

review is rather scanty. It includes a short paper on the American Tertiary Aphidæ, by Mr. Scudder.<sup>1</sup> This comprises a list of known species and five plates. A monograph, by the same author, on the Tertiary *Rhynchophorous Coleoptera*<sup>2</sup> contains descriptions and figures of a great number of new genera and species, 193 species having been found in the older American Tertiaries, while only 150 species have been described from the whole of the European Tertiary rocks. This makes a first instalment towards a history of fossil Coleoptera.

Mr. Whitfield has written a description of the mollusca and crustacea of the Miocene formation of New Jersey.<sup>3</sup> This work, which is illustrated by twenty-four plates, describes the only brachiopod and cirripede found in these beds, with a large number of gasteropoda and lamelli-branchiata, many of which are now described for the first time.

Mr. C. R. Keyes gives, in *Bulletin* 121,<sup>4</sup> a bibliography of North American Palæontology 1888-1892. This comprises 251 pages, and in an alphabetical series are included a list of names of authors, with a short synopsis of essential points, including lists of genera and species described and figured, a title-index, and subject entries and cross references. A list of subjects is given in the introduction, and also a list of works examined, which may save a good deal of trouble. The list is by no means perfect, but it is undoubtedly a most important contribution to bibliography.

In a subsequent article it is proposed to deal with researches in petrological, dynamical, and stratigraphical geography.

#### OSTWALD'S ENERGETICS.

IN the February number of *Science Progress* there is an interesting article, by Prof. Ostwald, on "Emancipation from Scientific Materialism." There are so many vague fallacies underlying it, that it would hardly be worth answering, only that there is considerable risk that others, chemists especially, may be carried away by the arguments of one whom they rightly value as a leader in their own domain when he descants positively about the realm of mechanics.

Prof. Ostwald begins by saying that the current view of a mechanical universe fails in two respects. (1) It does not fulfil the purpose for which it was designed, and (2) it is inconsistent with known truths. It is, in the first place, to be remarked that nobody who has considered the matter really seriously can maintain that atoms and motion must constitute the whole universe. Such a view leaves thought out of account, and all that can be held is that material phenomena are so explicable. Prof. Ostwald ignores such theories as that of vortex atoms, which postulate only a continuous liquid in motion; but, it may be, this is omitted because it is merely a way of explaining the atoms. He also ignores metaphysical questions, such as whether motion be not only the objective aspect of thought, and also whether an intuitively necessary explanation of the laws as distinct from the origin and consequent arrangement of phenomena is not postulated by the fact that the universe must be intelligible. Consequently his attempt to deal with nature in a purely inductive spirit is unphilosophical as well as unscientific. The view of science which he puts forward—a sort of well-arranged catalogue of facts without any hypotheses—is worthy of a German who plods by habit and instinct. A Briton wants emotion—something to raise enthusiasm, something

with a human interest. He is not content with dry catalogues; he must have a theory of gravitation, a hypothesis of natural selection. This deadly science without hypothesis is far worse than the materialistic *ignorabimus* of Du Bois Reymond; it is the culmination of the pessimism of Schopenhauer.

Prof. Ostwald's first line of attack is that the materialistic hypothesis does not fulfil the purpose for which it was designed. When this is investigated, it turns out that all he means is that everything in nature has not yet been explained on mechanical principles. And long may it be so. The zest of science is discovery. If everything were explained—well, it is so far off we may wait till it comes to describe what will happen. He notices several things which are certainly not explained yet. Such, for instance, as why when atoms combine they produce a result so very different from their components. As nobody has yet suggested any reason why the atoms themselves possess the very curious properties they do, we can hardly expect a satisfactory explanation of why these properties change when they combine. Any way, the existence of an uninvestigated region of this kind does not create any reasonable doubt as to the foundations of the road that has led us well so far.

His second attack is deliberately founded on this, that mechanical hypotheses have not yet been found to explain everything. "I grant," he says, "that for many individual phenomena the mechanical analogues have been given with more or less success. But all attempts to completely represent the whole of the known facts in any department by means of some such mechanical analogue have resulted without exception in some unexplainable contradiction between what really happens and what we should expect from our mechanical model. This contradiction may long remain hidden; but the history of science teaches us that it sooner or later makes its inevitable appearance, and that all we can say with complete certainty regarding such mechanical similes or analogues—usually termed mechanical theories of the phenomena in question—is that they will doubtless on some occasion fail."

