of biology, the study of life, and said that modern biological study began with Darwin's visit to the Galapagos Islands fifty years ago. "Activity of protoplasm cannot be called life. Vital phenomena are distinguished by what is done, not by the constituents of the organism. There is no necessary connection between life and protoplasm. The common characteristic in all life is education. Life is education, and education is life. Kick a stone and a dog: the difference in the result is caused by education." He then referred to examples of natural difference in life as caused by education, and adjustment by education to varied circumstances. "The common characteristic in all these forms of life, from the highest to the lowest, is education. If, then, life is education, in seeking the latter we are advancing the former."

At the close of the lecture, Dr. Brooks was tendered a reception by the lyceum, at its building, Jackson hall, where letters and speeches from old members showed that their interest was still great.

The lyceum is the only active college society in this country which has its own building. It has now about twenty working-members, and holds its meetings every week, at which reports are given by members appointed in advance, on the subject which they are studying. Since Dr. S. F. Clarke took the professorship of natural history in the college, a strong interest in biology has been aroused in the society.

Among the members who have devoted themselves to science after graduation, the following are the best known: Professor Addison Ballard, '42; Mr. William H. Edwards, '42; Prof. W. D. Whitney, '45; Hon. D. A. Wells, '47; Dr. P. A. Chadbourne, '48; Dr. William Goodell, '51; Prof. Henry A. Ward, '55; Professor James Orton, '55; Mr. Samuel H. Scudder, '57; Dr. R. H. Ward, '58; Dr. E. W. Morley, '60; Prof. F. H. Snow, '62; Dr. G. Stanley Hall, '67; Dr. W. K. Brooks, '70; Dr. E. A. Birge, '73; and Mr. J. S. Kingsley, '75.

THE UNITED STATES AT THE FISHERIES EXHIBITION.

It is impossible to do much more than indicate the contents of this immense volume of over thirteen hundred pages. It is entitled 'Descriptive catalogues;' but, as observed by Mr. Goode, it really partakes of the character of a report on the part played by the United-States exhibit at the London fisheries exhibition, — not only that of the government, but also that due to private American exhibiters. A considerable part of the volume was printed, and distributed to visitors, during the exhibition.

There is a short introduction by the commissioner, followed by some data from the census; a list of forty-two gold, fifty-five silver, and thirty bronze medallists; beside some fifty other awards to American exhibiters, followed by a report on the collective exhibits of the U. S. national museum and the U. S. fish-commission. It is needless to say that every branch of the subject is thoroughly presented, either by specimens, models, illustrations, or literature. There is included under these a useful series of catalogues by Messrs. Rathbun (Economic invertebrates, except mollusks), Ridgway (Water-birds), Winslow (Economic mollusks), Brown (Whale-fishery), Bean (Fishes, and illustrations of fishes), Rathbun (Scientific appliances for deep-sea investigation), True (Aquatic mammals), Capt. Collins (Vessels and boats), Earll (Fishing-tackle and appliances), Clark (Fishery products), and Earll (Fish-culture).

The catalogues of birds and fishes are of particular interest and value, apart from their present connection, to all interested in those departments of biology. The catalogues of mollusks and other invertebrates are necessarily much less complete, and are expanded and improved from the centennial catalogues of Messrs. Dall and Rathbun, prepared for Philadelphia.

The volume is a monument of well-systematized labor, but would probably have been more convenient for reference if it had been divided into two volumes. The anthropologist, ornithologist, ichthyologist, fisherman, or manufacturer can hardly fail to find useful and welcome information in these pages; while, by the staff of the commission and museum, the book can hardly be contemplated without a feeling of thankfulness that the period of extraordinary drudgery, apart from their usual and regular duties, which the volume commemorates, is at last entirely over.

Report upon the exhibit of the fisheries and fish-culture of the United States, made at the London fisheries exhibition, 1883. Prepared under the direction of G. Brown Goode. (U. S. nat. mus., bull. 27.) Washington, *Government*, 1884 [1885]. 8°.

PHYSICS OF THE EARTH.

