Brown and Red Algæ, on the other hand, where no simple forms of plant-body are certainly known, plants of large size and possessed of a highly developed parenchymatous soma are abundantly represented. It appears improbable that a class like the Isokontæ, showing such extreme capacity for morphological elaboration in every direction and for adaptation to very diverse habitats, should have failed to develop further in the direction generally indicated by Phæophyceæ and Rhodophyceæ. Moreover, it must be remembered that they possess the photosynthetic equipment which has evidently proved to be the only successful one on the land, and that practically every group and family of Isokontæ has its terrestrial representatives.

What then, it may be asked, has become of the more highly elaborated members of this class? It seems to me that there is every reason to suppose that, approximately at the level of morphological differentiation and stature reached by the Isokontæ of the present day, the terrestrial habit was adopted in the remote past, that the more highly elaborated Green Alga became a land-plant, the early forms of which are perhaps yet to be disclosed by palæontological research. In this connexion it is not without significance that the oogamous members of this class for the most part occupy a peculiarly isolated position, appearing as outliers well in advance of the rest, although for none of them is there, to my thinking, any possible connexion with the higher land-plants.

If one recognises among Phæophyceæ and Rhodophyceæ many features of anatomy, life-history, etc., that recall the characteristics of land-plants, I can see in that only a confirmation of the belief that environment has little to do with the broad evolution of the plant-organism, and that these features are a natural outcome of the evolutionary trend in the vegetable kingdom and no positive evidence for the view that they must necessarily have originated in a marine environment. The comparative study of the simpler forms of plant-body in the different classes of Protophyta lends great support to such a concept of a general evolutionary trend.

Obituary.

PROF. BERTRAM B. BOLTWOOD.

THE tragic death on Aug. 14, 1927, of Bertram B. Boltwood, professor of radiochemistry in Yale University, removes an outstanding scientific personality who played an important part in the rapid expansion of our knowledge of radioactive transformations in the early days of radioactivity. Prof. Boltwood was born on July 27, 1870, in Amherst, Mass. His father, a graduate of Yale, was of English descent, and his mother of Dutch extraction. He entered the Sheffield Scientific School of Yale in 1889, taking chemistry as his chief subject. After graduation he spent two years at the University of Munich under Prof. Krüss, paying special attention to analytical methods and to the rare earths. The knowledge and technique thus gained was to prove of great importance in his subsequent researches in radioactive minerals. In 1894 he returned to Yale as an assistant in the chemistry department, and did some research work both in organic and inorganic chemistry. In 1900 he left the University to take up work as a consulting chemist, but continued research in his private laboratory.

It was during this period that Boltwood became interested in the study of uranium minerals and the possible genetic relations between the radioactive elements. In 1903, Rutherford and Soddy had put forward the disintegration theory of the radioactive elements and had indicated that radium might prove to be a transformation product of uranium. If this were the case, radium should grow from uranium, and the amount of radium in old unaltered minerals should be proportional to their content of uranium. It was to this latter problem Boltwood first devoted himself in 1904. This involved a systematic chemical analysis of minerals for their uranium and radium content. The amount of radium with the uranium in solution was determined by boiling off the emanation and introducing it into an electroscope. This method in Boltwood's hands became a weapon of precision, and he was able to show that in properly selected minerals the amount of radium was always proportional to the amount of uranium, thus proving that a genetic relation existed between them. If uranium were transformed directly into radium, a solution of uranium, initially freed from radium, should grow radium at a rate that could easily be measured in a few days or weeks. He found, however, no trace of the growth of radium in a carefully purified solution of uranium over a period of about one year, and concluded that an intermediate product must exist between uranium and radium. We now know, due to the work of Soddy, that radium ultimately does appear in uranium solutions, the growth depending on the square of the time; but the small amount of radium produced in the first year is difficult to detect even by the delicate emanation method.

Investigations were then made to see if it were possible to isolate chemically from a uranium mineral the intermediate substance which is transformed directly into radium. A radioactive body was separated which Boltwood found grew radium at a rapid rate. From the similarity of the chemical properties of this body with those ascribed at that time to actinium, he naturally concluded that actinium was the direct parent of radium. Later investigations, however, showed that the properties of actinium had been wrongly described, and that the parent of radium was not actinium at all, but a new radioactive element which he named 'ionium.' In these experiments some thorium was added to the uranium mineral to effect a complete separation of the ionium. Boltwood found that it was impossible by chemical methods to separate the added thorium from the ionium. This was one of the first cases observed of inseparable elements, of which a number of examples came to light in later years. It was on observations of this character that Soddy later put forward the conception of isotopes which has proved to be of so much significance not only for the radioactive but also for the ordinary elements.

