DARWINISM AND DESIGN;

OR,

CREATION BY EVOLUTION.

BY

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"I feel profoundly convinced that the argument of Design has been greatly too much lost sight of in recent zoological speculations."—Sir W. THOMSON: *Address to Brit. Assoc.*, 1871.

"It is necessary to remember that there is a wider Teleology, which is not touched by the doctrine of Evolution, but is actually based upon the fundamental proposition of Evolution."—Prof. HUXLEY: *Academy*, Oct. 1869.

"Indeed, it is perhaps not too much to say that the more fully this conception of universal Evolution is grasped, the more firmly a scientific doctrine of Providence will be established, and the stronger will be the presumption of a future progress."—LECKY: *History of Rationalism*, vol. i. p. 317.

"——— I see in part
That all, as in some piece of art,
Is toil co-operant to an end."

—TENNYSON: *In Memoriam.*

PREFACE.

It is being assumed by our scientific guides that the Design argument has been driven out of the field by the Doctrine of Evolution. It seems to be thought by our theological teachers that the best defence of the faith is to deny Evolution *in toto,* and denounce it as antibiblical. My volume endeavours to show that if Evolution be true all is not lost, but on the contrary something is gained; the Design argument remains unshaken, and the Wisdom and Beneficence of God receive new illustration.

For the scientific facts on which the arguments of the book are founded, I am of course indebted to the great Biological writers of the day; and sometimes I use their very language, to guard the more surely against error; but the general treatment of the subject is entirely my own. So far as I know, the subject has never before been handled by any one in the same way for the same purpose.

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DARWINISM AND DESIGN.

CHAPTER I.

THE WISDOM AND BENEFICENCE OF THE ALMIGHTY ADMIT OF PROOF AND ILLUSTRATION.

THE purpose of this Essay being to illustrate the Wisdom and Beneficence of the Almighty in the evolution of living things, it might be permitted to the writer to take for granted the existence of a Divine Being, and the possession by Him of those attributes; but seeing that some prominent teachers of Evolution have asserted its inconsistency with Design in nature, or at least with our ability to perceive design, it seems desirable to show at the outset that the endeavour to be made in this Essay is not in its nature destined to fail. It need not be attempted here to prove and illustrate the Divine Beneficence and Wisdom, but only to show that there is no *à priori* impossibility in the way of proving them, and that the Theory of Evolution may be accepted without banishing the Almighty to the region of the unknowable.

Mr Herbert Spencer asserts that the explanation of the teleologist is untrue, though often an obverse to the truth; that, on the hypothesis of Evolution, it is clear that things are not arranged thus or thus for the securing of special ends, though it is also clear that arrangements which *do* secure these special ends tend continually to establish themselves—are established by their fulfilment of these ends.[1] Mr Darwin also seems to deny Design, when he says that however much we may wish it, we can hardly follow Professor Asa Gray in his belief "that variation has been led along certain beneficial lines," like a stream "along definite and useful lines of irrigation."[2] Professor Haeckel again, Darwin's great disciple in Germany, so disbelieves in design or teleology that he has invented the term "*dys*-teleology" for the study of the "purposelessnesses" observable in living organisms. These views are no doubt honestly expressed; but while accepting in the main the teaching of these philosophers on the subject of Evolution, we consider that the Design argument rests on as good a basis as before, and even receives new illustration.

The fundamental proposition of Evolution is, that "the whole world, living and not living, is the result of the mutual interaction, according to laws, of the forces possessed by the molecules of which the primitive nebulosity of the universe was composed."[3] There is nothing to be afraid of in this; for it is but the application to suns and planets, and to living things, of that which is familiarly known to be true of smaller and not-living things—that there is a cause for the present form and position of each, and a cause of *that* cause; that *every* effect has its cause. It is difficult to see why

[1] *Principles of Biology*, i. 234.
[2] *Variation of Animals and Plants*, ii. 432.
[3] Huxley, in *Academy*, October 1869.

Design need fare any worse in the presence of universal Evolution than it did before this philosophy assumed such grand proportions—in the days when the dominion of cause and effect was not known to be so limitless in space and in time.

As the first step in our argument, it may be well to show that the sway of natural law, or the rule that every event has a natural cause or causes, does not exclude the action of human *will* in some cases, as a force producing a new resultant. At the command of Jehu "two or three eunuchs" threw Jezebel out of a window.[1] As the body descended, a philosopher might have remarked that the line of its motion was a parabolic curve, and the velocity of descent constantly accelerated—16 feet in the first second, 48 feet in the next, and so on, in obedience to the law of gravity. The curvature of the line would indicate that, besides gravity, there was a projectile force, which, if it were traced to the muscles of the eunuchs' arms, would by no means bring one to the end of the inquiry. The motion of the muscles resulted from heat, liberated by the oxidation of the muscles themselves, and previously stored up in the arm through the food taken into the stomach. The food grew in the shape of sheep and corn; the sheep were dependent on grass; the corn and grass depended on rain and sunshine; the rain itself was raised in vapour from the sea through the action of the sun's rays—the source of all the motion is in the sun, and the current of successively dependent natural events, from that source downwards, is unbroken. Unbroken but *diverted*, new-directed; for at some point the stream of events was touched by the volition of the

[1] 2 Kings, chapter ix.

eunuchs, and the afterflow was such as Jehu desired and the eunuchs determined. Certainly, as Professor Huxley says, our volition counts for something as a condition of the course of events—a truth which can be verified experimentally as often as we like to try, and therefore one of our highest truths;[1] and to pass by volition in the above case was like tracing back for the source of a river by one of its branches, and overlooking the important tributary which came in at the fork. It seems a fair inference from this, that the continued necessary evolution of new states and events from those which preceded is not of itself a disproof of the existence of a Will superior to man's, and "counting for" more than man's as a condition of events that fall out.

