Art. III.—LIFE IN THE UNIVERSE.

Man's Place in the Universe. By Alfred R. Wallace, LL.D. London: Chapman and Hall. 1903.

Just fifty years after Dr. Whewell had surprised the general public, and scandalised a section of it, with his Essay on 'The Plurality of Worlds,' Dr. Wallace unexpectedly came forward as the champion of the same cause. Both writers aimed primarily at exalting the dignity of man by placing him *hors concours* in the universe; but they employed weapons of argument as different as the crossbow from the Mauser rifle. The controversy adjudicated upon in Number 208 of this Journal sounds to our ears thin and unreal, like the phonographically recorded speech of men long dead; ideas were ventilated in it which have long ago folded their wings in definitive repose; the positions occupied by all the disputants appear to us equally and incredibly remote. In October 1855 the old astronomy reigned without a rival; some prophetic words had been let fall regarding the possible uses of photography in celestial inquiries, but they remained virtually ineffective; sidereal science had made no considerable advance since Herschel's time; it had even partially retrograded in consequence of the illusory resolution into stars of certain great nebulæ; Herschel's interiorly cool and comfortably habitable sun kept its place, mainly because no one had as yet taken the trouble to pitch it into the lumber-room; Kirchhoff's interpretation of the Fraunhofer-lines was still in the future. The current of time has flowed swiftly during the last half-century; we have learned much, and learned, above all, to hold our acquisitions with a light hand. Discovery is unsparing of preconceived notions; the more prudent among us are careful not to expose themselves, by dogmatic pronouncements, to its silent ironies of refutation. The question mainly at issue in the Whewell-Brewster debate cannot, indeed, be peremptorily closed by any detections that can reasonably be anticipated; it will doubtless always be treated more or less speculatively. But facts bearing upon the probabilities of universal vitality have presented themselves unsought and very numerously within recent years, and their accumulation has stimulated the composition of the remarkable work the title of which heads this article.

For the first time in its pages the complex and far-reaching subject of life in other worlds has been treated with

the expert knowledge of a trained biologist, and this alone suffices to lend authority to the conclusions arrived at. Moreover, astronomers by profession may read with interest, and cannot read without surprised admiration, the brilliant summary of the latest results in their science produced by a writer whose acquaintance with it is secondary and incidental. They will detect some errors of detail; but these are readily overlooked amid the glow of vivid personality transfused throughout the six chapters which form a dramatic prelude to the leading theme. We most cordially agree with Dr. Wallace that attentive readers of his book cannot but admit that 'it was worth writing.'

'It is founded,' he tells us in the Preface, 'almost entirely on the marvellous body of facts and conclusions of the New Astronomy, together with those reached by modern physicists, chemists, and biologists. Its novelty consists in combining the various results of these different branches of science into a connected whole, so as to show their bearing upon a single problem—a problem which is of very great interest to ourselves.

'This problem is, whether or no 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. Of course, it is a point as to which absolute demonstration, one way or the other, is impossible. But in the absence of any direct proofs, it is clearly rational to inquire into probabilities; and these probabilities must be determined, not by our prepossessions for any particular views, but by an absolutely impartial and unprejudiced examination of the tendency of the evidence.'

Our thoughts are, nevertheless, to some extent biassed by an unfelt need for cosmic companionship. The social instinct of humanity extends to the spheres. We shrink from finding ourselves stranded inaccessibly on the one green island of space. The question of organic diffusion has seldom, accordingly, been dispassionately treated. An unconscious *parti pris* warps the judgement. It is warped, moreover, in a direction prescribed by our own racial egotism. We should not be much concerned to learn that dragons breathed fire in Mercury, that Behemoth 'upheaved his vastness' from the seething surface of Jupiter, or that Mars swarmed with 'minims of nature.' What really and profoundly affects us is the possibility of rational life in other worlds—a possibility corresponding with our vague prescience of a universal cosmopolitanism, our groping desire for ultra-mundane intercourse with beings vainly sought to be imagined other-

wise than as very counterparts of ourselves, spiritualised animals, that

> 'Look aloft, and with erected eyes
> Behold their own hereditary skies.'

