visual cells exist in these cases. I now call to mind the cases of Ostrea and Serpula. When the former has its purplish tentacles extruded from between its valves, and the latter its crown of cirri extended from its tube, if the hand is made to move rapidly over the water in the aquarium in a strong light, so as to cast a shadow upon these organs, both these animals appear to be sensitive to the movement, and independent of any jars or vibrations. The oyster, under these circumstances, at once retracts its sensitive mantle-border; the worms, their cirri.

Upon examining the end of the siphon of Mya arenaria, lines of pigment are found about the bases of both the inner and outer circlets of tentacles, and the upper end of the siphon is pigmented for about an inch, both inside and outside. On the outside, however, there are scattered low, minute, pigmented papillae just under the epidermis and in the pigmented layer or true skin covering the siphon. The questions now arise, What is the nature of these organs? and do not the habits of Ostrea, as above described, justify us in expecting to find rudimentary end-organs on the mantles and siphons of mollusks, answering the purpose of eyes, as appears to be the case in the instance of Solen? Mya, like Solen, in life has normally the end only of the siphon exposed: and visual powers, developed to a certain degree, would therefore be useful to the animal; for, when the siphon is extended above the level of the sand, there are several fishes with mouths and teeth well suited to nip it off, and which would doubtless actually take advantage of the helpless clam, if it could not appreciate their approach.

I find fishes much more sensitive to sudden vibrations established in the water in which they live than to shrill or grave sounds made in the surrounding air near by. This may be due to special powers of perception which they may possess on account of the development of the singular end-organs of the lateral line.

The study of dermal, terminal nerve-endings, modified as more or less specialized sensory apparatuses throughout the different groups of the animal kingdom, is bound to yield many important results in the near future, in addition to what is already known; and the writer is glad that the matter has been taken up by such competent hands. JOHN A. RYDER.

Nov. 27, 1883.

Probable occurrence of the Taconian system in Cuba.

Last year, while making two excursions across the mountains of eastern Cuba, between Baracoa and the southern coast, I had an opportunity to make some observations on the geological structure of these mountains. The rocks composing this end of Cuba fall naturally into three distinct groups, as follows: 1. Ancient, and for the most part coarsely crystalline, basic eruptive rocks; 2. Older stratified rocks, slates, schists, and limestones; 3. The post-tertiary limestones or elevated coral-reefs.

The eruptive rocks form the main mass of the mountains at most points. They appear on the shore in some places, and seem to be almost the only rocks found at greater distances than five or ten miles from the coast. The older stratified rocks occur principally in two irregular belts running parallel with the coasts, and lying one on either side of the great eruptive belt: hence they are found mainly on the flanks of the mountains. The stratified rocks, especially along their contact with the eruptives, are penetrated by numerous irregular masses and dikes of the latter. But that they are all older than all the eruptives is improbable, since the eruptives are themselves evidently of several distinct ages.

So far as I have observed, the stratified rocks are all alike unfossiliferous; and in consequence the precise determination of their stratigraphic positions is a difficult problem. I am satisfied, however, that some of them are widely separated in time. The newer beds, consisting chiefly of fissile slates, soft sandstones, and impure earthy limestones, are probably equivalent to the secondary and tertiary strata of San Domingo and Jamaica. These uncrystalline sediments occur chiefly on the northern slope of the mountains, and, although much disturbed and undulating, rarely exhibit high dips.

But on the south side of the dividing-ridge, or summit, I crossed a belt six to eight miles wide, reaching almost to the coast, of highly inclined crystalline schists. The stratification is usually distinct, the strike being parallel with the coast, or east-west. The schists are generally greenish, and are both hydromicaceous and chloritic. Associated with the schists are several immense beds of white crystalline limestone. The limestone undoubtedly belongs to the same series as the schists, and is often micaceous.

These rocks bear a strong resemblance to the Taconian system of western New England, and are essentially identical with the great series of semi-crystalline schists and limestones of Trinidad and the Spanish Main which I have elsewhere correlated with the Taconian.

