...	" "	Lingula sp.?.....	1	"	" ...	" "
394	" " ...	" "	Strophomena sp.?	1	.....	Galena	" "
395	" " ...	" "	.....	1	Minneapolis.....	Trenton....	" "
396	" 1875...	" "	Orthis subquadrata. Hall.....	1	Spring Valley.....	Galena	" "
397	" 1871?..	" "	Ammonites communis.....	1	Paris Basin. Fr.....	Tertiary...	
398	" " ?..	Dr. Stoneman..	Orthoceras bilineatum. Hall.....	1	Minneapolis.....	Trenton?..	Records doubtful
399	" 1872...	W. D. Hurlburt	Caudal extremity of trilobite.....	1	Trenton Falls, N. Y.	" ...	
400	" " ...	" " ..	Stenopora petropolitana. Pander. Or Chaetetes Lycoperdon. Hall. or Chaetetes petropolitanus. M. & W.....	1	" "	" ...	

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
401	1874.....	W. W. McNair.....	Cinnebar ore	1	California	....	From the New Almaden Mines.
402	Oct. 28, 1872	J. W. Pomeroy	Native Copper.....	3	.....	?	Probably from Lake Superior Mines.
403	" "	"	Copper Scoria	1	.....	.....	" " "
404	Jan. 10, 1873	J. Clarence Bryant.	Fern Leaves.....	3	Illinois Coal Measures.	Coal Meas.	
405	.....	G. D. B. Bainbridge	Talc. (Soapstone.).....	1	.....	.....	
406	1872	S. D. Haskin.....	Straparollus Minnesotensis. (Pl. II, figs. 12 & 13.) (v. Pal. N. Y., I, Pl. 3, fig. 1.).....	1	[dan Sandstone. Traverse Des Sioux, Jor-	Jordan	32 feet from surface of ground, 20 feet from [top of rock.
407	Jan. 6, 1875.	Burdett Thayer...	Large Crystal of Quartz.....	1	.....	... .	
408	Oct. 1872....	Geological Survey.	Pseudomorph after Pyrites.....	1	Winona.....	L. Mag.....	N. H. Winchell.
409	" ...	" "	Orthoceras junceum. Hall	1	St. Charles.....	Trenton ...	"
410	" ...	" "	.....	1	"	.....	"
411	Sept. 1875...	W. D. Hurlburt....	Isotelus gigas. Hall. (Cast.) Asaphus.	1	.....	Trenton ...	M. W. Harrington.
412	Oct. " ...	Geological Survey.	Galena	1	Near Rochester.....	Galena	Found on the surface.
413	" " ...	" "	Surface bog-ore.....	1	" Mantorville.....	.....	" "
414	Sept. " ...	" "	Asaphus. sp. ? (Or Bathyurus.)....	1	Rochester	Trenton....	Presented by W. D. Hurlburt.
415	Oct. " ...	" "	Siliceous iron ore	1	4 ms. N.W. Cannon Falls	Potsdam...	N. H. Winchell. (At Valentine's. See Andreas' Map.)
416	Jan. 8, 1875..	James Hinton.....	" " ..... [tion.	1	Quincy, Olmsted Co....	" ...	Obtained as a boulder at Quincy. It is magnetic and is known as "Loadstone."
417	July, 1873...	Geological Survey.	Cretaceous sandstone, with vegeta-	1	8 miles below New Ulm.	Cretaceous.	Fritz' quarry. Left branch of Minn. R.
418	Aug. 1876...	" "	Siliceous iron ore	4	4 miles w. Cannon Falls	Potsdam...	N. H. Winchell. (At Valentine's. See Andreas' Map.)
419	Oct. 1872....	" "	Isotelus gigas. Hall. (Cast.).....	1	Mantorville.....	Galena	Presented by Frank Wilson.
420	"	" "	Receptaculites ?	1	Near Rochester.....	"	N. H. Winchell.
421	"	" "	Isotelus gigas. Hall..... (Cast)	1	" "	"	"
422	" ...	" "		1	Mantorville.....	"	Presented by Frank Wilson.
423	"	" "	.....	1	Near Rochester	"	N. H. Winchell.
424	Apr. 1876...	J. A. Armstrong...	Mountain Bank (Penn.) soft coal....	1	.....	Coal Meas.	"
425	" ...	" ...	Briar Hill (Ohio) soft coal.....	1	.....	"	"

