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“Notes on Microscopic Geology, No. 1.”* By Mr. W. Hislop,
F.R.A.S.

BEFORE entering on the immediate subject indicated by the title of this paper, I had better explain my object in putting before you these detached notes. I originally intended to draw up a continuous paper on the subject; but I find that so little has been done in the way of digesting the material scattered up and down in various transactions, papers, and other sources of information, that it would occupy more time and require more ability than I have at command, to render such a complete paper worthy of the subject and of our Association. I have, therefore, decided on delaying no longer, but will endeavour to bring the matter before you in a few detached notes, which I hope may prove complete in themselves, and at the same time trust that they will put the Society in possession of the latest discoveries in microscopic geology.

To those who have only directed their attention to the general features of our science, and have examined minerals, rocks, and fossils in the more popular manner, it may seem difficult to apply the microscope to the study of these objects. While they can appreciate the cursory application of the hand-lens to the specimens under observation, the majority of geologists, whether students

* Read before the Association, June 1st, 1863. The publication of this Note has been delayed until the present time, in order that it might be placed in juxtaposition with Notes Nos. 2 and 3. See pages 378 and 386.

or professors, do not employ the achromatic microscope to anything like the extent which is desirable and warranted by its value in other branches of natural history. The character of a deposit may be often satisfactorily determined, and its position defined, by an examination of the minute forms contained therein; while very great light may be thrown upon the manner of its formation, and the probable changes which have taken place in its physical condition.

Take an instance in the organisms named *Xanthidia* by Ehrenberg, and placed by him in a distinct genus among what he called "Infusoria." These bodies are often found in flint, and in very large quantities. They are preserved with marvellous perfection, and exhibit all the details of their structure with very great beauty when properly examined. The microscope has brought us acquainted with a class of recent forms known as *Desmidiæ*, which appear to occupy a portion of the debateable ground between the animal and vegetable kingdoms. Many of them in the recent state possess the power of independent motion, and exhibit the curious ciliary arrangement over portions of their external and internal surfaces, which is so often found in animal structures. These organisms are generally regarded as minute plants. They are found in clear pellucid water, generally on open heaths, moors, or bogs, sometimes attached to the large plants growing in the water, or lying upon the stones, or on the surface of the mud at the bottom of the pool. They are usually enveloped in a clear mass of gelatinous matter, and present within this covering some most beautiful and exquisite forms. They are continued and increased by spores, which sometimes separate from the parent plant in a similar form, but very frequently take quite a different shape. The sporangia of some species resemble almost exactly the *Xanthidia* of Ehrenberg. They are exceedingly delicate in their structure, the slightest pressure or disturbance being sufficient to mutilate or destroy them. From this cause it is a difficult matter to preserve both the perfect forms and the sporangia for future examination, it being necessary to immerse them in some fluid, which shall preserve their structure intact and uninjured, for if dried, all traces of their original beauty and form are lost.

This in the case of the flints before us has been done during a period of time extending over ages; these minute forms being embedded in one of the hardest substances known in nature, suggest to us the inevitable conclusion, that at some period of time the flint must have been in a perfectly fluid state, or else the delicate forms could never have entered and been preserved within its substance. It also points out that the process of congelation of this fluid medium must have been without contraction or bringing of the particles closer together, as may be supposed to happen in the process of crystallization or congelation, otherwise the organism would present some alteration of form, or, more probably, would be entirely destroyed by a change which involves an enormous force of pressure.