The published reports on the geology of San Domingo and Jamaica show that the geologic structure of those islands is essentially similar to that of eastern Cuba. In each case there is a prominent axis of old eruptive rocks, flanked on either side by schists, slates, limestones, and other sedimentary formations, and by elevated coral-reefs. In San Domingo and Jamaica the eruptives are not wholly basic, but much granite occurs; and the metamorphic schists, which appear to be similar to those of Cuba, have been generally confounded with the cretaceous beds. I predict, however, that more careful study will show that they are distinct and vastly older, and that the Greater Antilles are similar in composition and structure to the southern coast of the Caribbean Sea, including the Spanish Main and Trinidad, except that the coral-reefs and the eruptive rocks are wanting in the latter region. We owe the coral-reefs largely to the great vertical movements of the Greater Antilles in recent times; and the eruptive rocks are but a continuation westward, and the older and more eroded portion, of the great Caribbee belt of volcanic rocks which begins a hundred miles north of Trinidad, and ends in Cuba, being about fifteen hundred miles long.

W. O. CROSBY.

THE RESTORATION OF ANCIENT TEMPLES.

The Parthenon: an essay on the mode by which light was introduced into Greek and Roman temples. By JAMES FERGUSSON, C.L.E., D.C.L., LL.D., etc. London, *Murray*, 1883. 8+135 p., 60 illustr., 4 pl. 4°.

ONLY a small portion of this book is devoted to the wonderful edifice from which it is named. It is in the main a reiteration of peculiar views concerning the lighting of ancient temples, — an amplification of theories advocated thirty-

four years ago by Mr. Fergusson, in his 'True principles of beauty in art.' In a preface to the present volume, the author states his conviction that it is certain to prove offensive to specialists 'from the novelty of the views advanced;' but as these views are almost exactly those adopted in his earlier publication, and as this application of a clere-story to ancient temples can hardly be called original, — it having been suggested by Boetticher in 1847, two years before its first mention by Mr. Fergusson, — it would seem more natural to seek for some other explanation for the discontent of the critics.

It is certainly true, that more has been written, and more angry controversies have arisen, regarding the hypaethron, than with reference to any other feature, either constructive or artistic, in the temples of the Greeks; and after careful study the conviction forces itself upon the reluctant mind, that this last contribution, surpassing in extent and elaboration all others, does little toward the confirmation of that hypothesis in any of its varieties.

Mr. Fergusson adopts for the Parthenon, the temple of Zeus and that of Hera at Olympia, the temples of Aegina, Paestum, Selinous, — in short, for all regular Greek peristyles, — a clere-story sunk by two long openings in the roof at either side of the ridge, which remains unbroken over the central aisle of the naos. The height between the entablature of the upper order of interior columns and the inclined lines of the roof is that of his vertical windows. The drainage from this imperfect covering is effected by perforating the lateral walls of the cella with gutters, leading the rain-water into the pteroma, in which ceiled and protected colonnade such dripping must have been particularly undesirable. Contrary to the fundamental separation of roof and ceiling universally carried out in Greek architecture, he leaves the central aisle open to the inclined roof-surface, like the Bavarian Walhalla, and defends this feature with the surprising statement that flat ceilings, in either wood or plaster, were unknown in classical times. The argument adduced to prove this inclination of the ceiling, visible from within, is found by Mr. Fergusson in the well-known complaint of Strabo (viii. 3, 30, p. 353), — that the statue of Zeus at Olympia was so large, that, if the seated deity should arise, the roof of the building would be carried away. This passage is certainly not "the only hint in any ancient author as to how the roofs of Greek temples were constructed," and, what is worse, its application to the point in question is dependent upon a mistranslation. The words of Strabo, 'almost touching the ceiling with *the top of its head*,' are wrongly rendered by Mr. Fergusson, 'nearly touched *the summit of the roof*.' This misleading version is twice given in the present volume (pp. 2 and 111), and from it the non-horizontal form of the ceiling is directly deduced. It seems high time that this blunder, repeated by so many writers since its first commission by Quatremère de Quincy, should at last be eliminated from discussions of the subject.

