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THE SANITARY AND UNSANITARY RELATIONS OF UNDERGROUND WATERS.

Read in the Section of State Medicine, at the Forty-second Annual Meeting of the American Medical Association, held at Washington, D. C., May, 1891.

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Gentlemen:—It is not my intention to deal at any length with this subject, but rather to present some of the principles to be observed in the selection of drinking waters.

Much has been said with regard to the dangers of drinking water from wells; but it has not been until recently that the differentiation has been made as regards wells that are dangerous and those that are healthy.

As a general principle, it may be said that practically all *really* underground waters are sanitarily good; but it must be clearly understood what is meant by an underground water. For instance:

1. A water lying in a shallow dug out in prairie or bog land, down only to the impervious clay or rock below, cannot fairly be called underground water.

2. Neither can a well down even into a true water-bearing stratum of sand or gravel, be called an underground water, if the water of the upper organic soil layer is allowed to percolate toward the well laterally, without really moving downward through the underlying beds of clay loam, sand or gravel, which serve to sterilize the waters in their passage downward.

3. Neither can a well be called underground if, as is commonly the case, the well is covered with loose boards, or a wooden framework, thereby allowing the filth washings from the surface of the boards to be carried down through cracks into the water of the well.

Carl Fraenkel and others have carefully examined into the water of pit-wells, and such have by Pflügge been called "hygienic monsters."

Clearly, then, underground waters mean those which have primarily fallen upon the surface, have there been contaminated with soil microbes, but which have, in their passage downward, through percolation to the water-bearing zone situated on some impervious stratum, been purified by the several natural agencies which are at work.

Of these, doubtless, the one of greatest importance is the mechanical retention in the upper layers, of the grosser organic matters, for instance those of sewage on a sewage farm.

I have found that at a sewage farm, the upper circle or two of the bed of sand has retained practically all suspended organic matters, and that even soluble organic matters are gradually abstracted by capillary adhesion from waters as they pass downward.

In addition, however, to this cleansing action of capillarity, we have at work, under favoring conditions, the destructive action of bacteria. With various kinds of organic matters, putrefaction bacteria deal largely, but their work, while purifying to the soil, may result in emanations of an extremely injurious character. In order that this decomposition may go on rapidly and without pernicious results, intermittency of deposit of organic matter on the surface and the penetration of air with its oxygen into the soil is required, in order that the nitrifying germ, proper, may carry on its beneficent work.

Manifestly, therefore, we have in towns conditions where, with the permanent presence of masses of organic matter in back-yards and in privies, waters may move laterally or from the surface, carrying to the largest extent their solubility admits of, organic materials to underground strata, which, appearing in wells, and there coming into contact with oxygen, supply conditions for the free multiplication of germs borne in from the surface or the air, and hence waters that have been sterile as underground streams, and loaded with soluble organic matters, become culture media for certain pathogenic bacteria in those seasons of the year when the water temperature makes their development abundant. Every one is familiar with wells dangerous only in the later summer months when deep, or from spring or early summer, when their water reaches a higher temperature.

Much interest has for many years attached to the experiments of Pettenkofer with regard to the rising and falling of underground waters, in their bearing upon the increase in the mortality from filth diseases, notably of typhoid fever. It has been assumed that he was correct in saying that after a summer lowering of the ground water, and then a rise with autumn rains, typhoid invariably increased.

Now, with regard to this, as with so many other conditions, individual local circumstances will decide whether or not he is correct. For instance, Buck and Franklin have laid special stress on *wetness of soil* in general, and the effect of highness or lowness of the *subsoil water*, as increasing *cholera infantum*. Hirsch, on the other hand, examined the relationship between the number of cases of cholera infantum and the level of the subsoil water at Berlin, from 1877 to 1882, and concluded that the height of the subsoil water in Berlin gives no measure of the rate of mortality. Now if we look closely into the facts there, his conclusions are as we would expect. The city is

largely supplied with public water from the river sources, and naturally we find that during periods of high ground water, the rivers become increased in their volume, and instead of the drinking-water being more impure at such times, it would be less so.