This is an admirable book. Dr. Günther, whose thoroughness has been well shown in his earlier writings, makes many physicists, mathematicians, and geographers his debtors by preparing so able a work on the subjects where they meet on common ground; and, if all teachers of physical geography and geology had the good fortune to possess the advanced training that this volume gives and requires, we should hear less from the classical men of the insufficient discipline afforded to the scholars in our secondary schools by their natural-his-

Lehrbuch der geophysik und physikalischen geographie. Von Siegmund Günther. Band i. Stuttgart, *Enke*, 1884. 10+418 p. 8°.

tory studies. A second volume is promised to contain the more geographic topics, while the one now issued treats of terrestrial physics in a more general sense under such headings as the relations of the earth to the other planets, the form of the earth, the effect of its motion, and the condition of its interior. These are preceded by an historical introduction, and followed by a brief and discriminating discussion of volcanoes and earthquakes; and all the chapters are closed by extended lists of citations that add greatly to their value. As indicative of the careful and learned investigation that has been required in the preparation of the work, we cannot do better than give in brief abstract an outline of three discussions on subjects that have not received sufficient attention on this side of the water,— the irregularities of the earth's shape, the effects of its rotary motion, and the hypothesis that its interior is gaseous.

The development of the belief in the globular form of the earth is treated at length; and the reasons for giving up the Cassinian view of its elongated polar diameter and accepting the Newtonian explanation of its polar flattening are clearly stated before mention is made of the difficulties that have been encountered in attempting to reconcile the accurate arc-measurements of modern times with the supposition that the earth must have a regular form. It is then shown, that after it had to be admitted that meridians measured in different countries could not be fitted on any single ellipsoid, and after it was found that mountains exerted a sensible lateral attraction on plumb-lines hung at their bases, it was still supposed, even by such men as Gauss and Bessel, that the ocean was essentially level, and that it would serve as a proper fundamental surface to which measurements of altitude, or distance from the earth's centre, could be referred. During the prevalence of this opinion, through the first third of this century, careful observations of swinging pendulums were made in many parts of the world; for, as the pendulum moves in obedience to gravity, the flattening of the earth could be deduced, it was thought, from the number of oscillations counted in a day at different latitudes. In the course of these difficult experiments, it was found, strangely enough, that pendulums would swing faster on mid-oceanic islands than on the opposite continental coasts: the difference was small, only eight or nine seconds a day; but it was persistent, and, as it implied a greater strength of gravity, it soon led to the conclusion that the earth was denser beneath the oceans than below the continents. This view is now widely quoted, and it probably will long remain in our text-books; although there can be little doubt that it is quite incorrect, and that the true explanation of the difficulty is to be found in the deformation of the ocean's surface by lateral continental attraction. The most important investigation of this deformity, and of the many difficulties it adds to geodetic work, is by Fischer, in a small volume entitled 'Untersuchungen über die gestalt der erde' (1868). Saigey, Stokes, and Hann have also considered the question; and, although it is not yet possible to say how much the sea is drawn up on the flanks of the continental masses, it is sufficiently demonstrated that the lifting amounts to many hundred feet on certain coasts. As a result, islands appear in mid-ocean that would be submerged if the ocean's surface were really level; and pendulums must naturally swing faster there than on the coasts, because they are nearer the centre of the earth.

Other important modifications of previous views follow from these conclusions; continental upheaval becomes more of a problem than ever; the great East-Indian arc is considered useless for determining the size and shape of the earth; and Airy's explanation of the absence of lateral attraction by the Himalaya is pronounced incorrect. Evidently, geodesists have still much to do.

Among the consequences of the earth's rotation, Günther gives a full and precise account of the lateral deflection of horizontal motions so conspicuously seen in the oblique motion of the trade-winds. There is not to be found an English text-book on physical geography in which this matter is properly explained: when mentioned, it is almost invariably stated that the deflective force acts only on north or south motions, and is nothing on bodies moving east or west. Even Herschel has explicitly given this meaning. But as a matter of fact, the deflective force is the same, whatever be the direction of motion from a given point, and the demonstration of this unapparent truth is here simply presented. Still a farther step is taken in quoting the results of Finger's recent investigations, where it is shown that on a spheroid, instead of on a sphere, it is not precisely true that the deflective force is independent of the direction of motion: it is greatest for eastward motion; and in confirmation of this, Günther quotes Darapsky, who finds that in artillery practice the observed deflections are greatest when the aim is directly to the east. The variation is extremely small, and

is only apparent in high velocities. For nearly all studies, it will suffice to consider the deflections as if produced on a sphere.