They are geometers, those planetary friends of ours, the First Book of Euclid presenting at any rate no difficulties to them. They dispose of many of the best resources of civilisation; and, the exigencies of their situation having sharpened their industry, they have greatly improved upon our systems of husbandry, and executed works of irrigation compared with which the barrage of the Nile is a trifle!

The strict consideration of facts, however, puts a curb on the diffusiveness of our sympathies. It checks the vagaries of fancy, and restricts the field within which we may reasonably speculate as to the developement of the higher forms of life. These certainly do not include extra-terrestrial man, in the proper sense of the term. The phenomenon of humanity does not exist in duplicate. It would be as reasonable to look for birds of paradise in Spitzbergen as for fellow-members of our species in Mars or Saturn. We scarcely realise all that we imply. All the forces of nature conspired towards the production of our race; all the forces of nature are held in leash to hinder its destruction. Moreover, the supreme and, assuredly, the unique gift of the human soul presupposes a unique receptacle.

Yet if we are to think at all on the subject, our thoughts must be guided by analogy; they can transcend experience only at the risk of falling into the quagmire of extravagance. Life is inconceivable to us save under conditions to some extent similar to those with which we are familiar. We postulate for it a physical basis; we assume that it is maintained and ministered to by chemical transformations occurring in subordination to laws which there is the strongest reason to believe are of universal validity. Certain definite stipulations have then to be complied with in order that life, as we understand it, should appear possible on any given orb; and grounds for the serious discussion of the possibility may be afforded by some among the varied methods of modern astronomical research.

Now it is significant that the promise of habitability in the celestial bodies continually diminishes as detailed acquaintance with them augments. The area of cosmic life shrinks as it is explored. To Giordano Bruno, Huygens, Fontenelle, it seemed indefinitely, almost infinitely wide;

they made no attempt to discriminate between fertile and desert districts in space. Herschel regarded it as a palmary recommendation of his solar scheme that it supplied the means of housing in stately splendour a vast crowd of superior beings. Schröter located a city on the moon, and noted artificial waterways cumbered with traffic; Gruithuisen collected evidence as to the stature and habits of the Selenites. Nevertheless, these agile little people have not been heard of, unless in fairy tales, since Beer and Mädler constructed their great chart of the lunar surface; while the distinguished 'children of the Sun' were, somewhat later, served with notice of ejectment by Helmholtz and Kirchhoff. Then, one after the other, the several planets have betrayed, under critical examination, their unfitness to harbour the higher organic types. Jupiter, Saturn, Uranus, and Neptune prove to be 'semi-suns'; their giant globes are ebullient; not a speck of protoplasm could subsist amid the tumult of their contending elements. Venus and Mercury are otherwise incapacitated. Their mode of rotation condemns them to utter and permanent barrenness.* Each spins on its axis in the same time that it revolves in its orbit; alternations of day and night are consequently excluded; one hemisphere, being always turned towards the sun, is baked as if in a brick-kiln; the opposite one, unlighted and unwarmed, enjoys the temperature, perhaps, of liquid oxygen. Mercury shows besides a cracked and dilapidated crust denuded of atmosphere, indicative, Mr. Lowell considers,† of an advanced stage of decrepitude.

There remains Mars, the cynosure of all eyes on the look-out for manifestations of ultramundane life. And it is here, at least, not barred by any patent disability. The analogy between Mars and the earth has been notorious ever since Herschel associated the periodical contraction and spreading of the Martian snow-caps with the changes of the Martian seasons. In this one planet, day and night, summer and winter, occasion vicissitudes differing comparatively little from those to which we are ourselves accustomed. Mars has weather-relations, and they are traceably connected with its calendar. Actual rain perhaps never falls, but mists form and disperse, cloud-summits catch the rays

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* The slow rotation of Mercury is certain. That of Venus is still doubted by some; but the evidence in its favour scarcely falls short of being demonstrative.

