SCIENCE:

PUBLISHED BY N. D. C. HODGES, 874 BROADWAY, NEW YORK.

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THE VALUE OF A WATER ANALYSIS.

BY W. P. MASON, RENSSELAER POLYTECHNIC INSTITUTE, TROY, N. Y.

A GREAT deal of popular misconception exists upon the subject of the analysis of potable water, and it is commonly supposed that such an examination may be looked upon from practically the same point of view as the analysis of an iron ore. That this belief is founded on fallacy may, however, be readily shown. When an iron ore is submitted for analysis, the chemist determines and reports upon the percentages of iron, phosphorus, sulphur, etc., found therein; and at that point his duties usually cease, inasmuch as the ironmaster is ordinarily capable of interpreting the analysis for himself. Even should the analyst be called upon for an opinion as to the quality of the ore, the well-known properties of the several constituents make such a task an easy one, and, assuming the sample to have been fairly selected, the opinion may be written without any inquiry as to the nature of the local surroundings whence the ore was taken.

A water analysis, on the other hand, is really not an analysis at all, properly so-called, but is a series of experiments undertaken with a view to assist the judgment in determining the potability of the supply. The methods of conducting these experiments are largely influenced by the individual preferences of the analyst, and are far from being uniform or always capable of comparison, thus often introducing elements of confusion where two or more chemists are employed to analyze the same water. Some of the substances reported, "albuminoid ammonia," for instance, do not exist ready formed in the water at all, and are but the imperfect experimental measures of the objectionable organic constituents, which our present lack of knowledge prevents our estimating directly.

Thus the numerical results of a water analysis are not only unintelligible to the general public but are not always capable of interpretation by a chemist, unless he be acquainted with the surroundings of the spot whence the sample was drawn, and be posted as to the analytical methods employed.

It is very common for water to be sent for analysis, with the request that an opinion be returned as to its suitability for potable uses, while at the same time all information as to its source is not only unfurnished but is intentionally withheld, with a view of rendering the desired report unprejudiced in character.

Such action is not only a reflection upon the moral quality of the chemist, but it seriously hampers him in his efforts to formulate an opinion from the analytical results.

For instance, a large quantity of common salt is a cause for suspicion when found in drinking water, not because of any poisonous property attaching to the salt itself, but because it is usually difficult to explain its presence in quantity except upon the supposition of the infiltration of sewage; yet an amount of salt sufficient to condemn the water from a shallow well in the Hudson valley, could be passed as unobjectionable if found in a deep-well water from near Syracuse, N. Y.

We thus see how important it is for the chemist to be fully acquainted with the history of the water he is to examine, in order that he may compare his results in "chlorine" with the "normal chlorine" of the section whence the sample is taken. A knowledge of the history of the water is no less important in order to interpret the remaining items of a water analysis. Some time since a water was sent from Florida to this laboratory for examination, and was found to contain 1.18 parts "free ammonia" per million.

Much "free ammonia" commonly points to comtamination from animal sources, and had it not been known that the water in question was derived from the melting of artificial ice made by the ammonia process, the enormous quantity of ammonia found would have condemned it beyond a peradventure. As it was, the water was pronounced pure, the other items of the analysis having been found unobjectionable.

Analytical results which would condemn a surface-water are unobjectionable for water from an artesian well, for the reason that in the latter case high figures in "free ammonia," "chlorine," or "nitrates" are capable of an explanation other than that of sewage infiltration. Even though such water should have, at a previous period, come in contact with objectionable organic waste material, yet the intervening length of time and great distance of underground flow would have furnished abundant opportunity for thorough oxidation and purification.

"Deep" samples taken from the same lake, at the same spot and depth, will greatly vary in analytical results if the temperature of the water at the several dates of sampling should be markedly different, owing to the disturbing influence of vertical currents.

Again, suppose it is desired to determine whether or not the water of a large stream is so contaminated with up-stream sewage as to be unfit for a town supply. An analysis of the water taken from the site of the proposed in-take would very probably be valueless, because the enormous dilution to which the admitted sewage would have been subjected would remove from the analytical results everything of an absolute character. Examinations of any real value in such cases should always be of a comparative nature. Samples should be taken above and below the point of contamination and again at the proposed in-take. If the difference between the first and second samples, which is a measure of the pollution, be maintained, or nearly so, at the point of in-take, then the water should be condemned no matter how completely the analytical results fall within the limits of the so-called standards of organic purity.

