

REVIEWS OF BOOKS.

Man's Place in the Universe. By ALFRED RUSSELL WALLACE.
New York, McClure, Phillips & Co., 1904. — pp. viii, 320.

The problem which the author undertakes to investigate is whether or not the logical inferences to be drawn from the various results of modern science lend support to the view that our earth is the only inhabited planet, not only in the solar system, but in the whole stellar universe. A thoroughgoing review of such a book should be undertaken only by an astronomer who possesses a first hand knowledge of the facts which form the ground of the many inferences of which Mr. Wallace's long and careful argument consists. It is possible, however, in viewing the subject from the standpoint of a layman, to judge as to whether or not the conclusions are justified by the premises, supposing of course that the premises rest upon undisputed facts. Therefore, without challenging Mr. Wallace's alleged facts and generalizations, it is a matter of considerable interest to inquire as to their bearing upon his ultimate conclusion that our earth is the only inhabitable planet within the vast stretches of the universe.

The argument is based upon the following considerations, which can be outlined here only in a very brief and general manner, — merely a rough sketch of the chief points of his position. The universe presents a unity of structure and arrangement. The stars are not infinite in number and extent, but fall within a single system. The earth occupies a central position within the stellar universe, whose outer bounds are marked by the enclosing circle of the Milky Way. Within the sweep of the solar cluster near the center of this vast system, all planetary motions are less rapid and more controlled, and therefore there is less danger of catastrophic collision, and greater stability of conditions is possible. Were the solar system nearer or within the bounding circle of the Milky Way, confusion and instability would prove wholly inimical to the evolution of organic forms of life, which require stable conditions continuing throughout unthinkable æons of time. Moreover, throughout the entire universe there is evidence of a mechanical, physical, and chemical uniformity. All living organisms such as appear upon the earth result from exceedingly complex combinations, adaptations, and adjustments within the scope of the well-known and recognized laws of nature. The conditions essential to life are solar light and heat, an adequate distribution of water upon

the earth's surface and in its atmosphere, alternations of day and night, an equable temperature, a sufficient density of the atmosphere to retain the gases which are necessary to the support of life. In order to maintain these terrestrial conditions, the following astronomical conditions must obtain: The proper distance of earth from the sun, the mass of the planet falling within certain defined limits, the obliquity of the ecliptic, the amount of water as compared with land, the surface distribution of land and water, the permanence of this distribution, dependent probably on the unique origin of our moon *i. e.*, its being a detached portion of the earth leaving behind suitable ocean basins, an atmosphere of sufficient density and composed of suitable gases, an adequate amount of dust in the atmosphere, and atmospheric electricity. Finally, none of the other planets of the solar system combine all these complex conditions, which, upon the earth, work harmoniously to the production and the support of life; therefore, it is reasonable to suppose the other planets to be uninhabited; and moreover, the probabilities are almost as great against any other sun possessing inhabited planets. Such being the line of argument, it will be readily seen that the force of Mr. Wallace's contention depends upon the exceedingly great complexity of living organisms, and the nice balancing of conditions which it is necessary to maintain in order to produce and preserve such organisms on any planet, and the improbability that such correlated conditions exist anywhere in the universe except upon our earth. It may be well, perhaps, to have before us Mr. Wallace's position as expressed in his own words: "The combinations of causes which lead to this result [the presence of living organisms] are so varied, and in several cases dependent on such exceptional peculiarities of physical constitution that it seems in the highest degree improbable that they can *all* be found again combined either in the solar system or even in the stellar universe" (p. 310).