Serial No.	Obtained. When.	Obtained. Whence.	Name.	Number of Specimens.	Locality.	Formation.	Collector and Remarks.
426	April 1876	A. J. Armstrong.....	Anthracite, Penn. Hard coal.....	1	Lehigh, Penn....	Coal Meas.	N. H. Winchell.
427	" "	" "	Canton Shaft, Illinois. Soft coal...	1	Canton, Ill.....	"	"
428	Oct. 1875	Geol. Surv...	Atrypa ?.	13	Spring Valley	Galena ?...	"
429	" "	" "	Orthis occidentalis. Hall.....	1	" "	Galena.....	"
430	" "	" "	Strophomena fluctuosa. Bill.....	5	" "	"	The specimens are smaller than stated by Billings. (Pal. Fos. p. 124.)
431	Sept. 1875	" "	Murchisonia bicincta. Hall ?.....	1	Mantorville.....	"	M. W. Harrington.
432	Oct. 1872	" "	Rhaphistoma lapicida. Salter ?....	2	Rochester, Olmsted Co.	Trenton....	N. H. Winchell
433	" 1875	" "	....	2	Chatfield, Fillmore Co.	"	"
434	" 1872	" "	Orthis testudinaria. Dal. Orthoceras, Strophomena deltoidea. Con. Cyrtoceras. Rhaphistoma lapicida. Sal.? Murchisonia. Isotelus gigas. Hall. Licahas sp. ?	1	Rochester, Olmsted Co.	"	" (Slab.)
435	" "	" "	Strophomena deltoidea. Con. Orthis testudinaria. Dal. Asaphus platycephalus. Lichas. ? Lingula quadrata. Eich	1	" "	"	" "
436	" "	" "	Atrypa recurvirostra. Hall	5	St. Charles, Winona Co.	"	"
437	" "	" "	....	....	....	.....	
438	" "	" "	Rhynchonella bisulcata. Hall.....	1	" "	"	"
439	" "	" "	Rhynchonella capax. Con.....	1	" "	"	"
440	" "	" "	Slab with Rhynchonella, Orthis and Strophomena.....	1	" "	"	"
441	Nov. 1876	Centennial Exhibition.	Cannel Coal.....	1	Greenup Co., Ky.....	Coal Meas..	N. H. Winchell, from the Kentucky Survey.
442	" "	" "	Itacolumite	1	Mariposa Co., Cal.....	.....	" Purchased of A. E. Foot.
443	" "	" "	Beryl.....	1	Ackworth, N. H.....	.....	" " "
444	" "	" "	Crystalized Brown Haematite.....	4	Stewart Co., W. Tenn..	....	" From Tenn. Commissioners
445	" "	" "	" " "	1	Brierfield, Ala.....	.....	" From S. W. Baird.
446	" "	" "	Haematite	4	——Kentucky.....	.....	" From Kentucky Survey.
447	" "	" "	Magnetic Oxide of Iron.....	7	Port Henry, N. Y.....	.....	"
448	" "	" "	Ochreous Brown Haematite	1	——Pennsyvania...	.....	" From Penn. Commissioners
449	" "	" "	Crystals of Franklinite.....	1	Franklin, N. Y.....	.....	" Purchased of Geo. Kunz.
450	" "	" "	Sulphate of Strontia.....	1	Ontario.....	.....	" From Geol. Surv. of Canada

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451	Oct. 1876	Cent. Exp.	Apatite	1	Bedford, Ontario		N. H. Winchell, Geol. Surv. of Canada.
452	"	"	Carbonate of Zinc	1	Union Co., Tenn		" Tenn. Commissioners.
453	"	"	Albertite	3	Albert Co., N. B		" Geol. Surv. of Canada.
454	"	"	"	Indefi	Canada		" P. 57, Canada Catalogue.
455	"	"	Sapphire	1	Near Franklin, N. J		" Geol. Surv. of Canada.
456	"	"	Antimony Ore	1	Prince William, N. B		" Purchased of Geo. F. Kunz.
457	"	"	Spathic Iron Ore	1	Sutherland's R., N. S		" Geol. Surv. of Canada.
458	"	"	Gmelinite, Natrolite and Datholite	1	Bergen Hill, N. J		" " "
459	"	"	Magnetite	1	Crosby, Ont		" Purchased of Geo. F. Kunz.
460	"	"	Fluor Spar coated with Pyrites	1	Thunder B., B A		" Geol. Surv. of Canada.
461	"	"	Copper Pyrites in micaceous sandstone.	2	Alleghany Co., N. C		" Purchased of A. E. Foote.
462	"	"	Coal. (Said to be nearly pure carbon)	1	Poplar Creek, E. Tenn		"
463	"	"	Magnetite	3	New Bed Mine, Port Henry, N.Y.		" 7 ft. thick.
464	"	"	Semi-Anthracite Coal	1	Rockwood, Tenn		"
465	"	"	Ankerite (ferriferous dolomite)	1	Canada		" 104 ft. thick.
466	"	"	Brier Hill Coal	2	Ohio		" Geol. Surv. of Canada.
467	"	"	Quartz Crystals	4	Herkimer Co., N. Y.	Calciferous	"
468	"	Geol. Surv.	Crag	1	Banks of Crow R., Hennepin Co.	Drift	Purchased of Geo. F. Kunz.
469	"	Cent. Exp.	Haematite and Magnetite	1	Hull, Ottawa		N. H. Winchell.
470	"	"	Sulp. Baryta	1	Two Islands, N. S		Geol. Surv. of Canada.
471	"	"	Dolomite, with crystals of Magnetite and carb. of Manganese	1	Sutton, Quebec		" "
472	"	"	Sussexite (containing Magnesia.)	1	Franklin, N. J		" "
473	"	"	Amazon Stone (smaller crystals)	5	Pike's Peak, Col		Geo. F. Kunz.
474	"	"	Spinel	1	Orange Co., N. Y / Harvey Hill Mine		Purchased of A. E. Foote.
475	"	"	Veined Copper Ore	2			" "
							Geol. Surv. of Canada. See p. 29, No. 10. a. & b. Canada Cat.

