surface. What offers a better repository for this than the formation of elements of high atomic weight which would then constitute with the granite a surface layer of limited thickness or a radioactive shell, as Dr. Becker terms it?

The whole paper is of extraordinarily suggestive character, not only in the direction of pure speculation, where but scanty data can ever be gathered, but in offering several points of contact with direct laboratory measurement.

ARTHUR L. DAY

SPECIAL ARTICLES

PREGLACIAL DRAINAGE IN CENTRAL-WESTERN NEW YORK[1]

THE present drainage in central-western New York is to the north. The principal river is the Genesee, which traverses the entire state from the Pennsylvania line, beyond which it rises, to Lake Ontario. Its principal tributary is the Canaseraga, which joins it below Mount Morris.

Throughout Allegany County, the Genesee flows in a comparatively broad and open valley with sloping drift-covered sides, and with more or less drift-filling in its bottom. In a few places the bed rock shows in the river bed, indicating that the drift-filling in the bottom of the valley is not deep. The middle portion of the river lies in a series of gorges, with a total length of about 20 miles. The first of these gorges begins opposite Portageville, and in it occurs the upper Portage falls, about 70 feet high. Beyond this the river passes across an ancient drift-filled valley, the rock floor of which lies nearly at the level of the present river below the upper falls. A partial reexcavation of this valley has produced Glen Iris. Having crossed the ancient valley on its rock bottom, the river drops a further 100 feet, cutting a gorge into the northeastern rock wall of the ancient valley to a depth of 365 feet. A mile and a quarter beyond this, the river again emerges into an ancient drift-encumbered valley, into the rock floor of which it has incised a narrow canyon. Just before this ancient valley is reached, the river makes a final drop of nearly a hundred feet, in the lower falls. The Genesee is thus incised at the lower falls about 250 feet below the rock bottom of the ancient valley which it crosses at Glen Iris. The distance between the two points is a mile and a half. The bottom of the gorge below the lower falls is likewise nearly 200 feet below the rock bottom of the ancient valley at that point. The two ancient valleys thus crossed by the modern stream have accordant bottoms. They are, however, two distinct valleys which join opposite Portageville, where the system of gorges begins. We will speak of these ancient valleys as the Glen Iris Valley, and as the Lower Falls Valley, respectively. The name Upper Genesee Valley is given to the open valley in which that river flows from its source to Portageville. The Glen Iris Valley and the Lower Falls Valley unite southward, and from Portageville south are continued as a single valley in the Upper Genesee Valley. A third narrower drift-filled valley joins the Upper Genesee Valley at this point, its mouth being at the head of the first of the postglacial gorges. Thus three ancient valleys, now drift filled, unite at Portageville, one from the north (Lower Falls Valley) a second from the northwest (Glen Iris Valley) and a third from the west. These valleys are con-

[1] Abstract of a paper presented before the New York Academy of Sciences, Section of Geology and Mineralogy, December 2, 1907. Read by title, Albuquerque meeting of the Geological Society of America, December 31, 1907. Only the main points are here discussed; the complete paper, which will appear shortly, will contain a detailed discussion of the critical points of the region. Since the manuscript of this paper was submitted (January, 1908) Fairchild's discussion of the drainage of this region (Bull. N. Y. State Mus. 118, January, 1908) and Spencer's "Evolution of the Falls of Niagara" (Can. Geol. Survey) have been received. In both the northward drainage systems are defended. Fairchild treats all the valleys as obsequent streams tributary to a westward flowing Ontario River, while Spencer reasserts the existence of his Laurentian River. These papers will be fully considered in the more extended discussion of this subject now in preparation.

tinued southward in a single valley about a mile wide (Upper Genesee Valley), which is only slightly clogged by drift.

