Iron-depositing Bacteria.¹

THE appeal of the monograph before us, which is one of the Professional Papers issued under the ægis of the United States Geological Survey, will probably be of direct interest only to a comparatively small section of scientific workers. Although there is much to attract the general reader, it is obvious that the work was not initiated with this end in view. It is worthy of note and a sign of the times that the data supplied by the bacteriologists should be used as a serious weapon of offence in attacking a geological problem.

Many changes, due to biological influences, take place on the earth's surface which profoundly modify the constitution of the material which is destined to become the geological strata of the future. A study of these changes will obviously throw light on the causes which have operated in the past to bring the earth's crust into being. We find in Mr. Harder's paper by far the most comprehensive treatment which we have yet seen of the activities of bacteria in effecting chemical changes in various iron compounds which come within the scope of their influence. He has undertaken the task of bringing together in the form of a critical survey the salient facts of our knowledge of the iron bacteria. This subject occupies the first half of the monograph, and is treated by the author with a masterly regard for essentials, and in it is included the results of some of his own observations and experiments on these interesting micro-organisms. It is interesting to note that the same iron bacteria are found in America as in Europe, although there are slight differences in their distribution and numbers. Thus *Spirophyllum ferrugineum* appears to possess a wider distribution than is the case in this country.

In the preface, which is written by Mr. F. L. Ransome, especial attention is directed to the results of Mr. Harder's inquiry into the physiology of the iron bacteria. Hitherto each investigator has assumed that the results claimed by him as a result of his research on the physiology of some particular species held good for all the iron bacteria. Mr. Harder, however, concludes that there are three principal groups of iron-depositing bacteria: (1) A group the members of which precipitate ferric hydroxide from solutions of ferrous bicarbonate. (2) A second group of iron bacteria that does not require ferrous bicarbonate for its vital processes. (3) A third group that attacks iron salts of organic acids, using the organic acid radicles as food and leaving ferric hydroxide, or basic ferric salts that gradually change to ferric hydroxide. We must confess to a scepticism as to the existence of such deep-seated differences among these organisms, and incline to the opinion that the phenomenon of iron-deposition on micro-organisms shows the working of a simple physiological law which operates on all in the same manner. In support we would advance the fact that *Spirophyllum* and *Leptothrix* are so closely allied that some have regarded them as pleiomorphic varieties of one and the same organism. They live in the same waters, they reproduce alike, and are in every way similar except in external form; and yet *Spirophyllum* is stated to be an example of the first group, whilst *Leptothrix* is relegated to the second group. A more cogent ground for scepticism lies in the fact that other organisms, including some of the algæ and the protozoa, possess the same attraction for iron compounds. Possibly a closer investigation of the *chemico-irritability* of micro-organisms will throw some light on the question.

¹ "Iron depositing Bacteria and their Geologic Relations." By Edmund C. Harder. United States Geological Survey. Professional Paper 113.

We can recommend the second half of the monograph to all who wish concise information from an authoritative source of the iron deposits of the world and of the factors which influence the formation and determine the mode of deposition of the iron precipitations that are taking place at the present day. With one exception iron is the most abundant element in the earth's crust. Iron salts are being constantly decomposed, and the genesis of the active agents which bring about their decomposition is given in detail. A consideration of these agents brings home to us the necessity of studying the life-histories of various micro-organisms in order to understand how the present deposits came into being. To give one example. The most important of the iron deposits is ferric hydroxide, and a study of the conditions of its formation centres largely round the fact that ferrous compounds are soluble in water containing CO₂ in excess. Now, in particular, ferrous bicarbonate percolates upwards in solution, and when it reaches the surface becomes subject to the interplay of forces, both chemical and biological, which determine its subsequent fate. We must refer the reader to the work itself for more precise information regarding the manner in which this fate is determined.

We are also given a very complete account of the various types of ferruginous sedimentary ores, and in each case the intervention of biological agencies, either in the primary or in the secondary rôle, as factors in the determination of the final deposition is explained in a comprehensive and accurate manner. Of greatest interest of all is, we consider, the examination of the conditions which determine the formation of bog-iron ore. These are undoubtedly mainly of a biological nature, and deserve more consideration than they have hitherto received. The interest in this ore is enhanced on account of its formation being a possible stepping-stone to the development of limonites and hæmatites, although Mr. Harder himself has not raised the point. In his reference to the ferrous carbonate deposits he does well to speak with reticence of the factors which have brought about their formation; enough evidence, however, is advanced to give pause to those who would eliminate altogether the activities of micro-organisms from the list of active agents which have brought these deposits into being. Again, Mr. Harder makes out a clear case for the intervention of micro-organisms in the formation of some, at any rate, of the iron sulphide deposits. Sulphuretted hydrogen is evolved as a result of the decomposition of animal and vegetable matter by the saprophytic bacteria. The formation of sulphides with iron compounds is the next step, and it is of great interest that we see the process at work at the present day in the development of the "blue mud" of the ocean bottom.

Both biologists and geologists will be grateful to Mr. Harder for the work which he has done in the preparation of this monograph. DAVID ELLIS.

The Association of Technical Institutions.

THE Association of Technical Institutions opened its summer meeting at the University of Cambridge on July 23, with the Marquess of Crewe, the president, in the chair. The meeting was extended over the following day, when the chairman of the council, Mr. Dan Irving, M.P., presided. Papers were submitted on "A National System of Education," by Principal J. C. M. Garnett (Manchester); on "The Necessity for Close Co-operation between Technical Colleges and the Universities," by Principal C. Coles (Cardiff); on "Continuation