a pamphlet entitled 'The land-system of the New-England colonies,'—a work which well supplements the series before us.

THE EXPLORING VOYAGE OF THE CHALLENGER.

(*Third notice.*)[1]

One of the most important of all the outcomes of the expedition is undoubtedly Alexander Agassiz's memoir upon the Echinoidea (vol. iii., 321 p., 45 pl.) which occupies fully two-thirds of one of the massive volumes of the report. Mr. Agassiz's personal acquaintance with all known types of Echinoidea, recent and fossil, gives him an advantage as an authority over all his contemporaries; and, without some such special training, it would have been a matter at least of extreme difficulty to decipher the complex relations of the multitude of singular forms intermediate between the faunas of ancient and modern times, which have been brought to light by the Challenger expedition. The value of these collections may best be shown by a bit of statistics. When the author's 'Revision of the Echini' was publishing (1872–74), there were enumerated 207 species, distributed in 89 genera, including 2 deep-sea species discovered by the Porcupine, and 13 by Count Pourtalès. In the general list which accompanies this report, there are 297 species and 107 genera enumerated, making, in all, 90 species and 25 genera added to the former list, in spite of the reduction in number by the cancelling of nominal species. This shows that 80 species of deep-sea echinoids have been discovered since those of Mr. Pourtalès, and that fully one-third of the whole number of known species of Echinoidea have been discovered since the days of deep-sea dredgings. It would seem absurd to attempt, in a review so limited as this, even to call attention to the main points of interest in a memoir of such extent as this. The most instructive chapters for biologists in general, however, are those upon the "character of systematic affinity of allied groups of Echinoidea" (p. 18), upon the "relations of the Jurassic Echinoidea to the echinid faunas of the present day" (p. 19), upon the "connection between the cretaceous and recent echinid faunas" (p. 25), and upon the "geographical range of the continental and abyssal species" (p. 246); in which latter, especially, is pursued a line of thought of great importance to all those who are considering the problems of the origin of marine faunas. Roetter's lithographic delineations are especially worthy of admiration.

Another paper, especially satisfactory by reason of its extent and completeness, is Col. Theodore Lyman's report on the Ophiuroidea (vol. v., 387 p., 48 pl.). This is a monograph of all the known species (500 in number), and is illustrated by about 750 beautiful lithographic figures, drawn by L. Trouvelot. Mr. Lyman's introductory remarks, with his diatribes against genealogical tables and theories of phylogeny, will delight even those whom he intends to criticise, so genial and keen is the humor with which his views are expressed; and there is something refreshing, too, in the curt, sharp-cut phrases in which his general conclusions are formulated. Exceedingly interesting, too, is the manner in which the writer has succeeded in framing his diagnoses of species, genera, and families, in simple words, half of them of one syllable, and Anglo-Saxon in origin at that. He surely has fulfilled his intention "not to add to the jargon in which zoölogy is now smothering,"—a jargon, he declares, "such as Molière would scarcely have ventured to put in the mouth of the medical faculty in his Malade imaginaire." The number of new species added by the Challenger was 170, with 21 new genera. The tables of distribution, geographical, bathymetrical, and thermal, with the 'brief reflections on their indications,' are suggestive in many directions, and we regret that the reflections may not here be quoted at length. In general terms, it may be said "that a very large proportion of the species live exclusively on the littoral zone, and that therein are included species both of cold and of hot water, though the number of the latter is much the larger. Then there is a large fauna of 50 species, which live exclusively below 1,000 fathoms, and which have to endure a degree of cold near to freezing, an enormous water-pressure, and an entire absence of sunlight. Between these extremes there are large groups whose favorite, or even necessary, habitat is restricted to given depths." Sixteen genera do not go lower than 30 fathoms; and they, without exception, inhabit warm seas. "This proves that certain groups demand a high temperature, and cannot accommodate themselves to a lower one. Should any of them, therefore, be found fossil, it would be reasonable to infer that the horizon was a shallow covered by warm water. Nine genera have not yet been found above 1,000 fathoms:" their occurrence, therefore, as fossils, might denote a geological bottom of great

[1] For previous notices see Nos. 66, 79.

depth, and covered by cold water of very heavy pressure.