Beyond the Lower Falls, the ancient valley is obscured by drift, yet not to the extent of becoming untraceable. The modern river makes a detour through the High Banks gorge, the walls of which are over 500 feet high. At St. Helena, four miles to the north of Portageville, the modern river again enters the old valley and continues in it for about 10 miles, flowing northeasterly. This St. Helena valley is clearly the northward continuation of the Lower Falls Valley, the old connection being drift filled. This course of the ancient valley (now partly reoccupied by the Genesee), from St. Helena to the Lower Falls, and thence in a direct line to Portageville, was outlined by Hall in 1842. Several miles above Mount Morris the modern river leaves this ancient St. Helena Valley, and has cut a fourth short gorge. At Mount Morris the modern river enters at right angles, from the west, a broad open valley nearly three miles in width and with a rock bottom 190 feet below the river level, and therefore more than 600 feet below the rock bottom of the ancient valleys first described, and more than 650 feet below the rock bottom (as tested by borings) of the Upper Genesee Valley at Portageville less than twenty miles away. In this broad and deep ancient valley, to which the present author fifteen years ago applied the name Preglacial Canaseraga Valley, the Genesee continues for thirty-five miles to Rochester, where it enters the Rochester gorge with its three falls. The preglacial Canaseraga Valley, which contains the Genesee flats north of Mount Morris, is continued southward as an open valley for fifteen miles to Dansville, beyond which it is choked by drift. The modern Canaseraga follows this valley to its junction with the Genesee at Mount Morris. This valley is clearly an independent valley, parallel to the Upper Genesee Valley, and cut by an independent stream as suggested by the author in 1894. There is practical unanimity of opinion on this point. The question at issue is: was this a northward or a southward flowing stream? It is generally held that this was a northward flowing stream, and that the Genesee, also a northward-flowing stream in preglacial times, joined the stream of this valley south of Mount Morris, by way of the broad Nunda Valley. The present Nunda River enters the Canaseraga Valley through a rock gorge. A careful examination of the banks of the Canaseraga Valley from Mount Morris southward, shows rock exposures everywhere, the lowest of which are more than 200 feet above the present bottom of the Canaseraga Valley. *The Genesee could not enter this valley except by a narrow gorge.* Moreover, unless it is assumed that the Canaseraga Valley was deepened by glacial erosion to the extent of 600 feet below its original depth, the Genesee could not be its tributary, since the old rock floor of the Genesee Valley is more than 600 feet above that of the Canaseraga Valley, the distance between the two being not much over fifteen miles along the supposed ancient course.

Attention is now invited to the Glen Iris Valley. This is half a mile or more in width, and 250 feet deep. Evidently such a valley could only have been cut by a stream of some length. If the Genesee flowed northward by way of the Nunda or some other channel, this valley must have been that of a tributary stream, unless it marks the path of the northward-flowing Genesee itself, as formerly suggested by the author. In any case this valley must have been continued far beyond Glen Iris. It is filled by local drift. For ten miles northwest from Glen Iris the country is flat and deeply drift-covered. Then we come to the Warsaw Valley, an ancient valley extending northwestward, and later bending to the north. At the bend north of Warsaw, another ancient valley, the Dale Valley, joins it from the northwest. The junction is somewhat obscured by drift, but can be traced. The Dale Valley at its junction with the Warsaw Valley is as broad and deep as anywhere along its course. It is evidently a tributary valley. If the Warsaw Valley was cut by a northward-flowing stream, two streams, one from the southeast, and the other from the northwest came together at Warsaw in exactly opposite

directions, and continued northward. The Dale would thus turn an angle of over 135 degrees, coming from the northwest, and turning north. Truly a remarkable course for a well-adjusted stream, though not an impossible one. On the hypothesis of a southward drainage, the Dale from the northwest and the Oatka from the north, united opposite Warsaw, and continued southeastward after the approved manner of normal streams. On this hypothesis we must look for a southeastward continuation of the Warsaw River formed by the junction of the Dale and Oatka. For ten miles the country is drift-covered, then we come to the Glen Iris Valley, which is exactly in line with the course of the Warsaw, and which, as we have seen, requires a northwestward continuation. This then is furnished after an interval by the Warsaw Valley, while conversely the Warsaw Valley finds its southeastward continuation in the Glen Iris Valley. Each finds its complement in the other, the requirements of each are fulfilled by the other. The only unknown quantity is the drift-filled interval between Glen Iris and Warsaw. Thus a southward drainage for the Preglacial Warsaw and its two tributaries, the Dale and the Oatka, and their junction with the Genesee at Portageville, explains all the known phenomena, and there are none known which oppose such an explanation. On the hypothesis of a northward flow of the Warsaw, many known facts are unexplained, many are opposed to it, and the drainage takes on a most complicated manner, instead of the simple direct course of a southward-draining system.