All that this really means is that we have not yet explained everything on mechanical principles, and that when we do get a little way on, we are delayed again by something more that requires explanation. But surely this and nothing else is what we ought in all reason to expect. It is about the best test we have that we are on the right track. Prof. Ostwald cites optical theories as an example of the kind of failure he refers to. He seems for some extraordinary reason to imagine that the *elastic solid* theory of the ether is in some curious way specially connected with the mechanical hypothesis of the universe. It is far from being so. The mechanical theory of an elastic solid itself has been only very dimly foreshadowed, and Prof. Ostwald's contention that transverse vibration "presupposes a solid body" is in direct contradiction to Lord Kelvin's theorem that a liquid in turbulent motion could transmit transverse vibrations. Even Lord Kelvin's elastic solid ether in a state of tension could exist if it be infinite, so that here again Prof. Ostwald is mistaken in saying that, because it could not be stable if finite, it can have no physical existence. And finally Prof. Ostwald takes refuge in the as yet unexplained constitution of an ether whose properties were discovered by assuming them to be mechanical, and were only discovered about thirty years ago, and have not been seriously investigated until within the last ten years. Surely no argument can be based upon the fact that there are limits to our present knowledge.

Prof. Ostwald's third attack opens out a new view. We see here a human reason for his desire for emancipation from the mechanical hypothesis. He is dissatisfied with Du Bois Reymond's *ignorabimus*. But even Du Bois

<sup>1</sup> Thirteenth Annual Report of the United States Geological Survey, 1891-92. (1893.)

<sup>2</sup> *Monograph* xxi., "The Tertiary *Rhynchophorous Coleoptera* of North America." By Samuel Hubbard Scudder. (1893.)

<sup>3</sup> *Monographs of the Geological Survey of the United States*, vol. xxiv. (1894.)

<sup>4</sup> *Bulletin* 121, "A Bibliography of North American Palæontology, 1888-1892," by C. R. Keyes. (1894.)

Reymond is not infallible, and most prophecies as to the limits of human knowledge have turned out to be only limits to the ingenuity of the prophet. It is very much more likely that Du Bois Reymond's apparently resistless logic has a flaw, than that the path of progress of science for three hundred years has been along the wrong route. There are plenty of philosophical speculations, which no doubt Du Bois Reymond brushes aside as hardly worth consideration, which would entirely invalidate the greater part of his arguments. Even though they do not, it is certainly quite unscientific to leave a road that has led to great discoveries merely because you imagine that there is some curious spectre in the distance to which you think it is leading you.

Prof. Ostwald's fourth attack is based on the fact that seeds grow into trees, but that trees do not grow back again into seeds. He thinks that if the universe were a mechanical system, there is no more reason for one than the other, and that they should occur equally often. As he says, "the tree could return again to the sapling, &c." But that is not the question. The question is, *must* it, if this is a mechanical universe. The order of events depends entirely, in a mechanical universe, upon the *initial conditions*, and all we can say is that the initial conditions of this earth were such that trees generally grow from seeds, and that the reverse operation has never been known to occur. That it *has* never occurred has nothing on earth to say to the question of whether this is a mechanical universe. As a matter of fact, I believe that this and other much simpler cases, such as are usually classed under irreversible actions in thermodynamics, can be shown to be not only, as I have here argued, *possible* mechanical processes, but to be *the most probable* mechanical processes. Hence it is quite possible that the actual sequence of events which Prof. Ostwald cites as disproving the mechanical theory of the universe may be the very best proof extant, not only that the mechanical theory is the most probable