As it would naturally have been impossible to surmount with a clere-story those smaller peripteral temples which were without columns in the naos, Mr. Fergusson is obliged to assume, against all evidence, that interior pillars or pilasters did originally exist, and that, while the Christian reconstruction of the Theseion obliterated the traces of these in that building, a figured mosaic pavement in the remarkably similar temple of Assos should be taken to indicate the position of such supports. The last example is certainly not favorable to the theory; for the bedding of the pavement in question is distinctly shown, by plan and text of the first report on the investigations at Assos,[1] to have extended to the very edge of the lateral walls, thus precluding the possibility of any columns or piers within the narrow hall.

The omission of galleries from interiors, which were provided with a double range of columns standing at some distance from the wall, is even less excusable. The assertion (pp. 8 and 73) that there were no galleries in the temple of Aegina is unwarranted. The only reason advanced for this, that the space between the shafts and the wall was only about one metre in width, is of no weight. To suppose that one order of columns was balanced upon another, with an intermediate entablature not tied to the wall by a floor, is unworthy our conception of the constructive wisdom displayed in Greek architecture. These galleries, known from literary sources to have existed in many temples, were actually found and measured at Paestum; and yet Mr. Fergusson omits them entirely from his section of that monument, without a word of justification (fig. 41). The notched architrave from the same site, in which he sees 'the most direct proof of the theory,' 'final in its correctness,' has really no bearing upon the question, being simply an example of the commonest method of construction, when adjoining horizontal ceilings were employed on different levels. This appears constantly in every kind of Greek buildings.

In one instance, however, the author must

[1] Rep. arch. inst. Amer.

be admitted to have proved his case. The plan and interior arrangement of the temple of Bassae — which is in so many ways exceptional among buildings of its class — certainly point to some system of lighting by vertical windows above the interior ranges of pilasters. The curious position of these buttresses, which are awkwardly spaced so as to stand in the axes of the intercolumniations of the side colonnade, and especially the discovery of perforated tiles on the site, make it more than probable that this remarkably archaistic temple displays an intentional reversion to the manner of lighting the primitive, non-peripteral cella through open metopes. It is to be observed that the statue of the deity was not placed in the space thus lighted, which seems to have been considered as a sort of inner vestibule before the Holy of holies, — a hall decorated, like the exterior of the Parthenon, with a carved zophoros, intended to be seen by the general public. Mr. Fergusson is probably at fault in supposing the image at Bassae to have been a mere *simulacrum*, which had become sacred among the rude inhabitants of the mountain from some accidental cause. He gives no reason for such a belief, and of no temple of antiquity is the story of the dedication so well known. The deliverance of the Arcadians by Apollo Epikourios, from a prevalent pestilence toward the end of the fifth century, does not admit the assumption of a rude symbol, or even of a xoanon, within his fane.

The explanation of the roof-opening of the little cella upon Mount Ocha is good, as is also the concise treatment of the corrupt text of Vitruvius. The importance of both these points has certainly been greatly overrated by previous writers upon the subject. Mr. Fergusson advocates the change of *octastylos* to *decastylos*, and *et* to *est*, in the confused description of the Roman builder; and this appears plausible in view of the acknowledged corruption of the manuscripts, and the fact that the temple of Olympian Zeus at Athens, thus alone referred to, was the only building in Europe possessing all the peculiarities described. Having been without a roof at the time Vitruvius wrote, it certainly was *sub divo* and *sine tecto*, as he says. Mr. Fergusson's restoration of this temple is ingenious; but as it is not known that the structure was ever completed at all, and as even its plan is not yet ascertained, the attempt to delineate its roof is hardly of greater value than that dissertation 'on the use of the particle δέ in the lost plays of Menander,' which a German scholar is wickedly reported to have written. And what are we to think of the disquisition on the Chaitya temple of Karlé, dragged in to lend weight to this restoration? That excavation in the native rock is lighted by a great window at the front, as it of course only can be: and yet in this feature Mr. Fergusson sees the direct influence of Greek and Roman architecture, felt after the incursion of Alexander into India, and the establishment of the Bactrian kingdom; making the system of illumination employed for the cave an imitation of that in the temple of Zeus at Athens by the argument that the appearance of light-openings on one side only must have been foreign to the wooden structures from which the Chaitya caves were in detail more or less imitated. Surely insistence upon precedent could be carried no farther.