† The Solar System, p. 46.

of the rising sun, and snow is deposited and melts. It melts, indeed, with unexpected facility. The climate of Mars is obviously much milder than it ought to be considering that the solar rays are attenuated there to half the strength they possess here.

The red planet is, however, severely straitened for those fundamental necessaries of life, air and water. Grave doubt has been thrown by recent observations on the reality of its 'seas'; morasses and watercourses may exist on its surface, but scarcely any large bodies of open water. And the thinness of its atmosphere is still less questionable. At about twice the height of Chimborazo we should meet terrestrial strata matching in density those resting on the level surface of Mars. A globe so poorly supplied with gas and water can hardly be prolific, although it may not be wholly barren of life; and it seems unlikely that out of a starved fauna and flora species of rich endowments should emerge. There is no strong reason for believing, as Dr. Wallace does, that Mars has finally lost its quondam store of aqueous vapour, and has fallen back upon solidified carbonic acid for the material of its polar hoods. Had its mass been slightly less than it actually is, this contingency must, by the dynamical theory of gases, have ensued, a certain power of gravitation being needed to control their elasticity. But the most authentic calculations show that this planet is not disabled from retaining an envelope of the ordinary atmospheric constituents; and we are accordingly exempted from the necessity of seeking any subterfuge of explanation for snow-caps which Mr. Lowell has seen dissolving into genuine blue water.

It cannot, then, be denied that Mars in some degree resembles the earth; but the likeness is imperfect and remote. Several lines of recent research converge upon the unlooked-for inference that our globe occupies an exceptional position in the solar system. Its tidal history—so to call it—has certainly been peculiar. Its distance from the sun just sufficed to safeguard it against the destruction of its axial movement by solar tidal friction, exemplified in a manner fatal to vitality in Mercury and Venus. Moreover, the earth, because rotational velocity was preserved to her, remained capable of satellite-production. Yet only barely capable of it. In the early stages of her developement, the sun's tidal power hindered acceleration from attaining the disruptive point, so that condensation was well advanced before the arrival of the crisis to which the moon's separation

was due. And precisely for this reason fission went deep, and yielded a secondary mass of very unusual dimensions. Relatively to its primary, our moon ranks as a giant among the satellites of the solar system. The relations of the earth and moon have, accordingly—as Professor Darwin has ably demonstrated—been from the first *sui generis*. They were attended by reciprocal influences of a most notable kind, brought to bear exclusively within lunar-terrestrial precincts; and that many of these influences were and are, if not essential, at any rate highly beneficial, to life on our globe, hardly needs argument to prove.

The scale of an inchoate planet is a factor no less potent for the determination of its destiny than the amount of constraint put upon its rotational speed. Atmospheric composition—admitting Dr. Johnstone Stoney's probable conclusions—is fixed by mass. Gases tend of themselves to indefinite diffusion. They form permanent envelopes to solid bodies only under the compulsion of their gravity. If it falls short of a certain standard, they fly away into space, those with the lightest and most mobile particles the most readily. A planet, for instance, while competent to retain an atmosphere of oxygen and nitrogen might be incapable of restraining the swifter flights of hydrogen-molecules. This is, in fact, the case of the earth. Let us think what it implies. The conclusion is irresistible that a globe much smaller or much larger than our terraqueous abode would be unlikely ever to become a nursery of organic forms. An object-lesson on one side is afforded by the moon. It quickly lost, if it ever possessed, an atmosphere. Lunar gravity is too feeble to counteract gaseous agility. Not only hydrogen, but also oxygen, nitrogen, and water-vapour, would set at naught its restraining influence. The Danaides could more easily dam up the oozing rivulets from their own leaky tub than stop the molecular trickle that has stript our satellite of aerial clothing.