Thus it is that a chemist must be in full possession of all the facts concerning the water which he is asked to examine, in order that his opinion as to its purity may be based upon the entire breadth of his passed experience, for in no branch of chemical work is experience and good judgment better exercised than in the interpretation of a water analysis.

As Nichols has well said, "It is a great mistake to suppose that the proper way to consult a chemist is to send a sample of water in a sealed vessel with no hint as to its source. On the contrary, the chemist should know as much as possible as to the history and source of the water and, if possible, should take the samples himself."

In the taking of samples for so important a matter as a town supply, the chemist should unquestionably personally superintend their collection; but, for individual outlying waters, printed instructions have to be frequently depended upon. Those issued from this laboratory are as follows:—

DIRECTIONS FOR TAKING A WATER SAMPLE.

Large glass-stopper bottles are best for sampling, but as they are seldom at hand, a two-gallon, new demijohn should be employed, fitted with a new soft cork. Be careful to notice that no packing straw or other foreign substance yet remains in the demijohn, and thoroughly rinse it with the water to be sampled. Do not attempt to scour the interior of the neck by rubbing with either fingers or cloth. After thorough rinsing, fill the vessel to overflowing so as to displace the air, and then completely empty it.

If the water is to be taken from a tap, let enough run to waste to empty the local lateral before sampling; if from a pump, pump enough to empty all the pump connections; if from a stream or lake, take the sample some distance from the shore, and plunge the sampling vessel a foot and a half below the surface during filling, so as to avoid surface scum.

In every case fill the demijohn nearly full, leaving but a small space to allow for possible expansion, and cork securely. Under no circumstances place sealing-wax upon the cork, but tie a piece of cloth firmly over the neck to hold the cork in place. The ends of the string may be afterwards sealed if necessary.

Bear in mind, throughout, that water analysis deals with material present in very minute quantity, and that the least carelessness in collecting the sample must vitiate the results. Give the date of taking the sample, as full a description as possible of the soil through which the water flows, together with the immediate sources of possible contamination.

STARFISHES OF THE INDIAN OCEAN.

BY DR. R W. SHUFELDT, TAKOMA, D. C.

BIOLOGICAL work of a very excellent character has within the last few years been accomplished in the Indian Seas through those employed on board H. M. Indian Marine Survey steamer, "Investigator," Commander C. F. Oldham, R.N., commanding. Much of this success is due to the labors of Mr. A. Alcock, Surgeon-Captain, I.M.S., and late Naturalist to the Survey.

Mr. Alcock has recently sent me from Calcutta a copy of his work, entitled "An Account of the Collection of Deep-Sea Asteroidea," from the region just mentioned — it being an extract from the *Annals and Magazine of Natural History* (Ser. 6, Vol. XI.) for February, 1893. From it, it would appear, that since the year 1885 many parts of the Indian Ocean, in waters varying from 100 fathoms to 1,000 fathoms and over, have been very profitably dredged by the naturalists of the "Investigator."

Mr. Alcock remarks, "A large collection of littoral and shallow-water forms [of starfishes] has also been made, but these are not here considered. If it be thought objectionable to have separated the deep-water from the shallow-water forms, it may be urged in justification that within the limits of Indian seas, so far as our experience at present goes, there is no instance of the two sections overlapping, and on another ground, that almost nothing has been published, and nothing else is promised, about the extremely interesting Asteroidea of the deeper waters of India. Of the basins into which these waters may conveniently be divided, the Bay of Bengal proper—the basin best explored by the dredge so far — gives us the smallest number of unknown species. Beyond the limits of the 30-fathom line it would seem as if the overwhelmingly muddy bottom of the bay presented conditions specially unfavorable to the existence of starfishes; and after passing this limit we usually dredge nothing until we reach true bathybial conditions in the middle of the bay" (pp. 73, 74).