It will of course be said that each portion of energy exerted by a man—energy of will as well as mechanical energy—implies the transformation of as much organic matter as contained this energy in a latent state; that *will* force also is transformed sun force, and volition one of the necessary events in a line of events serially dependent. Human will is part of the universe of things—its force part of the general sum of force—and to make a show of proving that the Will that formed and controls the universe is at the same time a part of it would be irreverent and absurd. Not disputing the force of this, it may still be shown that the fount and origin of a stream or chain of events may be of the same nature as some one particular event of the series. The heat given out by an ordinary fire is so much force in that particular form: the fuel once grew as vegetation, and the vegetation maintained its life through chemical action aided by the sun's rays. The heat

[1] *On the Physical Basis of Life.*

force now given out by the fire is the equivalent of that which was derived from the sun, and it is of a similar kind (for the sun is incandescent), and can do similar work (*e.g.*, can cause the evaporation of water), the difference being chiefly one of degree, though the sun is the originator of a series of phenomena, and the glowing coal has its place *in* the series. It seems fair to infer from this, that the fact of human volition having its place in a line of events serially dependent is not of itself a disproof that a similar though greater Will originated the series.

Further, if there be a greater Will than ours, it *must* be of similar kind to ours, the difference being chiefly in degree. Mr Spencer says that we everywhere see fading away the anthropomorphic conception of the Unknown Cause: in one case after another is abandoned that interpretation which ascribes phenomena to a will analogous to the human will, working by methods analogous to human methods.[1] But Mr Spencer has just referred to epidemics regarded as punishments inflicted by an angry Deity. Of course, we do not suppose that human whim or caprice would have its analogue in the Divine mind. But mind is mind, will is will, the universe over. A will not at all like a will would be a contradiction. Mind does not cease to be mind because it is great, nor even because it is infinite. The infinite differs from the finite, but the difference is not in all respects: that which makes each to be a mind remains unchanged, for it is the same in both.

Still further: if a greater Will operated in nature, making itself to be felt—to "count for something as a condition of the course of events"—its action would be

[1] *Principles of Biology*, i. 335.

of the same kind as that of human wills in this respect, that it would not violate natural law, but work by means of it; and the results would appear to come about by natural processes, much as in the illustration given of Jehu and Jezebel. Truth is eternal and unchangeable—persistently the same;—and the truths of mathematics must be seen to be truths, as well by the highest mind as by the lowest mind that can understand a demonstration. Matter exists—persists in existence;—it moves, and the laws of motion are necessary and unalterable; and to various modes of motion are traceable the phenomena of the universe. When human will operates, it is like another force striking a body which is already moving under the influence of one or more forces, and it of course produces a new resultant, the resultant which was willed. What the volition can effect is conditioned by the proportion of its force to the other forces concerned, and the antagonism of the angle at which it strikes in. All changes effected are but new collocations given to matter, new directions given to force. Greater wills can do more than lesser wills; but to the one as well as the other, matter, motion, the laws of motion, force, are the same; with the one as well as the other, the result of action is to produce the condition of things which is willed, and to leave the chain of natural causes unbroken. If the Will be Supreme, by which we mean, if it be the will of an Infinite Intelligence, all the relations and possibilities of things will be seen at a glance; the impossible will never be attempted; the possible will present no difficulty; *skill*, in the sense of *contrivance* to overcome *actual obstacles*, will be out of the question; yet, since the nature of things will remain the same, means and processes will be used, because they are the *right* means to produce the result. Wisdom shows itself in recognising the nature of things, the necessary conditions of action, and in adjusting suitable means to required ends, without mistake or tentative experiment, and waiting patiently for the sure result. Therefore, if it be true that triangles and ellipses have unchanging properties, that bodies moving in straight lines must continue so to move unless obstructed, that a number of bodies revolving about a centre, and attracting one another with a force varying inversely as the square of the distance, *must* have the squares of their periodic times related as the cubes of their mean distances, &c. &c., it follows that the working of Infinite Intelligence will show results which conform to "natural law," and in their nature admit of being compared with the results of man's intelligence. Mr Lewes complains that there is a traditional phrase much in vogue among the anthropomorphists, which arose naturally enough from the tendency to take human method as an explanation of the Divine—a phrase which becomes a sort of argument—"The Great Architect."[1] But unless there can be two sorts of geometrical truth, and two sets of laws to govern moving bodies, or two utterly distinct attributes, each of which deserves to be called Intelligence, a great will becoming a great worker might fairly be called a great architect. If man is really made in the image of God, so far as intelligence is concerned, though his capacity to discern truth be small, yet let him not deny its genuineness so far as it goes, and refuse to rise to his divine position because it may seem like degrading God to the human level. They judge much better,

