ADDRESS

DELIVERED BEFORE

THE BRITISH ASSOCIATION AT BELFAST 1874.

TYNDALL

ADDRESS

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ADDRESS

DELIVERED BEFORE

THE BRITISH ASSOCIATION

ASSEMBLED AT

BELFAST

WITH ADDITIONS

BY

JOHN TYNDALL, F.R.S.

PRESIDENT

FIFTH THOUSAND

LONDON

LONGMANS, GREEN, AND CO.

1874

'There is one God supreme over all gods, diviner than mortals,
Whose form is not like unto man's, and as unlike his nature;
But vain mortals imagine that gods like themselves are begotten,
With human sensations and voice and corporeal members;
So, if oxen or lions had hands and could work in man's fashion,
And trace out with chisel or brush their conception of Godhead,
Then would horses depict gods like horses, and oxen like oxen,
Each kind the divine with its own form and nature endowing.'

XENOPHANES of Colophon (six centuries B.C.), 'Supernatural Religion,' Vol. I. p. 76.

'It were better to have no opinion of God at all, than such an opinion as is unworthy of Him; for the one is unbelief, the other is contumely.' BACON.

PREFACE.

At the request of my Publishers, strengthened by the expressed desire of many Correspondents, I reprint, with a few slight alterations, this Address.

It was written under some disadvantages this year in the Alps, and sent by instalments to the printer. When read subsequently it proved too long for its purpose, and several of its passages were accordingly struck out. Some of them are here restored.

It has provoked an unexpected amount of criticism. This, in due time, will subside; and I confidently look forward to a calmer future for a verdict, founded not on imaginary sins, but on the real facts of the case.

Of the numberless strictures and accusations, some of them exceeding fierce, of which I have been, and continue to be, the object, I refrain from speaking at any length. To one or two of them, however, out of respect for their sources, I would ask permission briefly to refer.

An evening paper of the first rank, after the ascription of various more or less questionable aims and motives, proceeds to the imputation, that I permitted the cheers of my audience to 'stimulate' me to the utterance

of words which no right-minded man, without a sense of the gravest responsibility, could employ. I trust the author of this charge will allow me in all courtesy to assure him that the words ascribed by him to the spur of the moment were written in Switzerland; that they stood in the printed copy of the Address from which I read; that they evoked no 'cheers,' but a silence far more impressive than cheers; and that, finally, as regards both approbation and the reverse, my course had been thought over and decided long before I ventured to address a Belfast audience.

A writer in a most able theological journal represents me as 'patting religion on the back.' The thought of doing so is certainly his, not mine. The facts of religious feeling are to me as certain as the facts of physics. But the world, I hold, will have to distinguish between the feeling and its forms, and to vary the latter in accordance with the intellectual condition of the age.

I am unwilling to dwell upon statements ascribed to eminent men, which may be imperfectly reported in the newspapers, and I therefore pass over a recent sermon attributed to the Bishop of Manchester with the remark, that one engaged so much as he is in busy and, I doubt not on the whole, beneficent outward life, is not likely to be among the earliest to discern the more inward and spiritual signs of the times, or to prepare for the condition which they foreshadow.

In a recent speech at Dewsbury, the Dean of Manchester is reported to have expressed himself thus:— 'The Professor (myself) ended a most remarkable and eloquent speech by terming himself a material Atheist.' My attention was drawn to Dean Cowie's statement

by a correspondent, who described it as standing 'conspicuous among the strange calumnies' with which my words have been assailed. For myself I use no language which could imply that I am hurt by such attacks. They have lost their power to wound or injure. So likewise as regards a resolution recently passed by the Presbytery of Belfast, in which Professor Huxley and myself are spoken of as 'ignoring the existence of God, and advocating pure and simple materialism;' had the possessive pronoun 'our' preceded 'God,' and had the words 'what we consider' preceded 'pure,' this statement would have been objectively true; but to make it so this qualification is required.

Cardinal Cullen, I am told, is also actively engaged in erecting spiritual barriers against the intrusion of 'Infidelity' into Ireland. His Eminence, I believe, has reason to suspect that the Catholic youth around him are not proof to the seductions of science. Strong as he is, I believe him to be impotent here. The youth of Ireland will imbibe science, however slowly; they will be leavened by it, however gradually. And to its inward modifying power among Catholics themselves, rather than to any Protestant propagandism, or other external influence, I look for the abatement of various incongruities; among them, of those mediæval proceedings which, to the scandal and amazement of our nineteenth century intelligence, have been revived among us during the last two years.

In connexion with the charge of Atheism, I would make one remark. Christian men are proved by their writings to have their hours of weakness and of doubt, as well as their hours of strength and of conviction; and

men like myself share, in their own way, these variations of mood and tense. Were the religious views of many of my assailants the only alternative ones, I do not know how strong the claims of the doctrine of 'Material Atheism' upon my allegiance might be. Probably they would be very strong. But, as it is, I have noticed during years of self-observation that it is not in hours of clearness and vigour that this doctrine commends itself to my mind; that in the presence of stronger and healthier thought it ever dissolves and disappears, as offering no solution of the mystery in which we dwell, and of which we form a part.

To coarser attacks and denunciations I pay no attention; nor have I any real reason to complain of revilings addressed to me, which professing Christians, as could readily be proved, do not scruple to use towards each other. The more agreeable task remains to me of thanking those who have tried, however hopelessly, to keep accusation within the bounds of justice, and who, privately, and at some risk in public, have honoured me with the expression of their sympathy and approval.

JOHN TYNDALL.

ATHENÆUM CLUB.
September 15, 1874.

ADDRESS,

ETC.

An impulse inherent in primeval man turned his thoughts and questionings betimes towards the sources of natural phenomena. The same impulse, inherited and intensified, is the spur of scientific action to-day. Determined by it, by a process of abstraction from experience we form physical theories which lie beyond the pale of experience, but which satisfy the desire of the mind to see every natural occurrence resting upon a cause. In forming their notions of the origin of things, our earliest historic (and doubtless, we might add, our prehistoric) ancestors pursued, as far as their intelligence permitted, the same course. They also fell back upon experience, but with this difference—that the particular experiences which furnished the weft and woof of their theories were drawn, not from the study of nature, but from what lay much closer to them, the observation of men. Their theories accordingly took an anthropomorphic form. To supersensual beings, which, 'however potent and invisible, were nothing but a species of humar creatures, perhaps raised from among mankind, and retaining all human passions and appetites,'[1] were handed over the rule and governance of natural phenomena.

Tested by observation and reflection, these early notions failed in the long run to satisfy the more penetrating intel-

[1] Hume, *Natural History of Religion.*

lects of our race. Far in the depths of history we find men of exceptional power differentiating themselves from the crowd, rejecting these anthropomorphic notions, and seeking to connect natural phenomena with their physical principles. But long prior to these purer efforts of the understanding the merchant had been abroad, and rendered the philosopher possible; commerce had been developed, wealth amassed, leisure for travel and speculation secured, while races educated under different conditions, and therefore differently informed and endowed, had been stimulated and sharpened by mutual contact. In those regions where the commercial aristocracy of ancient Greece mingled with its eastern neighbours the sciences were born, being nurtured and developed by free-thinking and courageous men. The state of things to be displaced may be gathered from a passage of Euripides quoted by Hume. 'There is nothing in the world; no glory, no prosperity. The gods toss all into confusion; mix everything with its reverse, that all of us, from our ignorance and uncertainty, may pay them the more worship and reverence.' Now, as science demands the radical extirpation of caprice and the absolute reliance upon law in nature, there grew with the growth of scientific notions a desire and determination to sweep from the field of theory this mob of gods and demons, and to place natural phenomena on a basis more congruent with themselves.

The problem which had been previously approached from above was now attacked from below; theoretic effort passed from the super- to the sub-sensible. It was felt that to construct the universe in idea it was necessary to have some notion of its constituent parts—of what Lucretius subsequently called the 'First Beginnings.' Abstracting again from experience, the leaders of scientific speculation reached at length the pregnant doctrine of atoms and

molecules, the latest developments of which were set forth with such power and clearness at the last meeting of the British Association. Thought, no doubt, had long hovered about this doctrine before it attained the precision and completeness which it assumed in the mind of Democritus,[1] a philosopher who may well for a moment arrest our attention. 'Few great men,' says Lange, a non-materialist, in his excellent 'History of Materialism,' to the spirit and to the letter of which I am equally indebted, 'have been so despitefully used by history as Democritus. In the distorted images sent down to us through unscientific traditions there remains of him almost nothing but the name of "the laughing philosopher," while figures of immeasurably smaller significance spread themselves out at full length before us.' Lange speaks of Bacon's high appreciation of Democritus —for ample illustrations of which I am indebted to my excellent friend Mr. Spedding, the learned editor and biographer of Bacon. It is evident, indeed, that Bacon considered Democritus to be a man of weightier metal than either Plato or Aristotle, though their philosophy 'was noised and celebrated in the schools, amid the din and pomp of professors.' It was not they, but Genseric and Attila and the barbarians, who destroyed the atomic philosophy. 'For at a time when all human learning had suffered shipwreck these planks of Aristotelian and Platonic philosophy, as being of a lighter and more inflated substance, were preserved and came down to us, while things more solid sank and almost passed into oblivion.'

The son of a wealthy father, Democritus devoted the whole of his inherited fortune to the culture of his mind. He travelled everywhere; visited Athens when Socrates and Plato were there, but quitted the city without making

[1] Born 460 B.C.

himself known. Indeed, the dialectic strife in which Socrates so much delighted had no charms for Democritus, who held that 'the man who readily contradicts and uses many words is unfit to learn anything truly right.' He is said to have discovered and educated Protagoras the sophist, being struck as much by the manner in which he, being a hewer of wood, tied up his faggots as by the sagacity of his conversation. Democritus returned poor from his travels, was supported by his brother, and at length wrote his great work entitled 'Diakosmos,' which he read publicly before the people of his native town. He was honoured by his countrymen in various ways, and died serenely at a great age.

The principles enunciated by Democritus reveal his uncompromising antagonism to those who deduced the phenomena of nature from the caprices of the gods. They are briefly these:—1. From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules. 2. Nothing happens by chance. Every occurrence has its cause from which it follows by necessity. 3. The only existing things are the atoms and empty space; all else is mere opinion. 4. The atoms are infinite in number and infinitely various in form; they strike together, and the lateral motions and whirlings which thus arise are the beginnings of worlds. 5. The varieties of all things depend upon the varieties of their atoms, in number, size, and aggregation. 6. The soul consists of fine, smooth, round atoms, like those of fire. These are the most mobile of all. They interpenetrate the whole body, and in their motions the phenomena of life arise. The first five propositions are a fair general statement of the atomic philosophy, as now held. As regards the sixth, Democritus made his fine smooth atoms do duty for the nervous

system, whose functions were then unknown. The atoms of Democritus are individually without sensation; they combine in obedience to mechanical laws; and not only organic forms, but the phenomena of sensation and thought are the result of their combination.

That great enigma, 'the exquisite adaptation of one part of an organism to another part, and to the conditions of life,' more especially the construction of the human body, Democritus made no attempt to solve. Empedocles, a man of more fiery and poetic nature, introduced the notion of love and hate among the atoms to account for their combination and separation. Noticing this gap in the doctrine of Democritus, he struck in with the penetrating thought, linked, however, with some wild speculation, that it lay in the very nature of those combinations which were suited to their ends (in other words, in harmony with their environment) to maintain themselves, while unfit combinations, having no proper habitat, must rapidly disappear. Thus more than 2,000 years ago the doctrine of the 'survival of the fittest,' which in our day, not on the basis of vague conjecture, but of positive knowledge, has been raised to such extraordinary significance, had received at all events partial enunciation.[1]

Epicurus,[2] said to be the son of a poor schoolmaster at Samos, is the next dominant figure in the history of the atomic philosophy. He mastered the writings of Democritus, heard lectures in Athens, went back to Samos, and subsequently wandered through various countries. He finally returned to Athens, where he bought a garden, and surrounded himself by pupils, in the midst of whom he lived a pure and serene life, and died a peaceful death. Democritus looked to the soul as the ennobling part of

[1] Lange, 2nd edit., p. 23.

