

laws of motion is of the nature of definition, and how much is a statement of facts ascertained experimentally, is not disclosed. To assert that these laws still form the simplest foundation for the subject is to ignore the progress that has been made since the publication of Thomson and Tait's "Natural Philosophy." The difficulties into which writers who follow Newton uncritically must needs fall can be illustrated by sentences on pp. 27 and 28. On p. 27 we read, "Force is defined as any cause which alters the momentum of a body"; and on p. 28 we are told that force is "merely another name" for "the vector-acceleration of momentum." This makes the same word do duty for the cause of the change and the rate of the change. Others of the definitions given are wanting in precision. The definition of the *mass* of a body as the quantity of matter in it is a definition of one previously undefined thing in terms of another. The description of the first law of motion as a "statement of the inertia of matter" is not helpful; inertia is a property of matter under ordinary conditions, and the first law is a statement about matter under conditions in which it has never been observed. It ought to be realised that the three laws form a connected system, and that all of them are as much needed as any one of them for the precise definition of *force*, or the exact statement of the inertia of matter. The definition given of *work done* is obscure; the work of a force is defined as a product, and no indication is given of the sense in which this product can be said to be "done." What is wanted here is much the same as in the case of force: we all have an anthropomorphic idea that some cause must operate to start or stop the motion of a body; we have a similar idea that a man has done something when he has lifted a weight or thrown a cricket ball, and these ideas should be taken hold of and made precise by the introduction of measurable quantities which are adequate to represent them.

The difficult ground of definition and statement of principles once covered, the rest of the book is for the most part excellent, the geometrical methods employed being especially elegant. Room is found for an elementary discussion of strain, of compounded simple harmonic motions, of attractions, including the distribution of electricity on a sphere under influence, and of the velocity of waves along a stretched cord, in addition to interesting and unhackneyed accounts of the matters which are the stock-in-trade of books on the elements of mechanics. The book on the whole is thoughtful, in many parts it is much better than the current text-books, and the parts that call for criticism are no worse than the corresponding parts of most other books on the subject; but they are the most important parts, and they might have been so much better. There was a great opportunity, and it has been missed. A. E. H. L.

THE SCIENCE OF LAND FORM.

Physical Geography. By Prof. W. M. Davis, assisted by W. H. Snyder. Pp. xvii + 428 + 9 plates. (Boston and London: Ginn and Co., 1899.)

AN examination of this volume gives rise to feelings of both congratulation and regret—congratulation that so admirable a manual for the elementary student of

physical geography has been produced, and regret that so little attention is given to the subject in our schools and colleges. Rational methods of instruction are now advocated for all the concrete sciences, and are being extensively applied to physics and chemistry; but geography has only been very slightly benefited by the pedagogic reforms of the last decade, and in the majority of our secondary schools it is still represented by definitions, outline maps, uninteresting statistics, and lists of names which make no real impression upon the minds of the pupils. Physical geography, the elements of which should be presented at the very beginning of the study of the earth, is usually neglected altogether, or taught in a fashion that fails entirely to place pupils in the receptive intellectual attitude reached after sound instruction in any science.

The present position results chiefly from the want of teachers with a broad conception of the field of geographical science. Every teacher is supposed to be qualified to give instruction in geography; and if the word merely signified the description of the political divisions of the earth, any one could put pupils in the way of acquiring that information. But, rightly defined, geography should be the consideration of the earth as the abode of man, and it should comprise the elements of astronomy, physics, meteorology, botany, zoology, and ethnology, as well as knowledge of commerce and government. To present the subject in these broad aspects, the teacher must be inspired by the scientific spirit and have given personal attention to the facts and phenomena of nature; and where such teachers are not available instruction in geography cannot proceed on scientific lines.

The volume under notice provides an admirable means of improving geographical teaching. Prof. Davis is not only an expert in most of the branches of physical geography; he is also a practical teacher who has devoted much attention to the educational side of the subject. The result is that, with the assistance of Mr. Snyder, he has produced what is certainly one of the best manuals of physical geography ever published. The book is well planned, trustworthy, clearly written, and liberally illustrated; it presents the facts of physical geography in such a way that the reader sees them as part of an organic whole—as organised knowledge which constitutes science. The facts are traced backward to their causes and forward to their consequences; indeed the phrase "causes and consequences" has served as a touchstone by which the treatment of each subject has been tested.

