training, their culture and their research on mastery of the English language, it being the basis in after life for work in literature, scholarship, journalism, teaching, the church, or any other profession whatever.

Lafayette is both a school of technology and a college of liberal arts. It has this year 225 students of engineering and 176 students in the arts courses. The future of the work in engineering appears to be more definite and assured than the classical and general courses, due not to any deficiencies in these courses, but to the general tendencies of our civilization. Lafayette may become a great university; it now ranks midway among the hundred leading institutions of the country, and we need at least so many universities. Its situation, as well as its history, gives promise to which no limit need be set. But a man can not by taking thought add one cubit unto his stature, nor would it necessarily be desirable to do so if he could. Loyalty to Lafayette depends on what it was and is, not on what it is not. And it is one of the glories of the American college that it so completely conquers the affection of its students and alumni. Like Job, a man may find new flocks and a new wife and new children; but he can not choose a new college. The associations and memories of the unreturning past are awakened as we come to these festivals—whether as prodigal sons or as wise men bringing gifts—and the renewed piety enables each of us to go back to bear with better courage his share of the Atlantean load.

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SCIENTIFIC BOOKS

H. M. BERNARD'S WORK ON THE PORITID CORALS

Catalogue of the Madreporarian Corals in the British Museum (Natural History). Volume VI. The Family Poritidæ. II. The Genus Porites. Part II. Porites of the Atlantic and West Indies, with the European Fossil Forms. The Genus Goniopora, a Supplement to Vol. IV. By HENRY M. BERNARD, M.A. London, 1906.

This is the third and concluding volume by Mr. Bernard on the Poritidæ. Volume IV. of the British Museum Catalogue of the Madreporaria treats the genus *Goniopora;* Vol. V. contains the *Porites* of the Indo-Pacific region, and the one under review gives an account of the *Porites* of the Atlantic and West Indies, with the European fossil forms, and a supplement to the genus *Goniopora.* These volumes represent an enormous amount of work, Vol. IV. containing pp. viii + 206, pls. xiv; Vol. V., pp. vi + 303, pls. xxxv; Vol. VI., pp. vi + 173, pls. xvii, making a total of 699 pages and 66 plates on this one family.

Two phases of Mr. Bernard's work deserve especial consideration: (1) His contributions to the morphology of the hard parts of the Poritidæ, (2) his peculiar method of arranging and designating the various forms or variations of the corals that he has studied.

Contributions to the Morphology of the Hard Parts.—Mr. Bernard was the first to point out that the septa are bilaterally arranged in the genus *Goniopora.* There are in each calice two solitary directive septa, opposite each other, one at each end of the calice. These belong to the primary cycle; the other four primaries are fused to secondaries; the tertiaries are shorter and fuse to the sides of the secondaries.[1] The pali occur on the inner ends of the secondaries or at the points of fusion of the primaries and secondaries. *Porites* is supposed to be derived from *Goniopora* by the disappearance of the tertiary septa. The growth form is elaborately discussed. It is stated,

> So far as growth form is concerned Goniopora (and Porites) may be regarded as astreiform perforates.
>
> Starting from what we have described as the primitive form of colony, viz., the circular slightly convex astræiform stock which would result from the normal budding of the primitive parent calicle,

[1] "The Genus Goniopora," p. 21.

we find two clear lines of departure from this form:

(*a*) They have become less convex, and growth has gone on round the edges, and the colony has become explanate.

(*b*) They have become more convex, and the colonies have become hemispherical and columnar.[2]

Each of these types of growth undergoes further modifications. Under (*a*) two secondary modifications are recognized, one in which small areas by stimulation into rapid budding form irregular columns, that can immediately readopt the explanate method of growth if they come into contact with any body that they can incrust; the other, the edges may run out into lobes, which by curling around form knobs or cylinders, that are left behind on the surface by further growth of the edge. Five variations of the massive growth-form are recognized, the principal ones of which are designated, pulvinate, expanding sheaf formation, and branching. The remarks on growth-form apply to both *Goniopora* and *Porites*.

