was taught by Siebold, Huxley, Gegenbaur, Semper, etc. Recently discussion of the subject has been reopened by the appearance of numerous papers. Mr. Justus Carrière in several papers maintains that no *pori aquiferi* exist in the lamellibranch foot. Hermann Griesbach, last spring, in a careful paper (*Zeitschr. wiss. zool.*, 38), reviewed the whole subject, studying by sections and injections, and concluded that the molluscan vascular system was not closed, that the blood wandered in the lacunar tissues of the body-cavity, that large lacunar spaces communicated directly with the exterior through aquiferous pores in the foot, and that these pores were for the reception of water to be carried out through the Bojanus organ. He figures sections of Anodonta where the surface-epithelium of the foot bends up into the opening of the pores (there are three in Anodonta), and fades out as the pore opens into the lacunar body-cavity. During last October two quite independent papers appeared simultaneously upon the other side. Dr. Cattie, in *Zool. anzeiger*, vi., No. 151, p. 562, claims to have cut a complete series of about twenty-five hundred consecutive transverse sections through the foot of Anodonta. In no one of these was there any break in the epithelium. He has studied twenty-three species, and in no one finds the least trace of aquiferous pore. Dr. Th. Barrois, in a private imprint from Lille, dated Oct. 30, 1883, arrives at the same results. He discusses the work of Carrière and himself, and finds that they have studied most of the forms where the presence of aquiferous pores has been claimed, and in every case find pores absent, or in such position that it seems they are either connected with the functional byssogenous organ, or, where such is absent, in the aduct, with the remnant of the same. Barrois sums up his views thus: no pores exist for the introduction of water into the circulation; the only pores of the foot are those connected with the byssus organ, which never communicates with the interior of the foot. The blood may have water introduced into it, but this must be effected by osmosis, or in some manner not now to be discussed. H. L. OSBORN.

THE BORDERLAND OF SCIENCE AND FAITH.

Walks in the regions of science and faith: a series of essays. By HARVEY GOODWIN, D.D., Lord Bishop of Carlisle. London, *Murray*, 1883. 310 p. 8°.

Natural law in the spiritual world. By HENRY DRUMMOND, F.R.S.E., F.G.S. New York, *James Pott.* (Apparently sheets of the English edition.) 414 p. 12°.

THE 'science' of these regions is of course physical science; the 'faith' is the theistic and more specifically the Christian faith. These 'walks' are taken along the borders of the two. Normally, the course of this journal of science lies quite away from this borderland, which, indeed, has not always been an agreeable road for a scientific man to travel. Of late, however, a better understanding has made it pleasanter than it was for the peaceably disposed naturalist. And the Bishop of Carlisle, a trained mathematician as well as a divine, whose thoughtful essays are essentially irenical, is an instructive companion in an excursion "through that land which belongs exclusively neither to science nor to faith, but appertains more or less to both." A book "which opens with an essay on the connection between mechanics and geometry, which closes with a funeral sermon preached in Westminster Abbey," and the larger part of which had already appeared in widely read periodicals, — some of the articles being in fact, though not in name, of the nature of critical reviews, — hardly need be, and could not well be, reviewed in our journal; yet we are free to give a brief account of it, enough to indicate its lines of thought.

The first essay, on the connection between mechanics and geometry, is a modified reprint of a paper which was published almost forty years ago. The point made is, that these two sciences are essentially identical, being developments in different subject-matters of the selfsame ideas. The moral is, "that all demonstrations tend to merge in intuition, and that human knowledge, as it becomes more clear and more thorough, converges toward that absolute intuition which is the attribute of the Divine Mind." This idea is further worked out in the second essay (entitled 'The unity of nature, a speculation,' which appeared in the *Nineteenth century* in 1879), in which it is argued, that as the schoolboy begins by painfully proving the simpler theorems in geometry, and ends by perceiving that they are really self-evident, and that as all the propositions of Euclid appeared intuitively true to Sir Isaac Newton, "it is quite conceivable, by merely extending in imagination the powers of which we have actual experience, that all geometrical truth in any department might exhibit itself without intermediate steps of demonstration to a mind of sufficient acuteness, when the appropriate definitions had been given. . . . To a mind like that of Newton, I should imagine that the principles of mechanics would present themselves almost in the same self-evident light as those of geometry." And "that possibly, as the truths of geometry help us to realize those of mechanics, we may use the truths of mechanics to help us to realize some of the truths of the more subtle sciences, say, even that of biology." And the speculation, fortified and illustrated by mathematical analogies, goes on

to the conception, that "there may be a principle or law from which the existing order of physical life, with all its apparent anomalies [and its manifold diversities], flows as a necessary result," the knowledge of which, "if attainable, would exhibit to us the order of living nature as one consistent system, free from exceptions and anomalies."

