

later eliminates from his teaching all the vitalising enthusiasm for knowledge which a man who *believes* in his teaching can inspire in his boys. The best results are obtainable only when the teacher and the boys believe that the work which the class is doing is really worth while. How can a teacher hold such a belief steadfastly through the disillusionings of experience unless he has thought out, to some extent, the why and whereunto of his work?

Another objection to the scrappy manner of approaching problems of class-room and laboratory is that such procedure is unscientific because unorganised. An analysis of the recommendations which have been published by societies of teachers in England will be fairly certain to reveal example after example of statements which you can neither accept nor deny until you have settled the *aim* which justifies inclusion of science in the curriculum. Nor is it to be imagined that a realisation of the educational functions of the various subjects is of import only to persons placed in authority—to the high priests of our educational hierarchy. Such a realisation (or the absence of it) affects every minute of every lesson given by the humblest practitioner of the teacher's craft. In all teaching, the objective dictates the method.

Granted that the fundamental problem of science teaching is the determination of the aim of such teaching, how far is it possible to generalise? How far will the aim depend upon the sex, range of age, previous preparation, and probable after-life of the majority of the pupils? It is easy to enunciate a few general truths, but it is clear that each school has its own special problem. Every subject worthy of a place in the school course does at least two things—(1) it enriches the mental content with valuable knowledge; (2) it develops mental power through the process of acquiring the knowledge. The former is too often under-rated by the schoolmaster, the latter by his lay critic, *e.g.* the business man. We must promote the fitness of the boy for his particular *role* in life, and at the same time give him as intelligent an understanding as possible of his fellow-men and their work. The boy should acquire some sense of his inheritance in the round world and all that therein is. Properly taught, science will have a humanistic value; the teachers of literary subjects must be made to feel, by the demonstrated effect of the science teaching in evolving many-sided interest in the boy, that they have not the sole title to "the humanities." But beyond such broad generalities there are no rules to be laid down, and the individual teacher must study his own case. In this task he might derive much assistance from debate with colleagues and in educational conferences.

Teachers in the United States have organised large federations of associations in order to discuss the broad problems of teaching. The concluding paper of a "Symposium on the Purpose and Organisation of Physics Teaching in Secondary Schools" appeared last March, and now we find in "Bulletin Number Two" papers on "The Problems of Science Teaching," written by President Ira Remsen (chemistry), Messrs. G. F. Stradling (physics), J. M. Coulter (botany), W. T. Campbell (mathematics), and N. M. Fenneman (physical geography). We abstract from the paper which deals with botanical instruction. The first problem, writes Prof. Coulter, is the prepared teacher, a problem not peculiar to botany, but peculiarly conspicuous. The prepared teacher means one who, in addition to good laboratory and field experience, has a clear conception of the purpose of botany in secondary schools, as distinct from its purpose in higher institutions. To inject into these schools miniature duplicates of college and university courses is to defeat

their purpose. There is no ideal method of first attack; the most natural one is the one nearest to the pupils. It would be very unfortunate for any committee to assume to determine that some one method of approach is the best. A current problem is the place of the economic aspects of botany. The older educational theory emphasised mental discipline to the exclusion of useful things, so that sometimes no useful plants were included in the course. In these days there is a tendency to the other extreme, and it is proposed to substitute agriculture for botany—a short-sighted change, because the most practical thing in the world is the foundation of pure science upon which applied science rests. The fundamentals of botany can be obtained from useful plants; but there should never be a straining after such plants at the expense of a clear illustration of the principle to be established. Referring to the proposal to include botany in general biology, using plants and animals indiscriminately for giving knowledge of biological principles, the author finds that this method is inappropriate to immature students, as the perspective is far too large to be grasped by their limited experience; but he suggests that the question be settled in conference. Finally, Prof. Coulter asks for a clear statement of the real value of botany from the point of view of the pupil—a serious attempt to answer the honest question, "What is it good for?"

Our only comment is that the "prepared teacher" who has answered the last question for his own school is in a fair way to solve the other problems propounded. We welcome this series of papers, for unless the teachers of science study their work with scientific method, *quis custodiet?*

G. F. DANIELL.

MAGNETIC SURVEY OF SOUTH AFRICA.¹

THE Cambridge University Press has published for the Royal Society a work giving an account of the results of the magnetic survey of South Africa carried out by Prof. Beattie, of Cape Town, with the aid of grants from the Royal Society, the British Association, and the Governments of the Crown Colonies in South Africa. The author, in the preface, acknowledges help from a number of scientific gentlemen in South Africa, and he has been fortunate in securing for the final presentation of the work the help and acute judgment of Dr. Charles Chree. The observations were made at some 400 stations in British South Africa, and extend over the period from 1898 to 1906, and the region is bounded roughly by latitudes 18° to 34° S., and by longitudes 20° to 36° E. The epoch to which the results have been reduced is July 1, 1903.

The amount of observational work required is very great and of a peculiarly monotonous type. The reduction of the results must have been a still more arduous task. It is difficult for anyone looking at the final results to realise the amount of sheer labour involved.

A work of this kind appeals in the main to professional magneticians, and for this reason the first part of chapter i. strikes us as a little out of place. It was hardly necessary to define the magnetic elements, but if the author thought it well to do so, he might have made them strictly scientific, instead of giving the kind of descriptive definitions which are suitable for a popular lecture. Similarly, a very "rough" method of finding declination is given. It looks trifling in a work of professional character.