[2] Born 342 B.C.

man; even beauty without understanding partook of animalism. Epicurus also rated the spirit above the body; the pleasure of the body was that of the moment, while the spirit could draw upon the future and the past. His philosophy was almost identical with that of Democritus; but he never quoted either friend or foe. One main object of Epicurus was to free the world from superstition and the fear of death. Death he treated with indifference. It merely robs us of sensation. As long as we are, death is not; and when death is, we are not. Life has no more evil for him who has made up his mind that it is no evil not to live. He adored the gods, but not in the ordinary fashion. The idea of divine power, properly purified, he thought an elevating one. Still he taught, 'Not he is godless who rejects the gods of the crowd, but rather he who accepts them.' The gods were to him eternal and immortal beings, whose blessedness excluded every thought of care or occupation of any kind. Nature pursues her course in accordance with everlasting laws, the gods never interfering. They haunt

> 'The lucid interspace of world and world
> Where never creeps a cloud or moves a wind,
> Nor ever falls the least white star of snow,
> Nor ever lowest roll of thunder moans,
> Nor sound of human sorrow mounts to mar
> Their sacred everlasting calm.'[1]

Lange considers the relation of Epicurus to the gods subjective; the indication probably of an ethical requirement of his own nature. We cannot read history with open eyes, or study human nature to its depths, and fail to discern such a requirement. Man never has been, and he never will be, satisfied with the operations and products of the Understanding alone; hence physical science cannot

[1] Tennyson's *Lucretius*.

cover all the demands of his nature. But the history of the efforts made to satisfy these demands might be broadly described as a history of errors—the error, in great part, consisting in ascribing fixity to that which is fluent, which varies as we vary, being gross when we are gross, and becoming, as our capacities widen, more abstract and sublime. On one great point the mind of Epicurus was at peace. He neither sought nor expected, here or hereafter, any personal profit from his relation to the gods. And it is assuredly a fact that loftiness and serenity of thought may be promoted by conceptions which involve no idea of profit of this kind. 'Did I not believe,' said a great man to me once, 'that an Intelligence is at the heart of things, my life on earth would be intolerable.' The utterer of these words is not, in my opinion, rendered less noble but more noble by the fact that it was the need of ethical harmony here, and not the thought of personal profit hereafter, that prompted his observation.

There are persons, not belonging to the highest intellectual zone, nor yet to the lowest, to whom perfect clearness of exposition suggests want of depth. They find comfort and edification in an abstract and learned phraseology. To some such people Epicurus, who spared no pains to rid his style of every trace of haze and turbidity, appeared, on this very account, superficial. He had, however, a disciple who thought it no unworthy occupation to spend his days and nights in the effort to reach the clearness of his master, and to whom the Greek philosopher is mainly indebted for the extension and perpetuation of his fame. A century and a half after the death of Epicurus, Lucretius[1] wrote his great poem, 'On the Nature of Things,' in which he, a Roman,

[1] Born 99 B.C.

developed with extraordinary ardour the philosophy of his Greek predecessor. He wishes to win over his friend Memnius to the school of Epicurus; and although he has no rewards in a future life to offer, although his object appears to be a purely negative one, he addresses his friend with the heat of an apostle. His object, like that of his great forerunner, is the destruction of superstition; and considering that men trembled before every natural event as a direct monition from the gods, and that everlasting torture was also in prospect, the freedom aimed at by Lucretius might perhaps be deemed a positive good. 'This terror,' he says, 'and darkness of mind must be dispelled, not by the rays of the sun and glittering shafts of day, but by the aspect and the law of nature.' He refutes the notion that anything can come out of nothing, or that that which is once begotten can be recalled to nothing. The first beginnings, the atoms, are indestructible, and into them all things can be resolved at last. Bodies are partly atoms, and partly combinations of atoms; but the atoms nothing can quench. They are strong in solid singleness, and by their denser combination all things can be closely packed and exhibit enduring strength. He denies that matter is infinitely divisible. We come at length to the atoms, without which, as an imperishable substratum, all order in the generation and development of things would be destroyed.

The mechanical shock of the atoms being in his view the all-sufficient cause of things, he combats the notion that the constitution of nature has been in any way determined by intelligent design. The inter-action of the atoms throughout infinite time rendered all manner of combinations possible. Of these the fit ones persisted, while the unfit ones disappeared. Not after sage deliberation did the atoms station themselves in their right places, nor

did they bargain what motions they should assume. From all eternity they have been driven together, and after trying motions and unions of every kind, they fell at length into the arrangements out of which this system of things has been formed. 'If you will apprehend and keep in mind these things, nature, free at once, and rid of her haughty lords, is seen to do all things spontaneously of herself, without the meddling of the gods.'[1]

To meet the objection that his atoms cannot be seen, Lucretius describes a violent storm, and shows that the invisible particles of air act in the same way as the visible particles of water. We perceive, moreover, the different smells of things, yet never see them coming to our nostrils. Again, clothes hung up on a shore which waves break upon become moist, and then get dry if spread out in the sun, though no eye can see either the approach or the escape of the water particles. A ring, worn long on the finger, becomes thinner; a water-drop hollows out a stone; the ploughshare is rubbed away in the field; the street pavement is worn by the feet; but the particles that disappear at any moment we cannot see. Nature acts through invisible particles. That Lucretius had a strong scientific imagination the foregoing references prove. A fine illustration of his power in this respect is his explanation of the apparent rest of bodies whose atoms are in motion. He employs the image of a flock of sheep with skipping lambs, which, seen from a distance, presents simply a white patch upon the green hill, the jumping of the individual lambs being quite invisible.

[1] Monro's translation. In his criticism of this work, *Contemporary Review*, 1867, Dr. Hayman does not appear to be aware of the really sound and subtile observations on which the reasoning of Lucretius, though erroneous, sometimes rests.

His vaguely-grand conception of the atoms falling eternally through space suggested the nebular hypothesis to Kant, its first propounder. Far beyond the limits of our visible world are to be found atoms innumerable, which have never been united to form bodies, or which, if once united, have been again dispersed, falling silently through immeasurable intervals of time and space. As everywhere throughout the All the same conditions are repeated, so must the phenomena be repeated also. Above us, below us, beside us, therefore, are worlds without end; and this, when considered, must dissipate every thought of a deflection of the universe by the gods. The worlds come and go, attracting new atoms out of limitless space, or dispersing their own particles. The reputed death of Lucretius, which forms the basis of Mr. Tennyson's noble poem, is in strict accordance with his philosophy, which was severe and pure.

During the centuries lying between the first of these three philosophers and the last, the human intellect was active in other fields than theirs. The sophists had run through their career. At Athens had appeared Socrates, Plato, and Aristotle, who ruined the sophists, and whose yoke remains to some extent unbroken to the present hour. Within this period also the School of Alexandria was founded, Euclid wrote his 'Elements,' and made some advance in optics. Archimedes had propounded the theory of the lever and the principles of hydrostatics. Pythagoras had made his experiments on the harmonic intervals, while astronomy was immensely enriched by the discoveries of Hipparchus, who was followed by the historically more celebrated Ptolemy. Anatomy had been made the basis of Scientific medicine; and it is said by

Draper[1] that vivisection then began. In fact, the science of ancient Greece had already cleared the world of the fantastic images of divinities operating capriciously through natural phenomena. It had shaken itself free from that fruitless scrutiny 'by the internal light of the mind alone,' which had vainly sought to transcend experience and reach a knowledge of ultimate causes. Instead of accidental observation, it had introduced observation with a purpose; instruments were employed to aid the senses; and scientific method was rendered in a great measure complete by the union of Induction and Experiment.

What, then, stopped its victorious advance? Why was the scientific intellect compelled, like an exhausted soil, to lie fallow for nearly two millenniums before it could regather the elements necessary to its fertility and strength? Bacon has already let us know one cause; Whewell ascribes this stationary period to four causes—obscurity of thought, servility, intolerance of disposition, enthusiasm of temper—and he gives striking examples of each.[2] But these characteristics must have had their antecedents in the circumstances of the time. Rome and the other cities of the Empire had fallen into moral putrefaction. Christianity had appeared, offering the gospel to the poor, and, by moderation if not asceticism of life, practically protesting against the profligacy of the age. The sufferings of the early Christians, and the extraordinary exaltation of mind which enabled them to triumph over the diabolical tortures to which they were subjected,[3] must have left traces not easily effaced. They scorned the earth, in view of that 'building of God, that

[1] *History of the Intellectual Development of Europe*, p. 295.

[2] *History of the Inductive Sciences*, vol. i.

[3] Depicted with terrible vividness in Renan's *Antichrist*.

house not made with hands, eternal in the heavens.' The Scriptures which ministered to their spiritual needs were also the measure of their Science. When, for example, the celebrated question of antipodes came to be discussed, the Bible was with many the ultimate court of appeal. Augustin, who flourished A.D. 400, would not deny the rotundity of the earth; but he would deny the possible existence of inhabitants at the other side, 'because no such race is recorded in Scripture among the descendants of Adam.' Archbishop Boniface was shocked at the assumption of a 'world of human beings out of the reach of the means of salvation.' Thus reined in, Science was not likely to make much progress. Later on the political and theological strife between the Church and civil governments, so powerfully depicted by Draper, must have done much to stifle investigation.

Whewell makes many wise and brave remarks regarding the spirit of the Middle Ages. It was a menial spirit. The seekers after natural knowledge had forsaken that fountain of living waters, the direct appeal to nature by observation and experiment, and had given themselves up to the remanipulation of the notions of their predecessors. It was a time when thought had become abject, and when the acceptance of mere authority led, as it always does in science, to intellectual death. Natural events, instead of being traced to physical, were referred to moral causes; while an exercise of the phantasy, almost as degrading as the spiritualism of the present day, took the place of scientific speculation. Then came the mysticism of the Middle Ages, Magic, Alchemy, the Neoplatonic philosophy, with its visionary though sublime abstractions, which caused men to look with shame upon their own bodies as hindrances to the absorption of the creature in the blessedness of the Creator. Finally came

the Scholastic philosophy, a fusion, according to Lange, of the least-mature notions of Aristotle with the Christianity of the West. Intellectual immobility was the result. As a traveller without a compass in a fog may wander long, imagining he is making way, and find himself after hours of toil at his starting-point, so the schoolmen, having 'tied and untied the same knots and formed and dissipated the same clouds,' found themselves at the end of centuries in their old position.

With regard to the influence wielded by Aristotle in the Middle Ages, and which, though to a less extent, he still wields, I would ask permission to make one remark. When the human mind has achieved greatness and given evidence of extraordinary power in any domain, there is a tendency to credit it with similar power in all other domains. Thus theologians have found comfort and assurance in the thought that Newton dealt with the question of revelation, forgetful of the fact that the very devotion of his powers, through all the best years of his life, to a totally different class of ideas, not to speak of any natural disqualification, tended to render him less instead of more competent to deal with theological and historic questions. Goethe, starting from his established greatness as a poet, and indeed from his positive discoveries in Natural History, produced a profound impression among the painters of Germany when he published his 'Farbenlehre,' in which he endeavoured to overthrow Newton's theory of colours. This theory he deemed so obviously absurd that he considered its author a charlatan, and attacked him with a corresponding vehemence of language. In the domain of Natural History Goethe had made really considerable discoveries; and we have high authority for assuming that, had he devoted himself wholly to that side of science, he might have reached in

it an eminence comparable with that which he attained as a poet. In sharpness of observation, in the detection of analogies, however apparently remote, in the classification and organization of facts according to the analogies discerned, Goethe possessed extraordinary powers. These elements of scientific inquiry fall in with the discipline of the poet. But, on the other hand, a mind thus richly endowed in the direction of natural history may be almost shorn of endowment as regards the more strictly called physical and mechanical sciences. Goethe was in this condition. He could not formulate distinct mechanical conceptions; he could not see the force of mechanical reasoning; and in regions where such reasoning reigns supreme he became a mere *ignis fatuus* to those who followed him.