In Volume VI. the interesting observation is recorded, that metameric growth is usual in poritid corals, *i. e.*, the first distinctive growth form repeats itself in the later development of the corallum.

Porites differs from *Goniopora* chiefly by lacking the third cycle of septa. The calices of the genus are bilaterally symmetrical; at each end of the plane of symmetry is a directive septum; one directive, the dorsal, being solitary, not taking part in the formation of a septal group, while the opposite one, the ventral, may be free or have a secondary fused to each of its sides; this directive and the two adjacent secondaries are designated the "triplet."

On each side of the plane of symmetry are two lateral pairs of septa; each pair is composed of a primary and a secondary septum fused by their inner ends. The details of the arrangement of the pali have been worked out with care. These structures occur, when the formula is complete, before each lateral pair, at the points of the septal fusion, on the solitary directive and on each member of the triplet, *i. e.*, there are eight pali. The variations of the palar scheme are numerous. The members of the triplet may fuse together by their inner ends, then a single palus, developed at the point of fusion, stands before the group, reducing the number of pali to six. The pali may be absent from the laterals of the triplet, when they are free from the directive, or they may be present on the laterals but none on the directive; there may or may not be one on the dorsal directive. Those before the lateral pairs are the most persistent, but in deep calices all pali may be obsolete. The elucidation of the various types of palar formulæ is one of Bernard's most important contributions.

Bernard's account of the structure of the septa and wall will next be discussed. He considers that the septum of *Porites* is composed of upright trabeculæ, joined together by radial horizontal bars and by tangential bars, the latter known as synapticula. In the ideal calice, there is the vertical columellar tubercle; outside it, each septum is composed of three trabeculæ, which, named in order from the center outward, are the palar, the septal and the mural. These trabeculæ by projection on the septal margin produce respectively the pali, the septal granules and the mural ridge. When the calices are crowded, the mural trabeculæ of adjacent calices may alternate in position with each other and produce zigzag walls. In the ideal calice there is only one septal trabecula, and consequently only one septal granule between the palus and the wall for each septum. Sometimes, however, there appear to be two granules, corresponding to two trabeculæ, between each palus and the apparent wall, the outer trabeculæ being joined by a synapticular ring. Bernard here considers that there is only one septal trabecula, the one next the palus, and that the next outer trabecula is in reality the wall trabecula; the third trabecula outward from the palus is homologically to be regarded as costal. These homologies of Bernard are based upon the assumption that the trabeculæ of *Porites* are parallel in their courses, and in general perpendicular to the outer surface of the corallum, an assumption with which the reviewer

[2] "The Genus Goniopora," p. 23.

does not agree. The number of granules on the septal margins of many *Porites* is variable, varying, however, within narrow limits, from one to two, or at most three or four. Specimens broken so as to permit the study of septal faces through considerable distances, several centimeters, show that the wall trabecula is persistently vertical and continuous, and the columellar trabecula is often definitely persistent throughout the length of the corallite. The intermediate trabeculæ, however, are not always vertical, but often incline inwardly, new trabeculæ arising in the angle between the outermost septal trabeculæ and the mural trabeculæ of a given calice. The innermost of these trabeculæ form the pali, those outside the palar ring form the septal granules, which sometimes vary in number for the same calice. Typical *Porites* has septa entirely homologous with those of the other *Madreporaria* in which the line of trabecular divergence is coincident in position with the wall, but in which the outer portion of the septum is suppressed.[3] Although the reviewer does not agree with Bernard in his conclusions on the morphology of the *Porites* septum, it should be emphasized that he was the first one to call attention to the importance of studying the granules on the septal margins and the details of the walls in the genus.

Synaræa Verrill is referred to the synonymy of *Porites;* the cœnenchyma of the former is regarded as formed by fused costal prolongation of the septa.