A globe, on the other hand, greatly more massive than the earth, would be likely to contain an excess of hydrogen. None would drain off into the void; the whole of the original supply would be available for combination with oxygen; and this essential element being thus completely used up to form water, the surplus needed for vital purposes would be to seek. True, the proportions of the two gases might, from the beginning, have been adjusted with a view to the required surplus; but the end seems to have been attained, here on the earth, by indirect, though equally

effectual, means. The hydrogen imprisoned in our oceans can be only a small part of the vast envelope of that gas which encircled the primeval earth. At the high temperature which then prevailed, however, its escape must have been exceedingly rapid; and by the time cooling had progressed far enough to admit of chemical association, there remained enough to produce an aqueous store of lavish abundance, yet by no means enough to neutralise all the oxygen present, the quantity of which, owing to the comparative sluggishness of its particles, had suffered no material diminution. The result is a striking and beautiful instance of adaptation to beneficent purpose wrought by the balanced play of natural forces.

Dr. Wallace sketches with masterly traits the conditions *sine quâ non* fitting a globe to be the home of life. They are astonishingly numerous, delicate, and complex; yet we rarely advert to them. Contrivances for the welfare of humanity seem to the unthinking a matter of course. That they are realised elsewhere is, nevertheless, a pure assumption. It cannot be taken for granted that organic always and everywhere crowns inorganic nature; we are only fully assured that it is immeasurably and inestimably different from it.

Attempts to define 'life' have yielded some apt phrases descriptive of its properties, but none that brought nearer to intelligibility the mysterious 'thing in itself.' A 'continuous adjustment of internal to external relations' undoubtedly takes place in living things; such changes are associated with life, but they do not constitute it. In the Spencerian definition the crucial point is missed that they occur within an organism—that they affect an individual existence. In studying vital phenomena, a psychic principle has to be reckoned with—a regulative force which modulates, without destroying or originating, exterior inorganic energies. Life, even at its lowest and simplest stages, is thus a transcendent manifestation. Its developement cannot be postulated; it is a gratuitous gift of the Creator.

On our own globe we know that, at a given epoch, lowly organisms made their appearance; the warm Ordovician waters, previously sterile, became fruitful; and the long procession of animated beings was set in motion which finally ushered man upon the scene. Now it would be the height of rashness to pronounce this history unique; but it is practicable and permissible to form a qualified

judgement as to the likelihood of its repetition in other parts of space. That there might be prohibitive circumstances is obvious to the most superficial inquirer. Their wide prevalence is the main burden of Dr. Wallace's arguments. He estimates very strictly the requirements of life, and insists upon their approximate uniformity throughout the cosmos as a corollary to the physical and chemical unity established as reigning in it by the lofty generalisations of modern science.

'We may, therefore,' our author writes (p. 189), 'feel it to be an almost certain conclusion that—the elements being the same, the laws which act upon, and combine, and modify those elements being the same—organised living beings, wherever they may exist in this universe, must be, fundamentally, and in essential nature, the same also. The outward forms of life, if they exist elsewhere, may vary almost infinitely, as they vary on the earth; but, throughout all this variety of form—from fungus or moss to rose-bush, palm, or oak; from mollusc, worm, or butterfly to humming-bird, elephant, or man—the biologist recognises a fundamental unity of substance and of structure, dependent on the absolute requirements of the growing, moving, developing, living organism, built up of the same elements, combined in the same proportions and subject to the same laws.'

This defines the situation. Guided by the principles here laid down, we can fix some kind of standard by which to test our conclusions. Planets, for instance, should be regarded as uninhabitable on which albumen coagulated, or water remained permanently frozen. A fairly dense atmosphere, composed of the same ingredients as terrestrial air, would be further indispensable; besides an abundant supply of water, not yet absorbed or swallowed up in fissures, opened through the advance of central cooling. Our brief survey of the solar system having convinced us that none of its members, with the assured exception of the earth, and the doubtful exception of Mars, are adapted for the support of life, we turn to the broad firmament, in the confident expectation of meeting, among its multitudinous orbs, all but infinite possibilities of vital developement. One hundred million suns, each with a supposed retinue of planets, offer, indeed, an unbounded prospect of miscellaneous population. But, before permitting our thoughts to expatiate in it, we feel it only reasonable to inquire: first, as to the qualities and properties of the hundred million suns; next, as to the substantial reality of their planetary trains. Now bodies shining by reflected light can probably, at sidereal distances, never be directly observed;

but the stars are self-luminous, and hence fall within the immediate competence of astronomy—'Quicquid nitet, no-'tandum.' Nor are they all luminous after the same fashion. There are distinctions to be drawn; and some of the distinctions are extremely broad and significant.