On the Andaman side, however, in 561 fathoms of water, they met with *Brisinga*, and opposite to the Kistna and Godávari Deltas, in 500 to 700 fathoms, where the bottom was of a hardening clay, *Flabellum (japonicum* and *laciniatum)*, *Bathyactis*, *Phormosoma*, and Spatangoids, *Pentagonaster*, again appeared. In the middle of the bay, with a bottom of accumulating *Globigerina*-ooze, the well-nigh cosmopolitan forms of *Pararchaster*, *Dytaster*, *Porcellanaster*, *Styracaster*, *Hyphalaster*, *Paragonaster*, *Zoroaster*, *Marsipaster*, *Hymenaster*, and *Freyella* rewarded the efforts of the dredger.

Peculiarly favorable to starfish-life is the enclosed basin of the Andaman Sea, which thus far, however, has only been examined up to 600 fathoms. Of twenty-one species here collected, no less than sixteen were new to science, including three very remarkable generic types. Eighteen species were dredged in the Laccadive Sea, and other very interesting localities were examined. Little, however, was added to our knowledge of the life-habits of the deep-sea starfishes, though "like some of the common reef-forms they must sometimes live in swarms, as, for instance, *Zoroaster carinatus*, of which over a score have been taken at one haul, *Pontaster hispidus*, of which about fifty have been dredged at the same time, and *Nymphaster florifer*, of which a 150 have come up on the tangle-bar."

The food of these deep-sea types seems mainly to be mollusks, prawns, and amphipods, and in some cases they gorge themselves with *Globigerina*-ooze. "A curious case of symbiosis, which has been observed too often to be a merely accidental association, occurs between *Dictyaster xenophilus* and an annelid."

Mr. Alcock's work forms a brochure of about fifty pages, with some good figures on plates, and throughout the whole he has followed the classification of Mr. Sladen, now well-known to the students of the Asteroidea, through their reading of it in those classical volumes, the "Challenger Reports," to which it was contributed.

THE USE OF POISONS AS FUNGICIDES AND INSECTICIDES.

BY L. R. TAFT, AGRICULTURAL COLLEGE, MICH.

ALTHOUGH copper sulphate has been used for many years for the destruction of the smut spores of wheat and oats, it is only about ten years since it was first employed upon fruit and similar crops as a fungicide, and for fully one-half of this period it was only used in an experimental way.

Its effects have proven so beneficial, however, that the fruit-growers, of the State of Michigan alone, will this year use several tons in combatting the various diseases that infest their crops.

The amount in time and materials expended in the use of fungicides in the United States must then reach many thousands of dollars, and it is very desirable that as much light as possible be secured upon the time and number of the applications that are necessary to obtain the best results, as well as upon the mixtures that will be most effective and economical. It has been clearly shown by many experiments that, to be most effective, the applications must be made early in the season, before the disease has obtained a foothold; but, as the number of sprayings required to hold the disease in check will depend upon such conditions as character of crop, season, and location, and the prevalence of the disease, it is doubtful if anything more than a general rule can be given, and this must be modified to suit the conditions.

Experiments have demonstrated that very small amounts of the salts of copper will destroy the spores of fungi, and have shown that the original formulæ for most of the fungicides were deficient in water, or, in other words, the mixtures were unnecessarily concentrated. Although, as now used, the strength has been greatly decreased, the limit has by no means been reached. The amount of copper sulphate in Bordeaux-mixture has been reduced from sixteen to six pounds for twenty-two gallons of water, and the experiments of the writer tend to show that for many diseases one or two pounds are fully as beneficial.

Two or three years ago most writers recommended some form of ammoniacal solution of copper carbonate, but, after a thorough trial, most fruit-growers have come to consider Bordeaux-mixture preferable to any of the ammonia-containing mixtures. The ammonia solutions were commended as being cheaper and easier to apply, but, in fact, the Bordeaux-mixture of the same strength is much less expensive; if properly strained it is not likely to clog the pump or nozzles; it is less easily washed from the plants; and it is not only less likely to injure the foliage, but it allows the arsenites to be used at the same time, thus forming a combined fungicide and insecticide, and the lime also prevents all injury from the arsenic.

For these reasons the Bordeaux-mixture is preferable, and its use should be commended.

This lime-mixture covers the plants with a sort of whitewash, and, although this is in one way objectionable, in another, from the consumers' standpoint at least, it is preferable to some of the clear solutions, which, although they contain fully as much poison, are not very noticeable upon the plants.

Fruits sprayed within a few days of the time of gathering would in one case not be saleable, and in the other, although