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
476	Nov. 1876	Centen'l Exposition.	Chromic Iron ore	1	Bolton, Quebec		Geol. Surv. of Canada.
477	"	" "	Crysoprase. (Cut.)	1	S. Park, Col		A. E. Foote, cut at Oberstein, Ger.
478	"	" "	Agate. (Cut.)	2	" "		" " " " "
479	"	" "	Black Agate. (Cut.)	1	" "		" " " " "
480	"	" "	Moss Agate. (Cut.)	2	" "		" " " " "
481	"	" "	Cuprite on Copper	1	England		" "
482	"	" "	Native Copper	1	Lake Superior		" "
483	"	" "	Embolite	1	Silver City, N. Mexico		" "
484	"	" "	Rutile	1	Georgia		" "
485	"	" "	Celestite and Sulphur	1	Sicily		" "
486	"	" "	Orthoclace. Amazon Stone	3	Pike's Peak, Col.		" "
487	"	" "	Milky Quartz	1	Lake Superior		" "
488	"	" "	Ruby	3	Near Franklin, N. J.		Geo. F. Kunz.
489	"	" "	Amethyst	1	Amethyst Harbor, L. Sup		N. H. Winchell, Geol. Surv. of Canada.
490	"	" "	Calymene Senaria. (Trilobite.)	1	Warren Co., Ohio		A. E. Foote.
491	"	" "	Azurite	1	Chesse, France		" "
492	"	" "	Bornite	1	Mt. Catine, Tuscany		" "
493	"	" "	Smoky Quartz, Cairngorm Stone and Smoky Topaz	1	Pike's Peak, Col.		" "
494	"	" "	Saponite, *var.* Agalmatalite	1	Cherokee Co., N. C		" "
495	"	" "	Wavellite	1	Montgomery Co., Ark		" "
496	"	" "	Fossiliferous Iron ore	2	Pilot Knob, McMun Co., E. Tenn.		Gen. Wilder.
497	"	" "	Magnetite	1	Chattanooga, Tenn		" "
498	"	" "	Brown Haematite	7	" "		" "
499	1875	Prof. Laing	Sulphuret of Copper	1	Bolton, Quebec		
500	"	"	Plumbago	1	Canada West		

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Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
501	1875	Prof. Laing	Asbestos		South Stokely, Quebec		
502	"	"	Concretions	3	N. W. Iowa		
503	"	"	Galena ore	1	Galena, Ill		
504	"	"	Calcite	1	Brompton, Quebec		
505	"	"	Copper (native)	3	Lake Superior		
506	"	"	Coral	1			
507	"	"	"	1			
508	"	"	"	2			
509	"	"	"	1			
510	"	"	Chaetetes sp.? Coral	1			
511	"	"	Petraia sp.? "	1			
512	"	"	Coral	1			
513	"	"	Pleurotomaria umbilicata. Hall	1			
514	"	"	Fragment of a crinoid stem	1			
515	"	"	Spirifer sp.?	1			
516	"	"	Fragment of a crustacean	1			
517	"	"	Iron ores	4			
518	"	"		1			
519	"	"	Volcanic products	2	Sandwich Islands		
520	1871	D. A. Roe	Greenstone, veined with epidote	1	St. Croix Falls	Igneous	D. A. Roe.
521	"	"	Porphyritic Greenstone	1	" "	"	D. A. Roe.
522	"	"	Porphyry (Red crystals of Feldspar)	2	" "	"	"
523	"	"	Epidotic Rock	1	" "	"	"
524	"	"	Greenstone	1	" "	"	"
525	1873	I. J. Rochussen	Cathnite (cut in form of a book)	1	Pipestone Quarry	Potsdam	"

Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
526	1871 ?	?	Claystones	10	Massachusetts		?
527	"	?	Drusy Quartz	1	?		?
528	1873	Geol. Surv	Quartzite polished by blown sand	3	Pipestone Co., Minn	Potsdam	I. J. Rochussen.
529	1871 ?	?	Geode with Chalcadony lining	2	Keokuk, Iowa	Sub. Carb	?
530	1873	Geol. Surv	Quartzite. (Red)	1	Pipestone Co., Minn	Potsdam	I. J. Rochussen.
531	1871 ?	?	Geode lined with quartz crystals	1	Brown Co., Ill	Sub. Carb	?
532	"	?	Carb. Lime. Stalactitic.	7	Dubuque, Iowa	Galena	?
533	"	D. A. Roe	Wulfenite. (Molybdate of lead)	1	Southampton, Mass		
534	"	?	Albite	1	Mass		No records.
535	"	?	Pyritiferous mica schist ?	1	New Hampshire		"
536	"	?	Actinolite	1	Mass		
537	1876	Minneapolis boulder.	Labradorite	4	Minneapolis	Drift	N. H. Winchell.
538	1871 ?	?	Hornblende	1	Chester, Mass		?
539	"	?	Micaceous feldspar.	1	?		?
540	"	?	Chrysocolla	2	Arizona		?
541	"	?	Beryl	1	Ackworth, N. H		?
542	"	?	Tremolite (or Calamite)	1	Canaan, Conn		?
543	"	?	Andalusite (Macle).	5	?		? See Dana's Min. p. 371, No. 323.
544	"	?	Titanite (or yellow sphene)	1	Williams Bridge, N. Y		?
545	"	?	Topaz	5	Brazil, S. A		?
546	"	?	Kyanite	2	New Hampshire		?
547	"	?	Tourmaline	1	New York		?
548	"	?	Crag	1	?		?
549	"	?	Tourmaline	2	Ackworth, N. H		? Massive.
550	"	?	Amanthus	4	?		?

Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 13, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
551	1871 ?	Prof. Beardsley	Hornblende. (Amphibole.)	1	Chester, Mass		?
552	"	?	Amphibole. (Asbestos.)	1	Bex, Switzerland		
553	"	?	Chabazite.	1	William's Bridge, N. Y.		?
554	"	?	Muscovite	2	?		?
555	"	Prof. Beardsley	Serpentine	1	New Hampshire		?
556	March, 1876	Univ. Laboratory	Delessite	1	Minneapolis		N. H. Winchell. (In a boulder)
557	1871 ?	?	Talc	1	Massachusetts		?
558	"	?	Garnet, Muscovite and Quartz	1	?		? [air register frame.
559	"		Steatite. (Soapstone.)	3	Minneapolis. (Found at)		Probably the fragment of a hot
560	"	D. A. Roe	Apatite	1	Burgess, Canada		Terminated Crystal.
561	"	?	Native Sulphur	1	Sicily		?
562	"	?	Graphite	3	Ticonderoga, N. Y.		?
563	"	D. A. Roe.	Molybdenite	1	Westmoreland, N. H.		?
564	"	?	Sphalenite. (Zinc-blende.)	1	England		?
565	"	?	Sphalenite. (Zinc-blende.)	1	Brown Co., Ill		?
566	"	?	Fluorite	2	?		? Massive.
567	1876	W. E. Leonard	Sal Ammoniac	1	?		?
568	1871 ?	D. A. Roe.	Zincite and Franklinite	1	Franklin, N. J.		?
569	"	?	Rose Quartz	1	Connecticut		?
570	"	?	Haematite. (And specula iron)	1	Cumberland, Eng.		?
571	Feb. 1872,	Dr. McMasters	Itacolumite	1	Danbury, N. C.		
572	1873	I. J Rochussen	Conglomerate	1	Pipestone Co., Minn.	Potsdam	I. J. Rochussen.
573	1874	Geol. Surv	Agatized wood	1	Dakota		N. H. Winchell.
574	1871	?	Sandstone	1	Pictured Rocks, McGregor, Iowa	St. Peter	
575	1871	?	Barite	1	Cheshire, Conn.		?

Serial No.	Obtained. When.	Obtained. Whence.	Name.	Number of Specimens.	Locality.	Formation.	Collector and Remarks.
576	1875.....	N. H. Winchell...	Gypsum.....	2	Grand Rapids.....	Carb.....	? (Cut.)
577	1871?.....	?	Satin Spar. (Selenite.).....	1	?	.....	?
578	1874	N. H. Winchell..	Calcite—Fibrous, dark.....	1	Dakota	Cretac.....	N. H. Winchell.
579	1871?.....	?	Geode with lining of Calcite.....	Fragments.	Brown Co., Ill.....	Carb	?
580	"	?	Cannel Coal.....	3	Fort Dodge, Iowa....	"	?
581	"	?	Magnetite	2	Pilot Knob, Mo.....	.....	?
582	"	?	"Diaspore, white. Rutile, red. Biotite, laminated, (also iron and emery.").....	1	Mass.....	.....	?
583	1876.....	Cent'l Exposition	Gothite	1	Pike's Peak, Col.....	.....	A. E. Foote. (Dealer.)
584	Oct. 1875...	Geol. Surv.....	Red Granite.....	1	St. Cloud, Minn.	.....	N. H. Winchell.
585	1871?.....	?	Brown Haematite.....	1	?	.....	?
586	1873.....	Geol. Surv.....	Catlinite.	1	Pipestone Co., Minn.	Potsdam...	I. J. Rochussen.
587	1871?.....	?	Malachite.....	1	Plattville, Wis.....	.....	?
588	"	?	Tourmaline. (black).	1	Ackworth, N. H.....	... .	?
589	1874.....	Geol. Surv.....	Phonolyte.....	1	Bear Butte, Dakota..	Igneous....	N. H. Winchell.
590	1871?.....	?	Agate. (Cut.).....	1	Brazil, S. A.....	.....	?
591	"	?	Quartz and Tourmaline.....	1	Ackworth, N. H.....	.....	?
592	1872.....	Geol. Surv.....	Honestone. (Sawed.).....	1	Austin, Minn.....	Cretaceous.	N. H. Winchell.
593	Mar. 7, 1876	" "	Barite coated with limonite after pyrite.....	1	Missouri.....	.....	
594	Nov. 1872..	" "	Ripple marked slab of red sandstone.....	2	New Ulm, Minn.. ...	Potsdam...	N. H. Winchell.
595	1871?.....	?	Geode with lining of calc spar.....	1	Keokuk, Iowa.....	Carb.....	
596	"	D. A. Roe.... ...	Greenstone porphyritic with feldspar and epidote.....	1	St. Croix Falls, Minn.	Igneous....	D. A. Roe.
597	"	?	Pyrite, Galenite and calcite, on siliceous slate.	1	?	.....	?
598	1873..... .	Geol. Surv. (Manufacturers.)	Fire Brick.....	1	New Ulm, Minn.....	.....	N. H. Winchell.
599	Feb. 21, 1876	W. D. Hurlburt..	Cuprite and Malachite on Native Copper.....	1	Rochester, "	Drift... ...	On the bench of the Shakopee limestone other pieces weighed 5 pounds each.
600	Nov. 1876..	Cent'l Exposition	Brookite. (Crystals.).	5	Magnet Cove, Ark...	....	A. E. Foote.

Catalogue of the Geological and Mineralogical Specimens of the Museum, to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
601	Nov. 1876..	Centennial Exposition.	Staurolite crystals	2	Mink Point, N. H		A. E. Foote.
602	" ..	" "	Fluorite "	1	Cumberland, Eng		"
603	" ..	" "	Siderite on Fluorite crystals	1	"		"
604	" ..	" "	Chrysocolla	1	Mammoth Cave, Utah		"
605	" ..	" "	"Hallite" "	3	Near Chester, Mass		"
606	" ..	" "	Tourmaline "	1	Warwick, Mass		"
607	" ..	" "	Manganite "	1	Ilefeld, Hartz Mts		"
608	" ..	" "	Celestite	1	Pt. aux Peanx, Mich		"
609	" ..	" "	Picrolite (serpentine)	1	Bohemia		"
610	" ..	" "	Penninite	1	Lancaster Co., Penn		"
611	" ..	" "	Baltimorite (serpentine)	1	Texas, "		"
612	" ..	" "	Celestite	1	Ft. Dodge, Iowa		"
613	" ..	" "	Stilbite (crystals)	1	Nova Scotia		"
614	" .	" "	Perofskite "	4	Magnet Cove, Ark		"
615	" ..	" "	Scolecite (zeolite)	1	Cape Blomidon, N. S		"
616	" ..	" "	Lazulite (crystals)	1	Grass Mt., Ga		"
617	" ..	" "	Tourmaline	1	Goveneur, N. Y		"
618	1871?.	?	Quartz, mass of crystals	1	?		?
619	Dec.31, 1875	Geo. N. Bennett	Marbleized Slate	1	Hydeville, Vt		Marbleized at Troy, N. Y.
620	1871?	?	Geode, with quartz lining	2	Brown Co., Ill		
621	Dec. 1876 ..	S. F. Peckham, ...	Bowenite (serpentine)	1	Smithfield, R. I		
622	" ..	"	Vermiculite (Phyroselerite)	1	Milbury, Mass		
623	" ..	"	Metamorphic limerock	1	Rhode Island		Clouded.
624	" ..	"	Garnets in Mica schist	1	Chesterfield, Mass		
625	" ..	"	Lepidolite	1	Paris, Maine		