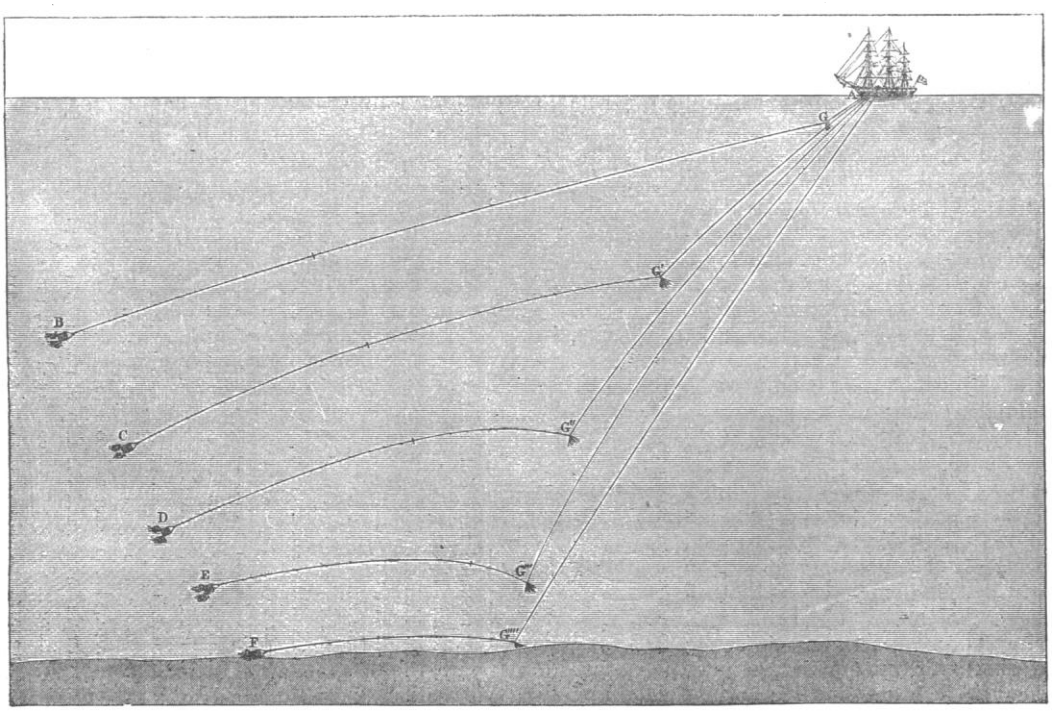
The reflections of the author upon the thermal tables are to the effect that the warm-water species, which are also of comparatively shallow water, are by far the most numerous, — a proportion which suggests that heat, light, and small pressure tend to produce variety in form and structure. "Yet," it is remarked, "there is not that vast difference between deep cold species and shallow warm ones which might reasonably be looked for, on the theory that so-called natural forces are alone potent to effect change."

The work on fossil species is simply a review of the present state of knowledge, which is admitted to be very unsatisfactory. At present it cannot be said that a single fossil genus is identical with the living; but there is much unstudied material in museums. The index is a workmanlike conclusion to a most scholarly production; and our transatlantic fellow-workers, who insist in their reviews upon calling the author Professor Lyman, will be surprised to know that he is not a professional zoölogist, but that science has been simply his diversion, in the midst of many other time-consuming occupations, as legislator, fish-culturist, farmer, and politician.

Two papers more will complete work upon the echinoderms, and these are being prepared by Mr. P. H. Carpenter of Eton college. The Comatulidae were his from the start; and the stalked crinoids, which were reserved for his personal study by the late director, will be completed by him, and reported upon in a paper under the joint authorship of Thomson and Carpenter.

Work upon the Coelenterata is progressing at a satisfactory rate. The Alcyonarians are still unpublished, the work being in the hands of Prof. E. Percival Wright.