An hypothesis, proposed to explain the relationship of tabulæ to gemmation, may be briefly expressed as follows: a corallite divided into sections by transverse tabulæ was not occupied by a single individual, but by a succession of individuals. Each segment, bounded above and below by a tabula, was occupied by an individual which had originated by gemmation from the individual that occupied the immediately preceding segment. The strobilation of *Aurelia* and the peculiar budding of such forms as *Ptychophyllum* (the name of this genus is not mentioned) are cited to sustain the hypothesis. The discussion is continued with the remarks:

> If this is a true account of the phenomenon, that the earlier cruder form of metamerism with its piles of obviously discrete calices, passes gradually into a continuous skeleton, the original segments of which are now so disguised as to be seen only in the succession of the tabulæ, we shall have, in the formation of every such coral, to distinguish *two methods of growth.* In the earliest stages of its individual development the growth will be normal growth *de novo* from the larva, with the gradual withdrawal of the expanding polyp from the cup which is progressively too small for it. This results in the deposition of *one* series of tabulæ. When the normal size of the adult is reached the growth is different, and can no longer be described as a growth of the individual with withdrawal of the enlarging polyp from too small a skeleton, but the deposition of a new skeleton upon the framework of the old, the new skeleton belonging to a new individual polyp which comes into existence in some way by gemmation from the old, but the only visible sign is still seen in *another* series of tabulæ, differing from the first in that there is now no increase in the diameter of the stock.

Calicinal budding and the rejuvenation in both solitary and compound corals are well-known phenomena. The presence of tabulæ and dissepiments (tabulæ are only horizontal dissepiments) in a corallite in which the septa and walls are definitely continuous, is explained by the polyp's needing a new basal support after the septal and mural margins have been built to a certain height, therefore the polyp draws upward and forms a new bottom to the calice. To hypothecate successive budding to explain the occurrence of tabulæ and dissepiments in coralla of the type indicated is unnecessary.

Bernard's opinion on the phylogeny of the Poritidæ may be introduced here: they are considered to have a common ancestry with the Madreporidæ and Eupsammidæ.

Bernard's Method of Arranging and Designating his Specimens.—The extreme difficulty of recognizing and defining species of the Madreporaria is known to practically every one who has given serious attention to the

[3] This subject is more specifically discussed in the reviewer's "Madreporaria of the Hawaiian Islands and Laysan." Bulletin 59, U. S. National Museum, pp. 169, 170, 1907.

group; some even doubt whether it can be divided into species as are the mammals, birds, mollusks, etc. The solitary Madreporaria are probably not very much more difficult to study than other lowly organisms that secrete exoskeletons; but it is different with the compound forms. The difficulty in the way of making adequate studies is increased by the usual insufficiency of material, which has almost never been collected in such a way as to furnish data on the physical environment under which it lived, and the entire absence of any information obtained through experiment. In working over collections as they are usually submitted for determination and report, one is often entirely at a loss whether to refer certain specimens to previously described species, or to consider them new. As the specimens may not exactly fit any hitherto characterized species, there is, naturally, hesitancy to apply an already established name; should they be described as new, subsequent collections may render the name applied invalid. As matters now stand, we know a large number of characters of the Madreporaria, but we often do not know the taxonomic values of these characters. Bernard in order to escape from the species dilemma, proposed to give the various forms recognized by him geographic designations: the collection from each area is divided into as many forms as possible; each one of these forms is given the genus name, followed by the name of the geographic area from which it comes; this in turn is followed by two numbers; the first, in parentheses, indicates the number of forms known from the area; the second, which particular form of the series is meant. To illustrate the method, in Volume V. of the "Catalogue" six kinds of *Goniopora* are recorded from northwest Australia; these are designated *Goniopora* Northwest Australia (6) 1, (6) 2, (6) 3, (6) 4, (6) 5 and (6) 6. Each form is described in detail, and when possible, figures are given. No attempt is made to determine the systematic value of the forms; that is left to future work. This method can be commended, as it furnishes a certain number of detailed descriptions and figures and accurate geographic data to subsequent students, and thus will aid them in unraveling problems of coral systematics.

In looking over Bernard's work, it appears that he has not by the careful study of the variation of different characters in the same specimen, nor has he by carefully comparing the variation of characters in different specimens, attempted to discover the systematic importance of the structural features described by him. As the whole problem of systematic zoology can be resolved into the ascertaining of the relative values of the characters possessed by the organisms under investigation, the reviewer feels that more in the line of determining these values was to have been expected of Bernard's work.

