Geological Conditions Affecting the Purity of Water.

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The subject of health, its preservation and its restoration, is one that in all civilized communities today demands the attention of many of our clearest and ablest thinkers. Investigating the causes, the cures, and the preventations of disease we find a scores of our brightest intellects zealously laboring for the advancement of science and the welfare of humanity. One of the most important and essential of human wants is water and it forms the subject of one of the principle branches of investigation demanding the scientists attention. Man cannot live without water to drink any more than a tree or plant can live without water in its tissues. It is as necessary for the healthy and harmonious action of his bodily functions as it is for the proper assimilation of mineral foods in vegtable organisms, or the digestion of organic foods in the animal kingdom. A thorough study of its physiological uses reveals its great importance as an agent in building up organic tissues as well as one for

tearing down and carrying off waste products and it impresses the investigator with the absolute necessity of using such water as is free from all injurious ingredients. None of the waters as found in nature can, strictly speaking, be called pure. When tested by a chemical analysis all are found to contain more or less of substances which in their ordinary conditions are either solids or gases. This may be partially explained when we learn that among the scientists water is regarded as the universal solvent because without any apparent change it will dissolve more substances than any other liquid. From this fact we must not infer, however, that all natural waters contain injurious materials for many of the ingredients are actually beneficial.

Its impurities may be considered under two general classes; first, those held in suspension, and; second, those held in solution. Suspended matter may be inorganic and existing as minute particles of clay, ferrous com-

pounds or other materials; or it may be organic of either vegetable or animal origin. Of the former, or vegetable organic matter, we have numerous examples in some species of microscopic Algae and also in the great group known as Protophyta under the class Schizomycetes we find vast numbers of little Desmids and Diatoms. But the most important of all are the myriads of unicellular individuals known as Bacteria. These are peculiarly important because they carry and communicate the germs of disease or perhaps, strictly speaking, they are the germs themselves and each disease has its species of germs possessing its own peculiar characteristics. Water is generally considered to be an excellent medium for the transference of bacteria and it is also believed that the germs are readily propagated as well as conveyed in water. Of the latter, or organic animal matter, we have the microscopic Rotifera or Wheel-animalculae, as they are called, as representing one class of organic animal impurity. These

are found in great numbers in some fresh water. Another class of animal impurity is, properly speaking, an animal product or waste and in many sections forms an important item in the character of the water.

The second class of impurities, or those in solution, may be from solids of either organic or inorganic matter or they may be from gaseous materials and again sometimes vegetable extractive materials are held in solution. Common salt, — sodium chloride — and calcium chloride are good examples of inorganic solids that are readily dissolved; while alcohol and glycerine are among the best of organic substances to be perfectly soluble in water. Lastly nearly all gases are, to a certain extent, soluble in water though there is great variation in the degree of their solubility. As an example of this difference we note that one cubic centimeter of water at zero degrees temperature will dissolve forty-one thousandths (.041) of its volume of

oxygen gas; while the same volume of water under the same conditions will dissolve one thousand forty-nine and six tenths (1049.6) times its volume of ammonia. Now while the oxygen absorbed is a very considerable amount that of ammonia is more than twenty-five thousand (25,000.) times as great; an enormous difference that is in many respects difficult to understand. In ordinary rain water the principal gases dissolved are Carbonic acid, Oxygen, and ammonia in varying proportions depending on location and the condition of the atmosphere.

Since we realize that water is so essential and necessary to human welfare and since it is so easily rendered impure by the above enumerated causes we think a study of those conditions and those agencies affecting, for good or for bad, our drinking water would be both profitable and interesting. We must not think, however, that since none of the natural waters are perfectly pure all are necessarily injurious for many of the foreign substances which must be

called impurities, in water, are harmless ordinarily. Some of them, especially those containing some mineral ingredients, are actually beneficial as is testified to by thousands of persons who have been cured or relieved of some ailment by the use of "mineral water".