[1] *Fortnightly Review*, June 1868.

says Maclaurin, who, without scruple, measure the Divine Omnipotence itself, and the possibility of things, by their own clear ideas concerning them; affirming that God himself cannot make contradictions to be true at the same time, and represent the certain part of our knowledge in some degree as the knowledge and wisdom of the Deity imparted to us, in the views of nature which He has laid before us.[1]

Is there, then, such a Will and Intelligence above us? Mr Spencer asks, Is it not just possible that there is a mode of being as much *transcending* Intelligence and Will as these transcend mechanical motion?[2] It is difficult to admit the possibility. He thinks that the Ultimate Cause cannot in any respect be conceived by us, because it is in every respect greater than can be conceived (*sic*); and asks, May we not therefore rightly refrain from assigning to it any attributes whatever, on the ground that such attributes, derived as they must be from our own natures, are not elevations but degradations? All that Mr Spencer says is the result of deep thought, and deserves to be pondered; but would it not follow from such reasoning, that we know nothing of Space, and should refrain from ascribing to it extension, or defining it as "unoccupied extension," because Space is infinite, and the infinite cannot be conceived? Yet Mr Spencer allows that we have a "consciousness of Space, a product of accumulated experiences, partly our own, but chiefly ancestral."[3] May we not to the same extent know what Wisdom and Beneficence are? And if we speak of Infinite Wisdom, will our conception be more inadequate than when we speak of Infinite Space?

[1] *Account of Newton's Discoveries*, iv. 9.

[2] *First Principles*, third edition, p. 109. [3] *Ibid.*, p. 166.

"If I am informed that the world is ruled by a being whose attributes are infinite, but what they are we cannot learn, nor what the principles of his government, except that 'the highest human morality which we are capable of conceiving' does not sanction them; convince me of it and I will bear my fate as I may, . . . but I will call no being good, who is not what I mean when I apply that epithet to my fellow-creature.[1] However, our immediate question is, not whether there exists a being possessing infinite attributes, but whether there is a Will and Intelligence above our own? Human will shows its power, as we have seen, in co-operating with other forces to produce a new resultant; human intelligence shows itself in making several resultants converge to effect the mind's purposes; that is to say, to bring about a condition of things which does not come about when intelligence is not concerned, and which therefore becomes the mark or note of intelligence. Light, heat, electricity, and the other forms of force, are mutually convertible, but each has its own peculiar manifestations while existing apart: both light and electricity may effect chemical decompositions; but with electricity there is a power of attraction, with light there is not; light may be reflected and refracted, electricity cannot be. In like manner *will* force may direct a stone to the ground, and the force of gravity may do the same; but when successive acts of will have brought materials into the form and category of a steam-engine or a printing-press, we have the mark or note of intelligence—gravity does not do this. None of the forces unaided by intelligence produce mechanism; although, when mechanism is produced, the forces of nature are concerned, the

[1] John Stuart Mill: *Sir Wm. Hamilton's Philosophy*, p. 103.

properties of bodies have admitted of the result, and it could be shown that the machine *must* work as it does, its parts being related as they are. The contents of a chemist's laboratory upset would give us terrible explosions, and a medley of new compounds, not by chance, but in precise accordance with unalterable laws; yet the results would be distinctly different from those elaborated by a skilful chemist conducting systematic analyses and syntheses with the same materials subject to the same laws. When, in the case of metamorphic rocks, we wish to know whether *heat* has changed their internal structure, we look for the marks or notes of heat as we find those marks in other materials which we know *have* been subjected to a high temperature; when in the case of irregularities in a ship's compass we suspect magnetism in the iron of the vessel, or in the iron which lies in the hold as freight, we test the iron for those marks or signs of magnetism usually exhibited by magnetic bodies; and in the same way, if we suspect or search for design in nature, we must look for marks like those which we know require intelligence to bring them about; as, for instance, mechanism. What Mr Lewes says in speaking of other matters is true in this matter also—" It is important to bear in mind, that whenever an analogy occurs it is founded on a corresponding similarity in the momenta;" and again, " It seems a truism to insist that similarity in the results must be due to similarity in the conditions."[1]

The question comes to be this: Are there collocations and appearances in nature analogous to those which require human will and intelligence to bring them about? Mr Spencer, basing his reasonings on the

[1] *Fortnightly Review*, June 1868.

unalterable laws of matter and motion, and the axiomatic truth of the persistence of force, derives everything—from stones and sand up to flowers and birds, and men with their thoughts—from the original nebulous haze[1] by a natural process of evolution. The great clock of the universe is running down, and the running down is the condition of all phenomena and work. Very well: do we see only the weights making straight for the floor, or is there a system of wheels and a dial? Are the hours pointed out, and the minutes and the seconds; and does the descent of the weight to the earth necessarily produce these results? How is it that we *have* the flowers and birds, the men with intellect and conscience? They are worked out by the running down of the clock; but could not the clock have run down without them? The clouds over a district are a wound-up universe of force on a small scale: they are destined to come down in rain, and the rain must descend to the sea or to some lake, taking the route which offers the least resistance. At any particular point of the stream's course it could be shown that, considering all the antecedents—the amount of vapour condensed, the nature of the ground, and so on—the volume of water must be what it is, and must move as it moves, every previous stage paving the way for this. Come back to the same point in a few years, other things we will suppose are the same—the rain is condensed in the same way, and its destination, as before, is the ocean; but some of the water is now running in canals, some is turning mills, and some passes