I have sometimes permitted myself to compare Aristotle with Goethe, to credit the Stagirite with an almost superhuman power of amassing and systematizing facts, but to consider him fatally defective on that side of the mind in respect to which incompleteness has been just ascribed to Goethe. Whewell refers the errors of Aristotle, not to a neglect of facts, but to 'a neglect of the idea appropriate to the facts; the idea of Mechanical cause, which is Force, and the substitution of vague or inapplicable notions, involving only relations of space or emotions of wonder.' This is doubtless true; but the word 'neglect' implies mere intellectual misdirection, whereas in Aristotle, as in Goethe, it was not, I believe, misdirection, but sheer natural incapacity which lay at the root of his mistakes. As a physicist, Aristotle displayed what we should consider some of the worst attributes of a modern physical investigator—indistinctness of ideas, confusion of mind, and a confident use of language, which led to the delusive notion that he had really

mastered his subject, while he had as yet failed to grasp even the elements of it. He put words in the place of things, subject in the place of object. He preached Induction without practising it, inverting the true order of inquiry by passing from the general to the particular, instead of from the particular to the general. He made of the universe a closed sphere, in the centre of which he fixed the earth, proving from general principles, to his own satisfaction and to that of the world for near 2,000 years, that no other universe was possible. His notions of motion were entirely unphysical. It was natural or unnatural, better or worse, calm or violent—no real mechanical conception regarding it lying at the bottom of his mind. He affirmed that a vacuum could not exist, and proved that if it did exist motion in it would be impossible. He determined *à priori* how many species of animals must exist, and shows on general principles why animals must have such and such parts. When an eminent contemporary philosopher, who is far removed from errors of this kind, remembers these abuses of the *à priori* method, he will be able to make allowance for the jealousy of physicists as to the acceptance of so-called *à priori* truths. Aristotle's errors of detail, as shown by Eucken and Lange, were grave and numerous. He affirmed that only in man we had the beating of the heart, that the left side of the body was colder than the right, that men have more teeth than women, and that there is an empty space at the back of every man's head.

There is one essential quality in physical conceptions which was entirely wanting in those of Aristotle and his followers. I wish it could be expressed by a word untainted by its associations; it signifies a capability of being placed as a coherent picture before the mind. The Germans express the act of picturing by the word *vorstellen*, and the

picture they call a *Vorstellung*. We have no word in English which comes nearer to our requirements than *Imagination*, and, taken with its proper limitations, the word answers very well; but, as just intimated, it is tainted by its associations, and therefore objectionable to some minds. Compare, with reference to this capacity of mental presentation, the case of the Aristotelian who refers the ascent of water in a pump to Nature's abhorrence of a vacuum, with that of Pascal when he proposed to solve the question of atmospheric pressure by the ascent of the Puy de Dome. In the one case the terms of the explanation refuse to fall into place as a physical image; in the other the image is distinct, the fall and rise of the barometer being clearly figured as the balancing of two varying and opposing pressures.

During the drought of the Middle Ages in Christendom, the Arabian intellect, as forcibly shown by Draper, was active. With the intrusion of the Moors into Spain, he says, order, learning, and refinement took the place of their opposites. When smitten with disease, the Christian peasant resorted to a shrine, the Moorish one to an instructed physician. The Arabs encouraged translations from the Greek philosophers, but not from the Greek poets. They turned in disgust 'from the lewdness of our classical mythology, and denounced as an unpardonable blasphemy all connexion between the impure Olympian Jove and the Most High God.' Draper traces still further than Whewell the Arab elements in our scientific terms, and points out that the under garment of ladies retains to this hour its Arab name. He gives examples of what Arabian men of science accomplished, dwelling particularly on Alhazen, who was the first to correct the Platonic notion that rays of light are emitted by the eye. He discovered atmospheric refraction, and

points out that we see the sun and the moon after they have set. He explains the enlargement of the sun and moon, and the shortening of the vertical diameters of both these bodies, when near the horizon. He is aware that the atmosphere decreases in density with increase of elevation, and actually fixes its height at 58½ miles. In the Book of the Balance Wisdom, he sets forth the connexion between the weight of the atmosphere and its increasing density. He shows that a body will weigh differently in a rare and dense atmosphere: he considers the force with which plunged bodies rise through heavier media. He understands the doctrine of the centre of gravity, and applies it to the investigation of balances and steelyards. He recognises gravity as a force, though he falls into the error of making it diminish simply as the distance increased, and of making it purely terrestrial. He knows the relation between the velocities, spaces, and times of falling bodies, and has distinct ideas of capillary attraction. He improved the hydrometer. The determination of the densities of bodies as given by Alhazen approach very closely to our own. 'I join,' says Draper, in the pious prayer of Alhazen, 'that in the day of judgment the All-Merciful will take pity on the soul of Abur-Raihân, because he was the first of the race of men to construct a table of specific gravities.' If all this be historic truth (and I have entire confidence in Dr. Draper), well may he 'deplore the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Mahommedans.'[1]

The strain upon the mind during the stationary period towards ultra-terrestrial things, to the neglect of problems close at hand, was sure to provoke reaction. But the reaction was gradual; for the ground was dangerous, a

[1] *Intellectual Development of Europe*, p. 359.

power being at hand competent to crush the critic who went too far. To elude this power and still allow opportunity for the expression of opinion, the doctrine of 'twofold truth' was invented, according to which an opinion might be held 'theologically' and the opposite opinion 'philosophically.'[1] Thus in the thirteenth century the creation of the world in six days, and the unchangeableness of the individual soul which had been so distinctly affirmed by St. Thomas Aquinas, were both denied philosophically, but admitted to be true as articles of the Catholic faith. When Protagoras uttered the maxim which brought upon him so much vituperation, that 'opposite assertions are equally true,' he simply meant that human beings differed so much from each other that what was subjectively true to the one might be subjectively untrue to the other. The great Sophist never meant to play fast and loose with the truth by saying that one of two opposite assertions, made by the same individual, could possibly escape being a lie. It was not 'sophistry,' but the dread of theologic vengeance that generated this double dealing with conviction; and it is astonishing to notice what lengths were possible to men who were adroit in the use of artifices of this kind.

Towards the close of the stationary period a word-weariness, if I may so express it, took more and more possession of men's minds. Christendom had become sick of the School philosophy and its verbal wastes, which led to no issue, but left the intellect in everlasting haze. Here and there was heard the voice of one impatiently crying in the wilderness, 'Not unto Aristotle, not unto subtle hypothesis, not unto church, Bible, or blind tradition, must we turn for a knowledge of the universe, but to the direct investigation of Nature by observation and

[1] Lange, 2nd edit. pp. 181, 182.

experiment.' In 1543 the epoch-making work of Copernicus on the paths of the heavenly bodies appeared. The total crash of Aristotle's closed universe with the earth at its centre followed as a consequence, and 'the earth moves!' became a kind of watchword among intellectual freemen. Copernicus was Canon of the Church of Frauenburg, in the diocese of Ermeland. For three-and-thirty years he had withdrawn himself from the world and devoted himself to the consolidation of his great scheme of the solar system. He made its blocks eternal; and even to those who feared it and desired its overthrow it was so obviously strong that they refrained for a time from meddling with it. In the last year of the life of Copernicus his book appeared: it is said that the old man received a copy of it a few days before his death, and then departed in peace.

The Italian philosopher Giordano Bruno was one of the earliest converts to the new astronomy. Taking Lucretius as his exemplar, he revived the notion of the infinity of worlds; and, combining with it the doctrine of Copernicus, reached the sublime generalization that the fixed stars are suns, scattered numberless through space and accompanied by satellites, which bear the same relation to them that our earth does to our sun, or our moon to our earth. This was an expansion of transcendent import; but Bruno came closer than this to our present line of thought. Struck with the problem of the generation and maintenance of organisms, and duly pondering it, he came to the conclusion that Nature in her productions does not imitate the technic of man. Her process is one of unravelling and unfolding. The infinity of forms under which matter appears were not imposed upon it by an external artificer; by its own intrinsic force and virtue it brings these forms forth.

Matter is not the mere naked, empty *capacity* which philosophers have pictured her to be, but the universal mother who brings forth all things as the fruit of her own womb.

This outspoken man was originally a Dominican monk. He was accused of heresy and had to fly, seeking refuge in Geneva, Paris, England, and Germany. In 1592 he fell into the hands of the Inquisition at Venice. He was imprisoned for many years, tried, degraded, excommunicated, and handed over to the civil power, with the request that he should be treated gently and 'without the shedding of blood.' This meant that he was to be burnt; and burnt accordingly he was, on the 16th of February, 1600. To escape a similar fate Galileo, thirty-three years afterwards, abjured, upon his knees, and with his hand upon the holy gospels, the heliocentric doctrine which he knew to be true. After Galileo came Kepler, who from his German home defied the power beyond the Alps. He traced out from pre-existing observations the laws of planetary motion. Materials were thus prepared for Newton, who bound those empirical laws together by the principle of gravitation.

In the seventeenth century Bacon and Descartes, the restorers of philosophy, appeared in succession. Differently educated and endowed, their philosophic tendencies were different. Bacon held fast to Induction, believing firmly in the existence of an external world, and making collected experiences the basis of all knowledge. The mathematical studies of Descartes gave him a bias towards Deduction; and his fundamental principle was much the same as that of Protagoras, who made the individual man the measure of all things. 'I think, therefore I am,' said Descartes. Only his own identity was sure to him; and the development of this system would have led to an idealism in

which the outer world would be resolved into a mere phenomenon of consciousness. Gassendi, one of Descartes's contemporaries, of whom we shall hear more presently, quickly pointed out that the fact of personal existence would be proved as well by reference to any other act as to the act of thinking. I eat, therefore I am; or I love, therefore I am, would be quite as conclusive. Lichtenberg showed that the very thing to be proved was inevitably postulated in the first two words, 'I think;' and that no inference from the postulate could by any possibility be stronger than the postulate itself.

But Descartes deviated strangely from the idealism implied in his fundamental principle. He was the first to reduce, in a manner eminently capable of bearing the test of mental presentation, vital phenomena to purely mechanical principles. Through fear or love, Descartes was a good churchman; he accordingly rejects the notion of an atom, because it was absurd to suppose that God, if he so pleased, could not divide an atom; he puts in the place of the atoms small round particles and light splinters, out of which he builds the organism. He sketches with marvellous physical insight a machine, with water for its motive power, which shall illustrate vital actions. He has made clear to his mind that such a machine would be competent to carry on the processes of digestion, nutrition, growth, respiration, and the beating of the heart. It would be competent to accept impressions from the external sense, to store them up in imagination and memory, to go through the internal movements of the appetites and passions, the external movement of limbs. He deduces these functions of his machine from the mere arrangement of its organs, as the movement of a clock or other automaton is deduced from its weights and wheels. 'As far as these functions are concerned,' he

says, 'it is not necessary to conceive any other vegetative or sensitive soul, nor any other principle of motion or of life, than the blood and the spirits agitated by the fire which burns continually in the heart, and which is in no wise different from the fires which exist in inanimate bodies.' Had Descartes been acquainted with the steam-engine, he would have taken it, instead of a fall of water, as his motive power, and shown the perfect analogy which exists between the oxidation of the food in the body and that of the coal in the furnace. He would assuredly have anticipated Mayer in calling the blood which the heart diffuses 'the oil of the lamp of life;' deducing all animal motions from the combustion of this oil, as the motions of a steam-engine are deduced from the combustion of its coal. As the matter stands, however, and considering the circumstances of the time, the boldness, clearness, and precision with which he grasped the problem of vital dynamics constitute a marvellous illustration of intellectual power.[1]

During the Middle Ages the doctrine of atoms had to all appearance vanished from discussion. In all probability it held its ground among sober-minded and thoughtful men, though neither the church nor the world was prepared to hear of it with tolerance. Once, in the year 1348, it received distinct expression. But retractation by compulsion immediately followed, and, thus discouraged, it slumbered till the seventeenth century, when it was revived by a contemporary and friend of Hobbes and Malmesbury, the orthodox Catholic provost of Digne, Gassendi. But before stating his relation to the Epicurean doctrine, it will be well to say a few words on the effect,

[1] See Huxley's admirable Essay on Descartes. *Lay Sermons*, pp. 364, 365.

as regards science, of the general introduction of monotheism among European nations.