Catalogue of the Geological and Mineralogical Specimen of the Museum, to December 31, 1876.—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	Name.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
626	Dec. 1876	S. F. Peckham.....	"Gothite." (Haematite mostly).....	1	Michigan Mine, Marquette, Mich..	Huronian....	
627	" "	"	Phorphyritic iron, containing Titanium.....	1	Cumberland Hill, R. I	....	
628	" "	"	Phyllite.....	1	Cranston, R. I.....	....	
629	" "	"	Ripidolite.....	1	Cumberland Hill, R. I.....	.....	
630	" "	"	Chalcopyrite.....	1	" "	.....	
631	" "	"	Orthite (allanite) small, dark crystals. Scapolite (Wernerite) white, main portion. Sphene (Titanite) greenish massive.....	1	Bolton, Mass.....	.....	
632	Dec. 1874	"	Slab of slate with impressions of plants	1	{ Portsmouth Mine..... { Rhode Island I.	Carb.....	
633	?	?	Plumbago	Many	Ticonderoga, N Y.....	....	
634	Nov. 1876	Centennial Exposition.	Native sulphur.....	1	Kilauea, Sandwich Islands.....	.....	

X.

ORNITHOLOGICAL NOTES.

By C. L. Herrick.

MINNEAPOLIS, Dec., 1876.

Prof. Winchell:

The work represented by the following list of birds was, of course, much impeded by the difficulties incident to the season during which it was prosecuted; for not only are there comparatively few birds, and those of the commonest species to be found during the heated term, but those actually collected are often unfit, on account of the summer moult, for preservation or study.

Yet though the field work was over before the fall migration was fairly commenced, a few facts of some interest were noticed.

From observations made during the summer it would seem that the Brotherly-Love Vireo (*Vireo philadelphicus*) is not as rare as until recently supposed, and, indeed, it may be found to be quite as common in this locality as the *Vireo gilvus*. The vireos collected were shot without discrimination, yet two were quite typical specimens of *philadelphicus*.

The results obtained from the study of the few shrikes as yet collected at Minneapolis are so unexpected and withal so contradictory, that the following remarks are given with some hesitancy, especially as they are at variance with what has been written upon these birds by others who have collected in this State.

The Great Northern Shrike, or *Collurio borealis*, is as yet only noted as occurring during Spring and Fall. I have never heard of the nest in this vicinity. I am led to believe that the bird is somewhat rare, even during the migrations, for in the Spring it is very conspicuous from the habit it has of perching on a high tree and uttering at intervals its peculiar metallic cry on its arrival in any

locality; and thus the comparatively small number of specimens collected is more significant.

The smaller shrikes, so abundant here, or many of them, seem to partake of the characteristics of both varieties, viz: *ludovicianus* and *excubitoroides*. The three in the museum seem to me to nearly accord with the descriptions of *ludovicianus*. They all, together with two in my own collection, have the two inner tail feathers black to the bases; but another, which also possesses several other resemblances to *excubitoroides*, has evident white patches on all the tail quills. Again a number of these birds in the possession of Mr. T. S. Roberts agree in disagreeing with every description of either variety.

I draw from these facts the inference that the variety *ludovicianus* predominates over the other, but that the types are mingled and blended so as to baffle any accurate identification.

The nesting of these birds may be easily observed in many parts of the suburbs, but the nests are often mistaken for those of the more northern Butcher Bird.

Perhaps the Red-bellied Nuthatch may be less rare during migration than supposed, if searched for in suitable localities.

The bird-fauna of the State has received one addition in the tern *Sterna caspia* (Thalassus c. Boie.) This is the largest of the terns, and is a very beautiful and striking bird. The only specimen as yet identified from this State, as far as I am aware, was secured at Long Lake by Will Secombe, of Minneapolis, by whom it was presented to the museum.

The English House-Sparrow was simultaneously observed by Mr. Roberts and myself during the early part of the winter about the streets of the city, and I learn from that observer that they have survived our severe weather as yet.

The fact that birds are often infested by intestinal worms particularly the Tape Worm, (Tænia) has attracted so much notice of late that I mention the collection of a variety of these parasites from the solitary Tattler; also a quasi-parasitic colony of crustaceans found upon a goose. I received from Mr. Roberts several specimens of crustaceans collected from Hutchins' goose, found deeply imbedded in the feathers near the skin. These proved to be miniature Sand Fleas (fresh water.) Of course it is hardly to be supposed that this was more than an accident. I cannot account for this except by supposing it to be the result of the proclivity of these fleas (so often noticed) to wedge themselves in the thick masses of leaves upon the Bladder-wort and other water plants.

AVES.

Note. A star (*) signifies male. A dagger (†) denotes the female.