In the opinion of the reviewer, Bernard in his last volume carries his geographic idea entirely too far. He says:

> It is in keeping with the conclusion at which our work has brought us: that while free-living organisms with highly developed powers of locomotion, such as fish or birds, may spread over the surface of the globe, and thus be largely independent of locality, this is not the case with sessile forms as highly developed as the corals. Whatever the "species" of corals may be, we know nothing about them, and can know nothing about them until we study them by means of experimental cultivation. We only know the local forms. Hence local forms are the only available units with which we can do solid work. We have to study them with a view to arranging them into larger groups extending over larger areas. * * *
>
> It now seems probable that the forms of the Indo-Pacific region will ultimately have to be divided into smaller groups corresponding to definite areas: for instance the Red Sea forms will be found to have characters peculiarly their own. A dim perception of this was pointed out by the author—but, as he now thinks, quite misunderstood—with regard to the genus *Turbinaria* (see Vol. II., 1896, p. 18, last paragraph). If this can be established generally, a great reform in the classification of corals can not be long delayed. All purely imaginary groups such as species or morphological "forms" of indefinite distribution will be abandoned as units, and the corals will have to be treated as we treat races of men—*as factors in the areas which they inhabit*, and upon the conditions of which they largely depend for their peculiarities.

Before criticizing the preceding quotation, it is desired to call attention to Bernard's geographic subdivision of the *Porites* of the western Atlantic, the Gulf of Mexico and the Caribbean Sea. They are Brazil, Curaçao, Trinidad, Barbados, Guadalupe, Antigua, Barbuda, Nevis Island, St. Christopher, St. Bartholomew, Anguilla, Santa Cruz, St. Thomas, Porto Rico, Santo Domingo, Jamaica, Belize, Vera Cruz, Florida, Bahamas, Bermuda: 21 different areas are recognized.

One would infer from the first sentence of the remarks just quoted that the free-swimming larval stage of the Madreporaria has been overlooked. Duerden's "West Indian Madreporarian Polyps" was examined to see if he gives any definite information on the duration of this stage in the corals that he studied. The data given by him are indefinite, but the larvæ of some species may be free for several days at least, and it is possible that those of *Siderastrea radians* may live in that state for several weeks. Over extensive areas where coral reefs occur, the three conditions favorable to the wide distribution of shallow-water coral species are realized; these conditions are: (1) Either shoal water or intermittent shoals; (2) oceanic currents; (3) larvæ that can live unattached for at least moderate, and possibly considerable, periods of time. There is every *à priori* reason for the relatively extensive distribution of coral species; and it will be impossible to convince many who have had wide experience with these organisms, that their species do not often have such distributions. A few instances of wide distributions are *Fungia fungites* (L.), from the East Coast of Africa to the Philippines; *Fungia paumotensis* Stutchb., the Philippines and Papeeti, Tahiti; *Fungia patella* (Ell. & Sol.), East Africa and the Hawaiian Islands; *Mœandra* (*Diploria*) *labyrinthiformis* (L.), Bermudas, Bahamas, Belize (British Honduras), Curaçao; and there are many other similar instances. As a further illustration, the results recently obtained by the reviewer from a study of *Orbicella annularis* (Ell. & Sol.) and its variations may be cited. The typical form of this species was determined by comparison with photographs of the type, kindly furnished by Professor J. Graham Kerr, of the University of Glasgow. The typical form, used in the most restricted sense possible, of this species is represented in the United States National Museum by specimens from Hog Island, Bahamas, Dry Tortugas, Florida, and Belize, British Honduras. One of the variations from the typical form comes from Dry Tortugas and Hog Island. The variation from the typical form may be of vegetative origin, *i. e.*, induced by something peculiar in the environment under which the specimens lived, or they may be due to variations in the germ cells. We do not know which of these causes is responsible for the variation; but that *Orbicella annularis* occurs throughout the coral reef areas of the coasts of the Gulf of Mexico and the Caribbean Sea, including the Antilles, Florida and the Bahamas, is undeniable. The implied postulate of Mr. Bernard that similar forms may have different phylogenies demands stronger proof than his mere suggestion that such may have happened; for there is no more reason to doubt that in corals morphologic identity means specific identity than there is to doubt its meaning for other groups of organisms.