'Were men,' says Hume, 'led into the apprehension of invisible intelligent power by contemplation of the works of Nature, they could never possibly entertain any conception but of one single being, who bestowed existence and order on this vast machine, and adjusted all its parts to one regular system.' Referring to the condition of the heathen, who sees a god behind every natural event, thus peopling the world with thousands of beings whose caprices are incalculable, Lange shows the impossibility of any compromise between such notions and those of science, which proceeds on the assumption of never-changing law and causality. 'But,' he continues, with characteristic penetration, 'when the great thought of one God, acting as a unit upon the universe, has been seized, the connexion of things in accordance with the law of cause and effect is not only thinkable, but it is a necessary consequence of the assumption. For when I see ten thousand wheels in motion, and know, or believe, that they are all driven by one, then I know that I have before me a mechanism the action of every part of which is determined by the plan of the whole. So much being assumed, it follows that I may investigate the structure of that machine, and the various motions of its parts. For the time being, therefore, this conception renders scientific action free.' In other words, were a capricious God at the circumference of every wheel and at the end of every lever, the action of the machine would be incalculable by the methods of science. But the action of all its parts being rigidly determined by their connexions and relations, and these being brought into play by a single self-acting driving wheel, then, though this last prime

mover may elude me, I am still able to comprehend the machinery which it sets in motion. We have here a conception of the relation of Nature to its Author which seems perfectly acceptable to some minds, but perfectly intolerable to others. Newton and Boyle lived and worked happily under the influence of this conception; Goethe rejected it with vehemence, and the same repugnance to accepting it is manifest in Carlyle.[1]

The analytic and synthetic tendencies of the human mind exhibit themselves throughout history, great writers ranging themselves sometimes on the one side, sometimes on the other. Men of warm feelings and minds open to the elevating impressions produced by Nature as a whole, whose satisfaction, therefore, is rather ethical than logical, lean to the synthetic side; while the analytic harmonizes best with the more precise and more mechanical bias which seeks the satisfaction of the understanding. Some form of pantheism was usually adopted by the one, while a detached Creator, working more or less after the manner of men, was often assumed by the other. Gassendi is hardly to be ranked with either. Having formally acknowledged God as the great first cause, he immediately dropped the idea, applied the known laws of mechanics to the atoms, deducing thence all vital phenomena. He defended Epicurus, and dwelt upon his purity, both of doctrine and of life. True he was a heathen, but so was Aristotle. He assailed superstition and religion, and rightly, because he did not know the true religion. He thought that the gods neither rewarded nor

[1] Boyle's model of the universe was the Strasburg clock with an outside Artificer. Goethe, on the other hand, sang

'Ihm ziemt's die Welt im Innern zu bewegen,
Natur in sich, sich in Natur zu hegen.'

See also Carlyle, *Past and Present*, Chap. V.

punished, and adored them purely in consequence of their completeness; here we see, says Gassendi, the reverence of the child instead of the fear of the slave. The errors of Epicurus shall be corrected, the body of his truth retained; and then Gassendi proceeds, as any heathen might do, to build up the world, and all that therein is, of atoms and molecules. God, who created earth and water, plants and animals, produced in the first place a definite number of atoms, which constituted the seed of all things. Then began that series of combinations and decompositions which goes on at present, and which will continue in future. The principle of every change resides in matter. In artificial productions the moving principle is different from the material worked upon; but in Nature the agent works within, being the most active and mobile part of the material itself. Thus, this bold ecclesiastic, without incurring the censure of the church or the world, contrives to outstrip Mr. Darwin. The same cast of mind which caused him to detach the Creator from his universe led him also to detach the soul from the body, though to the body he ascribes an influence so large as to render the soul almost unnecessary. The aberrations of reason were in his view an affair of the material brain. Mental disease is brain disease; but then the immortal reason sits apart, and cannot be touched by the disease. The errors of madness are errors of the instrument, not of the performer.

It may be more than a mere result of education, connecting itself probably with the deeper mental structure of the two men, that the idea of Gassendi above enunciated is substantially the same as that expressed by Professor Clerk Maxwell at the close of the very able lecture delivered by him at Bradford last year. According to both philosophers, the atoms, if I understand aright, are

the *prepared materials* which, formed by the skill of the highest, produce by their subsequent inter-action all the phenomena of the material world. There seems to be this difference, however, between Gassendi and Maxwell. The one *postulates*, the other *infers* his first cause. In his 'manufactured articles,' as he calls the atoms, Professor Maxwell finds the basis of an induction which enables him to scale philosophic heights considered inaccessible by Kant, and to take the logical step from the atoms to their Maker.

Accepting here the leadership of Kant, I doubt the legitimacy of Maxwell's logic; but it is impossible not to feel the ethic glow with which his lecture concludes. There is, moreover, a very noble strain of eloquence in his description of the steadfastness of the atoms:—'Natural causes, as we know, are at work, which tend to modify, if they do not at length destroy, all the arrangements and dimensions of the earth and the whole solar system. But though in the course of ages catastrophes have occurred and may yet occur in the heavens, though ancient systems may be dissolved and new systems evolved out of their ruins, the molecules out of which these systems are built—the foundation stones of the material universe—remain unbroken and unworn.'

The atomic doctrine, in whole or in part, was entertained by Bacon, Descartes, Hobbes, Locke, Newton, Boyle, and their successors, until the chemical law of multiple proportions enabled Dalton to confer upon it an entirely new significance. In our day there are secessions from the theory, but it still stands firm. Loschmidt, Stoney, and Sir William Thomson have sought to determine the sizes of the atoms, or rather to fix the limits between which their sizes lie; while only last year the discourses of Williamson and Maxwell illustrate the pre-

sent hold of the doctrine upon the foremost scientific minds. In fact, it may be doubted whether, wanting this fundamental conception, a theory of the material universe is capable of scientific statement.

Ninety years subsequent to Gassendi the doctrine of bodily instruments, as it may be called, assumed immense importance in the hands of Bishop Butler, who, in his famous 'Analogy of Religion,' developed, from his own point of view, and with consummate sagacity, a similar idea. The Bishop still influences superior minds; and it will repay us to dwell for a moment on his views. He draws the sharpest distinction between our real selves and our bodily instruments. He does not, as far as I remember, use the word soul, possibly because the term was so hackneyed in his day as it had been for many generations previously. But he speaks of 'living powers,' 'perceiving' or 'percipient powers,' 'moving agents,' 'ourselves,' in the same sense as we should employ the term soul. He dwells upon the fact that limbs may be removed, and mortal diseases assail the body, the mind, almost up to the moment of death, remaining clear. He refers to sleep and to swoon, where the 'living powers' are suspended but not destroyed. He considers it quite as easy to conceive of existence out of our bodies as in them: that we may animate a succession of bodies, the dissolution of all of them having no more tendency to dissolve our real selves, or 'deprive us of living faculties—the faculties of perception and action—than the dissolution of any foreign matter which we are capable of receiving impressions from, or making use of for the common occasions of life.' This is the key of the Bishop's position; 'our organized bodies are no more a part of ourselves than any other matter around us.' In proof of this he

calls attention to the use of glasses, which 'prepare objects' for the 'percipient power' exactly as the eye does. The eye itself is no more percipient than the glass; is quite as much the instrument of the true self, and also as foreign to the true self, as the glass is. 'And if we see with our eyes only in the same manner as we do with glasses, the like may justly be concluded from analogy of all our senses.'

Lucretius, as you are aware, reached a precisely opposite conclusion; and it certainly would be interesting, if not profitable, to us all, to hear what he would or could urge in opposition to the reasoning of the Bishop. As a brief discussion of the point will enable us to see the bearings of an important question, I will here permit a disciple of Lucretius to try the strength of the Bishop's position, and then allow the Bishop to retaliate, with the view of rolling back, if he can, the difficulty upon Lucretius.

The argument might proceed in this fashion:—

'Subjected to the test of mental presentation (*Vorstellung*), your views, most honoured prelate, would present to many minds a great, if not an insuperable difficulty. You speak of "living powers," "percipient or perceiving powers," and "ourselves;" but can you form a mental picture of any one of these apart from the organism through which it is supposed to act? Test yourself honestly, and see whether you possess any faculty that would enable you to form such a conception. The true self has a local habitation in each of us; thus localized, must it not possess a form? If so, what form? Have you ever for a moment realized it? When a leg is amputated the body is divided into two parts; is the true self in both of them or in one? Thomas Aquinas might say in both; but not you, for you appeal to the consciousness associated with one of the two parts to prove that the

other is foreign matter. Is consciousness, then, a necessary element of the true self? If so, what do you say to the case of the whole body being deprived of consciousness? If not, then on what grounds do you deny any portion of the true self to the severed limb? It seems very singular that, from the beginning to the end of your admirable book (and no one admires its sober strength more than I do), you never once mention the brain or nervous system. You begin at one end of the body, and show that its parts may be removed without prejudice to the perceiving power. What if you begin at the other end, and remove, instead of the leg, the brain? The body, as before, is divided into two parts; but both are now in the same predicament, and neither can be appealed to to prove that the other is foreign matter. Or, instead of going so far as to remove the brain itself, let a certain portion of its bony covering be removed, and let a rhythmic series of pressures and relaxations of pressure be applied to the soft substance. At every pressure "the faculties of perception and of action" vanish; at every relaxation of pressure they are restored. Where, during the intervals of pressure, is the perceiving power? I once had the discharge of a large Leyden battery passed unexpectedly through me: I felt nothing, but was simply blotted out of conscious existence for a sensible interval. Where was my true self during that interval? Men who have recovered from lightning-stroke have been much longer in the same state; and indeed in cases of ordinary concussion of the brain, days may elapse during which no experience is registered in consciousness. Where is the man himself during the period of insensibility? You may say that I beg the question when I assume the man to have been unconscious, that he was really conscious all the time, and has simply forgotten what had occurred to him. In

reply to this, I can only say that no one need shrink from the worst tortures that superstition ever invented if only so felt and so remembered. I do not think your theory of instruments goes at all to the bottom of the matter. A telegraph-operator has his instruments, by means of which he converses with the world; our bodies possess a nervous system, which plays a similar part between the perceiving power and external things. Cut the wires of the operator, break his battery, demagnetize his needle: by this means you certainly sever his connexion with the world; but inasmuch as these are real instruments, their destruction does not touch the man who uses them. The operator survives, *and he knows that he survives.* What is it, I would ask, in the human system that answers to this conscious survival of the operator when the battery of the brain is so disturbed as to produce insensibility, or when it is destroyed altogether?

'Another consideration, which you may consider slight, presses upon me with some force. The brain may change from health to disease, and through such a change the most exemplary man may be converted into a debauchee or a murderer. My very noble and approved good master had, as you know, threatenings of lewdness introduced into his brain by his jealous wife's philter; and sooner than permit himself to run even the risk of yielding to these base promptings he slew himself. How could the hand of Lucretius have been thus turned against himself if the real Lucretius remained as before? Can the brain or can it not act in this distempered way without the intervention of the immortal reason? If it can, then it is a prime mover which requires only healthy regulation to render it reasonably self-acting, and there is no apparent need of your immortal reason at all. If it cannot, then the immortal reason, by its mischievous activity in operating upon a broken instrument, must have the credit

of committing every imaginable extravagance and crime. I think, if you will allow me to say so, that the gravest consequences are likely to flow from your estimate of the body. To regard the brain as you would a staff or an eyeglass—to shut your eyes to all its mystery, to the perfect correlation of its condition and our consciousness, to the fact that a slight excess or defect of blood in it produces the very swoon to which you refer, and that in relation to it our meat and drink and air and exercise have a perfectly transcendental value and significance—to forget all this does, I think, open a way to innnumerable errors in our habits of life, and may possibly in some cases initiate and foster that very disease, and consequent mental ruin, which a wiser appreciation of this mysterious organ would have avoided.'