TURDIDÆ.

1. Harpochynchus rufas. Cab. Brown Thrush. Minneapolis, Aug. 20th, 1876. (69.)
2. Mimus carolinensis. Cab. Cat Bird.* Minneapolis, May 14th, 1875. (26.)

SITTIDÆ.

3. Sitta carolinensis. Gm. White-Bellied Nuthatch * Minneapolis, Aug. 12th, 1876. (64.)
4. Sitta carolinensis, Gm. White-Bellied Nuthatch. Minneapolis, July 24th, 1876. (65.)
5. Sitta canadensis, L. Red-Bellied Nuthatch. Minneapolis, Aug. 16th, 1876. (66.) *Not common.*

SYLVICOLIDÆ.

6. Mniotilla varia. Vieill. Black and White Creeper.* Minneapolis, Aug. 16th, 1876. (10.)
7. Mniotilla varia. Vieill. Black and White Creeper. Minneapolis, Aug. 18th, 1876. (77.)
8. Dendrœea æstiva. Bd. Golden Warbler. Minneapolis, May 7th, 1875. (6.)
9. Dendrœea æstiva. Bd. Golden Warbler.* Minneapolis, Aug. 16th, 1876. (7.)
10. Dendrœea æstiva. Bd. Golden Warbler.* Minneapolis, Aug. 14th, 1876. (8.)
11. Dendrœea coronata. Gray. Yellow-Rumped Warbler.† Minneapolis, May 15th, 1875. (9.)
12. Mniotilla varia. Vieill. Black and White Creeper. Minneapolis, Aug. 18th, 1876. (76.)

13. Seiurus aurocapillus. Sw. Golden-Crowned Thrush.* Minneapolis, Aug. 20th, 1876. (79.)
14. Seiurus aurocapillus. Sw. Golden-Crowned Thrush. Minneapolis, May 15th, 1875. (4.)
15. Seiurus novembraeinsis. Nutt. Water Thrush. Lake Minnetonka, Aug. 14th, 1876. (5.)
16. Setophaga ruticilla. Sw. Red Start.* Minneapolis, Aug. 20th, 1876. (80.)
17. Setophaga ruticilla. Sw. Red Start.* Minneapolis, Aug. 20th, 1876. (81.)
18. Setophaga ruticilla. Sw. Red Start. Minneapolis, Aug. 15th. (15.)

TANAGRIDÆ.

19. Pyranga rubra. Vieill. Scarlet Tanager.* Minneapolis, July 19th, 1876. (28.)

HIRUNDINIDÆ.

20. Cotyle riparia. Boie. Bank Swallow.* Minneapolis, Aug. 14th, 1876. (47.)

AMPELIDÆ.

21. Ampelis cedrorum. Bd. Cedar Bird.* Minneapolis, July, 1876. (25.)

VIREODINÆ.

22. Vireo olivacea. L. Red-eyed Vireo.* Minneapolis, July 19th, 1876. (11.)
23. Vireo philidelphica. Cassin. Philidelphia Vireo. Minneapolis, Aug. 1876. (14.)
24. Vireo philidelphica. Cassin. Philidelphia Vireo. Minneapolis, Aug. 20th, 1876. (78.)
25. Vireo gilva. Cass. Warbling Vireo.* Minneapolis, July 11th, 1876. (12.)
26. Vireo flavifrons. Bd. Yellow-throated Vireo.* Minneapolis, Aug. 16th, 1876. (13.)

LANIDÆ.

27. Collurio ludivicianus. Bd. Loggerhead Shrike.* Minneapolis, Aug., 1876. (7.)
28. Collurio ludivicianus. Bd. Loggerhead Shrike.† Minneapolis, July 20th, 1876. (2.)
29. Collurio ludivicianus. Bd. Loggerhead Shrike. Minneapolis, 1875. (3.)

FRINGILLIDÆ.

30. Chrysomitris tristis. Bon. Yellow Bird.† Minneapolis, Nov. 26th, 1875. (31.)
31. Chrysomitris tristis. Bon. Yellow Bird.* Champlin, Minn., June 18th, 1875. (30.)
32. Plectrophanes niralis. Meyer. Snow Bunting.* Minneapolis, Nov. 30th, 1876. (88.)
33. Plectrophanes niralis. Meyer. Snow Bunting.† Minneapolis, Nov. 30th, 1876. (89.)
34. Pocœcetes gramineus. Bd. Grass Finch. Minneapolis, Aug. 16th, 1876. (35.)
35. Pocœcetes gramineus. Bd. Grass Finch. Minneapolis, Aug. 1876. (36.)
36. Spizella socialis. Bon. Chipping Sparrow.* Minneapolis, Aug. 14th, 1876. (32.)
37. Spizella monticolor. Bd. Tree Sparrow.* Minneapolis, Oct. 9th, 1876. (84.)
38. Spizella pallida. Bon. Clay-Colored Bunting.* Minneapolis, Aug., 1876. (33.)
39. Spizella pallida. Bon. Clay-Colored Bunting.† Minneapolis, May 7th, 1875. (34.)
40. Chondestes grammaca. Bon. Lark Finch. Minneapolis, 1875. (38.)
41. Melospiza melodia. Bd. Song Sparrow.* Minneapolis, Aug. 12th, 1876. (37.)
42. Goniaphea ludiviciana. Bowdich. Rose-Breasted Grosbeak.* Minneapolis, June, 1875. (27.)
43. Coniaphea ludiviciana. Bow. Rose-Breasted Grosbeak. Minneapolis, Aug. 18th, 1876. (75.)
44. Cyanospiza cyanea. Bd. Indigo Bird.* Minneapolis, July, 1876. (29.)
45. Pipilo crythrophthalmus. Vieill. Chewink.* Minneapolis, Aug. 3d, 1876. (39.)
46. Junco hyemalis. Sd. Snow Bird.* Minneapolis, Oct. 9th, 1876. (83.)