Perhaps the most essential property of an orb destined for the fulfilment of vitalising functions is stability in the emission of light and heat. The defective nature of a reading-lamp subject to periodical extinctions is superfluously apparent; or of a source of warmth which alternately smoulders down to the embers, and blazes up to the roof-tree. Yet such are the variable stars. Not a few are one hundred times, some are as much as a thousand times, brighter at maximum than at least light. Others show no regular recurrent phases, but fluctuate capriciously, to an extent highly prejudicial to the agricultural interests of dependent worlds. In fact, none among the diverse sorts and kinds of variable stars can serve vital purposes as suns should; and the incapacitation already applies to twelve hundred stars. These are the catalogued variables, and those uncatalogued must be far more numerous. Nor are all the stars that radiate equably sun-like bodies in the strict sense. The majority belong to the Sirian and helium types; they lack the 'smoke-veil' which imparts a golden tinge to sunlight, and shine with undimmed, bluish-white lustre. Thus the balance of properties to which sunshine owes its varied physiological influences is in them overthrown by the strong predominance of the actinic over the thermal rays in their spectra. In the red stars, which are counted by thousands, it is overthrown in the opposite sense by an excess of heat-emissions, those of ultra-violet quality being largely cut off.

But these exclusions and limitations are still of indecisive import. The gist of the matter is reached through the consideration of double stars. They prove to be extraordinarily numerous. 'Single stars,' in Professor Newcomb's opinion, 'are probably the exception rather than the 'rule.'* The profuse existence of closely revolving binary systems is one of the startling revelations of the spectroscope. Multitudes of objects telescopically indivisible split up, on the application of the motion-test, into couples usually well-assorted in mass, though often profoundly contrasted in luminosity. About one-third, perhaps one-half, of all the stars in the sky are binaries of this evidently very primitive

* The Stars, p. 177.

type. They probably originated, like the earth-moon combination, by the rupture of a parent spheroid; and they reproduce, to some extent, the lunar-terrestrial relations during their initial stage. These, too, were essentially modified, and brought into their eventual condition by the moulding power of tidal friction, which in double stars, as being nearly equal in gravitational rank, attains a maximum of effectiveness. The developement, through its influence, of spectroscopic binaries into visibly circulating pairs of stars, follows almost as a matter of course from Dr. See's able reasonings.*

Tidal friction is, however, extremely inimical to planet-formation. It grinds down speed of rotation, and thus prevents those crises of instability through its acceleration which eventuate in the separation of satellites. For this reason it is virtually impossible that binary stars—those, at any rate, which came into being at close quarters, and they seem to be the overwhelming majority—should be attended by planetary trains. An ante-natal prohibition was placed upon their birth; nor could they well, if they had been born, have survived the destructive disturbances to which they would at once have been exposed.

We are not, however, entitled to assume that all double stars originated by fission. Cosmic processes are endlessly varied. Systems are not struck off as successive impressions from the same stamp; they show the large liberty in construction characteristic of hand-made articles. Many star-pairs, accordingly, which slowly traverse wide mutual orbits, may conceivably have sprung from the condensation of double nebulae; while more complex groups might be surmised to result from nebular condensations round many distinct foci in a far-reaching primitive structure. Signs, too, are legible of the occasional combination, in the same system, of different genetic methods; nebulous knots and kernels collecting apart into stars, and these, in due time, dividing into 'spectroscopic binaries,' to be shaped and modelled into their final form under the overruling sway of tidal friction.