All this, and indeed all the volume, proceeds on lines quite accordant with those of the purely scientific evolutionist. Moreover, in thus regarding intuition as a kind of acquisition or development, the theologian joins hands with the agnostic evolutionist, although they are moving in opposite directions. But the latter doubts, to use the words of one of them, "whether the law-governed mind of man is not itself the highest form of mind." The former, accepting "the admission which must be made by all parties of the co-existence of fundamental unity with almost unlimited diversity," and of inexplicable anomalies, endeavors to show, through mathematical analogies, that the existence of man may involve "the possibility of snakes, as truly and as really as the existence of elliptic motion involves that of parabolical," and "that a mind higher than human might see in the definition of man the possible existence of useless organs, both in man and in other creatures." At the close of the essay, descending from pure speculation of what may be, to more scientific considerations, his idea may be gathered from the following condensed abstract: —

"Let it be granted that all living beings have been developed according to some law, not necessarily known, or even capable of description in words, but still a real law of development; does this give us all the elements necessary for the solution of the life problem? If we say *yes*, do we not run into the mistake of a beginner who fancies that he can solve a problem of motion round a centre when he has been told what is the law of force? Is it not necessary to know the conditions of projection, the initial circumstances of motion or development? And may not this portion of the data be quite as important as the knowledge of the law of force? It seems to me that they who are most anxious to establish the principle of evolution should be the most ready to perceive the necessity of taking into account the consideration of initial circumstances. . . . A quantity of protoplasm with an assumed power of development will not account for existing forms of life, without the additional hypothesis of some causative power to determine the initial circumstances. Given an original germ, and given some power which shall direct the particular original cause of the development of that germ, and the whole subsequent development is conceivable: but the germ and the law of development left to themselves may be as insufficient as the particle and the law of attraction. . . . We have seen that the parabola, the ellipse, and the hyperbola are all possible curves for a particle moving round a centre of force. Only one of these curves — namely the ellipse, and only the ellipse under the condition of small eccentricity or approximate circularity — can suffice for the orbit of a planet which shall be the home of the highest form of life, namely, that of man. . . . The original conditions of motion, the initial circumstances as a mathematician would call them, must have been delicately adjusted in order to select, out of all possible forms of orbit, that one circular or nearly circular form which is compatible with the existence upon the earth's surface of beings like ourselves. May we not infer from this a similar necessity of original delicate adjustment in the process of the evolution of a highly organized creature from a protoplasmic germ?"

The third essay, entitled 'God and nature,' is mainly the development and application of a point made in a university sermon, which the author thought had been overlooked (but perhaps it really passed unnoticed because it is so obviously true), namely, that "all physical science, properly so called, is compelled by its very nature to take no account of the being of God: as soon as it does this, it trenches upon theology, and ceases to be physical science." And so, coining a discriminating word to express this, he would say that science was *atheous*, and therefore could not be *atheistic*. Intrenched in this position, he sharply criticises, as unscientific, Haeckel's denial of the existence of purpose in nature, and comes down upon Professor Seeley for his rash statement (in 'Natural religion') that 'science opposes to God, nature.'

In the fourth essay, 'The philosophy of crayfishes,' the text is supplied by Mr. Huxley's well-known lecture upon these little crustaceans, which lecture, the bishop insists, "leads the mind of the reader, and, as it would seem, intentionally, beyond the region of natural history into the domain of philosophy, and even of divinity." In that domain the bishop is a match for the naturalist: at least, he is able to verify an old prediction of Huxley's, that the evolutionist need not expect ever to drive the teleologist out of the field. Indeed, it cannot be easy to dislodge a teleologist who is so far-sighted as to "have great doubt whether we can properly speak of final ends at all, unless we embrace in our conception the whole cosmos." To Huxley's favorite line of remark that there is no great good in "demonstrating the proposition that a thing is fitted to do that which it does," and that it is "merely putting the cart before the horse to speak of the mind of a crayfish as a factor in the work done by the organism, when it is merely a dim symbol of a part of such work in the doing," the bishop replies, that the importance of demonstrating a proposition depends upon the point of view