In our consideration of the waters used by man we may think of them as being derived from four different sources. (1) Rainwater which comes the nearest to being pure of any that we get without the aid of the chemist. It usually contains an exceedingly small percent of solid matter as dust or the bodies of minute insects from the air and also a varying propotion of gases chiefly those already mentioned. (2) the class known as surface water including that obtained from streams and lakes. This and the class following are especially liable to impurities and of such a character that is injurious to health. It may be said however that surface waters are now very little used for living purposes and it is very probable that in a few years

no one will think of using such water without first having it properly filtered and purified. The character of stream and pond or lake water depends largely upon the character of the soil in the region from which the water has been collected. If the soil is a clay of a tenacious character not easily worked or washed the water will flow off the surface freely without gathering a very large amount of foreign substances and will not percolate through the strata very extensively. But if the soil is porous and made up largely of decomposed vegetable matter a much greater proportion of the rainfall will, for a time at least, remain in the soil and will take from it considerable of sediment and animal and vegetable materials. All of the most fertile sections of this country belong to the latter class. Nearly all of the central states and the states of the plains among them; but in some of the rougher sections of the country as New York, for example, the clayey soil prevents any extensive absorption of the rainfall and the soil does not erode so rapidly as compared

with the more porous soils and hence the water in the streams there is exceptionally clear and free from sediments.

The third class of potable waters is known as ground-water meaning that found in the soil not far below the surface; including all shallow wells. Drinking water obtained from this source is very common, indeed, and although very liable to contain injurious ingredients, either suspended or dissolved, we may find such wells almost anywhere except in rough or upland country. And though those who use them may be aware of the dangers associated with the drinking of such water the convenience is so much greater that they carelessly allow themselves to trifle with health by continued patronage. The great danger lies in the collecting of surface water and sewage and if in the neighborhood of a small stream the chances are very great that contaminated water will be carried to the well without sufficient filtration. Also in dry times when streams contain stagnant water the same danger

exists but in a much greater degree. The effects of such drinking water is noticeable almost every day during the warm summer months causing ague, malaria, and fevers. A moments thought as to the places where the above ailments are numerous shows us that there we also find this class of drinking water. Perhaps it would be presuming too much to say the trouble was all due to the water yet I believe fully that at least three-fourths of all such troubles might be avoided by the drinking of pure water. Pure in the ordinary sense, that is, free from all ingredients that are injurious to the human system.

The fourth class is called "deep-rated" or "mineral" waters and includes all deep wells, artesian wells, and springs. Water obtained from either of these sources is almost invariably healthier than that obtained from any of the other classes. They are frequently termed "mineral waters" because all mineral wells or springs are included in this class and usually they contain a greater percent of

some one mineral or mineral compound than others do. This is the class to which I wish to call especial attention and from which I shall draw my conclusions concerning the effects of rough and broken land surface on the water circulating through the various strata underneath.

It is an evident fact that that water which circulates through the soil freely is purer and more wholesome than that which remains stationary or nearly so and which is commonly termed sheet-water. Now in all level or nearly level country the water from the shallow wells is almost universally of this latter class or sheet-water, while that found in rougher hilly country is almost invariably the opposite for here the geological strata have been disturbed and greatly crumpled and folded by the contraction of the earths surface caused by cooling. And here the water following through crevices in the soft strata and between layers of harder rock is forced to keep in continual motion much more perfectly than that in nearly level strata. There

are many prominent examples of mineral springs, in this country, to which we may look and make our observations. One of the notable ones being the Hot Springs of Garland Co. Arkansas. There more than one hundred springs, varying from ninety to one hundred and forty degrees in temprature, issue from a strip bank in a mountainous section of the country. These springs pour out an almost unlimited supply of very valuable mineral water. In Texas are a number of valuable chalybeate and sulphur springs also found in rough and broken country. In Colorado, North Carolina, Virginia and several other states are similar medicated springs. The Saratoga springs, in Saratoga New York, are perhaps the most popular of their kind in this country and have for many years been famous as a health resort and fashionable watering place. Sulphur is the prominent mineral in solution. Here again the character condition and arrangement of the earths surface and underlying strata

bear out my previous assertions. To use an illustration from near home I would call attention to a similar mineral well among the hills near Deep-creek in this county. This was bored to a depth I think, about two hundred feet and the water rose to the top and has continued to flow out from the surface as any artesian well. The water is certainly very healthful though I am not sure that it has been well demonstrated to possess actively beneficial medicinal properties. I have referred to these mineral springs as examples because they are the ones best known to every one and though the same facts and principles are as applicable to the other kinds of drep-seated waters they could not be so well used to illustrate.