COCCOSPHERES AND RHABDOSPHERES.

THERE have been few more enduring puzzles in natural history than the nature of the Coccoliths, described by the late Mr. Huxley from Captain Dayman's deep-sea soundings in the North Atlantic in H.M.S. *Cyclops* in the summer of 1857. Dr. G. C. Wallich, who was on board H.M.S. *Bulldog*, engaged in a preparatory survey of the route for a telegraph cable about the same date, observed the aggregation of the Coccoliths into spheres, to which he gave the name of Coccospheres. He also pointed out the identity of the Coccoliths with bodies observed in chalk by Mr. Sorby. Mr. Huxley associated them with that unfortunate organism *Bathybius*. "I am led to believe that they are not independent organisms, but that they stand in the same relation to the protoplasm of *Bathybius* as the spicula of Sponges or of *Radiolaria* do to the soft part of those animals" (*Quart. Journ. Micr. Sci.*, vol. viii. N.S. p. 210, 1868). Prof. Haeckel, who received some ooze dredged by Wyville Thomson and Carpenter (*Porcupine* Exped.), put a like interpretation on the phenomena, and published in the *Jenaische Zeitschrift*, vol. v., 1870, a detailed account of the matter with illustrations. *Bathybius* is dead, but one cannot leave it without the reflection that there are few naturalists, the young and expert included, but would have given similar explanation of the appearances. The *Challenger* Expedition next entered the field, and discovered Coccospheres and Rhabdospheres on the surface of the ocean, living free in the water, entangled in the protoplasmic matter of *Foraminifera* and *Radiolaria*, and in the stomachs of *Crustacea* and *Salpæ*. The Rhabdospheres are known only from the tropics, and the Coccospheres, though tropical as well, yet find their finest development in temperate seas. "There is considerable variety both in the form and size of Coccospheres and Rhabdospheres, some varieties having the component parts (Coccoliths and Rhabdoliths) much more compactly united into a sphere than others. The interior of the spheres is perfectly clear when examined fresh from the surface, and becomes coloured brown with iodine solution, but with iodine and sulphuric acid no blue colour was observed. They were never observed to colour with carmine solution. When the calcareous parts are removed by dilute acids, a small gelatinous sphere remains, in the outer layer of which the Coccoliths and Rhabdoliths were embedded" (*Challenger* Reports, "Narrative," vol. i. p. 939). In the Report on the Deep-Sea Deposits, Dr. John Murray treats them as pelagic calcareous algæ (p. 257), and one of us has been criticised with some severity for adopting this view in an "Introduction to the Study of Seaweeds." The Hensen Plankton Expedition, probably through using silk nets of too coarse a texture, failed altogether to find Coccospheres or Rhabdospheres, and Dr. Schütt, the botanist of that expedition ("Pflanzenleben der Hochsee," p. 44), casts doubt on their very existence as organisms, and in any case will have none of them in the vegetable kingdom. Many other naturalists, wise and eminent, British and foreign, have shared, and do share, the opinion of Schütt.

What the Hensen Expedition failed to discover has been effected, however, by quite simple means. A few years ago, Dr. John Murray, while crossing the North Atlantic, obtained the Coccospheres again by simply pumping sea-water through a very fine silk bag. He observed them carefully, and noted their contents to be yellowish, of much the same colour, he now informs us, as the diatoms. While using such a bag last year in diatom work on the *Garland*, it occurred to one of us that Coccospheres and Rhabdospheres might be obtained by this method in the hands of some enterprising mariner. Captain Haultain Milner, of the Royal Mail steamship *Para*, to whom natural history owes many debts, readily consented to put the method to the proof; and, after rehearsing his part in the laboratory of the Botanical Department of the British Museum, sailed last January, equipped with a fine silk bag, tubes with non-acid fixing and preservative fluids, funnels, &c., for the port of Barbados. He was instructed that it would be sufficient to pump for a short time daily with the ordinary deck-hose (intake pipe, three fathoms deep) through the silk bag, and to transfer the residuum to the tubes containing the fixing and preservative fluids. Captain Milner has carried this out, pumping daily in the region agreed upon. It is interesting to observe that Coccospheres abound in the first day's capture (lat. 41·30 N. long. 19·40 W.)—the method succeeded in his hands in the most deadly way—and he subsequently obtained, in the tropical part of his voyage, both forms of Rhabdospheres figured by the *Challenger* Expedition. He got, in fact, not only what the German expedition failed to find any trace of, but all the three forms figured in the *Challenger* Report.

