SCIENCE:

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THE SEDIMENT OF THE POTOMAC RIVER.

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THE United States Geological Survey in May, 1891, established a gauging station on the Potomac River at Chain Bridge, D.C., for the measurement of the discharge of the river at that place. From that date to the present time daily readings of the height of the river have been maintained, which, taken in connection with the measurements of discharge, makes it possible to compute the daily discharges of the river at this place. A detailed account of the methods and results of this branch of the work may be found in a paper by the writer in the Transactions of the American Society of Civil Engineers, No. 537, Vol. 27, and entitled "The Hydrography of the Potomac River Basin." This article deals with the discharge of the river and its relation to the rainfall in the basin. It is also stated that measurements of the amount of sediment transported by the river were being made. The results are now available and are here given for publication.

Daily heights of the Potomac River at Great Falls, about sixteen miles above the City of Washington, have been kept since 1878 by the officials of the Washington aqueduct, together with a daily record termed "condition of water." Owing to the fact, however, that the dam across the river at Great Falls was not completed until 1886, the two sets of records previous to this latter date are valueless for discussion.

The results of this article are based in part upon the records of "condition of water," which are made as follows: A horizontal metallic tube, 36 inches long and with glass ends, is filled with water, and the distance at which a ball immersed therein can be seen from one end is noted. The observations vary from 1 inch in very muddy water to 36 inches, which is considered as clear. Samples of the river water at Great Falls were collected and were sent in to the main office in Washington, where they were analyzed quantitatively in so far as the determination of the ratio of the weight of the contained sediment to the total weight of the sample. At the same time the "condition of water" was recorded. Fifty-five samples were analyzed, with condition of water ranging from 1 to 36 inches. These quantities were plotted on cross-section paper, with condition of water as abscissæ and ratios of sediment to water as ordinates. Through the points thus obtained a smooth curve was drawn, from which a table was constructed, giving for each inch of condition of water the corresponding ratio of sediment. In order to obtain the total amount of sediment transported by the river for any length of time the discharge of the river for that period must be multiplied by the average ratio of the sediment to the water for the same period.

Simultaneous gauge readings of the height of the river at Great Falls and at Chain Bridge were maintained for a year and a half. From these observations a table was constructed, giving for the gauge height at one place the corresponding gauge height at the other. From the fact that no large tributary enters the river between these two points, the daily discharges at Great Falls may be computed from the table of gauge relations and from the daily discharges of the river at Chain Bridge. The daily ratio of sediment to water was found from the daily record of condition of water and the rating table of ratios and condition of water. Knowing then the daily discharge of the river in cubic feet per second and the daily ratio, it is simply a matter of multiplication of second-feet times the ratio times the weight of one cubic foot of water to obtain the weight of the total amount of sediment passing down the river per second. In this way the daily amounts of sediment from 1886 to 1891, inclusive, have been computed.

In considering the value of these figures, it would seem at first sight that the above method of measurement for condition of water was crude to base scientific results upon. The observations are not made for that purpose, but are more for the benefit of the fishermen in the vicinity of Washington. They have the advantage of being simple and inexpensive and can be maintained by an inexperienced observer. Another very important fact in their favor for this river is that, owing to the absence of lakes and extensive swamps throughout the basin, such as are found in the glacial region further north or the swampy regions of the extreme south, the coloring matter of this river is almost wholly due to mineral sediments and very little to vegetable deposits. It would be more accurate if daily samples of the water could be analyzed, but it would be expensive and would require a long time-interval before the results would be of value. There is a six years' record of condition of water, or over 2,000 observations. From a series of measurements certain average values for this record have been computed. Any one observation may depart greatly from this average, but when considered in connection with the total number of observations the effect of its departure from the mean is inappreciable.

The lowest record is 36 inches. In some cases the ball is just able to be seen at this mark; in others distant objects are plainly visible. There is here an arbitrary limit for the curve, which ought to extend considerably below this point, but taken in connection with the rest of the range, and especially with the upper part, where the ratios are large, the weight of this lower end is small. Errors will also arise depending upon the cloudiness of the day. However, errors due to this method of sediment measurement are not cumulative, but may be either plus or minus, and in a large number of observations tend to equalize each other.

It is therefore considered that the results are sufficiently accurate for all ordinary purposes.

