XXV.—Relative Purity of the City Waters in the United States.

By Dr. A. R. Leeds.

A legal suit has recently been instituted, which will probably have a very important bearing in the future upon the quality of water supplied to many of the principal cities in the United States. To understand more readily the nature of the questions raised in this suit, a few words of previous explanation will be requisite. The three cities of Newark, Jersey City and Hoboken, with an aggregate population of 300,000 inhabitants, all draw their water supply from the river Passaic. This is a large stream, having a daily flow at Newark of about 100,000,000 gallons. Its water-shed is mainly granitic in character, and occupies about 950 square miles in the northern part of the State of New Jersey. About three miles above the city of Newark, the Belleville pumping stations are located, and at this point the supplies of the three above-mentioned cities are taken. Some eighteen miles farther up the stream is the town of Paterson, a community almost entirely engaged in the manufacture of paper, cotton, woolen and silk goods, locomotives, etc., and which throws its entire refuse and the sewage of 50,000 inhabitants into the Passaic. Above Paterson there are few villages and factories, so that the water going over the great falls at this place is of superior quality for drinking purposes. Below Paterson manufactories are gradually springing up, and are a constant source of uneasiness and alarm to the large population using the water as pumped at Belleville. During the course of the year just past, one of these factories, an extensive paper mill, situated on the Third River, a small tributary emptying into the Passaic a short distance above Belleville, threw into the water the refuse derived from washing out some carbolized paper. The taste and odor of carbolic acid were so strong that they caused a temporary suspension of the use of the Newark, Jersey City and Hoboken water for drinking. The Newark Aqueduct Board summoned the parties to desist, which they did at the time, but afterwards repeated the offence, when suit was brought against them by the Board. In defence, the plea was entered, and an attempt made to substantiate it by the testimony of many manufacturers, that the water was already so badly polluted at Paterson that it could not be made more unfit for drinking purposes by the introduction of some carbolic acid. In fact, it was urged that, so far from being rendered

any worse from the carbolic acid, it was actually made better, for the reason that the carbolic acid served to purify and disinfect it. The case was decided in favor of the Aqueduct Board. The importance of having successfully established such a precedent can scarcely be overestimated in connection with its future influence upon the sanitary welfare of rapidly growing communities. In this category are to be placed the large cities in the Eastern and Middle States, nearly all of which are contending with one phase or another of the evils arising from the crowding in of population, and a population in many instances devoted to manufacturing, upon their source of water supply. As a consequence, the problem whether to abandon the original sources, which in most cases are those designed by nature, and to seek more distant and expensive ones, or to restrain the population by legal processes, is most urgent.

In this connection, the author has been asked by the Boards of Commissioners of Newark and Jersey City to examine into the amounts of impurities in the river Passaic, beginning with a point above Paterson, and making analyses of samples collected at an interval of a mile, until the stream has passed the city of Newark. The collection was made all upon the one day, at the close of a period of many weeks of almost unexampled drought. The analysis of the forty samples thus collected will show not only the composition of the river water, in its worst condition, but likewise the changes in that composition during a flow of twenty-one miles.

Connected with this inquiry was the important one of determining the quality of the water supply, as compared with that of other cities. The design was to collect the samples on the same day, and analyze them all by the same methods. It was but partially successful, owing to a failure to obtain simultaneous co-operation in so many places. In the case of Washington, this was due to the fact that Dr. Smith Townshend, the health officer of the district of Columbia, at the very time of receiving my telegraphic request, was summoned to attend the wounded President in the railroad station at Washington. In the great excitement and general distress, my telegram was naturally lost sight of for several days. Neither was it a mode of comparison unexceptionable in point of principle, inasmuch as the climatic conditions were not exactly the same in the various places. So that from the results gathered, it would be manifestly unfair to state that the order of purity was fixedly maintained as that given. It could only be said that at the time when the comparison was made, about the 1st of July of this year (1881), such an order existed.