I can imagine the Bishop thoughtful after hearing this argument. He was not the man to allow anger to mingle with the consideration of a point of this kind. After due reflection, and having strengthened himself by that honest contemplation of the facts which was habitual with him, and which includes the desire to give even adverse facts their due weight, I can suppose the Bishop to proceed thus:—'You will remember that in the "Analogy of Religion," of which you have so kindly spoken, I did not profess to prove anything absolutely, and that I over and over again acknowledged and insisted on the smallness of our knowledge, or rather the depth of our ignorance, as regards the whole system of the universe. My object was to show my deistical friends, who set forth so eloquently the beauty and beneficence of Nature and the Ruler thereof, while they had nothing but scorn for the so-called absurdities of the Christian scheme, that they were in no better condition than we were, and that, for every difficulty found upon our side, quite as great a difficulty was to be found upon theirs. I

will now, with your permission, adopt a similar line of argument. You are a Lucretian, and from the combination and separation of insensate atoms deduce all terrestrial things, including organic forms and their phenomena. Let me tell you, in the first instance, how far I am prepared to go with you. I admit that you can build crystalline forms out of this play of molecular force; that the diamond, amethyst, and snow-star are truly wonderful structures which are thus produced. I will go further and acknowledge that even a tree or flower might in this way be organized. Nay, if you can show me an animal without sensation, I will concede to you that it also might be put together by the suitable play of molecular force.

'Thus far our way is clear; but now comes my difficulty. Your atoms are individually without sensation, much more are they without intelligence. May I ask you, then, to try your hand upon this problem? Take your dead hydrogen atoms, your dead oxygen atoms, your dead carbon atoms, your dead nitrogen atoms, your dead phosphorus atoms, and all the other atoms, dead as grains of shot, of which the brain is formed. Imagine them separate and sensationless, observe them running together and forming all imaginable combinations. This, as a purely mechanical process, is *seeable* by the mind. But can you see, or dream, or in any way imagine, how out of that mechanical act, and from these individually dead atoms, sensation, thought, and emotion are to arise? Are you likely to extract Homer out of the rattling of dice, or the Differential Calculus out of the clash of billiard-balls? I am not all bereft of this *Vorstellungs-Kraft* of which you speak, nor am I, like so many of my brethren, a mere vacuum as regards scientific knowledge. I can follow a particle of musk until it reaches the olfactory nerve; I can

follow the waves of sound until their tremors reach the water of the labyrinth and set the otoliths and Corti's fibres in motion; I can also visualize the waves of ether as they cross the eye and hit the retina. Nay more, I am able to pursue to the central organ the motion thus imparted at the periphery, and to see in idea the very molecules of the brain thrown into tremors. My insight is not baffled by these physical processes. What baffles and bewilders me, is the notion that from those physical tremors things so utterly incongruous with them as sensation, thought, and emotion can be derived. You may say, or think, that this issue of consciousness from the clash of atoms is not more incongruous than the flash of light from the union of oxygen and hydrogen. But I beg to say that it is. For such incongruity as the flash possesses is that which I now force upon your attention. The flash is an affair of consciousness, the objective counterpart of which is a vibration. It is a flash only by your interpretation. *You* are the cause of the apparent incongruity, and *you* are the thing that puzzles me. I need not remind you that the great Leibnitz felt the difficulty which I feel, and that to get rid of this monstrous deduction of life from death he displaced your atoms by his monads, which were more or less perfect mirrors of the universe, and out of the summation and integration of which he supposed all the phenomena of life—sentient, intellectual, and emotional—to arise.

'Your difficulty, then, as I see you are ready to admit, is quite as great as mine. You cannot satisfy the human understanding in its demand for logical continuity between molecular processes and the phenomena of consciousness. This is a rock on which materialism must inevitably split whenever it pretends to be a complete

philosophy of life. What is the moral, my Lucretian? You and I are not likely to indulge in ill-temper in the discussion of these great topics, where we see so much room for honest differences of opinion. But there are people of less wit or more bigotry (I say it with humility) on both sides, who are ever ready to mingle anger and vituperation with such discussions. There are, for example, writers of note and influence at the present day who are not ashamed to assume the "deep personal sin" of a great logician to be the cause of his unbelief in a theologic dogma. And there are others who hold that we, who cherish our noble Bible, wrought as it has been into the constitution of our forefathers, and by inheritance into us, must necessarily be hypocritical and insincere. Let us disavow and discountenance such people, cherishing the unswerving faith that what is good and true in both our arguments will be preserved for the benefit of humanity, while all that is bad or false will disappear.'

I hold the Bishop's reasoning to be unanswerable, and his liberality to be worthy of imitation.

It is worth remarking that in one respect the Bishop was a product of his age. Long previous to his day the nature of the soul had been so favourite and general a topic of discussion, that, when the students of the University of Paris wished to know the leanings of a new Professor, they at once requested him to lecture upon the soul. About the time of Bishop Butler the question was not only agitated but extended. It was seen by the clear-witted men who entered this arena that many of their best arguments applied equally to brutes and men. The Bishop's arguments were of this character. He saw it, admitted it, accepted the consequences, and boldly embraced the whole animal world in his scheme of immortality.

Bishop Butler accepted with unwavering trust the chronology of the Old Testament, describing it as 'confirmed by the natural and civil history of the world, collected from common historians, from the state of the earth, and from the late inventions of arts and sciences.' These words mark progress; and they must seem somewhat hoary to the Bishop's successors of to-day.[1] It is hardly necessary to inform you that since his time the domain of the naturalist has been immensely extended—the whole science of geology, with its astounding revelations regarding the life of the ancient earth, having been created. The rigidity of old conceptions has been relaxed, the public mind being rendered gradually tolerant of the idea that not for six thousand, nor for sixty thousand, nor for six thousand thousand thousand, but for æons embracing untold millions of years, this earth has been the theatre of life and death. The riddle of the rocks has been read by the geologist and palæontologist, from subcambrian depths to the deposits thickening over the sea-bottoms of to-day. And upon the leaves of that stone book are, as you know, stamped the characters, plainer and surer than those formed by the ink of history, which carry the mind back into abysses of past time compared with which the periods which satisfied Bishop Butler cease to have a visual angle.

The lode of discovery once struck, those petrified forms in which life was at one time active increased to multitudes and demanded classification. They were grouped in genera, species, and varieties, according to the degree of similarity subsisting between them. Thus confusion was avoided, each object being found in the

[1] Only to some; for there are dignitaries who even now speak of the earth's rocky crust as so much building material prepared for man at the Creation. Surely it is time that this loose language should cease.

pigeon-hole appropriated to it and to its fellows of similar morphological or physiological character. The general fact soon became evident that none but the simplest forms of life lie lowest down, that as we climb higher among the super-imposed strata more perfect forms appear. The change, however, from form to form was not continuous, but by steps—some small, some great. 'A section,' says Mr. Huxley, 'a hundred feet thick will exhibit at different heights a dozen species of Ammonite, none of which passes beyond its particular zone of limestone, or clay, into the zone below it, or into that above it.' In the presence of such facts it was not possible to avoid the question:—Have these forms, showing, though in broken stages and with many irregularities, this unmistakable general advance, been subjected to no continuous law of growth or variation? Had our education been purely scientific, or had it been sufficiently detached from influences which, however ennobling in another domain, have always proved hindrances and delusions when introduced as factors into the domain of physics, the scientific mind never could have swerved from the search for a law of growth, or allowed itself to accept the anthropomorphism which regarded each successive stratum as a kind of mechanic's bench for the manufacture of new species out of all relation to the old.

Biassed, however, by their previous education, the great majority of naturalists invoked a special creative act to account for the appearance of each new group of organisms. Doubtless there were numbers who were clear-headed enough to see that this was no explanation at all, that in point of fact it was an attempt, by the introduction of a greater difficulty, to account for a less. But having nothing to offer in the way of explanation, they

for the most part held their peace. Still the thoughts of reflecting men naturally and necessarily simmered round the question. De Maillet, a contemporary of Newton, has been brought into notice by Professor Huxley as one who 'had a notion of the modifiability of living forms.' In my frequent conversations with him, the late Sir Benjamin Brodie, a man of highly philosophic mind, often drew my attention to the fact that, as early as 1794, Charles Darwin's grandfather was the pioneer of Charles Darwin.[1] In 1801, and in subsequent years, the celebrated Lamarck, who produced so profound an impression on the public mind through the vigorous exposition of his views by the author of the 'Vestiges of Creation,' endeavoured to show the development of species out of changes of habit and external condition. In 1813 Dr. Wells, the founder of our present theory of Dew, read before the Royal Society a paper in which, to use the words of Mr. Darwin, 'he distinctly recognises the principle of natural selection; and this is the first recognition that has been indicated.' The thoroughness and skill with which Wells pursued his work, and the obvious independence of his character, rendered him long ago a favourite with me; and it gave me the liveliest pleasure to alight upon this additional testimony to his penetration. Professor Grant, Mr. Patrick Matthew, Von Buch, the author of the 'Vestiges,' D'Halloy, and others,[2] by the enunciation of opinions more or less clear and correct, showed that the question had been fermenting long prior to the year 1858, when Mr. Darwin and Mr. Wallace simultaneously but

[1] *Zoonomia*, vol. i. pp. 500–510.

[2] In 1855 Mr. Herbert Spencer (*Principles of Psychology*, 2nd edit. vol. i. p. 465) expressed 'the belief that life under all its forms has arisen by an unbroken evolution, and through the instrumentality of what are called natural causes.'

independently placed their closely concurrent views upon the subject before the Linnean Society.

These papers were followed in 1859 by the publication of the first edition of 'The Origin of Species.' All great things come slowly to the birth. Copernicus, as I informed you, pondered his great work for thirty-three years. Newton for nearly twenty years kept the idea of Gravitation before his mind; for twenty years also he dwelt upon his discovery of Fluxions, and doubtless would have continued to make it the object of his private thought had he not found that Leibnitz was upon his track. Darwin for two and twenty years pondered the problem of the origin of species, and doubtless he would have continued to do so had he not found Wallace upon his track.[1] A concentrated but full and powerful epitome of his labours was the consequence. The book was by no means an easy one; and probably not one in every score of those who then attacked it had read its pages through, or were competent to grasp their significance if they had. I do not say this merely to discredit them; for there were in those days some really eminent scientific men, entirely raised above the heat of popular prejudice, willing to accept any conclusion that science had to offer, provided it was duly backed by fact and argument, and who entirely mistook Mr. Darwin's views. In fact, the work needed an expounder; and it found one in Mr. Huxley. I know nothing more admirable in the way of scientific exposition than those early articles of his on the origin of species. He swept the curve of discussion through the really significant points of the subject, enriched his exposition with profound original remarks and reflections, often summing up in a single pithy sentence an argument which a less compact

[1] The behaviour of Mr Wallace in relation to this subject has been dignified in the highest degree.

mind would have spread over pages. But there is one impression made by the book itself which no exposition of it, however luminous, can convey; and that is the impression of the vast amount of labour, both of observation and of thought, implied in its production. Let us glance at its principles.

