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The Water Supply of Minneapolis

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and its occurrence here is rather remarkable. So many plants peculiar to the great plains give this place a remarkable aspect, more so as the vegetation surrounding the ledge on all sides is the ordinary prairie flora. In the shallow stream, called Pipestone creek, large masses of the interesting liverwort Riccia fluitans, *Z.* were found, but none that were fertile.

Among the rare plants from Blue Earth Co., may be mentioned wolffia columbiana, Kasten. This plant occurs in a small pond near South Bend. The pond is a part of an old, abandoned channel of the Blue Earth river and is hemmed in on all sides by high bluffs. Here the wolffia occurs in great abundance, forming a stratum on the surface of the pond from one to two inches in thickness during the hot summer months. It has not yet been found in flower in this locality, and is doubtless an immigrant from localities further south, though it must have existed in this particular pond for many years, judging from the great masses of decomposed wolffias that have accumulated around the borders of the pond.

Blue Earth Co. is very rich in different forms of characeae. Five species were met with though no special search was made for them. They were as follows:

Nitella flexilis.
Chara foetida.
C. fragilis.
C. contraria.
C. ?

This latter has not yet been determined and may prove to be an undescribed species. The attention of our botanical collectors is called to this interesting group of plants. There are doubtless very many species of these plants within the borders of the state and a systematic search cannot but be rewarded with the discovery of many as yet, unknown species.

March 6, 1883.

[*Paper C.*]

Minneapolis, Minn., March 6, 1883.

MR. CHAIRMAN:—

The committee appointed at the last meeting of this Academy, to investigate and report on the subject of the water supply of the City of Minneapolis, now offer their report.

The committee interpreted their commission as including an investigation of the quality of the water of the river at present supplied, the quality of the water shortly to be supplied through the change in the location of the in-take, and the quality of the water from any other point or points from which the taking of water for the city supply seemed advisable or practicable. Questions connected with these, such as the location of sources of contamination of the water and the nature and amount of such contamination were also understood as lying within the province of your Committee.

The investigation of the quality of the water includes two branches: a *chemical examination* or analysis, and a *biological examination*. We will state the results of these separately. For purposes of a chemical examination, on the 12th of February a sample of water was obtained from the point at which the new intake is located, a "crib" on the line of the boom lying along the "mill-pond," nearly opposite the bridge by which First street south crosses the railway. On the same day a sample was obtained from a point about a mile and a half farther up the river, opposite Twenty-fourth avenue north-west and in the middle of the river, where an open space in the ice permitted the taking of the water. These samples were taken to the Chemical Laboratory of the University and analyzed by the tests commonly applied in an analysis of water for sanitary purposes. The results of the analysis of these two samples of water are given in the following table.

Results of Sanitary Analysis of the water of the Mississippi at two points in Minneapolis:

1. The test for *ammonia* (Wanklyn's process):—

a. Water above City opposite 24th Ave. N. W., showed free ammonia $\frac{11}{100}$ parts per million, albuminoid ammonia $\frac{25}{100}$ parts per million.

b. Water at new in-take pipe showed free ammonia $\frac{11\frac{1}{2}}{100}$ parts per million, albuminoid ammonia $\frac{23}{100}$ parts. (The difference is slight, but to the advantage of the water above City.)

2. The test for *Chlorine*:—

a. Water above City contained $1\frac{9}{100}$ parts per million.

b. Water at new in-take contained $1\frac{12}{100}$ parts per million. (To the advantage of the water above.)

3. The test for *nitrates and nitrites*:—

a. Water above City contained nitrogen as present in nitrates and nitrites $\frac{13}{100}$ parts per million.

b. Water at new in-take contained nitrogen as present in nitrates and nitrites $\frac{16}{100}$ parts per million. (To the advantage of the water above.

4. The test for organic matter with *permanganate solution.* (Tidy's process):—

a. Water above City required for oxidation of the organic matter $1\frac{75}{100}$ parts oxygen per million.

b. Water at new in-take required for oxidation of the organic matter $2\frac{3}{100}$ parts oxygen per million. (To the advantage of the water above.)

5. Determination of the *total solid residue* from evaporation:—

a. Water above City yielded 205 parts per million.

b. Water at new in-take yielded 205 parts per million. (No appreciable difference in this respect.)