One of the chief objections to the hypothesis of southward drainage of the Warsaw and its tributaries is the greater depth of the Warsaw over the Glen Iris Valley. This difference finds a very simple explanation in the hypothesis of glacial deepening of the Warsaw Valley. Is there any evidence of such deepening? There is the most direct evidence. The sides of the Warsaw Valley are much steeper than those of ancient valleys not deepened. At the aforementioned bend of the valley opposite Warsaw, the west or concave bank is almost precipitous. It is here that a valley glacier would produce the greatest erosion. The drift in the southern part of the valley and between it and Glen Iris, is local, composed of the material gouged out of the valley. But the most conclusive evidence of glacial deepening of the Warsaw Valley is the junction of the Dale Valley. This, as has been said, is as broad and deep at its junction with the Warsaw Valley, as anywhere above. But its rock bottom is nearly 200 feet above the rock bottom of the Warsaw Valley. It is thus clearly a hanging valley, and the only explanation of this relation would seem to be glacial deepening of the Warsaw valley by ice. This removes the only known objection to the southward drainage of the Warsaw system.

Considering the southward drainage of the Warsaw system into the Genesee at Portageville as proved, we must next note that the stream which formerly occupied the St. Helena-Lower Falls valley, and into the floor of which the modern Genesee has incised its bed, was also a southward-flowing stream. This is generally accepted, and was, I believe, first pointed out by Fairchild. It could indeed be interpreted in no other way, since it was very evidently not the path of the ancient Genesee. As has been shown, a third ancient valley of smaller size joined the Genesee from the west. Thus three southward and eastward flowing streams united at Portageville. If the Genesee was a northward-flowing stream, and the combined system flowed out to the Canaseraga Valley by way of the Nunda Valley, a complicated system existed, with the streams turning back in direction upon themselves. Moreover, in that case the Canaseraga Valley was deepened by ice to the extent of 650 feet. That it was glacially deepened to some extent will be shown later to be the case, but the evidence is clear that such deepening was not more than half the amount required by the hypothesis of northward drainage, and probably much less.

On the hypothesis of southward drainage of the Genesee, the Nunda Valley must be regarded as that of a southwestward-flowing tributary of the Genesee. Its junction with

the Genesee was about five miles south of Portageville, where now an immense drift barrier exists. The great apparent width of the Nunda Valley, much wider than the Genesee Valley, which has led almost all observers to accept it as the preglacial continuation of the Genesee, following Hall, is readily understood, when it is seen that the valley is worn out on the strike of the strata, and is therefore of the subsequent or inner lowland type. It lies at the junction of the soft Portage shales and the overlying hard Chemung sandstones. The latter form a cuesta inface, which rises several hundred feet above the top of the northern boundary of this broad and rather indefinite valley.