The following facts are brought out. The average annual discharge of the Potomac River from a drainage area of 11,043 square miles is 20,160 second-feet, varying from 2,000 second-feet in time of low water up to 470,000 second-feet during the great flood of 1889. The total annual amount of sediment transported is 5,557,250 tons, or 353 pounds per second, and distributed through the six years from 1886 to 1891 as follows: 1886, 4,283,000 tons; 1887, 2,372,800 tons; 1888, 4,996,800 tons; 1889, 10,142,600 tons; 1890, 5,994,000 tons; and 1891, 5,544,300 tons. The average daily amount varied from 1 pound to 21,900 pounds per second. It is found from these figures that the average annual amount of sediment is to the weight of the annual discharge of water as 1 to 3,575. Assuming that one cubic foot of sediment weighs 100 pounds, this average amount of sediment would cover one square mile 3.98 feet in depth, and if spread over the drainage area would cover it 0.0043 inches in depth. At this latter rate it would take the river 2,770 years to erode one foot from the drainage area.

These results appear in the following table, together with similar data compiled for several other large rivers. The first column gives the name of the river; second, its drainage area in square miles; third, the average annual discharge of the river in cubic feet per second. The fourth column gives the total amount of sediment, in tons, annually transported by the river; fifth, the ratio of the weight of this sediment to the weight of the water annually discharged; the sixth, the height of a column in feet having a base of one square mile that the sediment would cover; the seventh, the depth in inches that the drainage area would be covered if this total amount of sediment should be spread over it; and the last column the authority for the data. The discharge and drainage areas for the Rhone, Po, Danube, and Uruguay are taken from a paper by John Murray in the *Scottish Geographical Magazine* for February, 1887. The drainage area of the Nile was measured by planimeter from the best maps obtainable.

Discharge and Sediment of Large Rivers.

River.	Drainage Area, square miles.	Mean Annual Discharge, second-feet.	Sediment. Total Annual Tons.	Ratio by Weight.	Height column 1 square mile base, feet.	Depth over Drainage Area, inches.	Authority.
Potomac	11,(43	20,16	5,557,250	1:3575	4.0	.00433	
Mississippi [1]	1,214,000	610,000	406,250,000	1:1500	291 4	.00288	Humphreys and Abbot
Rio Grande [2]	30,000	1,700	3,830,000	1:291	2 8	.00110	U. S. Geological Survey
Uruguay	[3] 150,000	[3] 150,000	14,782,500	[5] 1:10,000	10.6	.00085	J J. Revy
Rhone	[3] 34,800	[3] 65,850	[4] 36,000,000	1:1775	31.1	.01071	J. Barois
Po	[3] 27,100	[3] 62,200	[4] 67,000,000	1:900	59.0	.01139	"
Danube	[3] 320,300	[3] 315,2 0	[4] 108,00 ,000	1:2880	93.2	.00354	"
Nile	1,100,000	[7] 113,000	[4] 54,000,000	1:2050	38.8	.00042	"
Irrawaddy [6]	125,000	475,000	291,430,000	1:1610	209.0	.02005	R. Gordon

GLACIATION IN PENNSYLVANIA.

BY EDWARD H. WILLIAMS, JR., LEHIGH UNIVERSITY, SO. BETHLEHEM, PA.

Owing to the difference of opinion regarding glaciation in this vicinity, I have taken the subject for the out-door work of the post-graduates in the mining course, during the past few months, as their geological survey, and I make now a preliminary statement of what has been found, without theorizing upon it in any way, as the work is to be continued and extended to adjoining regions.

The Lehigh University is situated on the north slope of what is called The South Mountain, or the Durham and Reading Hills, immediately back of South Bethlehem, Pa. The crest of the same varies from 325 to over 900 feet above tide, at the point mentioned. This is above the reach of glacial deposits by floating ice. To the north lies the great valley bounded by the Blue Ridge, and just north of this is a lower ridge of Oriskany sandstone in a vertical position. The nearest portion of this sandstone is therefore beyond the Blue Ridge. As the rocks of this ridge are mainly barren, while the Oriskany sandstone carries the usual fossils, this formation was taken as a test-rock, owing to the fact that the rock called Potsdam sandstone sometimes weathers so as to greatly resemble rocks of other formations.

Professor Salisbury stated that he had found glaciated stones 500 feet above the Lehigh River, on the mountain back of the University, and adduced that fact to refute the statement of Professor Wright, that the ice failed to come as far south as Bethlehem. The height of the point noted was proof that the specimen had not been brought by water, and that the ice-sheet had extended across the great valley. From this was deduced the idea that there had been two periods of glaciation, and that the one marked by the terminal moraine north of us, was the later of the two.