	HOBOKEN.				JERSEY CITY.					
	I June 23.	II June 23.	III June 23.	IV June 23.	V June 23.	VI June 23.	VII June 23.	VIII June 23.	IX June 23.	X June 23.
Free ammonia.	0.002	0.0024	0.0022	0.0033	0.00475	0.00525	0.005	0.003	0.0045	0.0075
Alb. ammonia	0.0305	0.0285	0.0328	0.0290	0.0427	0.0403	0.03775	0.0293	0.0423	0.042
Oxygen required	0.86	0.85	0.965	0.83	0.95	0.85	0.73	0.84	0.90	0.85
Nitrites	none	none	none	none	none	none	none	none	none	none
Nitrates	0.6845	0.666	0.702	0.6845	0.9065	0.629	0.6845	0.666	0.702	0.7585
Chlorine	0.26	0.215	0.27	0.305	0.235	0.215	0.225	0.230	0.210	0.220
Total hardness.	3.20	3.30	3.00	3.05	3.20	3.00	3.10	3.20	3.00	3.20
Total solids	12.20	15.60	8.50	7.40	9.30	10.80	9.70	10.00	10.80	10.50
Mineral matter	5.60	3.20	4.00	3.00	3 40	5.20	5.20	6.00	6.10	5.90
Organic and volatile matter	6.60	12.40	4.50	4.40	5.90	5.60	4.50	4.00	4.70	4.60

	Paterson, June 23.	New York, June 23.	Brooklyn, June 23.	Boston, June 23.	Philadelphia, June 24.	Wilmington, June 24.	Baltimore, June 25.	Washington, July 5.	Oswego, July 9.	Cincinnati, July 15.	Rochester, July 23.
Free ammonia.	0.0025	0.0027	0.00075	0.01325	0.001	0.0035	0.005	0.006	0.0035	0.0115	0.0015
Alb. ammonia	0.053	0.0270	0.00825	0.0605	0.018	0.0295	0.020	0.027	0.0256	0.024	0.023
Oxygen required	0.96	0.810	0.413	1.77	0.46	0.57	0.57	0.60	0.63	0.86	0.79
Nitrites	none	none	none	none	none	none	none	none	none	none	none
Nitrates	0.465	0.8325	1.2025	1.2395	0.6845	0.518	0.6100	0.8325	1.05	0.74	0.629
Chlorine	0.30	0.35	0.55	0.315	0.30	1.45	0.275	0.27	4.10	0.805	0.195
Total hardness.	3.00	3.30	2.27	2.10	4.40	3.20	3.90	4.80	10.00	6.40	5.50
Total solids	11.70	11.80	6.00	8.50	14.30	10.00	9.40	11.50	18.07	16.20	10.00
Mineral matter	3.50	5.00	5.00	2.00	6.00	3.00	7.20	5.50	11.37	9.00	4.00
Organic and volatile matter	8.20	6.80	1.00	6.50	8.30	7.00	2.20	6.00	6.70	7.20	6.00

Together with these determinations, a number are given of the water of the river Passaic as delivered at widely different points, and at nearly the same hour, on the same day, in Jersey City and Hoboken. They show not inconsiderable differences in composition, and illustrate to what extent water may differ when flowing at very different rates of velocity, or in the case of dead ends scarcely at all, in one and the same system of distributing pipes. Nearly all these pipes were of iron, cement pipes being little used. The results given are in parts per 100,000.

The labor of making a comparison was greatly facilitated by plotting these results on a large chart, so as to form a graphic representation of them.* From this, the following order of relative purity was inferred:

I. Brooklyn.
II. Rochester.
III. Philadelphia.
IV. Baltimore.
V. Washington.
VI. New York.
VII. Newark, Jersey City, Hoboken.
VIII. Cincinnati.
IX. Oswego.
X. Wilmington, Delaware.
XI. Boston.

In many particulars the order thus arrived at was quite unforeseen, and was a matter of great surprise. This was more especially true of Boston, which I anticipated would stand nearly at the head of the list, but which actually came at the bottom. And yet the water-sheds of both Brooklyn and Boston are on drift gravel. A month later I found that the best hotels in Boston, and private citizens who were willing to bear the extra expense, were supplied by spring water carted into the city, and sold at the rate of 10 cents per gallon. This state of affairs continued until the 28th of August, when I visited the city again, and inspected the Cochituate Lake and the Sudbury and Mystic Rivers, the three sources of supply. The water in the reservoirs supplied by the two latter streams had a yellow color and disagreeable, nasty taste and smell. During the earlier portion of the summer, all of the reservoirs had contained an abundant growth of algæ, which later on had decomposed, leaving