Coming farther south, we find an ancient valley joining the Upper Genesee Valley from the northwest, at Caneadea, where the present river makes a sharp bend. Still farther south, near Angelica, the ancient Black Creek joined the Genesee in a broad valley from the northeast. That the drainage, if southward, continued in the Genesee Valley to Wellsville, and beyond across the Pennsylvania line, and perhaps to the Susquehanna, seems to be indicated by the broad character of the Genesee Valley to within a short distance of the state line. The country beyond this point is deeply drift-covered, for we are near the terminal moraine. That this direction was not the one permanently followed by a southward-flowing stream is indicated by the much broader and more open valley which branches off from the Genesee Valley near Belfast, and which is followed by the Pennsylvania railroad to Cuba and Olean. This valley is as broad, open and deep as is the Genesee Valley. It is a very ancient valley cut into the hard Chemung rocks, and maintains its integrity all the way to the Alleghany at Olean. It is true that south of Cuba the valley is narrower, but this corresponds exactly to the nature of the rock. Near Cuba comes in the heavy Cuba conglomerate lentil, and a little south of Cuba this forms the bottom of the bank on either side. It is here that the narrowest part of the valley begins, perhaps half a mile to three quarters of a mile at the bottom, though over a mile at the top. This continues until the dip carries the conglomerate below the valley bottom, when the valley widens out again. This Cuba outlet forms an excellent one for a southward-flowing Genesee, to the Alleghany and thence to the Ohio, and the Mississippi. On the hypothesis of a northward-flowing stream, a divide must have existed somewhere in this Cuba Valley, unless the Alleghany and perhaps the Ohio also flowed north through the Genesee Valley. Then we are confronted with the remarkable fact that the valley at the divide is as deep and almost as wide and fully as well defined as at any other part. Regarded as the pathway of a southward-flowing tributary of the Alleghany, which, gnawing headward, finally tapped the Genesee at Belfast and diverted it into the Alleghany, all its characteristics are readily explained, and it becomes a part of a normal southward drainage system, of which all the features are normal and perfectly comprehensible. All that is required is a moderate tilting of the land as a whole, an elevation on the north, and a depression towards the south. That there is abundant independent evidence of such tilting is well known, and will be considered again. It will be shown farther on that the relation of these valleys to Lake Ontario is such that only a southward drainage can explain it.

Turning now to the Canasaraga Valley and its tributaries, we find that it constitutes an independent system, which in preglacial time had no connection with the Genesee. The valley south of Mount Morris, at which point the modern Genesee enters it, is as broad and open as above, in some places even broader, though its sides are steeper owing partly to the harder strata in which they are cut. The preglacial Canaseraga, then, which cut the southern part of the valley, was also fully competent to cut the northern part, without the aid of the Genesee River. As at present constituted the Canaseraga Valley is more than twice as wide as the Upper Genesee Valley, and its rock bottom is more than 600 feet below that of the Genesee. Evidently this was the master stream of the region, whether northward or southward flowing. From Mount Morris to Dansville the direction of the valley

is southeastward, and half way between these two points, it receives a tributary valley from the north, this valley in its upper part being occupied by Conesus Lake. The junction of this valley with the Canaseraga Valley is more or less obscured by drift, but can be readily traced. The former stream of this valley evidently discharged southward into the Canaseraga, and if the course of that stream was northward, we have here a swinging of the waters of the preglacial Conesus through an angle of 135 degrees or more. Since the present northern end of Conesus Lake is only five miles in a direct line from the Canaseraga Valley at the village of Avon, a point twenty miles north of, and therefore, on the supposition of northward drainage, down stream of, the point where the ancient Conesus joined the Canaseraga, it is difficult to understand why a branch of the main stream from Avon did not capture and reverse the drainage, especially since the modern drainage is along that line, and the rocks there are softer than farther south. On the other hand, the hypothesis of a southward drainage, in preglacial times, of the Canaseraga and its tributaries meets with no such difficulties, and the form of the system is a perfectly normal one.

South of Dansville the Canaseraga Valley is filled with drift, the top of which has a nearly constant level between 1,300 and 1,400 feet above sea-level. Since the elevation of the valley bottom at Dansville is 700 feet, the depth of the drift is between 500 and 600 feet. This is mostly local, and its characteristics indicate that a glacier occupied the valley to Dansville, and the discharge from it built up the drift deposits in the valley to the south. This valley, the southward continuation of the valley at Dansville, is fully as broad and ancient as the valley at Dansville. Without change in character, this valley continues south past Burns and Hornell and so along the present Canisteo Valley to the Susquehanna. Any one who has traveled through this region on the Erie railroad, must have noted the well-developed and continuous character of these valleys. If there ever was a divide here between a northward- and a southward-flowing stream, as contended by the advocates of a former northward drainage, this divide was in a valley as broad, as deep and as open as any portion of the valleys of these two streams for fifty miles to the north and to the south of this divide. Of course one might account for the character of these valleys, by assuming that the entire drainage system of the Susquehanna, including that stream as well, discharged northward into the Ontario Valley, but I doubt if any of the advocates of northward drainage would go to such an extreme. The non-existence of divides in these valleys, such as should be expected in a normal drainage system, even though it were developed on an ancient peneplain surface, as we have good evidence to believe was the case with the drainage system under discussion, this absence of divides is in itself almost sufficient to condemn the hypothesis of northward drainage.