It is conceded on all hands that what are called varieties are continually produced. The rule is probably without exception. No chick and no child is in all respects and particulars the counterpart of its brother and sister; and in such differences we have 'variety' incipient. No naturalist could tell how far this variation could be carried; but the great mass of them held that never by any amount of internal or external change, nor by the mixture of both, could the offspring of the same progenitor so far deviate from each other as to constitute different species. The function of the experimental philosopher is to combine the conditions of nature and to produce her results; and this was the method of Darwin.[1] He made himself acquainted with what could, without any manner of doubt, be done in the way of producing variation. He associated himself with pigeon-fanciers—bought, begged, kept, and observed every breed that he could obtain. Though derived from a common stock, the diversities of these pigeons were such that 'a score of them might be chosen which, if shown to an ornithologist, and he were told that they were wild birds, would certainly be ranked by him as well-defined species.' The simple principle which guides the pigeon-fancier, as it does the cattle-breeder, is the selection of some variety that strikes his fancy, and the propagation

[1] The first step only towards experimental demonstration has been taken. Experiments now begun might, a couple of centuries hence, furnish data of incalculable value, which ought to be supplied to the science of the future.

of this variety by inheritance. With his eye still directed to the particular appearance which he wishes to exaggerate, he selects it as it reappears in successive broods, and thus adds increment to increment until an astonishing amount of divergence from the parent type is effected. The breeder in this case does not produce the *elements* of the variation. He simply observes them, and by selection adds them together until the required result has been obtained. 'No man,' says Mr. Darwin, 'would ever try to make a fantail till he saw a pigeon with a tail developed in some slight degree in an unusual manner, or a pouter until he saw a pigeon with a crop of unusual size.' Thus nature gives the hint, man acts upon it, and by the law of inheritance exaggerates the deviation.

Having thus satisfied himself by indubitable facts that the organization of an animal or of a plant (for precisely the same treatment applies to plants) is to some extent plastic, he passes from variation under domestication to variation under nature. Hitherto we have dealt with the adding together of small changes by the conscious selection of man. Can Nature thus select? Mr. Darwin's answer is, 'Assuredly she can.' The number of living things produced is far in excess of the number that can be supported; hence at some period or other of their lives there must be a struggle for existence; and what is the infallible result? If one organism were a perfect copy of the other in regard to strength, skill, and agility, external conditions would decide. But this is not the case. Here we have the fact of variety offering itself to nature, as in the former instance it offered itself to man; and those varieties which are least competent to cope with surrounding conditions will infallibly give way to those that are most competent. To use a familiar proverb, the weakest comes to the wall. But the triumphant fraction again breeds to overproduction,

transmitting the qualities which secured its maintenance, but transmitting them in different degrees. The struggle for food again supervenes, and those to whom the favourable quality has been transmitted in excess will assuredly triumph. It is easy to see that we have here the addition of increments favourable to the individual still more rigorously carried out than in the case of domestication; for not only are unfavourable specimens not selected by nature, but they are destroyed. This is what Mr. Darwin calls 'Natural Selection,' which 'acts by the preservation and accumulation of small inherited modifications, each profitable to the preserved being.' With this idea he interpenetrates and leavens the vast store of facts that he and others have collected. We cannot, without shutting our eyes through fear or prejudice, fail to see that Darwin is here dealing, not with imaginary, but with true causes; nor can we fail to discern what vast modifications may be produced by natural selection in periods sufficiently long. Each individual increment may resemble what mathematicians call a 'differential' (a quantity indefinitely small); but definite and great changes may obviously be produced by the integration of these infinitesimal quantities through practically infinite time.

If Darwin, like Bruno, rejects the notion of creative power acting after human fashion, it certainly is not because he is unacquainted with the numberless exquisite adaptations on which this notion of a supernatural artificer has been founded. His book is a repository of the most startling facts of this description. Take the marvellous observation which he cites from Dr. Crüger, where a bucket with an aperture, serving as a spout, is formed in an orchid. Bees visit the flower: in eager search of material for their combs they push each other into the bucket, the drenched ones escaping from their involuntary

bath by the spout. Here they rub their backs against the viscid stigma of the flower and obtain glue; then against the pollen-masses, which are thus stuck to the back of the bee and carried away. 'When the bee, so provided, flies to another flower, or to the same flower a second time, and is pushed by its comrades into the bucket, and then crawls out by the passage, the pollen-mass upon its back necessarily comes first into contact with the viscid stigma,' which takes up the pollen; and this is how that orchid is fertilized. Or take this other case of the *Catasetum*. 'Bees visit these flowers in order to gnaw the labellum; in doing this they inevitably touch a long, tapering, sensitive projection. This, when touched, transmits a sensation or vibration to a certain membrane, which is instantly ruptured, setting free a spring, by which the pollen-mass is shot forth like an arrow in the right direction, and adheres by its viscid extremity to the back of the bee.' In this way the fertilising pollen is spread abroad.

It is the mind thus stored with the choicest materials of the teleologist that rejects teleology, seeking to refer these wonders to natural cases. They illustrate, according to him, the method of nature, not the 'technic' of a man-like Artificer. The beauty of flowers is due to natural selection. Those that distinguish themselves by vividly contrasting colours from the surrounding green leaves are most readily seen, most frequently visited by insects, most often fertilized, and hence most favoured by natural selection. Coloured berries also readily attract the attention of birds and beasts, which feed upon them, spread their manured seeds abroad, thus giving trees and shrubs possessing such berries a greater chance in the struggle for existence.

With profound analytic and synthetic skill, Mr. Darwin investigates the cell-making instinct of the hive-bee. His

method of dealing with it is representative. He falls back from the more perfectly to the less perfectly developed instinct—from the hive-bee to the humble bee, which uses its own cocoon as a comb, and to classes of bees of intermediate skill, endeavouring to show how the passage might be gradually made from the lowest to the highest. The saving of wax is the most important point in the economy of bees. Twelve to fifteen pounds of dry sugar are said to be needed for the secretion of a single pound of wax. The quantities of nectar necessary for the wax must therefore be vast; and every improvement of constructive instinct which results in the saving of wax is a direct profit to the insect's life. The time that would otherwise be devoted to the making of wax is now devoted to the gathering and storing of honey for winter food. He passes from the humble bee with its rude cells, through the Melipona with its more artistic cells, to the hive-bee with its astonishing architecture. The bees place themselves at equal distances apart upon the wax, sweep and excavate equal spheres round the selected points. The spheres intersect, and the planes of intersection are built up with thin laminæ. Hexagonal cells are thus formed. This mode of treating such questions is, as I have said, representative. He habitually retires from the more perfect and complex to the less perfect and simple, and carries you with him through stages of *perfecting*, adds increment to increment of infinitesimal change, and in this way gradually breaks down your reluctance to admit that the exquisite climax of the whole could be a result of natural selection.

Mr. Darwin shirks no difficulty; and, saturated as the subject was with his own thought, he must have known better than his critics the weakness as well as the strength of his theory. This of course would be of little avail

were his object a temporary dialectic victory instead of the establishment of a truth which he means to be everlasting. But he takes no pains to disguise the weakness he has discerned; nay, he takes every pains to bring it into the strongest light. His vast resources enable him to cope with objections started by himself and others, so as to leave the final impression upon the reader's mind that, if they be not completely answered, they certainly are not fatal. Their negative force being thus destroyed, you are free to be influenced by the vast positive mass of evidence he is able to bring before you. This largeness of knowledge and readiness of resource render Mr. Darwin the most terrible of antagonists. Accomplished naturalists have levelled heavy and sustained criticisms against him—not always with the view of fairly weighing his theory, but with the express intention of exposing its weak points only. This does not irritate him. He treats every objection with a soberness and thoroughness which even Bishop Butler might be proud to imitate, surrounding each fact with its appropriate detail, placing it in its proper relations, and usually giving it a significance which, as long as it was kept isolated, failed to appear. This is done without a trace of ill-temper. He moves over the subject with the passionless strength of a glacier; and the grinding of the rocks is not always without a counterpart in the logical pulverization of the objector.

But though in handling this mighty theme all passion has been stilled, there is an emotion of the intellect incident to the discernment of new truth which often colours and warms the pages of Mr. Darwin. His success has been great; and this implies not only the solidity of his work, but the preparedness of the public mind for such a revelation. On this head a remark of Agassiz impressed me more than anything else. Sprung from a race of theologians,

this celebrated man combated to the last the theory of natural selection. One of the many times I had the pleasure of meeting him in the United States was at Mr. Winthrop's beautiful residence at Brookline, near Boston. Rising from luncheon, we all halted as if by a common impulse in front of a window, and continued there a discussion which had been started at table. The maple was in its autumn glory; and the exquisite beauty of the scene outside seemed, in my case, to interpenetrate without disturbance the intellectual action. Earnestly, almost sadly, Agassiz turned, and said to the gentlemen standing round, 'I confess that I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible.'

In our day grand generalizations have been reached. The theory of the origin of species is but one of them. Another, of still wider grasp and more radical significance, is the doctrine of the Conservation of Energy, the ultimate philosophical issues of which are as yet but dimly seen—that doctrine which 'binds nature fast in fate' to an extent not hitherto recognized, exacting from every antecedent its equivalent consequent, from every consequent its equivalent antecedent, and bringing vital as well as physical phenomena under the dominion of that law of causal connexion which, so far as the human understanding has yet pierced, asserts itself everywhere in nature. Long in advance of all definite experiment upon the subject, the constancy and indestructibility of matter had been affirmed; and all subsequent experience justified the affirmation. Later researches extended the attribute of indestructibility to force. This idea, applied in the first instance to inorganic, rapidly embraced organic nature. The vegetable world, though drawing almost all its

nutriment from invisible sources, was proved incompetent to generate anew either matter or force. Its matter is for the most part transmuted gas; its force transformed solar force. The animal world was proved to be equally uncreative, all its motive energies being referred to the combustion of its food. The activity of each animal as a whole was proved to be the transferred activity of its molecules. The muscles were shown to be stores of mechanical force, potential until unlocked by the nerves, and then resulting in muscular contractions. The speed at which messages fly to and fro along the nerves was determined, and found to be, not as had been previously supposed, equal to that of light or electricity, but less than the speed of a flying eagle.

This was the work of the physicist: then came the conquests of the comparative anatomist and physiologist, revealing the structure of every animal, and the function of every organ in the whole biological series, from the lowest zoophyte up to man. The nervous system had been made the object of profound and continued study, the wonderful and, at bottom, entirely mysterious, controlling power which it exercises over the whole organism, physical and mental, being recognized more and more. Thought could not be kept back from a subject so profoundly suggestive. Besides the physical life dealt with by Mr. Darwin, there is a psychical life presenting similar gradations, and asking equally for a solution. How are the different grades and order of Mind to be accounted for? What is the principle of growth of that mysterious power which on our planet culminates in Reason? These are questions which, though not thrusting themselves so forcibly upon the attention of the general public, had not only occupied many reflecting minds, but had been formally broached by one of them before the 'Origin of Species' appeared.

With the mass of materials furnished by the physicist and physiologist in his hands, Mr. Herbert Spencer, twenty years ago, sought to graft upon this basis a system of psychology; and two years ago a second and greatly amplified edition of his work appeared. Those who have occupied themselves with the beautiful experiments of Plateau will remember that when two spherules of olive-oil, suspended in a mixture of alcohol and water of the same density as the oil, are brought together, they do not immediately unite. Something like a pellicle appears to be formed around the drops, the rupture of which is immediately followed by the coalescence of the globules into one. There are organisms whose vital actions are almost as purely physical as that of these drops of oil. They come into contact and fuse themselves thus together. From such organisms to others a shade higher, and from these to others a shade higher still, and on through an ever-ascending series, Mr. Spencer conducts his argument. There are two obvious factors to be here taken into account—the creature and the medium in which it lives, or, as it is often expressed, the organism and its environment. Mr. Spencer's fundamental principle is that between these two factors there is incessant interaction. The organism is played upon by the environment, and is modified to meet the requirements of the environment. Life he defines to be 'a continuous adjustment of internal relations to external relations.'

In the lowest organisms we have a kind of tactual sense diffused over the entire body; then, through impressions from without and their corresponding adjustments, special portions of the surface become more responsive to stimuli than others. The senses are nascent, the basis of all of them being that simple tactual sense which the sage Democritus recognised 2,300 years

ago as their common progenitor. The action of light, in the first instance, appears to be a mere disturbance of the chemical processes in the animal organism, similar to that which occurs in the leaves of plants. By degrees the action becomes localized in a few pigment-cells, more sensitive to light than the surrounding tissue. The eye is here incipient. At first it is merely capable of revealing differences of light and shade produced by bodies close at hand. Followed as the interception of the light is in almost all cases by the contact of the closely adjacent opaque body, sight in this condition becomes a kind of 'anticipatory touch.' The adjustment continues; a slight bulging out of the epidermis over the pigment-granules supervenes. A lens is incipient, and, through the operation of infinite adjustments, at length reaches the perfection that it displays in the hawk and eagle. So of the other senses; they are special differentiations of a tissue which was originally vaguely sensitive all over.