These results of chemical analysis do not show any very considerable difference in the two samples of water. But what difference there is in the figures is, in case of each test, to the advantage of the water taken above the City. The water opposite Twenty-fourth avenue north is conclusively shown to be better than that at the new in-take, on the 12th of February. If at this point the question be raised as to the absolute goodness of the waters in question, apart from their relative qualities, it is to be said that, *so far as chemical tests go*, neither of these samples would be classed among bad waters. Neither of them betrays to the tests of the chemist, a dangerous or even a very objectionable character. The chemical examination of water alone is not sufficient to settle its absolute character. Other modes of examination and other considerations of various kinds must have their place. But before passing on to these, we will first make reference to another question which we have settled at the Chemical Laboratory. On the 2d of March two samples of the river water were procured, one at the point where the water is at present taken into the pump-house to be supplied to the mains, the other at the new in-take pipe at the crib above mentioned. These two samples have been analyzed like the others. The several tests have shown a difference between the two samples to the advantage of the new in-take, although the difference is not very considerable. The water at the new in-take was conclusively shown to be better than

that taken into the pump-house at present. But even the water now taken and supplied to the city does not reveal *to chemical tests* a decidedly bad character.

To pass on to the biological part of the investigation, it should be said in the first place that the winter season is an unfavorable one for the purpose. The result of an investigation of the animal life found in the waters about Minneapolis in winter can have, at best, but a negative value. Water taken in February from near the location of the new in-take pipe of the city water-works was found to contain very few organic impurities visible by means of the microscope. A few orthopterous larvae, *Thysanurae*, occur. Water taken from a hydrant near the corner of Sixth street and Nicollet avenue in June last, however, exhibited considerable quantities of animal and vegetable impurities. Among the latter were algae of the genera *Closterium Staurastrum*, *Nostoc*, *Spirogyra*, etc., together with diatoms and the like. Among the former were several species of entomostraca, as *Bosmina*, *Ceriodaphnia* and several Lynceids, rotifers and infusoria, and an *unusually large proportion of parasitic worms*. A study of the waters of our larger lakes in winter shows that those forms of life which may be regarded as danger signals are absent or few in number, in other words the conditions are not favorable for such animals as inhabit by preference putrid waters. In larger lakes fed by springs are found minute crustaceans, such as *Daphnia pulex* and species of *Diaptomus*, *Cyclops fluviatilis* and others; while in the smaller lakes the common pond *Cyclops* species, with the associated *Canthocampus* are almost the only entomostraca. To this fact is due the survival of fish in the larger lakes, which perish in others even if sufficiently ventilated. That portion of the Mississippi which lies immediately about the mouth of Bassett's creek is subject during the summer to constant contamination from the numerous marshes, slums and ditches which border that creek and fester and rot in the sun. The figures given below show how enormous a number of animal forms are supported by the filth in the pool known as Oak Lake. In a quart of water dipped from Oak Lake the following were counted:—

Ceriodaphnia,	1,400.	Amphipods,	120.
Daphnia,	0.	Infusoria,	35.
Simocephalus,	56.	Mollusks,	22.
Cypris,	50.	Diptera(larvae)	100.
Cyclops,	28.	Hemiptera,	0.

These were all visible to the unassisted eye.

It is obvious that the present in-take at the city water-works must be subject to contamination from this source. The microscopic examination of hydrant water is sufficient proof that the water-supply is actually thus contaminated.

It must be repeated that the past month has not been a favorable time for showing fully the character and quality of the water supply of the city. The river and the banks have been covered with ice and snow, and the inflow of impurities has been greatly reduced below what it must be in the warm season. In the course of the spring and summer, individual members of your committee will probably make some further investigations from time to time in connection with this subject. To sum up the principal points of this communication thus far; the chemical analyses have shown that the water of the river as it is now supplied by the water-works is inferior to that which will be obtained through the new in-take pipe, and that this latter again is inferior to the water of the river a mile and a half above; the results of biological examination now and at a different season of the year have shown considerable animal and vegetable life both in the water that we are now supplied with and in the river at the point from which we are soon to be supplied; and it is the presence of this animal and vegetable life which affords decided proof of contamination from foul sources.