Professor Albert von Kölliker disposes of the Pennatulida in an essay of forty-one pages (vol. i., 41 p., 11. pl.), with 61 beautifully executed lithographic figures. The expedition brought home 38 species of 19 genera, of which 27 species and 7 genera were new to science. The author formerly believed the great majority of the Pennatulida to occur at depths



THE RELATIVE POSITIONS OF THE SHIP, THE MESSENGER-WEIGHTS, THE TOGGLE (G), AND THE DREDGE (B, ETC.), AT DIFFERENT STAGES OF PAYING-OUT FROM THE CHALLENGER.

of 20 fathoms or less; but the number of deep-sea forms now known is nearly equal to that of the shore-species of shallow-water forms. The deep-water forms appear, however, to be almost absent from the Atlantic, the Pacific, and the south polar seas. The simpler forms of the Pennatulida, especially those with sessile polyps, inhabit the great depths. These, of which the Protoptilidae and Umbellulidae are the most numerous, are believed to be the oldest, 'the last remnants of an extinct primary creation;' and of them the Challenger discovered a large number of species, with a wide distribution. This conclusion of the author is of especial interest, since the presence of their less complex representatives in deep water has been shown to be the rule in other groups of invertebrates as well.

The report upon the Actiniaria, by Professor Richard Hertwig of Königsberg (vol. vi., 136 p., 14 pl.), is a very laborious and exhaustive piece of work; and the fulness of the descriptions of anatomical details, as well as the elaboration of the drawings, are causes of surprise, when one remembers that zoölogists have hitherto usually refused to work with shrivelled alcoholic preparations; unless, indeed, drawings have been made from the living animals. 39 species were examined, of which 30 were new. The reader shares with the author his manifest disappointment, that the study of this group suggests answers to so few of the questions which naturally arise. At the same time, we cannot fail to recognize the importance of the author's concluding remarks, in which he demonstrates that life in the great depths has a visible influence upon the organization of the Actiniae, especially in the form of the tentacles, and shows how the nature of the food of the deep-sea forms has probably favored the transformation of the long tentacles of the ordinary littoral forms into tubes, or even simple openings in the oral disk. In the diverse arrangement of the septa in deep-sea forms, he finds, also, an important indication; namely, that the diversity in the structure of the Anthozoa was formerly much greater than it is at present, and that the remains of this diversity have been more extensively preserved in the depths of the sea than in the shallow waters.

Professor Hertwig makes frequent allusions to the work of the American authorities Verrill and Couthouy; and to the attainments of the former, in this department of zoölogy, he pays a well-merited compliment.

Prof. Henry N. Moseley of Oxford has printed his report upon the corals, chiefly in the group Hydrocorallinae, Helioporidae, and Madreporaria, which is worked out with the author's customary skill and minuteness. Many valuable papers on the structure of corals, based upon Challenger material, have also been published by Professor Moseley in the *Philosophical transactions*, and elsewhere.

Professor Ernst Haeckel's paper on the deep-sea Medusae (vol. iv., 259 p., 32 pl.) is, in its first half, devoted to an elaborate discussion of the general morphology and histology and phylogeny of the Medusae, having special reference to the new morphological facts derived from his study of this collection. The essentials of this paper were embodied by the author in his 'System der Medusen,' published in 1879; and it has already been reviewed in *Science*, vol. i. p. 195.

Professor Allman prints the first instalment of his memoir on the Hydroida, which consists of a report upon the Plumularidae (vol. vii., 55 p., 20 pl.). The introductory remarks upon the general morphology are of great importance as bringing the subject up to the present standard of information. It is pleasant to note the appreciation with which the work of Mr. Fewkes is now and again referred to. Out of the 31 species referred to, 26 are new, and a number of genera are for the first time characterized. Professor Allman asserts, that, in tropical and sub-tropical regions, this group has its maximum in multiplicity of forms, in the size of the colonies, and in individual profusion. He also calls attention to the apparent existence of two centres of maximum plumularian development, — an eastern one, in the warm seas of the East-Indian archipelago; and a western one, in the waters which surround the West-Indian Islands, and bathe the eastern shores of central and equinoctial America, — centres which are nearly coincident with those of maximum development in the Chiroptera.

Dr. William B. Carpenter's memoir on the genus Orbitolites (vol. vii., 47 p., 8 pl.) contains a *résumé* of an investigation which has been carried on by this veteran in deep-sea research, extending over more than a third of a century. The discussion of the four species under examination occupies but a small portion of the paper, which really deals with the entire group of Foraminifera, and concludes with a 'Study of the theory of descent,' in which the power of natural selection to originate any varietal forms whatever is distinctly denied.

