when away from home (as was frequently the case) to write and indicate not simply in what part of the library the book would be found, but in what portion of the volume, and almost always whether on the left or right hand page, any given passage required would be found.

Of late years I have found it desirable to rebind my tracts in something of a uniform manner. Their external individuality is thus destroyed, but the aspect of their title-pages and the location of particular passages of the contents remain as fresh as ever. CORNELIUS WALFORD

London, June 24

### Stags' Horns

WITH further reference to the above question I have pleasure in inclosing a letter received to-day from the head keeper at Bradgate Park, near Leicester, where both red and fallow deer are kept.

I may add that I saw at the end of July last, near the head of Loch Eribol, in Sunderland, a quantity of stags' horns in a gipsy encampment, which I supposed had been collected for sale by that curious fraternity. HERBERT ELLIS

62, New Walk, Leicester

"*To* HERBERT ELLIS, ESQ.

"*Bradgate Park, 22nd June*, 1880

"DEAR SIR,—In answer to yours of the 19th inst. respecting what becomes of the stags' horns after being shed, I beg to say they are regularly collected and sold. But there is not the slightest doubt of their eating each other's horns. I have myself seen several cases where both brow antlers and the top points have been gnawed off. I have also seen Scotch heads that have been quite spoiled by the tines having been gnawed, which must have been done after the horn had become hard, and whilst the animal was living. I am, sir, yours respectfully,

"C. OVERTON"

### Cup and Ring Stones

MANY of the markings mentioned by Mr. Middleton are hollows made by rain, or rather deepened by rain-water holding many low organisms in hollows, on the upper surfaces of exposed grit stones; overflow from these accounts for the groove or spout noticed at the margin of some of them. They are to be seen on the stones erected near Boroughbridge, and speak to the length of time these stones must have been raised into their present position. W. S.

June 21

### Diatoms in the London Clay

To enable me to determine the exact extent of the diatomaceous band in the London clay, I am anxious to obtain information of any wells in progress, or in contemplation, anywhere in the London Basins, *west* and *north* of London. With the help of some of your readers I have no doubt that I shall shortly be able to show that the one referred to is co-extensive with the London clay. The details I wish for are:—

1. Locality of well.
2. If begun, the depth attained.

I shall also be glad to hear of any railway cuttings now being made in the same area. W. H. SHRUBSOLE

## *WATER SUPPLY*

AMONG the improvements in sanitary matters that this generation has witnessed not one ranks higher than the settled and still growing conviction of the importance of a pure water supply, and nowhere are the various aspects of the question more keenly debated and considered than in the Metropolis at the present time.

At a discussion at a recent meeting of the Chemical Society there seems to have been some doubt thrown on the conclusions arrived at by chemists in determining the wholesomeness of a water by no less an authority than Prof. Huxley, and it may be well to inquire how far his allegations are borne out by facts.

In the earlier days of the history of chemistry, as was to be expected, the processes adopted in the analysis of water were crude in the extreme, and the quaint ideas promulgated in the treatises then published are not a little amusing. Gradually, however, and especially during the last few years, the methods of analysis have improved, and although, judging by the wide diversities of opinion that exist as to what may or may not be pronounced a water sufficiently pure for drinking purposes, the subject cannot yet be said to have arrived at a stage completely satisfactory; still, so far as the purely chemical evidence is concerned, it would seem to be able to furnish results which are sufficiently exact for all practical purposes. The operations involved are among the simplest and easiest the chemist has to perform, and consequently it is not the data furnished by analysis that are called in question, but the conclusions drawn from them.

Persons interested in sanitary questions, but who have no special knowledge of the difficulties that beset the forming a correct judgment as to the wholesomeness of water, are apt to express themselves as scandalised, and it must be confessed with some show of reason, that it should be possible there should be so little agreement amongst those who are looked up to as authorities on such matters.