But this is not all of the investigation. The examiners of a water supply are not to confine themselves to what they may be able to find in a quart or two of the water bottled up and taken to the laboratory. There are other ways of reaching just conclusions as to the quality of a water besides those involving the use of the microscope or the application of chemical tests. Attention must be given to the nature and condition of the surroundings of the stretch of water from which the supply is derived.

Your committee have given some attention to the matters here referred to; and to any who may not be acquainted with the ground in question, they would recommend the following walk. Starting from the Market building, pass up on the right hand side of First street north. We note that the slope of the ground is towards the river, and we observe that this ground, in the back yards of dwelling houses and around stables, etc., is in a very unclean state. We cannot doubt that in wet weather, the surface drainage will carry a large amount of impure matter into the

river. Keep on across the railway and come to the point where Bassett's creek is crossed by the road. We observe here the houses,—and the out-houses,—on the sides of the banks. Pass around through an avenue to a corresponding point of observation on Second street. Here among other things we find a general dumping place for mixed refuse. Now pass around to Washington avenue, and look at the surroundings of the creek on both sides of the road. In short, it will be apparent to any one that the water of Bassett's creek in that neighborhood must be of the foulest character. This being admitted, two practical questions present themselves: First, will the water of Bassett's creek,or any of it, find its way into the new in-take of the city water-works? Second, will any harm result from such contamination of our water supply? To the first of these questions your committee feel constrained to give an answer in the affirmative. The configuration of the west bank of the river from the mouth of Bassett's creek downward is such that the water flowing out of the creek cannot be expected to confine itself to the immediate neighborhood of the bank as it passes along. If we stand on the Suspension bridge and look along the stream above and below, observing the position of the new in-take, etc., or if we place before us a map of the city, the conclusion becomes inevitable that the intake pipe will receive its share of the foul water coming from that creek. Nevertheless we believe that we shall, after the completion of the work now being done by the water board, have a supply in some degree better than the old one. The surface drainage from the unclean premises along the steep bank on High street, below the Suspension bridge, will certainly not enter the new pipes to the extent that it has entered the old. But as we attend to points higher up stream, the smaller will be the difference in the effect of contamination derived from these sources upon the water at the two places,—the old and the new in-take. The dwelling houses and stables along First street, the mills and iron works, the railway structures, the three bridges crossing the river, will all contribute their portion of dirt, of which the water pipe at the crib will draw in its share. The second question in this connection was, whether any harm will result from the contamination of the water to which we have referred. This is not a question of mere uncleanliness. It is undoubtedly repulsive to all of us to think of the impure matters of whose presence in the river we have ample evidence. Contact with dirt we are all destined to

have, in some degree; but we generally seek to make that contact as small as possible. This is a question of positive danger to health and life. The matters in drinking water for which the chemist tests are in themselves comparatively or wholly harmless. The living creatures which are shown in the water by the microscope are to a great extent, also harmless. But the obtaining of these tests and observations is important as showing the contamination of the water by refuse animal substances. It is now everywhere held by medical and other scientific men that the presence in water of even very small quantities of excrementitious matter from diseased persons makes that water highly dangerous. The subtle germs of infection are in it, though they as yet defy the tests of chemistry and even the powers of the microscope. They are revealed by their effects. You may dilute the impure matters. The Mississippi does dilute the impurities of Bassett's creek to a very high degree. But the dilution only diminishes the chances that any one of us using the water may be infected. One other point in this connection. The question as to the rapidity and the degree of the oxidation and destruction of sewage matters, when these have found their way into a river, is as yet not settled. The evidence thus far is considered to show that it is a slow process, and the most objectionable parts of the impure matters possess the greatest vitality. It must at least be said that the distance of about three quarters of a mile between our water pipe and Bassett's creek is too short to admit of any considerable destruction of the impurities by natural causes.

Your committee have endeavored to ascertain and present to you the facts of this matter, as they are learned by the various lines of investigation. In conclusion, they need hardly state, after what has been read, that they deem it desirable that the water supplied to the city should, at the earliest practicable time, be taken from a point sufficiently far up stream to avoid the sources of contamination to which reference has here been made.

The chemical analyses were made by J. A. Dodge. The statement of the results of biological work are by C. L. Herrick. Dr. A. E. Johnson has found results quite analagous with these.

Signed by the Committee,

JAMES A. DODGE,
C. L. HERRICK,
C. W. HALL.