* The oxygen required to oxidize the organic matters was determined with potassium permanganate at 100° C.

behind the bad taste referred to. A striking peculiarity of these Boston waters is the large amount of decomposable organic matters held in solution. These points will best appear by examination of the results of tbe following analyses of samples collected on the 29th and 30th of August:

		Sudbury River.			
	Mystic Lake.	*Farm Pond.*	*First Dam.*	*Cochituate.*	*Pegan Brook.*
Free ammonia	0.015	0.001	0.012	0.025	0.289
Albuminoid ammonia	0.032	0.0325	0.039	0.064	0.240
Oxygen required to oxidize organic matters	0.900	1.180	1.190	0.830	6.630
Chlorine	3.010	0.460	0.440	0.460	7.650
Total solids	12.500	7.500	7.500	7.500	49.000
Mineral water	8.000	4.000	4.000	5.000	24.000
Organic and volatile matter	4.500	3.500	3.500	2.500	25.000

The causes of the inferior character of the Boston water supply are, first, its pollution by a few manufacturing towns, and, secondly, the growth of algæ, which again is favored by the shallow character of portions of the reservoirs and impounded streams. The worst of these sources of pollution is Pegan Brook, which flows through the town of Natick, a town of ten thousand inhabitants, almost entirely engaged in the manufacture of shoes, and empties into Cochituate Lake. The attempt has been made to mitigate the evil by throwing two filtering dams across the outlet of the stream, but both the forebays thus formed are densely overgrown with the lowest forms of aquatic vegetation, and may, to a certain extent, act as nurseries for the growth of these plants.

The Rochester water supply is derived from Hemlock Lake, remote from all sources of contamination, and after flowing through conduits for a number of miles, is discharged through a noble fountain into a reservoir near the city. A large portion of the Philadelphia supply is obtained from the river Schuylkill. At one time it was in imminent danger of fatal pollution from the growth of manufactories on the borders of the stream. But the city purchased the lands on both banks, nearly to the manufacturing town of Manyunk, located about seven miles above, and included these lands in a great park, so as to keep back all buildings from the water's edge. New York and all the places mentioned lower on the list receive their water supply from contaminated sources. The feeders which empty into Croton Lake, the principal reservoir of the New York water, pass through a settled country, with numerous tanneries, factories,

etc., along their banks. Analyses of the Croton water, made at different seasons during the past five years, have shown that it is to be classed among contaminated water supplies.

On the publication of the results above stated, it was indignantly claimed by the newspaper press of Wilmington, Delaware, that an injustice had been done to their city. But subsequently, letters published in reply by citizens of the place, have affirmed the correctness of the judgment founded on the analytical data, and have enumerated the various breweries, woolen, cotton and other mills and dye-houses, as affording a sufficient explanation of the low position assigned to the water supply.

XXVI.—Some New Facts Concerning Thymole Sulpho-acid, and some of its Salts.

By James H. Stebbins, Jr.

This work was undertaken for two reasons.

First, to establish certain facts, which thus far have either been neglected or overlooked; as for example, the production of free thymole sulpho-acid, which hitherto has only been obtained in combination with other salts. It was also my intention to produce from this latter, by direct combination, the calcium, ammonium, and soda salts, all of which have thus far not been mentioned. Or starting from, say, the barium salt, to produce by indirect combination either of the previously mentioned salts.

Second, to combine these new bodies with diazo compounds, and thus ascertain whether it is possible to produce azo compounds, from phenoles of this description.

This hypothesis seems all the more probable, as only a short time since, I obtained a yellow dye-stuff, by the direct combination of diazobenzole nitrate with an alkaline solution of thymole. As this dye was insoluble in water, the usual method of rendering such compounds soluble was resorted to, namely, the introduction of the sulpho group into the benzole nucleus.

My experiments in this line will be detailed in a subsequent paper.

The first person to engage in the study of these compounds was Lallemand,* who obtained a thymole sulpho-acid, by treating thymole with hydrochlor-sulphuric acid (SO_3HCl).

**Jahresber.* f. 1856, 617.