On the whole we cannot but agree with Dr. Wallace, that the outcome of recent investigations

'is entirely opposed to the old idea that the countless myriads of stars *all* had planets circulating round them, and that the ultimate purpose of their existence was that they should be supporters of life,

* Evolution of the Stellar Systems, 1896.

as our sun is the supporter of life upon the earth. So far is this from being the case, that vast numbers of stars have to be put aside as wholly unfitted for such a purpose; and when by successive eliminations of this nature we have reduced those possibly available to a few millions, or even to a few thousands, there comes the last startling discovery that the entire host of stars is found to contain binary systems in such rapidly increasing numbers as to lead some of the very first astronomers of the day to the conclusion that single stars may some day be found to be the rare exception. But this tremendous generalisation would, at one stroke, sweep away a large proportion of the stars which other successive disqualifications had spared, and thus leave our sun, which is certainly single, and perhaps two or three companion orbs, alone among the starry host as possible supporters of life on some one of the planets which circulate round them.'

'But we do not really *know*,' he continues (p. 288), 'that any such suns exist. If they exist, we do not *know* that they possess planets. If any do possess planets, these may not be at the proper distance, or be of the proper mass, to render life possible. If these primary conditions should be fulfilled, and if there should possibly be, not only one or two, but a dozen or more that so far fulfil the first few conditions which are essential, what probability is there that all the other conditions, all the other nice adaptations, all the delicate balance of opposing forces that we have found to prevail upon the earth, and whose combination here is due to exceptional conditions which exist in the case of no other planet—should *all* be again combined in some of the possible planets of these possibly existing suns?'

The probability, he contends, seemed considerable only through ignorance. With the growth of knowledge regarding the real nature of the stars, it tends to shrink towards evanescence.

A final argument for the scarcity of life in the universe, which Dr. Wallace, we believe, has been the first to employ, is interesting though somewhat vague and visionary. Based upon the nearly central situation of our planet in a universe of apparently finite dimensions, it assumes that situation to be attended by advantages for the promotion and protection of vitality which no other part of space would be likely to afford. The claim thus advanced for the dignified isolation of humanity left pre-Copernican pretensions far behind. And it was put forward with all the authority of the veteran biologist, whose 'gran rifiuto' had made him, in generous renunciation, the successful rival of Darwin. The essay in the 'Fortnightly Review' for March 1903, which formed the kernel of the volume now before us, was accordingly received with general surprise and considerable disfavour. Accepted opinions were boldly traversed by it; the doctrine of human animalism, which exempts from inconvenient

responsibilities, received no countenance in its pages; while the criticisms of astronomers were legitimately directed against certain oversights and inaccuracies, which have since been, for the most part, corrected, though with no abatement of confidence on the part of the author in the general justness of his views. They range over a wide field.

'Man's Place in the Universe' can be assigned only if we know something about its structure; and, if it be of infinite extent, it can have no structure that our minds are capable of appreciating. This is almost self-evident. Now, there is clear proof that the stars are not indefinitely numerous. Facts relating to their distribution are becoming, year by year, as charting operations progress, more copiously accessible; and they leave no practical alternative to the conclusion that the star-supplies grow more scanty with increasing distance from the earth. Before twelfth magnitude remoteness is reached they seem, indeed, to be fairly exhausted: that is, outside the Milky Way; for the actual galactic condensations, though palpable enough to sight, lie beyond the present range of detailed exploration. The stellar system, then, so far as we can judge, is no more infinite than the solar system; it has limits which are not illusory. Professor Pickering, whose photometric labours have furnished the most recent and authentic data on the subject, notes that the thinning-out of the stars does not admit of being explained on the supposition of an absorption of light in space*; and it could still less easily be accounted for by the interposition of dark bodies. Sir Robert Ball wittily remarked, in lecturing at the Royal Institution, that the attempt to reckon the constituents of the sidereal world by enumerating the stars visible to us because of their transitory power of shining 'would be like estimating the 'number of horse-shoes in England by those which are red-'hot.' It is certainly true that brilliantly luminous stars are frequently attended by obscure companions, and that temporary stars leap from invisibility into conspicuousness; but the proportion of such unseen to the seen bodies remains profoundly enigmatical. They can, however, be conjured up in any desirable multitudes to meet the exigencies of difficult theoretical situations; and a stock argument against the infinitude of the universe has been, in fact, triumphantly refuted with their aid. Were the stellar strata, it is urged, which we perceive to surround us continued *ad infinitum*,