Again, a large proportion of the rock which prevails through an extensive district in the Island of Barbadoes, has been found by Ehrenberg to be composed of Polycystina, a name given provisionally to a series of forms, the origin and position of which is but little understood. As an illustration of the enormous number of these geological remains, I may state that Ehrenberg found 39 species of the Polycystina in the Barbadoes earth, but Sir R. H. Schomburgk has estimated the number observed by him in that deposit to be 282. Many of these forms are identical with those brought up from the bottom of the Atlantic by means of the apparatus designed for the purpose of obtaining deep-sea soundings, and noticing the nature of the bottom. These last are no doubt of recent origin; but the fact points out the manner in which the Barbadoes deposit has been most probably formed. But the especial point to which I would allude is the occurrence of certain remarkable easel-like forms among these organisms, and the peculiar pitted structure which they exhibit. This particular structure has been found to characterize the calcareous shells and framework of the Echinidæ, and to obtain through all the changes which that curious class of animals exhibits. The skeleton of the Echinidæ has been found at one time of its existence to be internal, and in this, its larval condition, several species have been described by Müller, Gosse, and others. These marvellous easel-like forms greatly resemble some of the Barbadoes Polycystina, both in their

external form and in their pitted structure. This evidently suggests that the latter may be the skeletons of the larval forms of larger marine animals, concerning which forms our knowledge even of recent species is at present extremely limited.

Careful generalization is in this, as in every other case, absolutely necessary. It is not enough to find a minute form in great profusion in a deposit to determine at once that that deposit was formed by the agency of the bodies found there. It has been supposed by some that, because Foraminifera are found in large quantities in the Chalk, therefore those enormous masses, sections of which are so well exhibited on our coasts, owe their production to these minute animals. Probably a close examination of specimens from different localities will show that Foraminifera are not nearly so numerous as might have been supposed, and that, taken as a whole, there is a much larger proportion of calcareous matter in the shells of the animals, the fragments of which are found in such enormous profusion throughout these deposits, and which probably present a more likely and abundant source for the production of these cretaceous deposits.

In this introductory note I do not propose to stay to speak of individual species; but it is desirable briefly to indicate the kind of instrument to be used, and the method of manipulation. Nothing very elaborate is required. A firm and simple stand, with good inch and quarter-inch achromatic object-glasses, is all that is necessary; but the objective must be well corrected, or fallacious appearances may present themselves. Some of the forms of students' microscopes are probably the best for the purpose, and a very useful instrument of this kind may be obtained from many makers at an outlay of five pounds. It is necessary to be provided with nitric and muriatic acids, and a strong solution of potash in the form of "liquor potassæ." Many deposits exhibit the forms within them by simply taking some of the powder scraped with a penknife, or abraded by handling, and placing it on a slip of glass beneath the object-glass; but most require cleansing from extraneous matter.

If the presence of siliceous forms is suspected, some of the powder should be boiled in a test-tube with diluted nitric or muriatic acid. This will dissolve away the calcareous matter, and, after

washing and drying, the deposit may be examined with a low power, and any form that may appear may be removed with the point of a camel's hair pencil to a separate slip of glass, for future examination. The same course should be followed to obtain calcareous forms, substituting liquor potassæ for acids. If the deposit obtained after the washing and boiling be sufficiently rich, it may at once be mounted for preservation, either as opaque or transparent objects. The latter are generally the most useful. For this purpose the objects are generally immersed in Canada balsam, thinned with turpentine, and applied by dropping it on the objects previously arranged on a slip of glass. If properly dried, and the slip of glass carefully warmed over a lamp, the balsam will permeate the structure, and render it transparent without obliterating details. A thin disc of glass, previously warmed, should be laid on the surface of the balsam, and pressed to exclude any superfluity, and the object may then be cooled, labelled, and stowed away in box or cabinet, for future use. Opaque objects should be mounted in a small orifice bored in a thin piece of wood, and backed with black paper. They should be preserved from injury by a thin disc of glass, and the light can then be thrown upon them in any required direction.

In future notes I shall probably indicate the treatment to be preserved in especial cases which may arise in our consideration of the various forms known to microscopic geology.

The microscope so extends our power of observation as virtually to introduce us to a new world. New forms and facts meet us at every turn, and to the student of any branch of natural history it **must ever prove an invaluable aid both as an instrument of analysis and as a portal to new discoveries.**

Ordinary Meeting, April 5, 1864.

E. Cresy, Esq., President, in the Chair.

The following papers were read—

No. 1. "On the Possible Physical Causes and Molecular and