ICTERIDÆ.

47. Dolichonyx oryzivorus. Sw. Bobolink.* Minneapolis, July 20th, 1876. (42.)
48. Agelæus phœnicus. V. Red-Winged Black Bird.* Minneapolis, Aug. 4th, 1876. (41.)
49. Sturnella magna. Sw. Meadow Lark.* Minneapolis, July 18th, 1876. (40.)
50. Ieterus baltimore. Daudin. Baltimore Oriole.* Minneapolis, May 22d, 1875. (21.)
51. Ieterus spurius. Bon. Orchard Oriole.* Minneapolis, 1875. (22.)
52. Ieterus spurius. Bon. Orchard Oriole.* Minneapolis, 1875. *Juv. specimine.* (23.)

53. Ieterus spurius. Bon. Orchard Oriole.† Minneapolis, July, 1876. (24.)

CORVIDÆ.

54. Corvus corax. L. Raven.* (*Mounted.*) Minneapolis, Oct., 1876. (85.)
Not common.
Presented by N. Herrick, Esq.
55. Cyanurus cristatus. Sw. Blue Jay. Minneapolis, July 20th, 1876. (45.)

TYRANNIDÆ.

56. Tyrannus carolinensis. Bd. King Bird.* Minneapolis, May 14th, 1875. (20.)
57. Contonops virens. Cab. Wood Pewee.* Minneapolis, Aug. 11th, 1876. (16.)
58. C. virens. Cab. Wood Pewee.* Minneapolis, Aug. 15th, 1876. (17.)
59. C. virens. Cab. Wood Pewee.† Minneapolis, Aug. 15th, 1876. (18.)
60. C. virens. Cab. Wood Pewee. Minneapolis, July, 1876. (19.)

CAPRIMULGIDÆ.

61. Chordeiles virginianus. Bon. Night Hawk.* Minneapolis, Aug. 16th, 1876. (44.)

CYPSELIDÆ.

62. Cotyle pelasgio. Bd. Chimney Swift.* Minneapolis, July 10th, 1876. (43.)

ALCEDINIDÆ.

63. Cryle alcyon. Boie. Belted Kingfisher. Minneapolis, Aug. 1st, 1876. (46.)

PICIDÆ.

64. Picus pubescens. L. Downy Woodpecker.* Minneapolis, July, 1876. (60.)
65. Picus pubescens. L. Downy Woodpecker.* Minneapolis, Aug. 16th, 1876. (61.)
66. Picus pubescens. L. Downy Woodpecker.* Minneapolis, Aug. 20th, 1876. (73.)
67. Melanerpes erythrocephalus. Sw. Red-headed Woodpecker. July 23d, 1876. (62.)
68. Melanerpes erythrocephalus. Sw. Red-headed Woodpecker.* Minneapolis, Aug. 28th. (71.)
69. Colaptes auratus. Sw. Golden-winged Woodpecker. Minneapolis, April 29th, 1875. (63.)

70. Colaptes auratus. Su. Golden-winged Woodpecker.* Minneapolis, Aug. 28th, 1876. (72.)

STRIGIDÆ.

71. Bubo virginianus. Wilk. Great-horned Owl.* Minneapolis, Nov., 1876. (86.) *From Collection of C. L. Herrick.*

FALCONIDÆ.

72. Falco sparverius. L. Sparrow Hawk. Minneapolis, Aug. 2, 1876. (67.)
73. Falco sparverius. L. Sparrow Hawk. Minneapolis, Aug. 13th, 1875. (68.)
74. Buteo borealis. Vieill. Red-tailed Hawk.* Jav. Minneapolis, July, 1876. (82.) (*Mounted.*)

COLUMBIDÆ.

75. Ectopistes migratorius. Sw. Wild Pigeon. Minneapolis, July 11th, 1876. (58.)
76. Ectopistes migratorius. S. Wild Pigeon. Minneapolis, July 11th, 1876. (59.)

TETRAONIDÆ.

77. Bonasa umbellus. Stephens. Ruffed Grouse. Minneapolis, July, 1876. (48.)

CHARADRUDÆ.

78. Ægialitis vociferus. Cass. Killdeer Plover.† Minneapolis, July 22d, 1876. (57.)

SCOLOPACIDÆ.

79. Totanus solitarius. Wilson. Solitary Tattler.* Minneapolis, Aug. 17th, 1876. (55.)
80. Totanus solitarius. Wils. Solitary Tattler.* Minneapolis, Aug. 12th, 1876. (56.)
81. Totanus solitarius. Wils. Solitary Tattler. Minneapolis, Aug. 20th, 1876. (74.)
82. Tringoides macularius. Gray. Spotted Sandpiper. Minneapolis, Aug. 4th, 1876. (53.)
83. Tringoides macularius. Gray. Spotted Sandpiper.* Minneapolis, July 14th, 1876. (54.)
84. Actiturus bartramius. Bon. Upland Plover. Minneapolis, Aug. 6th, 1875. (52.)

ARDEIDÆ.

85. Botaurus mugitans. Coues. Bittern. Minneapolis, 1875. (49.)

RALLIDÆ.

86. Porzana carolina. V. Carolina Rail.† Minneapolis, Aug. 20th, 1876. (70.)

LARIDÆ.

87. Sterna caspia. Pall. Caspian Tern. Long Lake, Nov., 1876. (87.)
Rare.
Collected and presented by Will. Secombe.
88. Hydrochelidon lariformis. Coues. Black Tern. Minneapolis, July 19th, 1876. (50.)
89. Hydrochelidon lariformis. Coues. Black Tern, *young*. Minneapolis, July 19th, 1876. (51.)

