SATURDAY, JANUARY 12, 1924.

CONTENTS.

	PAGE
Fossils and Strata. By Dr. F. A. Bather, F.R.S.	37
Early Astronomy in Oxford. (<i>Illustrated.</i>) By Dr J. L. E. Dreyer	38
The History of Technology. By F. S. Marvin	40
Belgian Biology	41
Medical History of the War. By W. B.	42
Anthropology and Colonial Administration	42
Our Bookshelf	43
Letters to the Editor:—	
The Eyes of Spiders. (<i>Illustrated.</i>)—A. Mallock, F.R.S.	45
Mrs. Ayrton's Work on the Electric Arc.—A. P. Trotter	48
Is the Gulf of Suez a Rift Valley?—Dr. W. F. Hume; Prof. J. W. Gregory, F.R.S.	49
Colour Vision and Colour Vision Theories.—Sir Oliver Lodge, F.R.S.; Prof. W. Peddie	50
Deferred Annuities (Two Rates of Interest).—W. Palin Elderton	50
Mendelism and Evolution.—C. Tate Regan, F.R.S.	50
Bessemer Steel.—Prof. H. C. H. Carpenter, F.R.S.	51
Standardisation of Scientific and Technical Publications.—W. P. Widdowson	51
Scientific Names of Greek Derivation.—B. B. Woodward	51
Bird Migration in Relation to Foot-and-Mouth Disease. By Dr. A. Landsborough Thomson	52
The Utilisation of Volcanic Steam in Italy. (<i>Illustrated.</i>)	54
The Meridian of France. By Sir C. F. Close, K.B.E., F.R.S.	56
Obituary:—	
Dr. Frank Clowes. By J. B. Coleman	57
Mr. William Morfitt	57
Current Topics and Events	58
Our Astronomical Column	60
Research Items	61
The Bloemfontein Meeting of the South African Association for the Advancement of Science. By Prof. H. B. Fantham	64
Prize Awards of the Paris Academy of Sciences	66
The Physical and Optical Societies' Exhibition. By C. W. H.	67
Science Masters' Association Annual Meeting	68
University and Educational Intelligence	69
Societies and Academies	70
Official Publications Received	72
Diary of Societies	72

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Fossils and Strata.¹

FOR a little more than a hundred years, geologists, following the lead of William Smith, have utilised fossils to identify strata, to arrange them in the order of their formation, and to divide them into larger groups. At first they merely recognised certain fossils as characteristic; thus, *Micraster* indicated the Chalk, *Paradoxides* the Cambrian, *Nummulites* the Tertiary; even this century introduced an attempt to zone the British Carboniferous by species of unrelated brachiopod and coral genera; and the idea culminates in the lengthy list of characteristic fossils that a committee of the British Association has been trying to produce for more than thirteen years. It was high time for a president to point out to the Geological Section that this method leads to the burdening of stratigraphy with an enormous number of local subdivisions, and (she might have added) the burdening of our memories with innumerable specific names subject to perpetual change.

The remedy prescribed by Dr. Elles is twofold. First of all we are to pay more attention to the evolution of selected groups, not worrying over-much about nomenclature, but concentrating on the change of structures, and noting the horizons at which important stages of development are attained. To keep ourselves on the right lines in this study, we are to distinguish the faunas of shallow water from those of deeper water, because in the former, as so well illustrated by the work of C. G. J. Petersen and his colleagues, there is great variation from place to place in correspondence with the diverse physical and biological conditions; while in the latter, under more uniform conditions, evolution (it is assumed) progresses more regularly and continuously. These are principles that it is always well to urge on stratigraphers, but one is glad to think that they are not so foreign to palæontological literature as might be inferred by a reader of Dr. Elles' address. Let us look at them more closely.