[1] Helmholtz showed, in 1854, that the nebulous matter need not have been originally fiery. Sir W. Thomson, the same year, urged that it was probably solid, and may have been like the meteoric stones. (*See Address, British Association*, 1871.)

through a series of pipes ramifying into the streets and houses of a town. Still it is true that the stream must be as it is, and move as it moves, the canals, mill-apparatus, &c., being disposed as they are, and that all the previous stages—the configuration of the ground, the course of the stream higher up, the descent of the rain, &c.,—are necessary antecedents of these results. Therefore to show that the water must flow as it flows, &c., does not tell us whether will and intelligence have been at work: *this* must be tested by looking for marks of what will and intelligence usually do, and what the forces of nature unaided by intelligence fail to accomplish. And this is what we have to do in order to learn whether there be Design in nature. We are not obliged, as Descartes held, to know God before we can attribute Design to Him. We are not compelled, as Mr Spencer believes, to rest in utter ignorance of God, the Ultimate Cause being unknowable. Man's intelligence constructs machines, and resorts to contrivances, to overcome difficulties and effect desired ends. Nature, it is well known, is full of collocations and appearances so closely correspondent to these, that even writers who disbelieve in teleology constantly use its language, and speak of the *mechanism* of animal organisms, the *contrivances* by which orchids are fertilized, the *purpose* for which an organ has been developed, &c.; for truly, as the Duke of Argyle remarks, it seems *as if* all that is done in nature, as well as all that is done in art, were done *by knowing how to do it.*[1] In the opinion of Professor Owen, the analogy of the animal organs, and systems of organs, to the machines of man's invention, is so close, that, comprehending and admiring the rare degree of constructive

[1] *Reign of Law*, second edition, p. 130.

skill, foresight, and purposive adaption in many artificial machines, the healthy intellect, studying the more refined and perfect natural structures, cannot but conceive therein the like faculties in a transcendently higher degree.[1] No such analogy to machinery is found in a stone, in a handful of earth, or a pool of water: for although these consist of parts, it is not manifest that the parts are fitted together for any special purpose—their collocation is such as might be produced by natural forces unguided by intelligence, and may fitly be called accidental.

One point remains. Is this Intelligence supreme, or only superior? If we are right so far, and there be in the natural world collocations and appearances resembling man's contrivances—as, for instance, in the machinery of the human organism—then the control of the Contriver (if we may be allowed the term) extends to all the parts thus brought into unity; and no Power has prevented the accomplishment of the result He willed. But we find that throughout space and time, as far as we can trace, the most distant parts of nature are thus intelligently linked together; and the eye of a man, for instance, is connected on the one hand with the sun, distant by millions of miles; and on the other with the eye of the trilobite, distant by millions of years. Therefore (to quote Baden Powell) the unity of science is the reflection of the unity of nature, and of the unity of that Supreme Reason and Intelligence which pervades and rules over nature, and from whence all reason and all science is derived, . . . and the universality of order in time and space is the manifestation of the universality and eternity of the Supreme Mind.[2] In adopting the

[1] *Instances of the Power of God:* A Lecture by Professor Owen.
[2] "*Unity of the Sciences,*" and "*Uniformity of Nature.*"

phrase "universal order," however, we understand it as applying to the parts of nature fitted together or disposed for special purposes, and do not mean that every atom in the universe is exactly adjusted to every other atom in pre-established harmony. The "blind law" of gravitation keeps the atoms related, and when matter is pushed out of one path it *must* take some other; but it does not matter to gravitation whether atoms lie scattered apart, or are built up into a structure.

The appearances which militate against this unity of design in nature—the seeming breaks, interruptions, and failures, as when a monstrosity is produced, or animals die in the early stages of their existence—are traceable to the nature of things, to the conditions under which all Intelligence must work. If one end of a lever is raised the other will be depressed, whether we wish it or not; if we chisel a statue we must put up with the chippings: all work has its necessary concomitants, but the incidental results need not blind us to the success of the design; as Paley says, teeth are contrived to eat with, and not for the purpose of aching.

A full discussion of the subject in this place is not intended. It is sufficient if it is made to appear that the attempt to illustrate the Wisdom and Beneficence of the Almighty, in the circumstances connected with the evolution of living things, is not in its nature absurd.

CHAPTER II

EVOLUTION IN GENERAL.