With the development of the senses the adjustments between the organism and its environment gradually extend in *space*, a multiplication of experiences and a corresponding modification of conduct being the result. The adjustments also extend in *time*, covering continually greater intervals. Along with this extension in space and time the adjustments also increase in specialty and complexity, passing through the various grades of brute life, and prolonging themselves into the domain of reason. Very striking are Mr. Spencer's remarks regarding the influence of the sense of touch upon the development of intelligence. This is, so to say, the mother-tongue of all the senses, into which they must be translated to be of service to the organism. Hence its importance. The parrot is the most intelligent of birds, and its tactual power is also greatest. From this sense it gets know-

ledge unattainable by birds which cannot employ their feet as hands. The elephant is the most sagacious of quadrupeds—its tactual range and skill, and the consequent multiplication of experiences, which it owes to its wonderfully adaptable trunk, being the basis of its sagacity. Feline animals, for a similar cause, are more sagacious than hoofed animals—atonement being to some extent made, in the case of the horse, by the possession of sensitive prehensile lips. In the *Primates* the evolution of intellect and the evolution of tactual appendages go hand in hand. In the most intelligent anthropoid apes we find the tactual range and delicacy greatly augmented, new avenues of knowledge being thus open to the animal. Man crowns the edifice here, not only in virtue of his own manipulatory power, but through the enormous extension of his range of experience, by the invention of instruments of precision, which serve as supplemental senses and supplemental limbs. The reciprocal action of these is finely described and illustrated. That chastened intellectual emotion to which I have referred in connexion with Mr. Darwin is not absent in Mr. Spencer. His illustrations possess at times exceeding vividness and force; and from his style on such occasions it is to be inferred that the ganglia of this Apostle of the Understanding are sometimes the seat of a nascent poetic thrill.

It is a fact of supreme importance that actions the performance of which at first requires even painful effort and deliberation may by habit be rendered automatic. Witness the slow learning of its letters by a child, and the subsequent facility of reading in a man, when each group of letters which forms a word is instantly, and without effort, fused to a single perception. Instance the billiard-player, whose muscles of hand and eye, when he reaches the perfection of his art, are unconsciously

coördinated. Instance the musician, who, by practice, is enabled to fuse a multitude of arrangements, auditory, tactual, and muscular, into a process of automatic manipulation. Combining such facts with the doctrine of hereditary transmission, we reach a theory of Instinct. A chick, after coming out of the egg, balances itself correctly, runs about, picks up food, thus showing that it possesses a power of directing its movements to definite ends. How did the chick learn this very complex coördination of eye, muscles, and beak? It has not been individually taught; its personal experience is *nil;* but it has the benefit of ancestral experience. In its inherited organization are registered all the powers which it displays at birth. So also as regards the instinct of the hive-bee, already referred to. The distance at which the insects stand apart when they sweep their hemispheres and build their cells is 'organically remembered.'

Man also carries with him the physical texture of his ancestry, as well as the inherited intellect bound up with it. The defects of intelligence during infancy and youth are probably less due to a lack of individual experience than to the fact that in early life the cerebral organization is still incomplete. The period necessary for completion varies with the race and with the individual. As a round shot outstrips a rifled one on quitting the muzzle of the gun, so the lower race in childhood may outstrip the higher. But the higher eventually overtakes the lower, and surpasses it in range. As regards individuals, we do not always find the precocity of youth prolonged to mental power in maturity; while the dulness of boyhood is sometimes strikingly contrasted with the intellectual energy of after years. Newton, when a boy, was weakly, and he showed no particular aptitude at school; but in his eighteenth year he went to Cambridge, and soon afterwards aston-

ished his teachers by his power of dealing with geometrical problems. During his quiet youth his brain was slowly preparing itself to be the organ of those energies which he subsequently displayed.

By myriad blows (to use a Lucretian phrase) the image and superscription of the external world are stamped as states of consciousness upon the organism, the depth of the impression depending upon the number of the blows. When two or more phenomena occur in the environment invariably together, they are stamped to the same depth or to the same relief, and indissolubly connected. And here we come to the threshold of a great question. Seeing that he could in no way rid himself of the consciousness of Space and Time, Kant assumed them to be necessary 'forms of intuition,' the moulds and shapes into which our intuitions are thrown, belonging to ourselves solely and without objective existence. With unexpected power and success Mr. Spencer brings the hereditary experience theory, as he holds it, to bear upon this question. 'If there exist certain external relations which are experienced by all organisms at all instants of their waking lives—relations which are absolutely constant and universal—there will be established answering internal relations that are absolutely constant and universal. Such relations we have in those of Space and Time. As the substratum of all other relations of the Non-Ego, they must be responded to by conceptions that are the substrata of all other relations in the Ego. Being the constant and infinitely repeated elements of thought, they must become the automatic elements of thought—the elements of thought which it is impossible to get rid of—the "forms of intuition."'

Throughout this application and extension of the 'Law of Inseparable Association,' Mr. Spencer stands upon his

own ground, invoking, instead of the experiences of the individual, the registered experiences of the race. His overthrow of the restriction of experience to the individual is, I think, complete. That restriction ignores the power of organizing experience furnished at the outset to each individual; it ignores the different degrees of this power possessed by different races and by different individuals of the same race. Were there not in the human brain a potency antecedent to all experience, a dog or cat ought to be as capable of education as a man. These predetermined internal relations are independent of the experiences of the individual. The human brain is the 'organised register of infinitely numerous experiences received during the evolution of life, or rather during the evolution of that series of organisms through which the human organism has been reached. The effects of the most uniform and frequent of these experiences have been successively bequeathed, principal and interest, and have slowly mounted to that high intelligence which lies latent in the brain of the infant. Thus it happens that the European inherits from twenty to thirty cubic inches more of brain than the Papuan. Thus it happens that faculties, as of music, which scarcely exist in some inferior races, become congenital in superior ones. Thus it happens that out of savages unable to count up to the number of their fingers, and speaking a language containing only nouns and verbs, arise at length our Newtons and Shakespeares.'

At the outset of this Address it was stated that physical theories which lie beyond experience are derived by a process of abstraction from experience. It is instructive to note from this point of view the successive introduction of new conceptions. The idea of the attrac-

tion of gravitation was preceded by the observation of the attraction of iron by a magnet, and of light bodies by rubbed amber. The polarity of magnetism and electricity appealed to the senses; and thus became the substratum of the conception that atoms and molecules are endowed with definite, attractive, and repellent poles, by the play of which definite forms of crystalline architecture are produced. Thus molecular force becomes *structural*. It required no great boldness of thought to extend its play into organic nature, and to recognize in molecular force the agency by which both plants and animals are built up. In this way out of experience arise conceptions which are wholly ultra-experiential. None of the atomists of antiquity had any notion of this play of molecular polar force, but they had experience of gravity as manifested by falling bodies. Abstracting from this, they permitted their atoms to fall eternally through empty space. Democritus assumed that the larger atoms moved more rapidly than the smaller ones, which they therefore could overtake, and with which they could combine. Epicurus, holding that empty space could offer no resistance to motion, ascribed to all the atoms the same velocity; but he seems to have overlooked the consequence that under such circumstances the atoms could never combine. Lucretius cut the knot by quitting the domain of physics altogether, and causing the atoms to move together by a kind of volition.

Was the instinct utterly at fault which caused Lucretius thus to swerve from his own principles? Diminishing gradually the number of progenitors, Mr. Darwin comes at length to one 'primordial form;' but he does not say, as far as I remember, how he supposes this form to have been introduced. He quotes with satisfaction the words of a celebrated author and divine who had 'gradually

learnt to see that it is just as noble a conception of the Deity to believe He created a few original forms, capable of self-development into other and needful forms, as to believe that He required a fresh act of creation to supply the voids caused by the action of His laws.' What Mr. Darwin thinks of this view of the introduction of life I do not know. But the anthropomorphism, which it seemed his object to set aside, is as firmly associated with the creation of a few forms as with the creation of a multitude. We need clearness and thoroughness here. Two courses and two only, are possible. Either let us open our doors freely to the conception of creative acts, or, abandoning them, let us radically change our notions of Matter. If we look at matter as pictured by Democritus, and as defined for generations in our scientific text-books, the notion of any form of life whatever coming out of it is utterly unimaginable. The argument placed in the mouth of Bishop Butler suffices, in my opinion, to crush all such materialism as this. But those who framed these definitions of matter were not biologists but mathematicians, whose labours referred only to such accidents and properties of matter as could be expressed in their formulæ. The very intentness with which they pursued mechanical science turned their thoughts aside from the science of life. May not their imperfect definitions be the real cause of our present dread? Let us reverently, but honestly, look the question in the face. Divorced from matter, where is life to be found? Whatever our *faith* may say, our *knowledge* shows them to be indissolubly joined. Every meal we eat, and every cup we drink, illustrates the mysterious control of Mind by Matter.

Trace the line of life backwards, and see it approaching more and more to what we call the purely physical

condition. We come at length to those organisms which I have compared to drops of oil suspended in a mixture of alcohol and water. We reach the *protogenes* of Haeckel, in which we have 'a type distinguishable from a fragment of albumen only by its finely granular character.' Can we pause here? We break a magnet and find two poles in each of its fragments. We continue the process of breaking, but, however small the parts, each carries with it, though enfeebled, the polarity of the whole. And when we can break no longer, we prolong the intellectual vision to the polar molecules. Are we not urged to do *something* similar in the case of life? Is there not a temptation to close to some extent with Lucretius, when he affirms that 'nature is seen to do all things spontaneously of herself without the meddling of the gods?' or with Bruno, when he declares that Matter is not 'that mere empty capacity which philosophers have pictured her to be, but the universal mother who brings forth all things as the fruit of her own womb?' Believing as I do in the continuity of Nature, I cannot stop abruptly where our microscopes cease to be of use. Here the vision of the mind authoritatively supplements the vision of the eye. By an intellectual necessity I cross the boundary of the experimental evidence, and discern in that Matter which we, in our ignorance of its latent powers, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of all terrestial Life.

If you ask me whether there exists the least evidence to prove that any form of life can be developed out of matter, without demonstrable antecedent life, my reply is that evidence considered perfectly conclusive by many has been adduced; and that were some of us who have pondered this question to follow a very common example, and

accept testimony because it falls in with our belief, we also should eagerly close with the evidence referred to. But there is in the true man of science a wish stronger than the wish to have his beliefs upheld; namely, the wish to have them true. And this stronger wish causes him to reject the most plausible support if he has reason to suspect that it is vitiated by error. Those to whom I refer as having studied this question, believing the evidence offered in favour of 'spontaneous generation' to be thus vitiated, cannot accept it. They know full well that the chemist now prepares from inorganic matter a vast array of substances which were some time ago regarded as the sole products of vitality. They are intimately acquainted with the structural power of matter as evidenced in the phenomena of crystallization. They can justify scientifically their *belief* in its potency, under the proper conditions, to produce organisms. But in reply to your question they will frankly admit their inability to point to any satisfactory experimental proof that life can be developed save from demonstrable antecedent life. As already indicated, they draw the line from the highest organisms through lower ones down to the lowest, and it is the prolongation of this line by the intellect beyond the range of the senses that leads them to the conclusion which Bruno so boldly enunciated.[1]

The 'materialism' here professed may be vastly different from what you suppose, and I therefore crave your gracious patience to the end. 'The question of an external world,' says Mr. J. S. Mill, 'is the great battle-ground of metaphysics.'[2] Mr. Mill himself reduces external phenomena to 'possibilities of sensation.' Kant, as we have seen, made time and space 'forms' of our

[1] Bruno was a 'Pantheist,' not an 'Atheist' or a 'Materialist.'