This disagreement, however, is more or less inevitable in the present state of our knowledge, and is largely due to the intricacy of some of the problems involved in the question, which is by no means a simple chemical one.

The debatable ground is the nature and estimation of organic matter and the amount of significance that should be attached to the presence of oxidised nitrogen compounds.

Organic matter may be of animal or vegetable origin, the former being dangerous and the latter much less so, if indeed it be not altogether innocuous. To distinguish between the two kinds is therefore all important; but unfortunately it is impossible directly to do this, as both animals and vegetables yield albuminoïd matters, which are, chemically speaking, practically identical in composition.

Of the various processes for the estimation of organic matter there are three that are in general use. One, the oldest, known as the permanganate process, finds its advocate in the present day in Dr. Tidy, and consists in measuring the organic matter by the quantity of oxygen required to oxidise it. Another, originated by Prof. Wanklyn, and which he calls the albuminoid-ammonia process, consists in decomposing the organic matter by an alkaline solution of potassium permanganate, and taking the resulting ammonia as the measure of the organic matter. The third process, the one employed in the laboratory of the Rivers Pollution Commissioners and advocated by Dr. Frankland, its originator, estimates the organic carbon and nitrogen separately.

A good deal may be said in favour of all these processes, as affording a rough estimation of the quantity of organic matter, but none of them can be relied upon as giving any indication of its nature, *i.e.*, as to whether it is dangerous or not; and yet it is the almost invariable custom to judge of a water by the quantity of organic matter it contains, no matter what its origin, and a variation of two or three times a given amount is held to make the difference between a good and bad water.

It was to this point that Prof. Huxley especially addressed himself in his remarks already referred to. He gave it as his opinion, speaking as a biologist, "that a water may be as pure as can be as regards chemical analysis, and yet, as regards the human body, be as deadly as prussic acid, and on the other hand may be chemically gross and yet do no harm to any one." "I am aware," said he, "that chemists may consider this as a terrible conclusion, but it is true, and if the public are

guided by percentages alone they may often be led astray. The real value of a determination of the quantity of organic impurity in a water is, that by it a very shrewd notion can be obtained as to what has had access to that water."

However startling these statements may be to those who judge of the wholesomeness of a water by the amount of organic matter it may contain, we believe it to be none the less an accurate description of facts. It is within our knowledge that some of our most wholesome supplies sometimes contain an excess of organic matter, and that the waters which give rise to typhoid fever and other hardly less serious disorders are frequently just those which contain the least, the difference of course being that in the one case the organic matter is innocuous, in the other deadly.

Since, then, chemical analysis fails entirely to distinguish between these two kinds of matter, it may be thought to be a work of supererogation to have recourse to it at all. Not so, however, for what analysis fails to do directly it can to a large extent do indirectly. Organic matter in solution in water is more or less prone to oxidation, the highly putrescible matter of sewage being most so, and that derived from vegetation very much less so. Hence it follows that one would expect to find the oxidised nitrogen compounds in greater excess in the one case than in the other, and as a matter of fact that is just what we do find. Almost invariably, in all waters of acknowledged wholesomeness, the quantity of nitrates never exceeds a certain small amount, whereas in waters, such as polluted well and spring waters, that have given rise to illness, the oxidised nitrogen compounds, with other accompaniments of sewage, are to be found in excess. By means then of these oxidised nitrogen compounds we get collateral evidence throwing light on the nature and probable source of the contamination of which a mere percentage estimation of organic matter would fail to give the slightest indication.

The mistake has been hitherto that the discussion has been narrowed by looking at the question almost entirely from a chemist's point of view. It is, however, to the biologist that we must look chiefly for the future elucidation of the subject, and he has a field of the widest range, embracing much untrodden ground, for his investigations.

Putting on one side the specific poisons which through the medium of water are able each to generate, after its kind, diseases such as typhoid fever, it is highly probable, judging from what has already been proved to take place in analogous cases, that dangerous organic matter is not poisonous as such, but acts by affording the pabulum for organisms which are able to set up putrefactive changes in the blood of the person drinking polluted water. Even the conversion of organic matter into nitrates is not a mere chemical process of oxidation, since we now know that the oxidation only takes place by the help of a distinct ferment.