Evolution (from "E," *out of*, and "volvo," *to roll*) signifies the continuous out-rolling of phenomena from preceding phenomena, as a flower is unfolded from the bud, or a man's character developed from the character of the youth. When we see a man, we know that he has previously been a youth, and before that a child and an infant; we judge also that he may grow older, and we know that he will eventually die. In like manner, we are certain that our furniture consists of wood which previously had the form of trees, which changed their appearance with the seasons, and grew from small to large; and we know that it is slowly decaying, and will sooner or later lose its present coherent shape. This general information, which all men gain concerning the past and future careers of surrounding things, science has extended, and continues unceasingly to extend. To the biography of the individual man it adds an intra-uterine biography, beginning with him as a microscopic germ; and it follows out his ultimate changes until it finds his body resolved into the gaseous products of decomposition. In all such changes, what really goes on is a redistribution of matter and motion; not the destruction of either, not the creation of either. When one moving ball strikes another and is brought to rest, it is only because its motion is transferred; or if the two move on together they share the motion between them, and its total amount is exactly the same as when it all existed in the first ball before the collision. This rule is universal: the forces at any time manifested are linked with those preceding and succeeding them; their amounts are fixed and measurable, and produce fixed and measurable results. Phenomena constitute a chain of connected history, which stretches forwards as well as backwards; and as the present is the outgrowth of the past, so also it contains the seed of the future. The law of Evolution, thus briefly indicated, applies to the whole of nature as far as known to us, and in several departments its truth has long been universally acknowledged. As illustrations of its operation, let us trace it in the departments of astronomy and geology, choosing these because the truths brought under notice will have some relation to the arguments of future chapters.

§ 1. *Evolution of the Solar System.*

If we think of the solar system as consisting of a fixed central sun, with a score or two of planets and comets repeating their circling motions with undeviating regularity, our conception is inadequate and erroneous. The sun is not fixed, but has a motion round some larger luminary; the comets of the system are not a constant number, but new ones come and go; the planets do not move in perfect ellipses, but in each revolution deviate from their previous path. No cycle is ever exactly repeated, either in the heavens or on the earth; the forces at work are so involved that throughout nature their action and reaction never bring about a complete return to a previous state.

Moreover, in addition to the sun's proper motion, carrying us to new regions, and the perturbations which every planet causes in the motion of every other, there are changes going on in the solar system which can only end in its transformation or its decay. To begin with small matters: the shooting stars, of which several may be seen on every starlight night, and considerable showers on 14th November, 10th August, and other dates, are particles and pieces of solid matter flying through space, and occasionally coming within the influence of the earth's attraction. On entering our atmosphere—which they do at a great speed—the friction hinders their motion, and they grow hot and luminous, as the wheel of a tender gets hot when the brake is put on. When the particles are small they are entirely vaporized, and leave a luminous train behind; when they are larger they sometimes reach the earth undestroyed. In the British Museum is a collection of more than 200 of these "meteoric stones," for the most part small, but several of them weighing many hundred-weights, and one of them 3½ tons. It appears, then, that at least one of the planets of the solar system is continually receiving slight additions to its bulk, at the expense of meteor-streams, which thereafter must afford less material for the gravitating power of the sun to act upon, while the earth must offer more.

Calculations made after the magnificent meteor display of November 1866, prove that these little bodies are not scattered uniformly through space, but are collected into groups, some of which stream round the sun in cometary orbits. Adams showed that this very group (of November 1866) had been previously detected by Tempel and set down as a comet; and the investigations of Signor Schiaparelli, director of the Observatory of Milan, have proved that the August and April meteors also travel round the sun in orbits identically the same with those of recorded comets. Meteor streams must therefore be either the same thing with comets, or must be closely allied to that class of bodies. If they be identical, it is evident that the masses of comets are becoming less through the scattering of their parts upon the surfaces of planets, and so their eventual entire dissipation may be prophesied. Moreover, if we can see forward far enough to detect this new phase for some of the meteoric matter, so also will a backward glance show us that there were phases which preceded the present arrangement. Astronomers find reason to believe that the solar system was once without the November meteors; that those bodies were dragged into it by the planet Uranus in the early part of the Christian era; and that the August meteors, though of higher antiquity, made their first acquaintance with us in a similar way.[1] Mr Sorby also, from a study of the microscopical structure of meteorites, has ascertained that the material was at one time in a state of fusion, and that the most remote condition of which we have positive evidence was that of small detached melted globules, the formation of which can only be satisfactorily explained by supposing that their constituents were originally in the state of vapour, as they now exist in the atmosphere of the sun, and condensed on the temperature becoming lower. These "ultimate cosmical particles" afterwards collected into larger masses, which have been variously changed by subsequent action, and broken up by repeated col-

[1] *Report of Committee: British Association.* 1871.

lisions among themselves, and often again collected together and solidified.[1]

In January 1866, the astronomers were looking for two little comets, moving in distinct but similar orbits which intersected the orbit of the earth. In spite of the strictest watching the comets were not detected, and it is believed that the gravitating influence of some other body, probably the November meteor stream, has thrown them into new orbits.[2] With regard to their past history also, it is known that the two comets were formerly one, having been discovered by M. Biela in 1826, and watched in its successive revolutions round the sun, which it accomplished in 6¾ years. Such a diversion from the old route is known to have taken place with the comet of 1770, which was found by Lexell to revolve in a moderate ellipse in the period of about five years, and whose return was predicted by him accordingly. The comet got entangled among the satellites of Jupiter, and changed its small orbit for a longer one, which keeps it out of sight, and occupies it twenty years or so to traverse. This new phase of its history is only one of a series; for the comet had never been seen previous to the year 1770, and Laplace found that it was the action of Jupiter which then brought it into view.