The report on the Calcarea, by N. Poljaeff, of the University of Odessa (vol. viii., 76 p.,

9 pl.), is in the main devoted to developing a new system of classification for the group, and to the criticism of Professor Haeckel's monograph, 'Die kalkschwämme.' 30 species were brought in by the Challenger, 23 of which were new. All these are elaborately described, and illustrated by most exquisite plates, chiefly drawn by the author. Mr. Poljaeff expresses the hope, "that the systematic arrangement of the group Calcarea, here proposed, will serve as a sufficiently sure basis for further investigations," — a hope which will be shared by all, but which in the present unsettled state of opinion among specialists in this department, and in view of the scarcity of material for investigation, is perhaps a trifle premature.

Other papers upon the Protozoa are promised, but are mostly far down in the list. The Hexactinellid sponges are assigned to Prof. F. E. Schulze; the Tetractinellidae, to Professor Solles; the Monactinellidae, to Mr. S. O. Ridley. Mr. H. B. Brady's paper on the Foraminifera, and Professor Haeckel's on the Radiolaria, will probably first be printed.

G. BROWN GOODE.

Smithsonian institution.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

RECENT PROGRESS IN PHYSICS.[1]

AFTER referring to what at first appeared a rather startling experiment, the holding of a meeting of the association outside of Great Britain, and to the undoubted pleasure and benefit the members would receive from their visit to Canada, Lord Rayleigh spoke of the loss the association had met in the death of Sir W. Siemens, and gave a brief account of Siemens's scientific work. He called attention to the fact that it is now some years since the presidential chair had been occupied by a physicist, and, while regretting that he should be called on to preside when the association met in a country of so great interest to the naturalists, he proposed to do the best he could by giving a sketch of the progress in late years of physical science.

It is one of the difficulties of the task, that subjects as distinct as mechanics, electricity, heat, optics, and acoustics, to say nothing of astronomy and meteorology, are included under physics. Any one of these may well occupy the lifelong attention of a man of science; and to be thoroughly conversant with all of them is more than can be expected of any one individual, and is probably incompatible with the devotion of much time and energy to the actual advancement of knowledge. Another difficulty incident to the task, which must be faced but cannot be overcome, is that of estimating rightly the value, and even the correctness, of recent work. It is not always that which seems at first the most important that proves in the end to be so. The history of science teems with examples of discoveries which attracted little notice at the time, but afterwards have taken root downwards, and borne much fruit upwards.

One of the most striking advances of recent years is in the production and application of electricity upon a large scale. The dynamo-machine is, indeed, founded upon discoveries of Faraday, now more than half a century old; but it has required the protracted labors of many inventors to bring it to its present high degree of efficiency. Looking back at the matter, it seems strange that progress should have been so slow, not merely in details of design, the elaboration of which must always require the experience of actual work, but with regard to the main features of the problem. It would almost seem as if the difficulty lay in want of faith. Long ago it was recognized that electricity derived from chemical action is (on a large scale) too expensive a source of mechanical power, notwithstanding the fact that (as proved by Joule in 1846) the conversion of electrical into mechanical work can be effected with great economy. From this it is an evident consequence that electricity may advantageously be obtained from mechanical power; and one cannot help thinking, that, if the fact had been borne steadily in mind, the development of the dynamo might have been much more rapid. But discoveries and inventions are apt to appear obvious, when regarded from the stand-point of accomplished fact; and he drew attention to the matter only to point the moral that we do well to push the attack persistently when we can be sure beforehand that the obstacles to be overcome are only difficulties of contrivance, and that we are not vainly fighting unawares against a law of nature.

The present development of electricity on a large scale depends, however, almost as much upon the incandescent lamp as upon the dynamo. The success of these lamps demands a very perfect vacuum, — not more than about one-millionth of the normal quantity of air should remain, — and it is interesting to recall, that, twenty years ago, such vacua were rare even in the laboratory of the physicist. It is pretty safe to say that these wonderful results would never have been accomplished had practical applications alone been in view. The way was prepared by an army of scientific men, whose main object was the advancement of knowledge, and who could scarcely have imagined that the processes which they elaborated would soon be in use on a commercial

[1] Address to the British association for the advancement of science at Montreal, Aug. 27, 1884, by the Right Hon. Lord Rayleigh, M.A., D.C.L., F.R.S., F.R.A.S., F.R.G.S., professor of experimental physics in the University of Cambridge, president of the association.