[2] *Examination of Hamilton*, p. 154.

own intuitions. Fichte, having first by the inexorable logic of his understanding proved himself to be a mere link in that chain of eternal causation which holds so rigidly in Nature, violently broke the chain by making Nature, and all that it inherits, an apparition of his own mind.[1] And it is by no means easy to combat such notions. For when I say I see you, and that I have not the least doubt about it, the reply is, that what I am really conscious of is an affection of my own retina. And if I urge that I can check my sight of you by touching you, the retort would be that I am equally transgressing the limits of fact; for what I am really conscious of is, not that you are there, but that the nerves of my hand have undergone a change. All we hear, and see, and touch, and taste, and smell, are, it would be urged, mere variations of our own condition, beyond which, even to the extent of a hair's breadth, we cannot go. That anything answering to our impressions exists outside of ourselves is not a *fact*, but an *inference*, to which all validity would be denied by an idealist like Berkeley, or by a sceptic like Hume. Mr. Spencer takes another line. With him, as with the uneducated man, there is no doubt or question as to the existence of an external world. But he differs from the uneducated, who think that the world really *is* what consciousness represents it to be. Our states of consciousness are mere *symbols* of an outside entity which produces them and determines the order of their succession, but the real nature of which we can never know.[2] In fact, the whole process of evolution is the manifestation of a Power absolutely inscrutable

[1] *Bestimmung des Menschen.*

[2] In a paper, at once popular and profound, entitled *Recent Progress in the Theory of Vision*, contained in the volume of Lectures by Helmholtz, published by Longmans, this symbolism of our states of

to the intellect of man. As little in our day as in the days of Job can man by searching find this Power out. Considered fundamentally, then, it is by the operation of an insoluble mystery that life on earth is evolved, species differentiated, and mind unfolded from their prepotent elements in the immeasurable past. There is, you will observe, no very rank materialism here.

The strength of the doctrine of evolution consists, not in an experimental demonstration (for the subject is hardly accessible to this mode of proof), but in its general harmony with scientific thought. From contrast, moreover, it derives enormous relative strength. On the one side we have a theory (if it could with any propriety be so called) derived, as were the theories referred to at the beginning of this Address, not from the study of Nature, but from the observation of men—a theory which converts the Power whose garment is seen in the visible universe into an Artificer, fashioned after the human model, and acting by broken efforts, as man is seen to act. On the other side, we have the conception that all we see around us, and all we feel within us—the phenomena of physical nature as well as those of the human

consciousness is also dwelt upon. The impressions of sense are the mere *signs* of external things. In this paper Helmholtz contends strongly against the view that the consciousness of space is inborn; and he evidently doubts the power of the chick to pick up grains of corn without preliminary lessons. On this point, he says, further experiments are needed. Such experiments have been since made by Mr. Spalding, aided, I believe, in some of his observations by the accomplished and deeply lamented Lady Amberly; and they seem to prove conclusively that the chick does not need a single moment's tuition to enable it to stand, run, govern the muscles of its eyes, and to peck. Helmholtz, however, is contending against the notion of pre-established harmony; and I am not aware of his views as to the organisation of experiences of race or breed.

mind—have their unsearchable roots in a cosmical life, if I dare apply the term, an infinitesimal span of which is offered to the investigation of man. And even this span is only knowable in part. We can trace the development of a nervous system, and correlate with it the parallel phenomena of sensation and thought. We see with undoubting certainty that they go hand in hand. But we try to soar in a vacuum the moment we seek to comprehend the connexion between them. An Archimedean fulcrum is here required which the human mind cannot command; and the effort to solve the problem, to borrow a comparison from an illustrious friend of mine, is like the effort of a man trying to lift himself by his own waistband. All that has been here said is to be taken in connexion with this fundamental truth. When 'nascent senses' are spoken of, when 'the differentiation of a tissue at first vaguely sensitive all over' is spoken of, and when these processes are associated with 'the modification of an organism by its environment,' the same parallelism, without contact, or even approach to contact, is implied. Man the *object* is separated by an impassable gulf from man the *subject*. There is no motor energy in intellect to carry it without logical rupture from the one to the other.

Further, the doctrine of evolution derives man in his totality from the inter-action of organism and environment through countless ages past. The Human Understanding, for example—that faculty which Mr. Spencer has turned so skilfully round upon its own antecedents—is itself a result of the play between organism and environment through cosmic ranges of time. Never surely did prescription plead so irresistible a claim. But then it comes to pass that, over and above his understanding,

there are many other things appertaining to man whose perspective rights are quite as strong as those of the understanding itself. It is a result, for example, of the play of organism and environment that sugar is sweet and that aloes are bitter, that the smell of henbane differs from the perfume of a rose. Such facts of consciousness (for which, by the way, no adequate reason has yet been rendered) are quite as old as the understanding; and many other things can boast an equally ancient origin. Mr. Spencer at one place refers to that most powerful of passions—the amatory passion—as one which, when it first occurs, is antecedent to all relative experience whatever; and we may pass its claim as being at least as ancient and valid as that of the understanding. Then there are such things woven into the texture of man as the feeling of Awe, Reverence, Wonder—and not alone the sexual love just referred to, but the love of the beautiful, physical, and moral, in Nature, Poetry, and Art. There is also that deep-set feeling which, since the earliest dawn of history, and probably for ages prior to all history, incorporated itself in the Religions of the world. You who have escaped from these religions into the high-and-dry light of the intellect may deride them; but in so doing you deride accidents of form merely, and fail to touch the immovable basis of the religious sentiment in the nature of man. To yield this sentiment reasonable satisfaction is the problem of problems at the present hour. And grotesque in relation to scientific culture as many of the religions of the world have been and are—dangerous, nay destructive, to the dearest privileges of freemen as some of them undoubtedly have been, and would, if they could, be again—it will be wise to recognize them as the forms of a force, mischievous, if permitted to

intrude on the region of *knowledge*, over which it holds no command, but capable of being guided to noble issues in the region of *emotion*, which is its proper and elevated sphere.

All religious theories, schemes and systems, which embrace notions of cosmogony, or which otherwise reach into the domain of science, must, *in so far as they do this*, submit to the control of science, and relinquish all thought of controlling it. Acting otherwise proved disastrous in the past, and it is simply fatuous to-day. Every system which would escape the fate of an organism too rigid to adjust itself to its environment must be plastic to the extent that the growth of knowledge demands. When this truth has been thoroughly taken in, rigidity will be relaxed, exclusiveness diminished, things now deemed essential will be dropped, and elements now rejected will be assimilated. The lifting of the life is the essential point; and as long as dogmatism, fanaticism, and intolerance are kept out, various modes of leverage may be employed to raise life to a higher level. Science itself not unfrequently derives motive power from an ultra-scientific source. Whewell speaks of enthusiasm of temper as a hindrance to science; but he means the enthusiasm of weak heads. There is a strong and resolute enthusiasm in which science finds an ally; and it is to the lowering of this fire, rather than to the diminution of intellectual insight, that the lessening productiveness of men of science in their mature years is to be ascribed. Mr. Buckle sought to detach intellectual achievement from moral force. He gravely erred; for without moral force to whip it into action, the achievements of the intellect would be poor indeed.

It has been said that science divorces itself from literature; but the statement, like so many others, arises from

lack of knowledge. A glance at the less technical writings of its leaders—of its Helmholtz, its Huxley, and its Du Bois-Reymond—would show what breadth of literary culture they command. Where among modern writers can you find their superiors in clearness and vigour of literary style? Science desires not isolation, but freely combines with every effort towards the bettering of man's estate. Single-handed, and supported not by outward sympathy, but by inward force, it has built at least one great wing of the many-mansioned home which man in his totality demands. And if rough walls and protruding rafter-ends indicate that on one side the edifice is still incomplete, it is only by wise combination of the parts required with those already irrevocably built that we can hope for completeness. There is no necessary incongruity between what has been accomplished and what remains to be done. The moral glow of Socrates, which we all feel by ignition, has in it nothing incompatible with the physics of Anaxagoras which he so much scorned, but which he would hardly scorn to-day.

And here I am reminded of one amongst us, hoary, but still strong, whose prophet-voice some thirty years ago, far more than any other of this age, unlocked whatever of life and nobleness lay latent in its most gifted minds—one fit to stand beside Socrates or the Maccabean Eleazar, and to dare and suffer all that they suffered and dared—fit, as he once said of Fichte, 'to have been the teacher of the Stoa, and to have discoursed of Beauty and Virtue in the groves of Academe.' With a capacity to grasp physical principles which his friend Goethe did not possess, and which even total lack of exercise has not been able to reduce to atrophy, it is the world's loss that he, in the vigour of his years, did not open his mind and sympathies

to science, and make its conclusions a portion of his message to mankind. Marvellously endowed as he was—equally equipped on the side of the Heart and of the Understanding—he might have done much towards teaching us how to reconcile the claims of both, and to enable them in coming times to dwell together in unity of spirit and in the bond of peace.

And now the end is come. With more time, or greater strength and knowledge, what has been here said might have been better said, while worthy matters here omitted might have received fit expression. But there would have been no material deviation from the views set forth. As regards myself, they are not the growth of a day; and as regards you, I thought you ought to know the environment which, with or without your consent, is rapidly surrounding you, and in relation to which some adjustment on your part may be necessary. A hint of Hamlet's, however, teaches us all how the troubles of common life may be ended; and it is perfectly possible for you and me to purchase intellectual peace at the price of intellectual death. The world is not without refuges of this description; nor is it wanting in persons who seek their shelter and try to persuade others to do the same. The unstable and the weak will yield to this persuasion, and they to whom repose is sweeter than the truth. But I would exhort you to refuse the offered shelter and to scorn the base repose—to accept, if the choice be forced upon you, commotion before stagnation, the leap of the torrent before the stillness of the swamp.

In the course of this Address I have touched on debatable questions and led you over what will be deemed dangerous ground—and this partly with the view of telling you that as regards these questions science claims unrestricted

right of search. It is not to the point to say that the views of Lucretius and Bruno, of Darwin and Spencer, may be wrong. Here I should agree with you, deeming it indeed certain that these views will undergo modification. But the point is, that, whether right or wrong, we ask the freedom to discuss them. For science, however, no exclusive claim is here made; you are not urged to erect it into an idol. The inexorable advance of man's understanding in the path of knowledge, and those unquenchable claims of his moral and emotional nature which the understanding can never satisfy, are here equally set forth. The world embraces not only a Newton, but a Shakespeare—not only a Boyle, but a Raphael—not only a Kant, but a Beethoven—not only a Darwin, but a Carlyle. Not in each of these, but in all, is human nature whole. They are not opposed, but supplementary—not mutually exclusive, but reconcilable. And if, unsatisfied with them all, the human mind, with the yearning of a pilgrim for his distant home, will turn to the Mystery from which it has emerged, seeking so to fashion it as to give unity to thought and faith; so long as this is done, not only without intolerance or bigotry of any kind, but with the enlightened recognition that ultimate fixity of conception is here unattainable, and that each succeeding age must be held free to fashion the Mystery in accordance with its own needs—then, casting aside all the restrictions of Materialism, I would affirm this to be a field for the noblest exercise of what, in contrast with the *knowing* faculties, may be called the *creative* faculties of man.

'Fill thy heart with it,' said Goethe, 'and then name it as thou wilt.' Goethe himself did this in untranslateable language.[1] Wordsworth did it in words known to

[1] Procœmium to 'Gott und Welt.'

all Englishmen, and which may be regarded as a forecast and religious vitalization of the latest and deepest scientific truth,—

> 'For I have learned
> To look on nature; not as in the hour
> Of thoughtless youth; but hearing oftentimes
> The still, sad music of humanity,
> Nor harsh nor grating, though of ample power
> To chasten and subdue. *And I have felt*
> *A presence that disturbs me with the joy*
> *Of elevated thoughts; a sense sublime*
> *Of something far more deeply interfused,*
> *Whose dwelling is the light of setting suns,*
> *And the round ocean, and the living air,*
> *And the blue sky, and in the mind of man:*
> *A motion and a spirit, that impels*
> *All thinking things, all objects of all thought,*
> *And rolls through all things.'* [1]

[1] Tintern Abbey.

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