When comets experience no such tremendous perturbation, they are subject to a more regular and slower change, which threatens to bring their career to an end. Biela's comet, previous to disappearing, was found to be gradually approaching the sun, its period diminishing in the course of each revolution. Encke's comet, which

[1] Lockyer's *Elementary Astronomy.*

[2] The meteors of November 27, 1872, were, it is believed, a portion of one of these comets.

goes round the sun in 3⅓ years, now performs the journey in three days less than it did eighty years ago. It will, therefore, probably fall ultimately into the sun, should it not first be dissipated altogether; and the same fate may be anticipated for most of the other comets of the system. This acceleration of a comet, says Sir J. Herschel, is evidently the effect which would be experienced from a very rare ethereal medium pervading the regions in which it moves; for such resistance, by diminishing its actual velocity, would diminish also its centrifugal force, and thus give the sun more power over it to draw it nearer.[1]

While we have this glimpse of the probable future of comets, we are not altogether without light in regard to their previous history. The credit of discovering the apparent identity between comets and meteor shoals is due principally to Signor Schiaparelli, who finds reason to believe that they did not form part of our system when that was first constituted, but are wandering nebulæ picked up by our sun.[2]

Even the planets, which have more right to be regarded as the true children of the sun, are not children who never grow older nor experience any changes. The rings of Saturn, it is now believed, cannot be solid, nor continuously fluid, but must be composed of myriads of satellites moving round the planet in their several orbits, with different velocities according to their respective distances.[3] It is even thought that they frequently

[1] *Treatise on Astron., Cabinet Cyclopedia.*

[2] Mr Wm. Lassell: *Presidential Address to Royal Astronomical Society*, February 9, 1872.

[3] *On the Stability of Saturn's Rings*, Prof. Clerk Maxwell. *Saturn and its System*, Mr R. Proctor.

come into collision with one another, and that the orbits alter; the general result being, that the rings are widening, and new ones forming nearer the planet. Our own Earth, in its character as one of the planets, and independently of the aerolites which fall upon it, is not without some slight change, which only needs the lapse of time to make it considerable. The moon, by attracting the surface of the earth more than its centre, heaps up the waters of the ocean under her, and, by attracting the centre more than the further side, causes them to bulge out on that side also; and these waters are held in these positions while the solid earth rotates or slips round beneath them. The tidal undulation, indeed, moves forward in its effort to keep under the moving moon, but not so fast as the earth rotates; and so the piled-up water comes to act as a break upon the earth, tending to hinder it from slipping round. It has been contended by Professor Helmholtz that inappreciable as may be the effect of this friction within known periods of time, it must be slowly diminishing the earth's rotatory motion. The extreme effect to be anticipated from this process is an extension of the earth's day to the length of a lunation.

The resistance of the ethereal medium before referred to must tell at last upon the planets as well as the less solid comets; indeed, certain astronomers contend that it even now shows its effects in the relative nearness to one another of the orbits of the older planets. If, then, retardation is going on, there must come a time, no matter how remote, when the slowly diminishing orbit of the earth will end in the sun, the collision reducing the earth's substance to a gaseous state. This event will be followed at intervals by the similar dissolution of every other planet of the solar system.

And what of the sun itself, the source of all the life and energy of this world? Can it continue to give off an undiminished amount of light and heat through all future time? Can it continue to raise huge masses of water every day from the sea to the skies, and lift every year endless vegetation from the earth; set breeze and hurricane in motion; perform, in fine, the great bulk of the endless labour of this world and of other worlds, and never lose its energy? No; for force is a definite, measurable thing, and its absolute quantity never changes; the force known to us in solar radiations is the changed form of some other force of which the sun is the seat; and by the gradual dissipation of these radiations into space, this other force is being slowly exhausted. The central fire cannot glow for ever, unless the supply of force be replenished, any more than an ordinary fire can be kept in without fuel. Perpetual motion is a delusion; no finite construction of physical materials can continue to *do work* for an infinite time; the heat of the sun is just as surely limited in its power of doing work as a given number of tons of coal in the furnace of a steam-engine. Probably, therefore, there will come a time when the sun, having previously swallowed up all the planets, will roll on its solitary way through space a cold black ball.[1]

Here, again, science indicates the past as well as the future: the present contains the record of the one as

[1] See Tyndall's translation of Helmholtz's paper in the *Philosophical Magazine*, supplement to vol. xi., fourth series. See also the famous article on the "Origin of Species" in the *North British Review*, June 1867.

well as the prophecy of the other, if we know how to interpret its characters. As Mr Grove says: Saturn's ring may help us to a knowledge of how our solar system developed itself; for it as surely contains that history as the rock contains the record of its own formation.[1] The planets all move nearly in one plane, the plane to which they approximate being that of the sun's equator; the motion of the sun on its axis, of the planets on theirs, of the planets round the sun, and the moons round the planets, are, with scarcely an exception, in one direction—namely, from west to east. These facts of uniformity, Laplace calculates, tell against the supposition of separate accidental causes by a probability of four millions of millions to one, and point to one general cause. Kant, Laplace, Sir W. Herschel, and others, have offered an explanation in the Nebular Hypothesis, according to which the matter of our solar system once existed in a diffused gaseous condition, from which it became more concentrated through the operation of gravitation. The aggregating spheroid, dissipating its heat, would acquire an unlikeness of density and temperature between its interior and exterior; this unlikeness would become more marked; from time to time "rings" of matter would be left behind, and eventually these would break up and concentrate into planets. This hypothesis fell into discredit, because every time a telescope larger than any formerly used was turned to the heavens, some fresh nebula was found to be a cluster of stars, so distant that telescopes of inferior power had failed to "resolve" it. But recent discoveries with the spectroscope have shown that some of these cloud-like patches are true nebulæ; that is to say, masses of glow-