The order of treatment is the earth as a globe, the atmosphere, the oceans, and the lands. These facts are not, however, treated in equal detail; indeed, the last part occupies more than four times the number of pages devoted to the three preceding parts taken together. From this it will be seen that the book is not concerned with physiography as it is usually understood in this country, but with the science of land form. In physiography the student receives practical instruction in physics, chemistry, astronomy and cognate sciences before he considers atmospheric phenomena the circulation of water on the land, the earth's solid

crust, and the changes which take place in it : in physical geography, however, the facts of physical science are made subservient to the descriptions of land forms and other matters directly connected with the study of the earth. In the present volume, for instance, "the non-geographical elements of astronomy, the principles of physics, and the divisions of geological time, are carefully excluded." The authors are, of course, entirely justified in limiting the sections dealing with these subjects to any dimensions they please ; and many teachers of physical geography will agree that the method of treatment adopted distinctly defines the scope of physical geography. At the same time, the opinion of the writer is that it is impossible for a student to clearly perceive many of the facts of physical geography unless he has a practical acquaintance with physical science. A student with a knowledge of Boyle's law can fully understand why half the earth's atmosphere is left behind in ascending to a height of three and a half miles above sea-level ; but a student of physical geography may be told that this is the case, and have no real conception of the cause. Almost every fact concerning the constitution and movements of the atmosphere can be far more easily comprehended by students who have received experimental instruction in the principles of physics than by those who read them for the first time in connection with natural phenomena. Similar introductory knowledge is also required to intelligently follow the action of internal forces such as give rise to volcanic eruptions, the system of oceanic movements, the solvent and disintegrating actions of water, causes which affect climate, and many other natural operations and conditions. A practical knowledge of the principles of the science of matter and energy is indeed essential to the scientific study of the earth ; and without such knowledge students of physical geography can have only a limited comprehension of the causes of natural processes.

As bearing upon this point, mention may appropriately be made of a new syllabus of physical geography which has just been prepared for the Cambridge Local Examinations. The syllabus includes a course of practical instruction drawn up with the distinct object of cultivating the pupils' faculties of observation and reasoning ; it therefore represents a praiseworthy attempt to make lessons in physical geography of real educational value. So far as the descriptive part is concerned, the volume under notice is exactly the kind of book to use in classes which follow the Cambridge course, and the appendices will be found of service in showing the observations which may be usefully made out of doors. But the sections on the atmosphere and on astronomical geography are too brief to be clearly comprehended by students unfamiliar with the rudiments of physics and astronomy. In the Cambridge syllabus experimental work in each of these divisions of physical geography is rightly given prominence ; and we consider that a larger amount of space might have been devoted to them with advantage in the present volume. As these sections now stand they will convey information, but will not do much to encourage individual observation. Moreover, most teachers will find it necessary to postpone the descriptions of atmospheric circulation to a later stage than is suggested by

the place in which it is here dealt with ; for though the volume contains a most admirable account of wind systems, every teacher knows that charts of winds and isotherms are not easily visualised by the student who has not learned to read such diagrams.

Apart from the question of the relative importance which should be attached to the different divisions of physical geography, it would be difficult to suggest how the volume could be improved. No better description of the lithosphere, and the changes which take place in it, could be desired by the student of physical geography than is given by the authors. The examples of characteristic land forms are naturally more often American than European or British ; but as emphasis is always laid upon the association of land forms with settlements and industries, a useful lesson is conveyed even if the selected district is strange to the reader. Several words, such as *monadnock*, *cuesta*, *drumlin*, *peneplain*, *esker*, and *mesa*, not usually found in books of physical geography used in this country, are employed to describe particular formations, though no explanation appears to be given of more common terms in physical geography, such as *hydrosphere*, *lithosphere*, *erratic*, *volcanic dyke*, *geoid*, *Roches moutonnées*, *scoriae*, *tundra*, *selvas*, *pampas*, and *regelation*—or if they are mentioned they are not indexed. Little importance need be attached to this, for physical geography should be more than a collection of definitions ; but as the student will in all probability meet with the words later, he should know their significance. This is, however, but a minor point, for a good dictionary will furnish the meanings of these words, but it is only occasionally that a volume of such an inspiring character as the one here noticed is produced, and where so many good qualities are exhibited, a judicious critic hesitates to suggest any alterations.

R. A. G.

THE REMINISCENCES OF A. D. BARTLETT.

Bartlett's Life among Wild Beasts in the "Zoo." By the late A. D. Bartlett. Edited by E. Bartlett. Pp. xviii + 375. (London : Chapman and Hall, Ltd., 1900.)

THE issue of the present volume may be taken as an indication that its predecessor, "Wild Animals in Captivity," was a success and has met with the appreciation of the public. Obviously, therefore, it is not the part of a critic to decry what has practically been already approved, the work before us being a continuation of the first series of *Reminiscences*. Undoubtedly there is a very large amount of extremely entertaining matter in this second venture. Especially is this the case with regard to the author's experiences of Gorillas and Chimpanzees, his important practical experiments and observations with regard to hybrids, his account of the verification of the hunters' stories as to the annual shedding of its horns by the American Prongbuck, and his description of the habits of the Indian Panda, or Cat-bear. The latter observations afford, indeed, an excellent example of the acuteness of Bartlett's judgment as to the affinity of an animal by the study of its habits alone. The systematic position of the Panda was at the time in question much disputed. Mr. Bartlett insisted on its