By comparing the rate of growth of radium in the separated ionium with the amount of radium in equilibrium with uranium in the mineral, Boltwood was able for the first time to fix by a direct method the average life of the radium atom. In later researches he was able to show that a genetic relation also existed between actinium and uranium, but that the amount of actinium was only a few per cent of that to be expected if it were in the main line of descent. This work suggested that the actinium must be regarded as a branch product at some point of the uranium-radium series. This is a conclusion we hold to-day, but the exact point of branching is still uncertain.

These investigations, which were carried out with great experimental skill and accuracy, thus yielded results of fundamental importance. Boltwood had not only proved a genetic relation between uranium and radium, but also had isolated the new element which was the immediate parent of radium, and had shown that actinium was also genetically connected with uranium but not in the main line of descent.

I must not omit here to refer to another deduction which has proved to be of great importance. As a result of his own analyses and the analyses of Hillebrand, Boltwood found strong evidence that the amount of lead in old minerals of the same geological age is proportional to their content of uranium and increases with the geologic age. This led him early (1905) to suggest that lead was the final inactive product of the uranium-radium series of transformations. The correctness of this view has been abundantly verified in recent years. We know that the end product of uranium is an isotope of lead of atomic weight 206, and the end product of the thorium series is another isotope of weight 208. These observations have thus supplied a definite method of estimating the age of radioactive minerals and thus of the geological horizons in which they are found.

The importance of Boltwood's work was at once recognised by Yale University, where he was appointed assistant professor of physics in 1906 and professor of radiochemistry in 1910. He took an active part with the late Prof. Bumstead in building the new Physics Laboratory in Yale, and later, in 1918, as professor of chemistry, in building the new chemical laboratories. The labour and detail involved in such undertakings, which he cheerfully undertook, made serious inroads not only on his time for research but also on his energy. He had a breakdown in 1922, and never completely recovered from its effects.

I first made the acquaintance of Boltwood in 1904, when he was carrying out his first radioactive experiments. One could not fail to be impressed by the breadth and accuracy of his scientific knowledge, and by his scrupulous care and accuracy in experimental work. He possessed to an unusual degree the power of anticipating experimental difficulties which were likely to arise and in arranging his apparatus and methods to overcome them. This characteristic feature of Boltwood's work was well illustrated in his investigations with me in the University of Manchester in 1910 on the rate of production of helium by radium and other radioactive bodies. Every detail of the complicated apparatus and arrangements was so carefully thought out beforehand that not a single change was required for the successful conclusion of the measurements.

A man of cosmopolitan tastes, Boltwood was much attracted by many aspects of European life and spent many of his summers on the Continent. He took an active interest in the undergraduate life of his university and had the gift of gaining the interest and confidence of young people. His premature death will be mourned by a wide circle of friends, who held him in high esteem for his personal qualities as well as for his outstanding scientific achievements.

E. RUTHERFORD.

MR. W. H. DINES, F.R.S.

BY the death of Mr. William Henry Dines, meteorology loses an outstanding figure. It is scarcely possible to overrate the importance of his work. He was a meteorologist of the first rank before he began the upper air work for which he is best remembered. Born in 1855, he was the son of George Dines, himself a meteorologist of note. He was educated at Woodcote House School, served an apprenticeship as a railway engineer, and then went to Christ's College, Cambridge; he obtained first class honours in the Mathematical Tripos, and took his B.A. degree in 1881. The bent of his first meteorological work was occasioned by the disaster to the Tay Bridge, which, only recently opened, was destroyed by a gale while a train was crossing it. So George Dines investigated wind pressure and his son helped him. Later, as a result of this work, W. H. Dines designed the pressure tube anemometer. This instrument in its final form records each gust of wind and each transient change of direction, and is the standard recording anemometer for all serious purposes.

Dines's most notable work, that of upper air research, began in 1901 with kite ascents. When possible, Dines always preferred to design and make his own apparatus, and it was his modification of the box kite, his winding gear, and his meteorographs which were used. The meteorograph was simple, efficient, and cheap, a great point for upper air research, when instruments are apt to be lost or broken. Dines took observations at Crinan, on the west coast of Scotland, in the summers of 1902 and 1904, flying kites from a shore station, from a tug in 1902, and from H.M.S. *Seahorse*, lent by the Admiralty for the purpose in 1904. He also used his house at Oxshot in Surrey, and later at Pyrton Hill, near Watlington, as an upper air observatory.