South of Dansville, where the ancient valley changes from a southeasterly direction to one a little west of south, the Wayland Valley, of similar width and ancient character, comes in from the east. Five miles east of the junction the Wayland Valley receives the Springwater Valley as a tributary valley from the north, opposite the village of Wayland. Seven miles north of Wayland, this ancient Springwater Valley forks, the two prongs being occupied by Hemlock and Canadice lakes, respectively. Here we have another drainage system, of the southward-draining type, which joins the Canaseraga near Dansville. Such a southward uniting of all the valleys is wholly inexplicable on the hypothesis of northward drainage during its development. The Wayland Valley continues eastward to North Cohocton, without change of character, and with an average width of about a mile. Here it receives another ancient tributary from the northeast. This also forks, and in the western branch lies Canandaigua Lake. The valley of Honeoye Lake comes in here from the north as another ancient tributary valley. The points of junction of these valleys near Naples are obscured by heavy drift deposits, but they are not difficult to trace. They are well shown by the outcrops of the strata delineated on the geological map of the

Naples quadrangle issued by the state survey. Here we have another series of southward-uniting valleys, easily understood as tributary, with other similar series, through the Wayland Valley, to a southward-flowing Canaseraga, but difficult to understand if not inexplicable on the hypothesis of preglacial northward drainage.

If this system drained southward, and there seems to be no escape from such a conclusion, it appears that the Honeoye and Canandaigua system originally drained south by way of the Cohocton to the Chemung and the Susquehanna, but was diverted by capture to the Canaseraga-Canisteo drainage system. Or it is possible that the Canandaigua-Honeoye system originally was tributary to the Canaseraga, and that the Cohocton cut off these more eastern branches from that drainage system, conducting them by a shorter route to the Chemung than is traversed by the more western tributary of the same stream. If that was the case, the capture by the Cohocton was accomplished in comparatively late preglacial time, since the Cohocton Valley is still narrow, though deep. We do not know enough of the elevations of the rock bottoms of these ancient valleys to decide which is the more likely.

On the hypothesis of northward drainage, we are again confronted by the anomalous character of the valleys at the point where a divide should have existed. Dryer has pointed out that the broad, open character of the east and west Wayland Valley is incomprehensible on the hypothesis of northward drainage, such a valley being entirely out of place at the divide of two normal river systems which flow in opposite directions. On the hypothesis of southward drainage this valley is easily understood.

It should be noted in this connection that the rock bottom of the Wayland Valley, so far as it is known from outcrops in the beds of streams south of Dansville, is above that of the Canaseraga Valley, the difference being perhaps 200 feet. Since the valley at Dansville is a thousand feet deep, not counting any drift-filling in the bottom of this valley, this difference is of no great significance, so far as the importance of the valleys is concerned. It indicates a deepening of the Canaseraga Valley by ice. This is further suggested by the steepness of some parts of the banks of the valley at Dansville, and the local character of the drift which partly fills the southward continuation of the Canaseraga Valley.

A glance at the geological and topographical maps of the regions around the other Finger lakes shows that they too have the southward drainage expression. Keuka Lake has two southward-uniting branches, the united valleys becoming tributary to the Cohocton. Seneca and Cayuga Lakes are continued southward in more or less open valleys to the Chemung and Susquehanna. That these and many of the other valleys were more or less deepened and widened by ice erosion is, I believe, pretty generally held in spite of objections raised against this idea. The evidence seems to be overwhelmingly in favor of this explanation of their characteristics.

