Wolf (R.) Astronomische Mittheilungen. LXXVII. 8vo. *Zürich* 1891. The Author.

Phototype Portrait of Horace Benedict de Saussure.
M. Henri de Saussure

April 23, 1891.

Sir WILLIAM THOMSON, D.C.L., LL.D., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "Contributions to the Chemical Bacteriology of Sewage." By Sir HENRY E. ROSCOE, F.R.S., D.C.L., LL.D., and JOSEPH LUNT, B.Sc., F.C.S. Received April 23, 1891.

(Abstract.)

The present research contains the results of experiments on the chemical and bacteriological examination of sewage micro-organisms, made with the object, in the first place, of ascertaining what species are there present, and, in the second, of determining some of their chemical characteristics.

The authors have isolated from crude sewage, by methods which are fully described, a number of organisms which may serve as typical examples of those usually present in this material. Some of these have already been described, whilst others are believed to be new organisms.

The microscopic and macroscopic appearances of the organisms and their pure cultures have been carefully recorded by means of photographs, which give in a permanent form their morphological characters and the plate- and tube-cultivations in their most characteristic stages of growth. This method of illustration the authors consider to be of much importance, as bacteriological descriptions of organisms are frequently of little value for the want of accurate representations of the microscopic preparations and pure cultures.

The experiments described were undertaken with the object of studying the reactions of sewage organisms from a chemical point of view, and of gaining information as to the rationale, both chemical

and bacteriological, of the two marked changes which sewage is liable to undergo, *i.e.*, on the one hand purification, or the gradual destruction of putrescible matter without the formation of offensively smelling products, and on the other putrefaction. It was desired to ascertain which organisms are concerned in the first of these processes and which in the second, as likewise to gain an insight into the methods by which such changes are effected.

For all the organisms described, the authors have determined the absorptive power for free oxygen when cultivated in a perfectly pure state, and also for which of the organisms free oxygen is a necessity of their activity and growth.

Each organism has been examined as to its power of growth in a liquid medium from which every trace of free oxygen, both gaseous and dissolved, has been rigorously excluded.

It is shown that anaërobic organisms associated with putrefaction, although able to grow in complete absence of oxygen, yet when that gas is present are able to *absorb it rapidly*, and thus prepare the conditions for their anaërobic growth.

The following methods for the isolation of micro-organisms have been used:—

(1.) The method of gelatine plate-culture.

(2.) A method, fully described, for the isolation and cultivation of anaërobic organisms.

(3.) A method for the isolation of spore-forming organisms.

(4.) The dilution method.

The method used for the isolation of anaërobic organisms consists in their cultivation in a specially devised form of flask containing sterile nutrient broth, through which liquid could be passed a stream or pure hydrogen, freed from all traces of oxygen by passing over glass beads, in two Emmerling's tubes, moistened with alkaline pyrogallate.

As the authors have shown in a previous paper ('Chem. Soc. Journ.,' 1889, Trans., p. 554), this treatment frees the liquid completely from dissolved oxygen.

Crude sewage was carried through three cultivations in pure hydrogen, when it was found that not only had all aërobic organisms been eliminated, but only one form of anaërobic organism appeared, viz., *Proteus vulgaris*, and this method may be used for its isolation. Several other organisms, although isolated by different methods to the above, were found to grow in the pure state in nutrient broth from which all traces of free oxygen had been excluded. These are fully described in the paper.

In the method for the isolation of spore-forming organisms, all others were eliminated by heating the sterile broth, in which a sowing had been made from crude sewage, to 80° C. for ten minutes.

The still living spores were then further isolated by plate cultivation, either with or without previous incubation of the broth tube.

For the purpose of studying the absorptive power for free oxygen, pure cultures were sown in sealed flasks with two necks, containing 25 c.c. of nutrient broth and 250 c.c. of air. These were incubated at 20—23° C. for seven days, after which time the flasks were opened and the gases remaining abstracted for analysis. It was seen that the various organisms exhibited great differences in their absorptive power for free oxygen, some showing the feeblest absorption, whilst others abstracted nearly every trace of oxygen from an atmosphere ten times as large as the culture liquid during seven days' incubation.

The rate of absorption of *dissolved* oxygen was also determined for a number of the organisms by sowing tap-water aërated under known conditions, and containing a definite amount of dissolved oxygen, with 1 per cent. of a pure broth culture of the organism which had been incubated for two days after sowing. It is shown, in the case of those organisms which absorb oxygen rapidly from the air, that the water is completely de-aërated in fourteen hours.

It is shown that certain organisms which are capable of growing in an atmosphere devoid of oxygen, *i.e.*, anaërobic, are yet incapable of liquefying gelatine without the presence of that element, although when grown in air such liquefaction is extremely rapid.

Cultivations were made in the form of flask referred to for anaërobic organisms, in which the organisms were sown in molten gelatine, through which pure hydrogen was passed for half an hour. The flask was then sealed. After five days' incubation, no liquefaction whatever took place, although, when exposed to air, the normal rapid liquefaction of the gelatine afterwards occurred.

It is also shown, both in the case of aërobic and anaërobic organisms, that a very appreciable diminution of the liquefying power of organisms takes place after repeated sub-cultivation in nutrient gelatine.

The method employed for photographing the micro-organisms is also described. In all cases the bacteria were stained with methyl violet, but, as this stain transmits chemically active rays, it was necessary, in order to obtain actinic contrast, to use a coloured screen and isochromatic plates. The screen adopted (a weak solution of potassium bichromate) was spectroscopically adjusted to the stain employed, so that the objects appeared black on a bright yellow background. The apparatus employed was of the simplest kind, and the source of illumination was a common duplex paraffin lamp.

The organisms isolated from the sewage under examination are described and illustrated photographically, as regards microscopic preparations and plate- and tube-cultures.