ANATIDÆ.

90. Bucephala clangula. Wils. Golden-Eye. Garrot. Minneapolis, Jan. 17th, 1877.

Just as this proof is going to press, I have the pleasure of announcing that I had the good fortune to secure for the collection two specimens of Le contes Sparrow, *coturniculus lecontei*, thus adding this to the very few localities of its occurrence. A more extended notice will doubtless be given hereafter.

XI.

A NEW CYCLOPS.

By C. L. Herrick.

Cyclops quadricornis has often been used as an object for study by those desirous of becoming familiar with the process of development in crustacea. For this it is eminently fitted both on account of its very distinct changes and its abundance in every pond and pool.

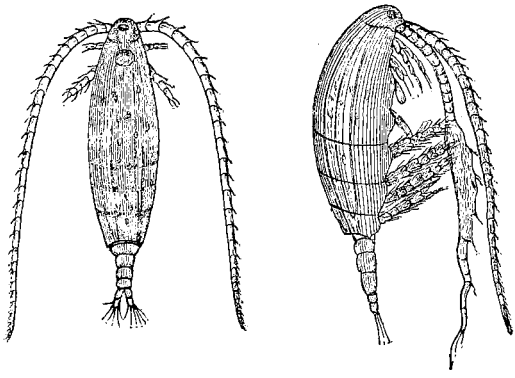

Fig. 1.

There is another member of the same genus which has not, apparently, been described, and I have therefore provisionally named it *C. longicornis* from the very long primary antennæ.

The appearance of an ordinary individual (*Fig.* 1.) is not very widely different from the ordinary species. But the first glance of the female with the spherical sac of ova under the abdomen makes the creature seem quite distinct.

The general appearance and its movements while swimming briskly about cause it to look like a magnified cladocera, the long

spreading antennæ increasing the similarity. The glass at once dispels the illusion however.

The eggs are larger in proportion than those of *quadricornis* and are loosely aggregated beneath the abdomen. The cephalothorax is very large and carries the usual complement of motory appendages. The first antennæ are long—exceeding the body. The second pair are specialized enough to be called antennæ, and the claws are, according to my observation, small though they were indistinctly seen.

The abdomen is in proportion smaller than in *quadricornis*, and the tail similar to that of a young of that species. Of internal structure little was made out, but the red glands are as prominent as in the other. A curious case of malformation of antennæ is shown in the figure. The color is transparent white, except the tips of the antennæ and the last segments of the abdomen.

The process of cephalization is well illustrated by the cyclops, though not as aptly as in the larger crustaceans, the Sand Fleas.

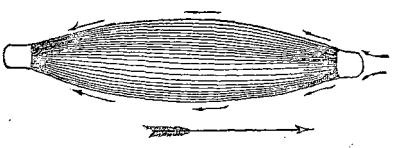

Fig. 2.

A recent observation of a number of diatoms dipped from the bottom of the deeper portion of Lake Calhoun, seems to prove that one species is clothed with cilia throughout, and not simply at the ends as usually described. While watching the motions of a Navicula-like plant propelling itself slowly along it was seen to collide with a large mass of vegetable matter, and while thus brought to a stand-still the infinitesimal particles floating near it were seen to traverse its whole length, the diatom and particles beyond reach of its influence remaining motionless in the meantime. This specimen was of sufficient length to preclude the possibility of the cilia at the ends having any influence upon the particles.

Other Collections.

Besides the Moose mentioned in the report of last year, the following mounted mammals are on exhibition:

Antilœapra Americana. Ord. Pronghorn Antelope. 2 male and 2 female. Custer Expedition to the Black Hills. 1874.

Corvus Canadensis. Exl. American Elk. Custer Expedition to the Black Hills. 1874.

Badger. Custer Expedition to the Black Hills. 1874.

Ursus horribilis. Ord. Grizzly Bear, female. Custer Expedition to the Black Hills. 1874.

Corvus lencurus. Doug. White-Tailed Deer; 1 male, 2 females. Cus. Ex. Blk. Hills. 1874.

Rangifer Caribou. And. and Bach. Woodland Caribou (unmounted.) Presented Dec., 1875, by Nathan Butler.

Seiurus hudsonius. Pall. Red Squirrel. Three specimens.

Tamius striatus. Bd. Chipmunk.

Spermophilus tridecemlineatus. Mitch. Striped Gopher.

Hesperomys michiganensis. Wag. Michigan Mouse.

Procyon lotoi. Ston. Common Raccoon.

Reptiles.

Pana catesbiana. Shaw. Bull Frog.

Amblystoma tigrinum. Bd. (Immature.) Common Salamander.

Eutaenia radix. Bd. & Gir. Garter snake.

Skeletons Mounted.

Podilymbus podiceps. Lawr. Pied-billed Grebe.

Botaurus mugitans. Bart. Bittern.

INDEX TO THE GEOLOGICAL REPORT.

ERRATA.

Page 5, line 4 from bottom, for "fossiliforous" read fossiliferous.

Page 139, line 14, for " There" read This.

Page 156, line 12 from bottom, for " nine" read eight.

Page 158, line 6, for "(gray hardpan to near the top of the bluff)." read (gray hardpan) to near the top of the bluff.

Page 179, strike out " This fall is forty or fifty feet high, divided in the middle by a rocky island of pyramidal form."

Page 220, line 10 from bottom, for " left branch" read left bank.

Page 230, strike out " X."

Page 238, strike out " XI."

On the map of the vicinity of the Falls of St. Anthony, under " *Explanation*," last line, strike out " Gray."