* Harvard Annals, vol. xlviii. p. 185.

the heavens should blaze with uniform and intolerable lustre. Quite true, comes the reply, were there nothing in the way; but, if there be—and why should there not be?—as many dark stars as bright, one infinity would counterbalance the other and render its effects unapparent. Unapparent, that is, to the eye; but as regards gravitational power the result would be to pile Pelion upon Ossa. In actual fact, nevertheless, the stars move under the dominion of a strictly measurable force. Infinite gravity is a fantastic imagination.

Again, the darkness of our skies is commonly sought to be reconciled with the limitless store of light-giving orbs presumed to be contained in them by attributing to the ether which transmits their rays the faculty of arresting a percentage of them. The attribution is, however, quite gratuitous; ethereal absorption is an unproved hypothesis; and to build a theory of the universe upon an arbitrarily devised property of an entity so evasive as the luminiferous medium, strikes our minds as a rash and unphilosophical proceeding.

We gather, then, from all the evidence at our disposal that the sidereal universe—the only universe within our ken—has boundaries; and that it has a centre of symmetry, or of gravity, inevitably follows. Further, our position cannot be very far removed from that centre. The Milky Way, which may be described as a rudely outlined equatorial belt encircling the vast spheroidal aggregation of stars and nebulæ designated as the galactic system, traces out, in its medial line, a great circle of the sphere. This means that we are neither above nor below its fundamental plane, while indications are altogether wanting of our being nearer to its great condensations in any given direction than in any other. Our survey of the celestial sphere is then executed sensibly from its centre; that is, from a central area, which, though small relatively to the span of the galactic zone, may be actually enormous. It is wide enough, in Dr. Wallace's opinion, to include the sun's orbit, if that word be properly applicable to the track along which our planet is being hurried by an over-ruling force. It is wide enough also to accommodate the main part of the stellar collection to which our sun belongs; sometimes, in rash phraseology, termed 'the solar cluster.' There is really no proof at all that the sun is one of the constituents of a genuine cluster. It travels, to the best of our present knowledge, in complete independence of the surrounding stars; it pursues its solitary way through space in obedience to a call from afar inaudible

to our intelligence; no stars can be picked out as bound to it by a special tie, physical or dynamical. Under these circumstances, our domestic cluster can only be organised on a hypothetical basis; and Dr. Wallace is, we think, unwarrantably precise in his definition and delineation of it. But the error—if such it should be called—does not affect his contention 'that our central position in the stellar 'universe has a meaning and a purpose in connection with 'the developement of life and of man upon this earth.' The purpose, setting aside problematical stellar influences, is to secure prolonged stability. Stable conditions, he rightly insists, are a primary requisite for a thriving home of life, especially of the higher grades, and they must last indefinitely. Subversive change must be averted during uncounted æons of time. The preparation of a globe for the reception of the most lowly organisms is a process demanding endless leisure; and the advance is slow and gradual from vegetative to intelligent existence. It presupposes tranquillity and continuity; and it may be conceded that they are likely to be better secured in some sections of the sidereal system than in others. Within the Milky Way itself, certainly, storm and stress appear to be more or less prevalent. Equilibrium can hardly yet be established in the gigantic nurseries of stars of which it seems to consist. Here and there they are tangled and choked with nebulous stuff, which cannot but impede free circulation; and it is remarkable that 'new stars,' with the rarest exceptions, flare in dense galactic aggregations. From the vicinity of such catastrophic outbursts vital developements must assuredly stand aloof.