Not the least difficulty in making a magnetic survey

¹ Report of a Magnetic Survey of South Africa. By Prof. J. C. Beattie. Pp. x+235. (Cambridge: University Press, 1909.) Price 21s. net.

is the fact that the magnetic elements are constantly changing. The only satisfactory way of eliminating this trouble is by reference to a recording magnetic station within reasonable distance of the point at which the absolute observations are taken. Unfortunately, there is no such station in South Africa, and thus Prof. Beattie has been severely at a disadvantage. He has attempted by other means to eliminate the effects of periodic and secular change, but after giving an account of his attempts he concludes that the result is somewhat illusory, and probably most impartial readers will agree with him. This naturally sets a limit to the general accuracy, and unfortunately it is a case in which the excellent maxim of considering the pennies does not ensure that the pounds will behave with their reputed propriety.

A statement of the reduced results and tables for the purpose of drawing charts of equal values of any element naturally occupies a considerable proportion of the book.

The problem of drawing equivalent curves from observations at discrete points calls for great experience and discrimination on the part of the operator. As regards the main features, no question can arise. The results agree well with the known geological formation, of which an excellent map is given. Moreover, the localisation of magnetic districts is fairly definite and must prove of value to geological and mining science; but some of the minor fluctuations may as well be due to local magnetic matter as to incidental error, from which, under the conditions, the observations cannot be quite free. The manner of presentation of the results will, we feel sure, meet with general approval. We trust that the author will not accuse us of unduly exceeding the limits of reasonable criticism if we suggest that the phrasing "with one instrument first, then with the other, and finally with the one again," is not the most elegant way of describing the operation of comparing instruments. Further, X, Y, Z, T so naturally represent the northerly, westerly, vertical components and total force that we deprecate the use of Z for total force and T for the northerly component.

In appendices which really occupy more than half the volume, a statement of the method of reduction and of the station observations is given. That the observations should occupy so large a space is only right, for we trust that future generations will desire to examine the record of this important work. In Appendix D the author gives a typical example of reduction of the determinations of horizontal force. We observe that Prof. Beattie estimates times in the vibration experiment to one-twentieth of a second. While several magneticians adopt this practice, we have some doubt whether, by counting chronometer ticks, one can always be certain of one-tenth of a second. Even with an electric chronograph it is not customary to estimate a single transit to nearer than one-tenth of a second.

In the determination of horizontal force a number of points arise. One's object being the value at a definite instant, we require a vibration and deflection experiment. In taking a vibration experiment, both before and after the deflection experiment, Prof. Beattie is well advised, but we are unable to follow the logic of his elaborate system of taking means. If the change in horizontal force during the experiments is linear and small, it will not make the least difference whether we take the average of the first and second vibration experiments or adopt Prof. Beattie's more elaborate procedure; while if the question enters on squares and non-linear change, we would point out that this has not been examined fully on the theoretical side. Again, we notice that the

practice of reversing the magnet at a given distance was followed. A really better average is got by changing the distance on each reversal of the magnet according to the Kew practice. Whatever the elaborate way of combining the results may mean, it does not eliminate the frequent possibility of the value of H during the deflection experiment being different from the average value during the two vibration experiments, nor the fact that H may differ for the 30-cm. and the 40-cm. distances in the deflection experiment. These are, however, criticisms of detail, and do not affect the general accuracy of the final result, and the record of the first South African survey will remain a memorial to the industry and conscientious work of its director.

G. W. W.

M. BOUQUET DE LA GRYE.

AMONG French men of science, few have been more respected or have worked more indefatigably than M. Bouquet de la Grye, whose death, at the advanced age of eighty-two, was recently announced. His official work was more immediately connected with engineering and hydrography, but his scientific interests were wide, and he was equally well known as an astronomer and geodesist. As marking his qualities as a hydrographer, it is sufficient to recall that at an early age, shortly after leaving the *École Polytechnique*, he took a prominent part in charting the parts of the Mediterranean adjacent to the coasts of Italy and the Island of Elba. To estimate correctly the importance of this work, we must remember that in the early 'fifties, methods of surveying were not so systematised as they have since become, and mechanical routine had not displaced opportunities for original treatment. Subsequently, he was engaged in correcting the charts of the French Atlantic coast, and in the course of this work he assisted in improving the navigation of the River Loire and contributed greatly to the establishment of the successful port of Nantes. His work on river navigation, and his appreciation of the facilities for traffic which inland waterways offered, seem to have inspired him with the hope of converting Paris into a seaport, utilising the Seine, which he proposed to deepen for the purpose, and avoiding its irregular bends by the construction of canals. A system of docks and the whole machinery of a seaport were to be constructed at Saint Denis. Needless to say that this project, which demonstrates the extent of the imagination and enterprise of the regretted man of science, has not met with public favour. It seems to be the fate of canals either to be rendered useless by the increasing growth in the tonnage of steamers, or to involve such gigantic expenditure in construction that their commercial success is jeopardised at the outset.

In his astronomical work, M. Bouquet de la Grye will be remembered in connection with his loyal and long continued efforts to render the observations of the transit of Venus available for the determination of the solar parallax. In 1874, and again in 1882, he took active part in the preparations and in the actual observations, on the first occasion visiting Campbell Island, and on the second, Mexico. This method of determining the sun's distance may now be discredited. Improved technique and greater knowledge have permitted the use of methods of greater accuracy, providing results less difficult of interpretation; but it would be ungenerous to undervalue the devotion of astronomers of a past generation, who have been actuated by a sincere desire to benefit science and have exhibited both ingenuity and energy in the pur-