This method of reasoning from known conditions which produce known results to the conclusion that the absence of these conditions renders the same or similar results impossible, must be regarded as possessing cogency only when extended to adjacent cases. As regards the cases which are necessarily so far removed from the sphere of direct observation, the unknown so far overbalances the known that the inference as to what must be considered impossible is exceedingly precarious. What seems to be impossible in a setting which is completely within the compass of our knowledge, may be quite possible in a setting which transcends our knowledge. No one has

brought out more clearly than has Mr. Wallace in this work the indefinite variety and unknown possibilities of the forces of nature. Under changed conditions, without violating at all the general uniformity of nature, other forms of organisms may be evolved which the limited conditions prevailing upon the earth will not allow, and which our limited experience can not even conceive. We have been reminded very forcibly of late that new discoveries produce many revolutionary movements within the general body of received opinions. How tremendously have the Roentgen rays and the radio-activity of radium changed our views as to the possibilities of physical forces. Moreover, as regards the stellar motions, it was held to be a matter of most obvious certainty that they were to be accounted for solely by the laws of gravitation. This position, however, has been recently questioned. The following, which Mr. Wallace has quoted in the work before us, bears testimony to a radical shifting of fundamental considerations: "I doubt whether the principal phenomena of the stellar universe are consequences of the law of gravitation at all. I have been working myself at spiral nebulae, and have got a first approximation to an explanation — but it is electro-dynamical and not gravitational. In fact, it may be questioned whether, for bodies of such tremendous extent as the Milky Way or nebulae, the effect which we call gravitation is given by Newton's law; just as the ordinary formulæ of electrostatic attraction break down when we consider charges moving with very great velocities" (p. 292). This statement is taken from a letter of Mr. E. T. Whittaker, Secretary to the Royal Astronomical Society, written in reply to certain questions which had been sent out by Mr. Wallace to various men of science. Now, inasmuch as such changes in the fundamental conception of the constitution of matter and the nature of physical forces have taken place, and are taking place, is it not reasonable to insist that the possibilities of unknown conditions which may obtain in unknown regions are wholly incalculable? It is extremely hazardous to state any exact limits which even present known conditions may be regarded as necessitating. The possibility of variation, of new developments, of the manifestation of newly discovered properties in connection with phenomena of exceedingly great complexity must be reckoned with.

Moreover, essential conditions so regarded might prove to be unessential, or at least capable of radical modification, if only the horizon of knowledge were lifted somewhat. And even in the world of science at present, there is much difference of opinion as to what are to

be regarded as essential conditions in reference to certain phenomena. Take, for instance, the question as to the age of the earth upon which we live. The geologist tells us that at least two hundred millions of years are required; the physicist, on the other hand, tells us that the life of the sun cannot be stretched to nearly that number of years. Lord Kelvin says: "It would, I think, be exceedingly rash to assume as probable anything more than twenty million years of the sun's light in the past history of the earth, or to reckon more than five or six million years of sunlight for time to come."¹

Such radical difference of opinion naturally gives us pause when we undertake to state just what can and cannot come to pass in regions and ages which lie wholly beyond our ken. If we cannot easily interpret the past when we have the data before our eyes, how can we expect to interpret the future or the far remote when we are precluded from knowing so vast an amount of the data.

Mr. Wallace no doubt would take exception to our strictures upon his argument on the ground that the progress of science has been so uniform and so comprehensive as to determine quite definitely the essential conditions which must be fulfilled in order that living organisms should be produced and preserved. In the marvelous advance of knowledge, however, we have as yet before us great and undiscovered countries whose outskirts we have not commenced to penetrate. What is known of the potential properties of matter, and the forces of nature whose operations are still undisclosed? Is our scientific knowledge such as to set a necessary limit to the nature and scope of such forces, should they be discovered? We think not. The difficulty of interpreting comprehensively any known conditions, even of the simplest nature, should deter us from too dogmatic conclusions concerning hypothetical relations under unknown conditions.

Moreover, it is quite impossible for us to know certainly that mind manifests itself only through the medium of brain structure central to a highly developed living organism. There may be other forms which intelligible beings assume in the outer confines of the universe. This is, of course, merely conjectural; nevertheless, the mere possibility of unknown forms, through whose media thought may find expression, should cause us to hesitate in our inferences as to what does, and what does not, transcend the sphere of the possible, or even of the probable.

JOHN GRIER HIBBEN.

PRINCETON UNIVERSITY.

¹ Quoted by Wallace, p. 275.