The author's restorations of other temples are interesting, but hardly less improbable; the complicated makeshifts to which he is driven, by his various systems of windows in light-shafts, being too remote from the simple and straightforward methods of ancient building to please our imagination, or satisfy our practical sense of constructive fitness. A detailed consideration of all the temples treated of would here lead to undue length.

The account of the derivation and timbered prototype of the Doric style is inadequate; and the attempt to rehabilitate Falkener's proto-Doric capital unreasonable, after the well-known proof by Bergau and Erbkam of its wrong combination out of fragments of Egyptian bases. Incorrect, also, is the reiterated statement, that no Doric temples were built after the age of Alexander the Great. In certain parts of the Hellenic world other styles were but exceptionally employed, even in the latest epoch; as we know, for instance, from the ruins of Pergamon, where there is a complete Doric peripteros (that of Athena Polias), which certainly was constructed under the dynasty of the Attalidae. The comparison of the development of temple-architecture among the Greeks with Catholic church-building during the middle ages and during the reign of Queen Anne is misleading. Style among the ancients depended rather on geographical, or, to speak more correctly, on ethnographical, distribution than on passing fashions.

The description of the Parthenon is as thorough as any review antedating the recent investigations of Doerpfeld, which may not have been available at the time of writing. A model of the building, constructed by Mr. Fergusson on a generous scale, one-fortieth of real size, must be extremely interesting. Too much can-

not be said in recognition of this interest in a branch of science not over-popular in these days, which has led the author to an expense of time and money hardly likely to be appreciated. Still, it is to be regretted that the chief attention devoted to this reproduction was evidently directed to an exemplification of an improbable method of lighting. A second gallery is added to the temple, the trenches sunk deeply in the roof being made accessible by stairs; and these *piombi* Mr. Fergusson sets apart for the females of the Athenian congregation, who must have been as uncomfortable there as the most confirmed misogynist of antiquity could have desired. The staircases, by the way, present in the section (pl. 3) a curiously impossible arrangement, approaching from either side as they ascend, so as to intersect at the level of the gallery, and leave no landing-place, — not a good instance of that application of common sense to the study of Greek architecture which Mr. Fergusson so warmly advocates. It has, moreover, been ascertained that the stairs in the Parthenon were situated where they might naturally be expected, — next to the entrance-door, not at the farther end of the naos.

A part of the book sure to be read with great satisfaction by students of archeology is the arraignment of Mr. Wood, the explorer of Ephesos, whose inadequate publications, and selfish hiding-away of the results of his richly endowed work, deserve all the asperity with which Mr. Fergusson treats them (p. 32).

The printing is careful. We notice few minor errors. Lagardette's folio is dated Paris, 1879, instead of 'seventh year of the republic (1799);' while 'M.' Boetticher's essay, published at Potsdam in 1847, is said to be without date.

SCALLOWAY FROM THE NORTH-EAST.

THE ORKNEYS AND SHETLAND.

The Orkneys and Shetland; their past and present state. By JOHN R. TUDOR. London, *Stanford*, 1883. 29+703 p., illustr. 8°.

MR. TUDOR has collected and revised a series of letters published under the *nom de plume* of 'Old Wick,' in *The field*, the English sporting-journal, from 1878 to 1880, on the Orkneys and Shetland, and, with contributions from several scientific friends, has prepared a very entertaining book on these out-of-the-way islands. The general reader will find in it an interesting historical essay, embracing the period from Norse occupation to modern times, followed by local descriptions and numerous