The groups of animals suitable for the construction of an evolutionary scale are those which run with the requisite continuity through a considerable series of strata and have, at the same time, a wide distribution in space. Dr. Elles calls these "stable or successful types," and implies that they are found in the deeper waters. Put thus crudely, her thesis may appear open to some objection. By "stable" can scarcely be meant "persistent," for it is "the so-called long-ranged species" of brachiopoda that are said to appal the heart of the palæontologist; and clearly the change of form must be readily appreciable in rate and in amount. The stability needed is that not of a house

¹ "Evolutional Palæontology in Relation to the Lower Palæozoic Rocks." Presidential Address by Dr. Gertrude L. Elles to Section C (Geology) of the British Association at Liverpool, 1923.

but of a bicycle, and the epithet must therefore apply to a series of forms or a trend of evolution. "Successful," again, seems to imply no secure station, but the highway of progress as opposed to blind alleys. As for deep water, one pictures it rather as a retreat from the evolutionary stress of the more changeable littoral, and one hesitates to accept the idea of a progressive trend pursuing the even tenor of its way through the night of the abyss. A gloss is needed, and is given. The Graptolite Shales form the instance, and "the factors controlling their accumulation" are "not depth as such," but those "associated with depth, especially quietness of water and absence of coarse sediment." Now, since it is admitted that the graptolites did not live on the bottom but were probably "pseudoplanktonic," one concludes that they appear to characterise the black shales mainly because they were more readily preserved therein and were not there confounded with the shelly fragments frequent in rocks formed under other conditions. It may, in fact, be suggested that the graptolites of the Lower Palæozoic, like the ammonite shells of the Mesozoic, meet the want of the stratigrapher simply because they present rapidly evolving series, the successive forms of which were swiftly borne throughout the sea waters of the world.

Turning from the deep-water rocks to those formed in shallow waters, we find that the latter have their special advantages and disadvantages for the palæontologist and stratigrapher. Not only do the faunas change with the conditions of each locality, but even fossils of identical species may present a variety of appearances due to mode of preservation, diverse deformation of the rocks, or differences of food-supply affecting size. Here Dr. Elles emphasises the need for work in the field to illuminate that in the laboratory. But these rocks yield an advantage from their diversity and their thickness, in the clearer separation of variants in space and time: the successive steps of evolution are more spread out. In them we cannot hope so often to have long continuous series within a single group of animals; but it is often possible to study briefer successions within species-groups. Such work, Dr. Elles reminds us, has been done on Carboniferous corals by several British workers, and on the Silurian Pentamerids of Christiania by Kiaer; she proceeds to illustrate her point by original observations on the changes of the glabella lobes and the increasing fusion of tail-segments in two species-groups of Ordovician trilobites, observations which could be made only by one familiar with the occurrence of the fossils in the field.

Some day, perhaps, the authorities of national museums in Great Britain will realise, as already is understood in America, that those who are to study

and catalogue the specimens in the cabinets must be sent to collect and observe them in the cliffs and quarries. If stratigraphy depends on palæontology, palæontology no less depends on stratigraphy. It is the merit of this address that it presents the carefully considered views of one who has earned high distinction in both branches of the science. F. A. BATHER.

Early Astronomy in Oxford.

Early Science in Oxford. By R. T. Gunther. Vol. 2: Astronomy. Pp. xv+408+66 plates. (Oxford: Printed for the Subscribers, 1923.) n.p.

SOME six or seven years ago Mr. Gunther began to examine the old instruments of various kinds, most of which had until then been utterly neglected or forgotten, preserved in the Colleges and Museums at Oxford. The present volume is the outcome of his studies of the astronomical instruments, not only of those found in Oxford, but also of the magnificent collection of portable instruments, chiefly astrolabes and sun-dials, formed by Mr. Lewis Evans during the past thirty years. This collection is at present exhibited in the portrait gallery of the Bodleian Library, and has been offered as a free gift to the University, on the sole condition that it shall be properly housed and exhibited. Owing to the rarity of examples of the work of many of the makers, it is a collection which it would be difficult or impossible to bring together again. It is very much to be hoped that the gift may be accepted, and that it may form the nucleus of a museum illustrating the progress of science since the Middle Ages.

While studying these and other instruments Mr. Gunther has made good use of many of the medieval manuscripts in the Bodleian bearing on the subject, giving in an appendix lengthy extracts from some of them in the original Latin, and in the text full references to all he has seen, quoting the Library numbers, so that any one wishing to look them up himself can do so without a tiresome search. The book is most beautifully and most profusely illustrated by plates and figures in the text, which make it a positive pleasure to turn over the pages, while they contribute very much to make the descriptions of the instruments intelligible.

The author begins by giving a rapid summary of what has been preserved at Oxford in the way of old instruments. No instrument associated with the name of Roger Bacon or of his time has survived, and even the building on the Folly Bridge supposed to have been his observatory was pulled down long ago. The Oxford collections begin with astrolabes (Fig. 1) dating from the middle of the fourteenth century and associated with a number of men who studied astronomy and