[1] "Report upon the Physics and Hydraulics of the Mississippi River," by A. A. Humphreys and H. L. Abbot, Philadelphia, 1861, p. 149.

[2] "Eleventh Annual Report U. S. Geological Survey," Washington, 1891, Part II., p. 57.

[3] Scottish Geographical Magazine, February, 1887, p. 76.

[4] "Irrigation in Egypt," by J. Barois, translated by Major A. M. Miller, Washington, 1889, p. 18.

[5] "Hydraulics of Great Rivers," by J. J. Revy, New York, 1874, p. 135.

[6] "Report on the Irrawaddy River," by R. Gordon, Rangoon, 1880, Part III. p. 25.

[7] Special Consular Reports, House of Representatives, 51st Congress, 2d Session, Ex. Doc. 45, Part I., p. 259.

To the south of that part of the mountain back of the University, lies a land-locked valley, so that there was no drainage southward, except at high levels, during the time when the bowlder clay was deposited and therefore there would be no current to divert icebergs into that valley and cause a universal distribution of that clay, as there is to the north of the South Mountain.

The preliminary work shows that Oriskany pebbles and bowlders are found at all altitudes over this mountain, and the great majority of the smaller ones lie in a clay, which may be due to the decomposition of the gneiss of the mountain; but which exists on the top of the highest part of the ridge. These have been traced into the Saucon Valley to the south as far as a line running from Friedensville to the second railroad cut south of Bingen. South of that line we find the clays from the subjacent limestones generally free from foreign stones, as far south as Centre Valley, the southern part of the survey. North of that line we have found four lines of glaciated material. In the valleys these run across all the formations from gneiss to limestone, in lines generally parallel, and with a freedom of glaciated material except in the lowest parts, where ice may have been present. Oriskany bowlders are found of considerable size, and in some parts abundantly. Only one of these lines has been traced fully, and that runs from the north of Bingen and at an elevation of about 300 A. T., across the Saucon Creek and Valley, and, passing south of Seidersville, has been followed to the summit of a hill west of the latter place, and at an elevation of 720 A. T.

It is comparatively easy to trace these lines, as the farms are provided with wooden and wire fences, except where these lines exist, and there the fences are of stone heaps, and the soil is stony. Digging under these lines shows that they are resting on rock in some cases, and on soil in others.

It may be said that the ice went over the South Mountain. In this case there has since been a great disintegration of the gneiss, as the cuttings for the South Bethlehem reservoir show 25 feet of rotten rock in some places. It may be said that these are evidences of a older glaciation; but this older intrusion followed exactly the lines of the later one, as can be seen by running a line from the points in New Jersey noted by Professor Salisbury (Pattenburg, etc.) to Seidersville, Pa., so that the advocates of a single period can say that this was a sudden intrusion for a short period followed by rapid retreat for twenty miles.

This work is not sufficiently extended to furnish data for theorizing, and it will be extended in the future; but attention is called to the fact that here exists a good field for observation, as the rocks of the country (gneiss quartzite and limestone) cause intrusive rocks from the Blue Ridge to be very prominent.

INFLUENCE OF PARASITES ON OTHER INSECTS.

BY G. C. DAVIS, AGRICULTURAL COLLEGE, MICH.

From a philantrophic standpoint, it seems cruel to see one class of insects preying upon another. The eager female parasite is so vigilant in her search that one would think a subject of her search could not escape till it had reached maturity; yet strategy, mimicry, offensive odor, hairy and other coverings, and many other peculiar and interesting methods of protection help to shield and protect the invader from its insidious foe till out of danger. In watching the ups and downs of the two from year to year, about the only effect that is noticeable is that the parasite generally holds the balance of power, though usually the balance is well equipoised.

Viewed from an economic and practical side, the practice loses its cruel aspect and is encouraged and fostered in many ways, as it means an inexpensive control of many of our common pests. There is little doubt but parasites do much more good than we are wont to give them credit for. In a large share of the cases of parasitism, about so many individuals of a species are parasitized each season, and the number left remains too small to produce serious damage. On the other hand, if the species had no parasite to contend with, it would soon be numerous enough to be a dreaded pest.

Very often certain species do appear in greatly increased num-