is missing from all the essays, however, is the attempt to assess the value of chemical study in its various branches. That chemical discovery has contributed greatly to public and industrial welfare is beyond question. What, however, has been done, what is being done, to make the study of mental and moral value? Is not its value for all purposes steadily diminishing under the influence of examinations and the degree-hunger? Instead of being severely trained in scientific method and the worship of truth, the student to-day is taught didactically and dogmatically and 'faith' now plays as great if not a greater part in science than it does in religion. The 'research' work for the degree, for the most part, is mere exercise work, the equivalent of figuring out an untried example in the mathematical primer: there is no element of imagination or discovery in it. The teacher dare not set a task of difficulty of doubtful outcome. We talk ecstatically of the great increase in the number of papers published in our journals but the work, in large part, is of no real scientific merit or value. Much of it were better left unpublished.

The pursuit of science is necessarily an anti-human practice as it involves an all but impossible self-abnegation and a modesty which is more than rare. Let us admit that publication is largely a matter of personal advertisement: we shall then realise what is desirable in the interests of scientific altruism.

Problems such as these are in sore need of attention in Britain and America, if the faith of our forefathers is to be justified. Science to-day is as much in danger as is religion—there is a lack of morality behind it as there is behind religion—it is being overcome by the democracy of ignorance, by our failure to recognise that it is probably only attainable by the few, by the lack of discipline owing to lack of leadership. The American Jubilee proceedings are particularly disappointing in this respect. Chemists are in no way alive to the greatness of the subject of which they are guardians. HENRY E. ARMSTRONG.

The Cretaceous Plants of Greenland.[1]

IT was a noteworthy event in the annals of the University of Cambridge when a Master of a College undertook a successful expedition to Arctic regions shortly before becoming Vice-chancellor, and the publication of the scientific results of the expedition must also be described as an important event. For the significance of this work goes beyond the confines of palæobotany and geology into the regions of cosmic history. A knowledge of the plants which grew in Greenland in the far past provides, within certain limits, good evidence as to the former climate of the region, and so provides data for the study of secular climatic changes. This paper concerns the evolution of plants and the evolution of climate.

It has long been known that the remains of abundant vegetation are found in high latitudes. These are not merely fragments of plants which have been drifted by ocean currents far from their place of origin, but, as Prof. Seward has shown, may be accompanied by beds containing remains of roots and rhizomes *in situ*. In one place a great mass of remains of the fern Gleichenia indicates a district covered with this bramble-fern, while at another locality the abundance of conifer leaves reminded Heer of the carpet of fir-needles in a modern forest.

The Cretaceous plants of Greenland are of especial interest because the majority are allied to plants now living. It has been assumed that the Cretaceous forms grew under climatic conditions closely approximating to those under which their modern representatives grow to-day. Prof. Seward points out, however, that as times have changed in the world the plants themselves have in all probability changed in their relations to external factors. But no conclusions can be drawn without a thoroughly sound knowledge of all the forms making up the flora. Hitherto our information has been mainly based on the determinations of the famous Swiss palæobotanist, Oswald Heer, but his work belongs to an epoch when fossil species were established somewhat less critically than to-day. Seward has had the heavy task of working through Heer's results and reducing them to data which will satisfy modern requirements. A part of this critical review recently appeared in the jubilee volume of the Geological Society of Belgium, and it is here completed.

The list of species now given is very different from that of Heer, for many of his specimens were found to be too fragmentary or too badly preserved for reference even to their genera, while other remains of leaves were referred to modern genera on quite inadequate grounds. The names of many modern genera have therefore disappeared from the list, while others have been altered to indicate that leaves of the form possessed by certain modern genera were present, though their actual identity with these genera is not yet proved; for example, some leaves previously called Magnolia are now called Magnoliæphyllum. But while the author is very cautious in attributing fossil-leaf impressions to modern genera, he considers that many of them belong to modern families, and, after considering the distribution of some of these, he comes to the unquestionable conclusion that the fossils point to an Arctic environment very different from that of to-day. From the study of the chief forms he infers that "the climate of Greenland in Cretaceous times was probably comparable with that of Southern Europe to-day. Genera that are now characteristic members of tropical floras, the floras which are in part legacies from the Cretaceous age, were then represented by species less sensitive than their modern descendants to external factors."

The importance of these conclusions is that the changes in temperature needed to enable such a flora to live at high latitudes is not great. A freer interchange between the Arctic Ocean and the tropical oceans might be quite sufficient to allow the growth of the flora described, in the absence of the Greenland ice-sheet. There is no need to postulate considerable movements of the pole.