[1] Grove's *Discourse on Continuity.*

ing or incandescent gas; and there are indications that the gases are nitrogen and hydrogen. It is even beginning to be shown that the nebulæ are undergoing rapid change at present; for the Melbourne astronomers, directing the Great Melbourne telescope to the star η (Argûs) and the great nebula near it, and making careful drawings of what they see, find that drawings made at intervals of a few months are considerably different from one another, and all of them different from Sir J. Herschel's drawing made in 1838. One change is that the star η, which Herschel saw involved in dense nebula, was, in April 1869, seen on the bare sky, the nebula having disappeared for some distance around it.[1]

Here, then, even if we exclude what is hypothetical, we have a respectable list of changes going on, we may say, under our eyes, in the solar system. The present aspect of the system is not that which it wore in the yesterday of ages; in the very remote past the unlikeness to the present was still more considerable, and in the far distant future the system will be transformed beyond all power of recognition.

§ 2. *Evolution of the Earth's "Crust."*

Between the years 1780 and 1790 a vessel from Purbeck, laden with 300 tons of stone, struck on a shoal off the entrance of Poole harbour and foundered. The crew were saved, but the vessel and cargo remain to this day at the bottom, where they have checked the velocity of the tidal current, and caused it to deposit its sediment. As a consequence the shoal at the entrance of the harbour has so extended itself towards Peveril Point, in Purbeck, that the navigable channel is thrown

[1] See *Nature*, May 2, 1872.

a mile further west. But for the obstruction caused by the sunken ship, much of this sediment would have been carried out to sea—the finest particles the farthest—and deposited on the ocean floor. All the rivers of the world are carrying material to the sea, the largest rivers such enormous quantities that it is scarcely possible to present to the mind any picture which will convey an adequate conception of the scale of the operation. The Ganges, as it glides through its alluvial plain, and on to the sea, in the course of one rainy season of four months' duration, carries tranquilly, and almost insensibly, material enough to outweigh forty Egyptian pyramids. On the borders of the ocean, currents and tides co-operate with the waves to destroy and transport the materials of the land; and as numerous tributaries discharge their alluvial burden into the channel of one great river, so we find that many rivers deliver their earthly contents to one marine current, to be borne by it to a distance, and deposited in some deep recess of the ocean. The stream of the Amazon enters the Atlantic with such force that its waters are not wholly mingled with those of the ocean at 300 miles from its mouth. The equatorial current crosses this stream, and constantly carries the sediment of the river to the north-west, as far as to the mouths of the Orinoco; and an immense tract of swamp is formed along the coast of Guiana, with a long range of muddy shoals bordering the marshes, and becoming converted into land. The sediment of the Orinoco is partly detained, and settles near its mouth, causing the shores of Trinidad to extend rapidly, and is partly swept away into the Caribbean Sea by the Guinea current. The great denuding agents of the earth are land-ice, frost, rain, running water, chemical agency, &c.; but it is the work of the marine current to transport the loose materials brought down by rivers, and spread them out on the ocean floor.

When a tree falls into a river from the undermining of the banks, or from being washed in by a torrent or flood, it floats at first on the surface, but when the water has had time to soak into its pores, it becomes water-logged and sinks. When timber is drifted down by a river it is often arrested by lakes—where it may sink and become imbedded in any sediment which may be forming—but sometimes a portion floats on till it reaches the sea. The bays of Spitzbergen are filled with drift-wood, consisting of larch-trees, pines, Siberian cedars, firs, and Pernambuco and Campeachy woods, which appear to have been swept away by the great rivers of Asia and America, some of them being brought from the Gulf of Mexico by the Bahama stream. River inundations recur, at irregular intervals, in most climates, and expend their fury on those rich alluvial plains where herds of herbivorous quadrupeds congregate together. These animals are often surprised, and, being unable to stem the current, are hurried along until they are drowned, when they sink at first immediately to the bottom. Here their bodies are drifted along, together with sediment, into lakes or seas; and may then be covered by a mass of mud, sand, and pebbles, thrown down upon them. If there be no sediment superimposed the gases generated by putrefaction usually cause the bodies to rise again to the surface about the ninth, or at latest the fourteenth day. When the body does not rise, the skeleton may be preserved entire; but if it comes again to the surface while in the process of putrefaction, the bones commonly fall piecemeal from the floating carcase, and may in that case be scattered at random over the lake, estuary, or sea; so that a jaw may afterwards be found in one place, a rib in another, and a humerus in a third. Besides the organic remains brought down by the rivers, there are the marine creatures themselves, which, like all others, sooner or later die, their shells and hard parts lying at the bottom till the fine sediment covers them over and protects them from further change. When the sediment hardens into limestone or sandstone, according to its nature, the shells of these animals will be firmly imbedded in it, to tell their story at some future time, like the writing in a book of history.