from which the proposition is regarded; that the assumption made, "that the preservation of the individual and the continuance of the species are the final causes of the organization of an animal," is quite on a par with the old-fashioned teleology which is nowadays justly reprobated; that, at any rate, the pleasure which the crayfish apparently takes in watching for and capturing his prey is something quite distinct from 'work done by an organism;' and that, "if pleasure of some kind be denied to the crayfish, contrary to all appearances, I do not know at what point in the scale of animal life pleasure is to be admitted as a factor. If to speak of mind as a factor in work done be an absurdity in the case of a crayfish, is it not an absurdity in the case of a dog, or even in the case of a man?" And he proceeds to vindicate the delight of existence as one of the ends for which animals exist.

This idea, and the vindication of the mind of brutes, have a prominent place in the next following essay, on 'Man's place in nature.'

'Law, physical and moral,' is the topic in the sixth essay, in which a passage from Hooker's 'Ecclesiastical polity' is set over against one from the Duke of Argyll's 'Reign of law.' We need not continue our analysis, which is already longer than was intended: indeed, there is less occasion to continue; for the remaining articles, being popular addresses reproduced, are less thorough, however sensible. Even the last essay, on 'Evolution and evolution,' and the appreciative funeral sermon for Charles Darwin preached in Westminster Abbey on the Sunday following his burial there, need not detain us.

The noteworthy thing, to which this volume adds its testimony, is this: that thoughtful churchmen are following the example of thoughtful men of science. They are accepting the scientific principle of evolution as a working-hypothesis, — trying it, as naturalists and physicists have done, in their several lines of research and thought, and with somewhat similar results. The new science is accepted with complacency, if not with welcome, by the discerning. The questionable philosophy, in which it has too often been dressed, is examined and exposed.

THE second book named above appears to have excited considerable attention in England. Like the volume we have just noticed, it is an excursion into the borderland of science and faith, but with a difference. The divine is the more scientific, the layman and naturalist (for such we take him to be), the more homiletical of the two. The one picks his way along the ground with firm but cautious and carefully chosen steps: the other soars into the air. The one discriminates between science and faith, and in his book guards rather than enters upon the field of morals: the other seeks to identify the two, and in a novel way. He has discovered that natural laws, meaning the principles of physics and biology, extend to the spiritual world, and help us to understand it. He does not mean that there are analogies between the two, which may be profitable for instruction, but identities; that 'in the spiritual world,' to use his own figure, 'the same wheels revolve, but without the iron.' And the laws to which he refers are the principle of continuity, of conformity to type, action of environment as causing variation, the adage *omne vivum ex vivo*, possibly even gravitation, if there be any thing for it to act upon; and, if there is nothing for these laws to act upon, "it is not the law that fails, but opportunity." We cannot look upon this as any great improvement upon Swedenborg's 'law of correspondences;' and, as the helpfulness of the book is entirely upon the religious side, we need not further notice a volume which attracted us by its title, but which we find to be morally edifying rather than scientifically satisfying.

BACTERIA, AND THE GERM-THEORY OF DISEASE.

On the relations of micro-organisms to disease. The Cartwright lectures, 1883. By WILLIAM T. BELFIELD, M.D. Chicago, *Keener*, 1883. 131 p., illustr. 24°.

Bacteria, and the germ-theory of disease. Eight lectures by Dr. H. GRADLE. Chicago, *Keener*, 1883. 4+219 p. 8°.

DR. BELFIELD'S little book is cheaply gotten up, and, beyond the possession of a few poor woodcuts, seems to be his original lectures, four in number, delivered before the Alumni association of the College of physicians and surgeons in New York in February, 1883. Even the phraseology of the lecture-room is apparently preserved throughout, and is sometimes decidedly more forcible than polite. Nevertheless, these four lectures, making in all about one hundred and thirty pages, give an admirable summary of the germ-theory of disease as it stood a year ago. Beginners or casual readers, perhaps, will not find the book diffuse enough; but pathologists and biologists will prize it for its lucidity, crispness, and keen discriminations.