On the evidence of fossils, the view has been widely maintained that during the Mesozoic period the climate

[1] "The Cretaceous Plant-Bearing Rocks of Western Greenland," by A. C. Seward, *Phil. Trans. Royal Society*, Ser. B, vol. 215, pp. 57-175. London, 1926.

was uniform throughout the world. Prof. Seward does not think this theory tenable, and he brings forward evidence to show that the Greenland plants were not contemporaneous with the forms from the Wealden beds of England and from the Cretaceous rocks of the United States, which resemble them so closely. He holds that some of the older European plants migrated northwards, where they became mingled with new forms, and afterwards many species of the Greenland flora travelled southwards again. Distinct climatic zones may then have already existed and "it is reasonable to assume that in Cretaceous Greenland, as at present, short summers with continuous sunshine alternated with longer periods of comparative darkness."

For the botanist these Cretaceous plants are of special interest, for they grew in the period when angiosperms, agreeing with the present-day flowering plants in the morphological character of their foliage shoots, assumed a prominent position in the vegetation of the world. This work has led its author to the view that "the Greenland Cretaceous flora represents more fully than the floras of other countries the early stages in the transitional period from an older Jurassic-Wealden vegetation in which flowering plants were absent, to a type of flora which still persists in regions remote from its ancestral home." Together with ferns and gymnosperms of an archaic type were found dicotyledonous leaves of a surprisingly modern form, and the view is supported that the evolution of the deciduous angiosperms progressed with greater rapidity in these high latitudes. The alternation of prolonged periods of continuous activity with complete rest from growth through the winter, may have provided conditions of the type under which we should expect the evolution of the deciduous habit.

Prof. Seward makes the important suggestion that the shifting of the balance of the vegetation types was not merely the expression of a stage in organic evolution, but may have been a response to some physical stimulus. He does not make any suggestion as to the nature of the stimulus, but in this connexion the work of Garner and Allard, and Tincker may be significant. These investigators have found that alterations in the number of hours of daylight in which plants are grown produce changes in the time of flowering and also in some morphological features of many of the species investigated. Thus the northern and southern migrations referred to above may have induced morphological changes owing to the changes of illumination experienced in the course of the migration.

The rapid evolution of the angiosperms in high latitudes is no new theory, but though flowering plants appear to be quite absent from the lowest Cretaceous rocks, it is likely, as Seward points out, that they had antecedents in much earlier times. It may be that the evolution of the deciduous habit led to the frequent and abundant preservation of leaves from plants the evergreen ancestors of which had little chance of fossilisation, and so the sudden appearance of the flowering plants in the rocks does not represent the real history of the group.

The general conclusions which have been discussed above form but a small portion of this publication and, whatever their fate in the future, the great bulk of accurate and critical information which Prof. Seward has amassed will always remain of the greatest value and serve as a solid foundation for future work. The paper terminates with a fine paragraph in which the author hopes that his labours may stimulate others to extend and render more precise our knowledge of the Cretaceous plants of Greenland. It is interesting to record that within a few days of the publication of the work Mr. T. M. Harris, whose help is acknowledged in the introduction, landed in Greenland with the intention and prospects of making a more extended examination of the Rhætic plant-bearing beds of eastern Greenland than has hitherto been possible. We may look forward to further important contributions from Cambridge in this fascinating study. H. H. T.

Electric Waves and their Propagation.[1]

By Sir ERNEST RUTHERFORD, O.M., P.R.S.

AMONG the many developments of science during the past thirty years, none has left a deeper impression on the lay and scientific mind alike than the remarkable growth of wireless as a means of long-distance transmissions of signals, speech, music, and even of pictures. The history of this new method of signalling is of special interest to all scientific men, for it illustrates in a vivid way the value of a close co-operation between pure and applied science for rapid progress. The first great chapter in the history of radio-communication we owe to the genius of Maxwell, who, in a paper communicated to this Society in 1864 entitled "A Dynamical Theory of the Electromagnetic Field," showed that electric and magnetic effects cannot be produced instantaneously at a distance, but must be propagated through space with the velocity of light. He demonstrated the wave-nature of these electrical disturbances in space and the mode of their propagation. It is no exaggeration to say that the complete theory of electrical waves and their transmission in space is contained in his famous equations, and that too at a time when no experimental methods were known of producing or studying such electrical waves.

The next great step in advance we owe to the brilliant researches of Hertz, who in 1887, in his laboratory at Karlsruhe, showed how electrical waves in space could be produced by an open electric oscillator, and devised methods for their detection and study.

It was not long before the results of these small-scale laboratory experiments were applied for practical ends. In 1896, attempts began to be made in England to utilise electric waves for signalling purposes, and the rapid development of this new branch of applied science owes much to the pioneer work of Marconi and Lodge. Progress in the later stages has been largely influenced by the utilisation of another scientific discovery, namely, the use of electric currents in vacuum tubes as a powerful method of producing and detecting electrical waves. It is of interest to note that the first

[1] From the anniversary address delivered before the Royal Society on November 30.