In Fig. 1, *a* and *b*, there are copied from the *Challenger* "Narrative" a Rhabdosphere and a Coccosphere. The Coccosphere figured was obtained from the bottom, and

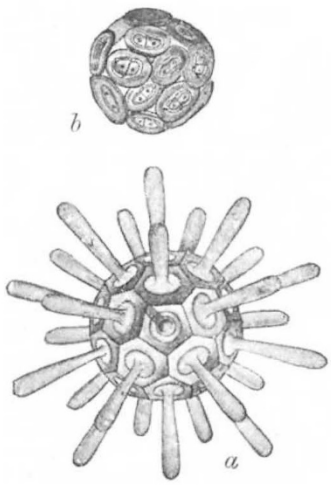

FIG. 1.—*a*, Rhabdosphere × 250; *b*, Coccosphere × 500 (after *Challenger* Report).

shows a disorganised condition. The plates composing the shell of the Rhabdosphere are represented as fitting into each other with geometrical regularity. In the specimens we have seen and been able to examine, not on the heaving deck of a ship at sea, but with the resources and apparatus of modern research, the structure of the shell appears in each case different from that given in the *Challenger* Report. Fig. 2, A, represents a Coccosphere, as we see it, and a very minute and elusive microscopic object it is, under a 1/12th aprochromatic objective. The calcareous scales (or Coccoliths) overlap each other, and constitute not only an excellent defensive armour, but from their arrangement admit of the growth of the organism, which is not thus limited by its calcareous coat, as the diatoms are by their siliceous shells. Each Coccolith is attached to the cell by a button-like projection on its inner surface. A figure nearly resembling ours occurs in *Challenger* Reports, "Deep-Sea Deposits," plate xi. Fig. 3. In the Rhabdosphere, with projecting rods shown in Fig. 2, B, C, the plates (Rhabdoliths) do not fit into each other in the manner figured in the *Challenger* Report, but their bases or bed-plates are embedded on the surface of the cell, each by itself without contact. This may be, on the one hand, a

temporary condition due to turgidity in the specimens observed, or the plates we see may be themselves connected with each other by a finer incrustation. Fig. 2, D, E, represents another Rhabdosphere with trumpet-shaped projections; D, being an optical section, and E a surface view. We have hitherto been unable, partly from the rarity of the objects, to define microscopically the bed-plates to which the trumpets are attached, if such exist. The wall of the cell, probably composed of such plates, presents, in optical section, indications of their existence. At 2 F there is shown the outer end of one of the trumpets.

As to the cell-contents, we have been unable to discover more than the existence of a granular material inside the Coccospheres and Rhabdospheres of both types—a granular material which, under ordinary circumstances, no one would hesitate to call protoplasm. On decalcifying the Coccospheres with very dilute acid, there is left a small gelatinous-looking body which slowly swells up. There is no trace of colouring matter in our

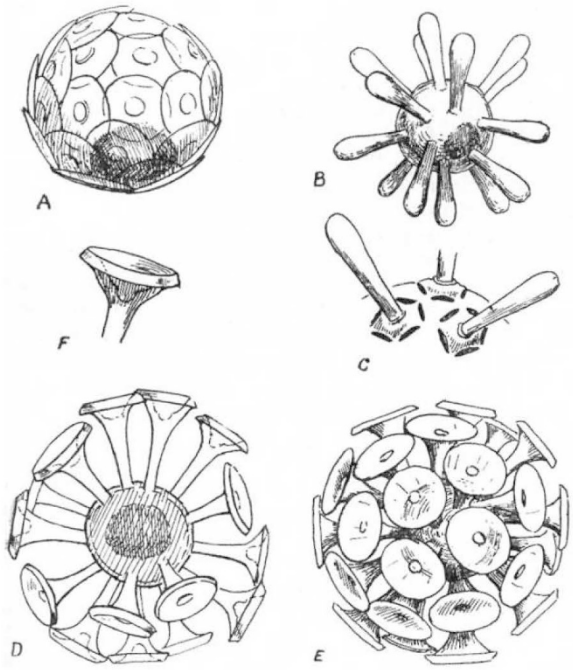

FIG. 2.—A, Coccosphere × 1300; B, Rhabdosphere × 900; C, portion of the same × 1300; D, Rhabdosphere of another type, in optical section, × 1900; E, the same, in surface view, × 1900; F, end of trumpet-shaped projection × 2500.