Let us now consider the evidence which Lake Ontario has to offer in this connection. Opposite the mouth of the modern Genesee, the lake is 576 feet deep. Eighteen miles further east it is 738 feet deep. The surface of the lake is 247 feet above mean sea level. The fall of the Genesee from Mount Morris to Avon is ten feet in a distance of fifteen miles in a straight line but twice that distance by the river. This gives on the average a fall of a third of a foot per mile. The rock-bottom at Mount Morris is 191 feet below the river level; at Cuylerville, four miles to the north, it is 184 feet below that level. At Piffard, four miles farther north, it is 158 feet below the same level. This gives a *rise of the rock floor northward,* of about six feet for the first four miles and of twenty-six feet for the next four miles. The record at Piffard is probably not of the greatest depth, yet the northward rise of the rock floor of this valley seems to be undoubted. Taking the smaller figure, a rise northward of 1½ feet per mile, the rock bottom of this ancient valley at Lake Ontario, forty miles north of Mount Morris, would be 196 feet above the *level* of Lake Ontario, or 772 feet above its floor (934 feet above its deepest part). This

is truly an astonishing relation for a tributary of a river occupying the Ontario Valley. The differences in elevation between the rock bottom of the Canaseraga Valley (modern Genesee Valley) at Mount Morris, forty miles south of Lake Ontario, and the surface of Lake Ontario, is 136 feet; the rock bottom at Mount Morris is 712 feet above the valley bottom of Lake Ontario opposite the mouth of the modern Genesee, and 874 feet above the deepest part of Lake Ontario, seventy miles away. We have seen evidence that the valley at Mount Morris was deepened by ice to the extent of at least 200 feet. This would make a difference of over a thousand feet between the valley bottom at Mount Morris and the bed of Lake Ontario. The advocates of northward drainage will find it difficult to make the preglacial Genesee descend this interval in the space of seventy miles. Nor can they appeal to constant deepening of the valley northward, which would enable us to regard the difference as due to tilting; for we have seen that, instead of declining, the valley bottom rises northward, until on the smallest recorded rise it reaches very nearly the general level of the country about Rochester.

It is thus very evident that the valley of Lake Ontario has been deepened far below that of the Genesee and Canaseraga Valleys. (The rock floor of the Genesee Valley at Portageville, which on the hypothesis of southward drainage is regarded as independent of the Canaseraga Valley, is 1,500 feet above the deepest part of Lake Ontario, the distance between the two points being about ninety miles.) What has produced this excessive deepening? Those who know the region will not consider differential warping as a factor: the dip of the strata scarcely varies over this region. Ice erosion of the Ontario Valley can not be appealed to, since the course of the valley is nearly at right angles to the movement of the ice. (The question of ice erosion of the Ontario Valley has been fully discussed by Gilbert, and more recently by Grabau in the Bulletin on Niagara Falls. Both authors agree that the evidence does not favor the ice erosion theory.) Other explanations, such as deepening by the solution of the limestones are not favored by the facts. The only satisfactory explanation seems to be that Lake Ontario Valley was deepened by normal river erosion. If that is the case, and the preglacial streams of western New York flowed northward, and were tributary to the Ontario River, their valleys should have been deepened in conformity. That they were not so deepened is a powerful argument against the northward flow of these streams.

On the hypothesis of southward drainage first advocated by the present writer, in 1901 (Bull. 45 N. Y. State Museum), and subsequently in this journal, the ancient valleys of central and western New York must be regarded as formed by streams arising in the Canadian region, and flowing across New York. They were gathered in by either the Susquehanna or the Alleghany. This drainage developed upon an old peneplain which beveled the strata, as shown by abundant evidence (this is discussed quite fully by Grabau in Bulletin 92, New York State Museum). The development of this drainage system took place in Tertiary time, when the land in the north stood high, and the Mississippi embayment and the Atlantic coast south of New York were depressed. The evidence for this is well known. The main stream of the region was the Dundas, flowing out through the Dundas Valley at the west end of Lake Ontario. This stream was of the consequent type, and one of its subsequents carved out the broad Ontario Valley as an inner lowland on the soft Siluric and Ordovicic strata. This subsequent stream gradually beheaded the streams flowing across New York, capturing their headwaters, and carrying the drainage to the Mississippi embayment. Such a stream would soon deepen its valley on the soft Medina rocks, and thus the great subsequent deepening of Lake Ontario would be accounted for. This deepening, then, occurred after the valleys of New York were cut, these valleys remaining behind with beheaded southward-flowing streams which were incapable of deepening or widening their valleys any further. Meanwhile short northward-flowing or obsequent streams came into exist-