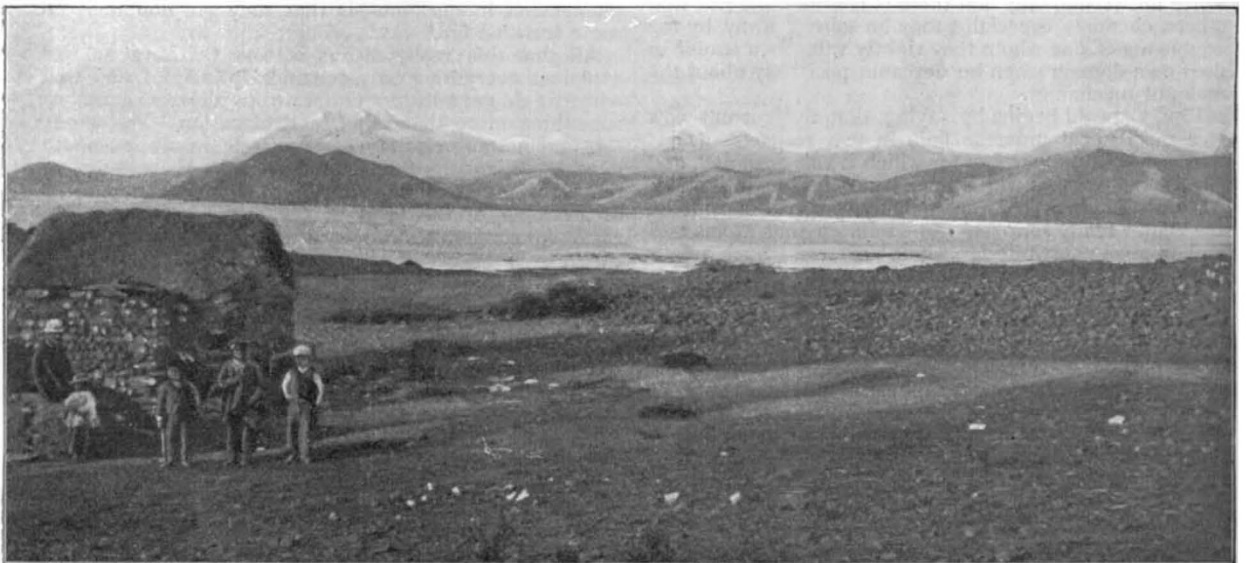
from those dreadful hypotheses. He prefers volume energy to the molecular theory of gases. He criticises this latter by neglecting to see that the quantity often quoted as energy per cubic centimetre of the gas is really momentum per second carried across a plane, and has consequently that very element of direction which he accuses it of not possessing, and the absence of which in volume energy one might possibly expect him to explain. Prof. Ostwald's idea of science as free from hypothesis is the most advanced form of pure positivism. If he were consistent, he should deny the existence of thought in the moving coloured, soft, objects he sees and feels around him, and calls men. That other men think is a hypothesis; and if he rejects all hypotheses, why not this?

In conclusion, Prof. Ostwald seems to have some dim doubt whether energetics will explain everything. As the doctrine of the conservation of energy will not determine by itself the motion of even a single planet round the sun, it is somewhat curious to see the doubt that seems to haunt him in answering this question. The doctrine of the conservation of energy is most valuable, but it goes only a very little way in explaining phenomena. More than energetics is certainly required unless we are prepared to endow energy with all sorts of curious properties after the manner of our predecessors, who used to invent a new subtle fluid with convenient properties in order to explain every new difficulty. Prof. Ostwald's energy seems more like one of these subtle fluids than any product of modern thought.

GEO. FRAS. FITZGERALD.

#### THE HIGHLANDS OF PERU.<sup>1</sup>

THE two first volumes of this work were noticed in NATURE, vol. li. p. 388, and the general remarks made there apply in great measure to the new volume also. We must, however, observe that the highlands of



The Andes from Chililaya, Lake Titicaca

theory, but it may even lead us to conclude that it is the only possible theory.

Finally, Prof. Ostwald tries to build up something instead of what he thinks he has demolished. A vague energetics is what he presents instead of the mechanics of the past. He advocates the deadly view that science should be a catalogue, well arranged, no doubt, but free

Peru afford material for a much more interesting description than the coast and the capital, which were dealt with in somewhat wearisome detail. Here the narrative form is not unwelcome, for there is always a charm in the

<sup>1</sup> "Beobachtungen und Studien über das Land und seine Bewohner während eines 25-jährigen Aufenthalts." III. Band. Das Hochland von Peru. Von E. W. Middendorf. Pp. 604. (Berlin: Robert Oppenheim [Gustav Schmidt], 1895.)