Ritter's speculations concerning the gaseous condition of the earth's interior are of especial importance, inasmuch as they may tend to counteract the very positive statements made by English physicists and geologists in recent years in regard to the age and contraction of the earth as determined by its cooling. The English school generally regards the earth as essentially solid, with a great central volume of dense matter at a high, and, roughly speaking, uniform temperature. On the basis of certain plausible assumptions concerning the original temperature and conductive power of the mass, it has been possible to approximate fairly well to the age for an earth of such characters, and to determine roughly the shortening of its radius, and consequent diminution of circumference since it has had a definite solid crust on which water might condense from the vaporous atmosphere into the oceans. The age of an earth thus limited has greatly reduced the estimates in vogue by the followers of Hutton and Lyell, even though its years are still to be counted by millions. Its contraction from cooling has also been pronounced insufficient to produce the observed structure of mountain ranges in the way that Élie de Beaumont had suggested. Strongly contrasted with these assumptions and their legitimate results are the conclusions reached by Ritter. His original papers were published in Poggendorff's 'Annalen,' and have received an approving review from so trustworthy a physicist as Zöppritz. Günther quotes largely from the latter. We cannot here do justice to the hypothesis, for it would need a somewhat deliberate statement to make it clear. Excessively dense vapors, probably dissociated from their ordinary combinations, and existing at temperatures high above their 'critical point,' are supposed to occupy the earth's centre; and from these there is a gradual transition to the solid superficial crust. The cooling of such a central mass follows a paradoxical law, — the more heat it loses, the hotter it becomes, — and so the supply of interior heat is long maintained, and the time allowed for geological processes is lengthened. Moreover, the contractional theory here finds a cause for all the diminution of interior volume demanded by the wrinkling of the crust in mountain ranges. Altogether, while the venturesome hypothesis is very far indeed from any thing like demonstration, its consideration is profitable if it prevent our settling down prematurely to a fixed belief concerning the condition of the earth's interior.

We shall wait impatiently for the second volume of the work, in which the physics of the air and sea will be discussed; and it will be particularly interesting to see what treatment so learned an author gives to the physical geography of the land.

ROMANES' RESEARCHES ON PRIMITIVE NERVOUS SYSTEMS.

All who are interested in the physiology of the nervous system in lower animals will find in this volume a most useful popular contribution to this subject. The book, as the author states, is restricted to experiments made in his own researches; but these are so numerous and varied that it will be found to contain a summary of the most important results in this line of investigation which are at present known.

'Do they feel?' and 'Have they senses?' are questions which are very naturally asked by any one who watches the varied movements of the jelly-fishes, star-fishes, and sea-urchins. A natural credulity prompts one to question whether the medusae, whose bodies contain over ninety-eight per cent of water, have a nervous system, and organs of special sensation. Twenty-five years ago, science would have given a very unsatisfactory answer to these questions; but to-day we have a very accurate knowledge of the anatomy of these structures. With this advance in anatomical knowledge, physiological research has kept pace; and certainly no one has done more than Romanes in this kind of research. Thanks to these advances, we can now reply to our questioner with more confidence than formerly. These animals not only feel, but also have special organs of sight, hearing, and probably smell.

The author puts the anti-vivisectionists in a receptive frame of mind for the work which follows by declaring, in the introduction, that his experiments on living animals involve no pain, and that the "consciousness which is present must be of a commensurately dim and unsuffering kind."

The work is mainly taken up by experiments in excising portions of the body, and noting the effects on the movements of the animal. Many very interesting experiments

Jelly-fish, star-fish, and sea-urchins: being a research on primitive nervous systems. By G. J. Romanes. New York, *Appleton*, 1885. (International scientific series.) 12+323 p., illustr. 8°.