But the case is different where well water is used. During the periods of dry weather, as the water in the superficial soil layers has gradually passed downward, it has been followed, according to the permeability of a soil, by atmospheric air, thereby extending the line of organic decomposition downward—this, however, being limited usually by the upper 4 or 5 feet.

What then takes place when heavy rains come? The first result is that the upper permeable bed, loaded with bacteria from free decomposition of organic matters, becomes saturated with moisture, while privies also, which have during the dry weather lost most of their fluid contents by evaporation, likewise become surcharged with moisture. The water from both these supersaturated sources moves along laterally downward toward the wells, as the lowest point, and loads them with soluble organic impurities, and with putrefactive and nitrifying bacteria; in addition to suspended impurities washed in from the surface. This causes disease, beyond question; but this is not due to the rise of ground water necessarily, since, as all know, the actual rise, in other than shallow subterranean water streams and in springs, does not take place till weeks, or even months, after the spring or autumnal heavy rainfalls.

We, therefore, can see that the conditions governing the purity of water supplies from ponded streams and small lakes, are very different from those governing well waters, as in pit-wells. When the first are most foul, the latter are often least so.

The question, then, of the use of underground waters, is of a much wider nature than that relating merely to pit-wells in town and country.

Falling upon pervious upper soil and upland and cultivated fields, the rain forms those great reservoirs upon which river and lake supplies, as also that of ordinary wells, depends. Springs on the hillside are the index of their existence, and to these streams must we look for a pure water supply, obtained under conditions widely different from those we have just referred to.

Analyze these spring waters before contaminated by surface filth, drive an iron pipe down to this water-bearing stratum, and we find a water in all cases absolutely free from bacterial life, and those conditions which make pit-wells under ordinary conditions, such dangerous sources of supply.

As the rivers, in recent years, have been falling during the long summer, through the loss of the upland forests which formerly held back the water, and whose absence likewise creates long summer droughts, relieved at most by destructive

thunder-storms, we have found ourselves depending upon ponded waters, becoming more impure by evaporation, lessening their amount, or upon rivers becoming more polluted by this lessened amount, together with increasing pollution by our growing towns. We are hence forced to turn our attention to these underground waters, sometimes, it is true, somewhat excessive in hardness, but always sterile, and supplying to artesian wells, driven wells, water-galleries of perforated pipes, and springs carefully collected and protected against surface pollution, while the utilization of such will do much to solve the questions both of water supply and sewage which, upon this rapidly populating continent, are to-day of more importance than probably all other health problems combined.

SECTION OF OPHTHALMOLOGY.

RECORD OF THE MEETINGS.

DR. LEARTUS CONNOR, Chairman.

DR. T. E. MURRELL, Secretary.

The sessions of this Section were held in the afternoon of May 5th, 6th and 7th, in the Medical Department of Georgetown University.

The chairman opened the first meeting with an address which contained very valuable suggestions in regard to promoting the interests of the Section. After the reading of this paper, upon motion, a committee of three was appointed to consider the suggestions in the Chairman's Address; the Chairman to be one of the committee.

The committee, consisting of Drs. Geo. E. Frothingham, Edward Jackson and Leartus Connor, reported on the second day as follows:

Gentlemen of the Ophthalmological Section, American Medical Association:

Your Committee, to whom was referred the Chairman's Address, begs leave to report upon his suggestions, by recommending the Section to adopt the following:

First, That the Section appoint an Executive Committee of three, whose general duties shall be to look after all matters pertaining to the development of the Section, not already in the hands of existing officers. When first appointed the members of this Committee shall serve for three, two and one years respectively, the yearly vacancy occurring thereafter shall be filled by the retiring chairman of the Section. Should other Sections appoint similar committees, it shall coöperate with them in all efforts to promote the interests of all Sections. It shall hold a yearly meeting, previous to the beginning of the sessions of the Section, at an exact date and place to be named by the Chairman of the Committee, and at such other times and places as the Committee may deem best for the promotion of the growth of the Section.

Second, That the Executive Committee be instructed to formulate and execute the plans needful for securing the re-publication from THE JOURNAL of the work of the Section, including papers with the discussions thereon, a complete list of all members of the Association who are active workers in ophthalmology, and such other facts as may be necessary for the completeness of the publica-