As isolation is one of the well-recognized factors in evolution, its influence in the Madreporaria is to be expected, and this expectation is realized. For instance, as the Isthmian region of America has been closed for some time, geologically speaking, divergence between the recent Atlantic and Pacific faunas of America is to be expected, and is a fact.

Mr. Bernard is right in insisting on the need for the experimental cultivation of Madreporaria in order to understand many problems pertaining to the group; but we have obtained a number of solid facts without such experimentation, and studies of variation and general ecological investigations are fully as necessary as experiments.

Ninety-six forms of *Porites* from the Atlantic Ocean, six fossil forms from Europe, and sixteen recent forms of unknown locality are described.

From a comparison of the Atlantic and

Pacific forms the conclusion is reached "that the trabecular, horizontal, and synapticular elements which compose the skeleton are thicker and coarser in the Atlantic and West Indian forms than they are in those of the Indo-Pacific."

After the descriptions are the following analytical tables:

Table I. Contains the Locality, the Depth or Geological Horizon, when given, references to published figures, the museums in which the type is preserved, and the page in this Catalogue where the detailed description will be found, for each form.
(With a supplementary Table of Porites from no recorded locality, some of which undoubtedly belong to the Indo-Pacific area; the list of known forms from that area is given in Vol. V., p. 248.)

Table II. Survey of the Geographical and Geological Distribution of the Atlantic, West Indian and European fossil representatives of the Genus, so far as at present known.

Table III. Analysis and Distribution of the Known Variations in Growth-form of the Porites of these same regions.

Table IV. Analysis and Distribution of the more easily definable Types of Calicle discoverable in the same.

In the supplement to *Goniopora* seventeen additional forms are described.

In concluding these remarks the reviewer wishes to state that he does not agree with Mr. Bernard's conclusions regarding the structure of the septa of *Porites*, and is opposed to the hypothesis of serial gemmation for each tabula in tabulate corals; he also considers that Mr. Bernard attributes too much importance to the geographic-number system for designating forms. The existence of the three factors favorable to the wide distribution of shallow water species of corals seems not to have been considered; these factors are: (1) Shoal water or intermittent shoals over extensive areas; (2) oceanic currents; (3) free-swimming larvæ. The reviewer, while recognizing the importance of isolation in causing divergence between coral faunas of separated areas, insists that some species of corals have wide geographic distribution and that there is no more reason for doubting that morphological identity in corals means specific identity than there is for similar doubt in any other group of organisms.

Mr. Bernard discovered the principles underlying the septal arrangement for *Goniopora* and *Porites* and worked out the various palar formulæ for the latter genus; he has shown students of Madreporaria the importance of studying in much greater detail the calicular structure of these corals; he has pointed out important calicular features that had previously received little or no attention; and his work on the growth forms of coralla is of importance. These are what the reviewer considers Mr. Bernard's solid contributions to the morphology of the poritid skeleton. The descriptive work of the catalogues is of value, for many forms are described in detail, excellent figures of a number of them are given, and they are referred to definite localities. No attempt was made to define species and to determine their distribution, as the data for such an undertaking were considered insufficient. However, when his contributions to the morphology of the skeleton are taken in connection with his descriptive work, Mr. Bernard deserves congratulations on having done much that will ultimately aid us in understanding the systematics of these perplexing corals.

T. Wayland Vaughan

Discussion and Correspondence

The First Species Rule: An Objection

To the Editor of Science: Pray allow me to range myself with Dr. Bather in entering a caveat against the first species rule, at any rate for paleontology. It is demonstrable that such a rule fails to interpret the views of authors. It can be tested. There are authors who have stated or obviously indicated their genotypes; there are those who have not—in fact, the same author may come in both categories. Now if the former are always found to have placed their genotypes first then is the first species rule first for the latter; but if not, then it fails.