In the inquiry as to how far organic matter is destroyed in rivers, it is clearly insufficient to rely upon laboratory experiments in which diluted sewage is exposed only to the oxidising influence of air. This is entirely to ignore the agency of vegetation and of the vast army of organisms, identical with or allied to bacteria, which, being endowed with various functions of reorganisation, convert the carbon and nitrogen of organic matter into simpler inorganic compounds, these in turn to become the food of the more highly organised aquatic vegetation.

Whilst therefore duly recognising the practical help that chemistry can afford in the more limited scope that properly belongs to it, we trust, in the interest of sanitary science, that the enunciation of the views of so distinguished a biologist as Prof. Huxley may have their due weight with those to whom these questions are ordinarily referred, and will tend to promote a better understanding and more solid ground for agreement than has up to the present seemed possible.

CHARLES EKIN

## *THREE YEARS' EXPERIMENTING IN MENSURATIONAL SPECTROSCOPY*[1]

BY A NEW HAND THEREAT

II.

*The Whole Solar Spectrum.*—Could an observer, who had once made close acquaintance with the glories of symmetry resident in great A of the solar spectrum, when seen in the brightness of a southern noon-day, under a dispersion of 33° and magnifying power of 10, ever remain content therewith?

Never! if a particle of soul belonged to him! for he would be imperiously constrained from that moment to feel that he must see the whole solar spectrum as it is given forth effulgently to the denizens of the south by a nearly zenith sun, before he died; or to what purpose would he have lived in a sun-illumined world?

Out, therefore, once more to Lisbon the experimenter and his Wife went in 1878, with the important assistance again of the Pacific Steam Navigation Company of Liverpool; but now, armed with a rather different apparatus. There was indeed the same heliostat and there were all the prisms belonging to the aurora spectroscope; but instead of each of them being looked through singly and successively, they were now used all together, set out in a curvilinear line several feet long on a large table, and looked through all at once; with telescope and collimator each 32 inches in focal length; with magnifying power of 20, and a further prismatic method supplanting the usual employment of coloured glasses to prevent false glare in the field of view; and then what a new world was opened up to behold and admire!

Lines multiplied on lines and in a perfection of finish and refinement, sometimes of infinite thinness, sometimes remarkable power; and the classic fields of those more refrangible portions of the spectrum where the great spectroscopists of the age, Kirchhoff and Secchi, Lockyer and Janssen, Huggins and Young, have chiefly gained their laurels, as expounders of the constitution of the sun, were surveyed with respect and all admiration; but first, foremost, and beyond everything else, were the glories of the illimitable depths of solar colour; colour, the best leading index that has ever been invented yet, to simplify and facilitate the description of all spectrum place.

After having got completely rid of those usual attendant impurities in solar spectroscoping, viz., chemically coloured glasses used as shades, the large dispersions now employed enhanced rather than dulled the solar colours; raised one's ideal of what colour in light can be, and gave, through near fifty gradations, a definite and ever-memorable colour-characterisation to as many portions of the whole spectrum.

In presence of *such* solar colours, it seemed to be a wilful ignoring of one's best and plainest faculties to speak of the spectrum colours as being only 3, or 5, or even 7. They might indeed be rather spoken of as next to infinite in number; or rather still, as being just so many as there are easily perceptible differences of spectral place; *but* for that law of locomotion of colour-bands within certain limits, already discovered by the experimenter in his absorption spectra, and found equally applicable to the solar spectrum. Confining therefore the number of colours to something which should give each of them a breadth, not likely to be overpassed by the locomotive effects + and − on their boundaries, the following table of fifteen spectral colours was prepared after much discussion and criticism of each individual member of it:—

[1] Continued from p. 195.