Inside the ring of the Milky Way, however, there is a prodigiously large, star-filled sphere, in any portion of which, for aught that appears, a family of planets might be reared in perfect security. Hence there is no sufficient reason for ascribing, as Dr. Wallace does, a critical importance to our central position. We do not venture to assert that it is a matter of entire indifference; but we can convince ourselves, through ocular inspection, that a multitude of stars are subjected, by the eccentricity of their places, to no disadvantages through lack of quietude in their surroundings.

In the last few pages of his work our author brings to a focus the conclusions enforced by it. They are as follows:—

(1) The stellar universe forms one connected whole of finite and determinable extent.

(2) The solar system is situated in the plane of the Milky Way, and not far from its middle point. The earth is, therefore, nearly at the centre of the stellar universe.

(3) The universe consists throughout of the same kinds of matter, and is subjected to the same physical and chemical laws.

So much he takes to be certain; while three further propositions have 'enormous probabilities in their favour' (p. 317). These are:

(4) No other planet in the solar system besides the earth is inhabited or habitable.

(5) The probabilities are almost as great against any sun besides our own being attended by inhabited planets.

(6) The nearly central position of our sun is probably permanent, and has been specially favourable, perhaps absolutely essential, to life-developement on the earth.

The 'great and definite' outcome of his reasonings is, then, 'that man, the culmination of conscious organic life, 'has been developed here only in the whole vast material 'universe we see around us.' Nor does he admit any incongruity in the idea that our race, 'the unique and supreme 'product of this vast universe,' was its final cause—the purpose for which it was designed. Man is the superlative of nature. One living soul, as Dr. Bentley says, outweighs the worth of all the stars. They do not, indeed, tilt the balance in any degree against beings with a moral sphere of action. And it is his profound sense of the subordination of the physical to the spiritual order which lends to Dr. Wallace's principal writings their peculiar and noble character. It is strongly imprinted on the eloquent concluding paragraphs of the book we are engaged in reviewing. We cannot forbear from making a final brief extract from them.

'All nature,' he says (p. 321), 'tells us the same strange, mysterious story, of the exuberance of life, of endless variety, of unimaginable quantity. All the life upon our earth has led up to and culminated in that of man. It has been, I believe, a common and not unpopular idea that during the whole process of the rise and growth and extinction of past forms, the earth has been preparing for the ultimate—Man. Much of the wealth and luxuriance of living things, the infinite variety of form and structure, the exquisite grace and beauty in bird and insect, in foliage and flower, may have been mere by-products of the grand mechanism we call Nature—the one and only method of developing humanity.

'And, is it not in perfect harmony with this grandeur of design, this vastness of scale, this marvellous process of developement through all the ages, that the material universe needed to produce this cradle of

organic life, and of a being destined to a higher and a permanent existence, should be on a corresponding scale of vastness, of complexity, of beauty? Even if there were no such evidence as I have here adduced for the unique position and the exceptional characteristics which distinguish the earth, the old idea that all the planets were inhabited, and that all the stars existed for the sake of other planets, which planets existed to develope life, would, in the light of our present knowledge, seem utterly improbable and incredible.'

Unquestionably the trend of modern research is to encourage the opinion that the solar system is set apart among the stars, and the earth among the planets, as if for the express purpose of harbouring in safety the frail craft bearing the burthen of life. But demonstrative evidence on the point is not at hand, and cannot be looked for. Arguments *à priori* are futile. They rest on arbitrary assumptions. Our minds are inadequate to grasp the vastness of creative design; yet common sense obliges us to admit that what is inconceivable to us may nevertheless really exist. All that we are quite certain of regarding our place in the Cosmos is that the genus Homo, from the Man of Cannstadt to the most transcendental philosopher, is earth-bound. No second island in space is attainable by him in his present condition. His habitation begins to seem inconveniently narrow; but there is small chance of adding to it by annexation—there are no more worlds for him to conquer.