specimens, and Dr. John Murray, who has seen them, tells us this is frequently the case with specimens examined immediately after capture. They all came from three fathoms, and not from the surface itself. It may be that the living, coloured cell is most abundant at the surface itself, and that our specimens are those which have already begun to sink.

The importance of the part probably played by Coccospheres and Rhabdospheres in the economy of marine life entitles them to a large claim on our interest. They abound in regions of the ocean, out in blue water, and far away from coastal waters, where diatoms and *Peridinieæ* are comparatively scarce; and here their occurrence is in such plenty that their shells on sinking to the bottom constitute nearly 20 per cent. of some deep-sea deposits. Of a like geological history with the diatoms, first appearing in the ancient Cretaceous seas, Coccospheres and Rhabdospheres probably share with them, with the *Peridinieæ* and with the pelagic *Oscillatorieæ*, the *rôle* of food providers to the animal life of the ocean.

GEORGE MURRAY.
V. H. BLACKMAN.

M. ANTOINE THOMSON D'ABBADIE.

THE name of Abbadie has been long and honourably known in the history of science in France. Three brothers of the name have all played a worthy part in geography, in physics, or in ethnography, but the best known is the subject of this short note. The family, which is of ancient descent, appears to have temporarily left their home in the South of France at the time of the political troubles at the end of the last century, and to have settled in Ireland, where, in 1810, Antoine d'Abaddie was born. On the restoration of the Bourbon dynasty, his father returned to France, and it is entirely as a French man of science that Abbadie has won his reputation.

At a time when travelling into and opening-up of the less known and inaccessible parts was not so common as it has proved since, M. d'Abbadie's tastes marked him out as an early explorer. His first journey was made to the Brazils, in 1835, under the auspices of the French Academy; and on his return from South America he started, in 1837, in company with his brother Michel, for Ethiopia, as it was then known. In Abyssinia and in Central Africa the two brothers made a prolonged stay, returning to France in 1848, and their ethnographic and linguistic studies had much interest at the time. The principal results of the voyage were communicated to the French Geographical Society, and were published under the title "Notes sur le haut fleuve Blanc," 1849. The early date at which this exploration was made is of equal importance with the results gathered. If the accuracy of some of these results has been questioned, they at least indicated the necessity for further investigation. The journeys of Richardson and Barth were some years later. Burton and Speke began their travels in 1853. Livingstone returned to this country with his first results in 1856; so that M. d'Abbadie is certainly entitled to be remembered as a pioneer in African research.

Though M. d'Abbadie gave much attention to linguistic work, he applied himself to astronomical pursuits with some eagerness. In 1857, he visited Norway, with the view of observing the total solar eclipse of that year. The point to which he directed his attention was the examination of the light of the solar prominences for the detection of polarisation. With the view of still further satisfying himself on this point, he took advantage of the eclipse of 1860 to go to Spain, where, accompanied by M. Petit, of the Toulouse Observatory, he made some further observations at Briviesca. Observing with a quartz plate and double-image prism of small angle of separation, no trace of polarisation was detected. The account is given in the *Ast. Nach.*, No. 1290. Later, in 1882, and notwithstanding his advanced age, M. d'Abbadie took charge of one of the French stations selected for the observation of the transit of Venus. The position occupied was at Port au Prince, in Saint Domingo, a station well adapted for observing the effects of both retarded ingress and accelerated egress. The observations were successful.

M. d'Abbadie was elected Chevalier of the Legion of Honour in 1850, and became Member of the Academy in 1867. He has occupied a seat at the Board of Longitude since 1878. He was elected a Fellow of the Royal Astronomical Society so recently as 1895, his interest in astronomy having probably quickened in the later years of his life. This is shown by the disposition of his property, which is handed over to the Academy of Sciences on the condition that the Society publishes a catalogue of half a million of stars within the next fifty years.