ence along the southern border of the deepening Ontario Valley. This southern border, partly shown in the Niagara escarpment, must be regarded as the inface of a revived cuesta, of which the Ontario Valley is the inner lowland. Examples of obsequent streams flowing down the inface of the cuesta, and cutting backward from it, are found in the old Saint David's gorge, which had cut back as far as the present Whirlpool; in Irondequoit Bay, often regarded as the former path of the Genesee, but clearly deepened beyond any depth reached by the Genesee or Canaseraga; and probably Sodus Bay. Eastward the Ontario Valley becomes narrower though the flooded portion is wide. The Ontario River headed eastward, probably passing through Oneida Lake from Little Falls, where the divide between the eastward-flowing Mohawk and the westward-flowing Ontario River was situated. At the Thousand Islands occurred another divide, between the northeastward-flowing preglacial St. Lawrence and a southwestward-flowing tributary of the Ontario River. Spencer's Laurentian River, which carried the drainage of all the Great Lake valleys (except Superior) out across the Thousand Island divide, never existed. There is no good evidence for, and abundant evidence against, its existence.

To sum up: The evidence seems to be all in favor of southward drainage in Tertiary time of the streams which cut the Finger Lakes and the other parallel valleys of New York. Many of these were subsequently deepened by ice erosion. Part of this drainage went out by the Susquehanna to the Atlantic, and that of the more western valleys probably to the Ohio and Mississippi embayment. The drainage of the valleys of the Great Lakes also went out in that direction, and the system developed as a normal sequential drainage system on a peneplain surface of nearly horizontal strata. Capture of the headwaters of the New York streams left their beheaded portions in the old valleys which they had not the power to further deepen or widen. The Ontario Valley, however, was deepened without reference to the Finger Lake Valleys. All this occurred while the land in the north stood higher than now, and the Mississippi embayment and the Atlantic coast south of New York, lower, as shown by marine sediments of Tertiary age.

A. W. Grabau

Columbia University,
December, 1907

NOTES ON A SMALL COLLECTION OF SHELLS FROM TEXAS

During part of the month of August, 1906, Mr. A. B. Wolcott, a Chicago entomologist, collected extensively about the region of Brownsville and Corpus Christi, Texas, and incidentally secured an interesting collection of land and fresh-water mollusks. Mr. Wolcott found the river very high and hence was able to do nothing in the way of collecting the Unionidæ. A few fresh-water shells were secured from the river drift. The land mollusks were notably abundant, particularly the Polygyras and the Bulimulæ, as were also the Helicinas and the Euglandinas. No novelties were obtained, but the material seems to be of enough interest to be placed on record. The collection has been presented by Mr. Wolcott to the Chicago Academy of Sciences.

In working up this list constant reference has been made to the excellent paper by Pilsbry and Ferriss, on the "Mollusca of the Southwestern States," II., published in 1906 in the *Proceedings* of the Academy of Natural Sciences of Philadelphia, page 134.

HELICINIDÆ

Helicina orbiculata tropica "Jan" Pfr.

Corpus Christi; tropical forests, Esperanza ranch, Brownsville, on shrubbery; river drift, Brownsville; on beach, Port Isabel.

In a lot of 25 specimens, 5 are partly red and blue and the balance are blue. A common species in this locality.

HELICIDÆ

Praticolella griseola (Pfr.).

Chaparral near Brownsville; old Fort Brown and in river drift, Brownsville; Port Isabel, on beach.

The specimens collected show a wide range of variation in the number and position of the