If I dig into the ground beneath my feet I find shells imbedded and bones scattered about in the same way; and sometimes entire skeletons, which of course must have become buried soon after the flesh left them, if not before. In the British Museum is the skeleton of an elephant dug up at Ilford, in Essex, at which place also may be found bones of the rhinoceros, and fresh-water shells of the genera called Unio, Cyclas, Paludina, Valvata, Ancylus, &c. Evidently this place was once under the water. If I go on to Walton-on-the-Naze, and dig into the Red Crag under my feet, or as I find it exposed in the cliffs, I discover shells of several hundred species, associated with numerous teeth of fish, and occasionally some remains of leopards, bears, hogs, &c. Not far from the same place, or at Southend, as I return to London by steamboat, I find the soil to be clay containing shells, with remains of crustacea, fish, reptiles, mammals, &c.; and I notice that I have among them a monkey, an opossum, and a bat. If I trace this clay I find that it passes under the crag, and I infer that not only was the crag formed under water at some remote period, but the clay had been formed in some lake or sea, before the crag could be laid upon it—there has been *a succession* of deposits. Further inquiry shows me that under this clay there is chalk, and under the chalk sand, and lower still limestone, and clay and sand again, till the entire thickness of these *stratified* rocks—beds laid down in strata by the agency of water—is something like fourteen miles, the number of fossil species something like 40,000; and then I am stopped by hard crystalline rocks, which seem to have been melted, and therefore to contain no evidences of life, and I don't know what is underneath.

The succession of rocks in the order of their superposition is found to be as follows:—

STRATIFIED ROCKS.

Tertiary or Cainozoic.	RECENT.	
	PLEISTOCENE,	Drift and Glacial Beds.
	PLIOCENE,	Mammaliferous Crag, Red Crag, &c.
	MIOCENE,	Bovey Beds, &c.
	EOCENE,	Bagshot Sands, London Clay, &c.
Secondary or Mesozoic.	CRETACEOUS,	Chalk, Upper Greensand, Gault, Lower Greensand.
	WEALDEN,	Weald Clay, Hastings Sands.
	PURBECK,	Purbeck Beds.
	UPPER OOLITE,	Portland Rock and Sand, Kimmeridge Clay.
	MIDDLE OOLITE,	Coralline Oolite, Oxford Clay, &c.
	LOWER OOLITE,	Forest Marble, Stonesfield Slate, &c.
	LIAS,	Upper Lias Clay, Marlstone, Lower Lias.
	RHŒTIC,	Rhaetic or Penarth Beds.
	TRIASSIC, OR NEW RED SANDSTONE.	

Primary or Palæozoic.	PERMIAN, or MAGNESIAN LIMESTONE.	
	CARBONIFEROUS, .	Coal Measures, Mountain Limestone, &c.
	DEVONIAN, or OLD RED SANDSTONE.	
	UPPER SILURIAN .	Ludlow Rocks, Wenlock Rocks, &c.
	MIDDLE SILURIAN,	Llandovery Rocks, &c.
	LOWER SILURIAN,	Llandeilo Rocks, Lingula Flags, &c.
	CAMBRIAN, . .	Longmynd Rocks, &c.
	LAURENTIAN, .	(Found in Canada and parts of Wales and Ireland).

It is not meant that there is any pit or mine fourteen miles deep, to exhibit a section of these strata: it is not meant that we should find all these rocks in any one place where we might sink a shaft. If we dig at Dover or Brighton, we may find the chalk on the surface, and all the beds above it absent; if we sink a well at Kentish Town, it may happen that, after passing through Tertiary strata, Chalk, Upper Greensand, and Gault, we come unexpectedly on sandstones which seem to be of Palæozoic age, all the intermediate strata—Lower Greensand, Oolite, Lias, &c.—being missing.[1] But we are not in danger of supposing that the Gault was laid down immediately after the deposition of the Palæozoic sandstones, because in other places we find the Lias above the Palæozoic rocks, the Oolite above the Lias, the Lower Greensand above the Oolite, and the Gault above the Lower Greensand; while we know that the lower rocks must have been laid down before the upper could be laid upon them. We have, again, all the advantage which very deep shafts could give us, in the circumstance that since the strata were laid down, many of

[1] Mr J. Prestwich, F.R.S., *Annual Address to Geological Society*, February 16, 1872.

them have become *tilted* and exposed at the surface of the earth. If we set up twenty or thirty books in a row, without support at the ends, and by a blow make them fall from right to left, each volume will be seen passing under its right-hand neighbour; and we shall have in such a tilted row a rough representation of the sedimentary strata, as they are passed over when we journey by the Great Western Railway from London into Cornwall or South Wales.

When we investigate the composition of the strata we find that, speaking generally, the more ancient are the more simple, the less ancient the more complex; the materials of *several* older rocks often lending their aid to form one newer stratum. Each newer bed must of course have been formed from older ones, worn away for the purpose, just as the beds forming on the sea-floor to-day consist of materials which the rivers are washing down from the lands they drain. Here we see one cause of the absence of some of the strata in some localities; they may have been deposited, but afterwards washed away to form new beds. In other cases, they may never have been laid down; for the sediment of a river, though that river be as large as the Ganges, is never spread over all the ocean floors of the world, and the sediment from different rivers would usually form strata of different kinds, and containing life of different forms. It is well known that the stream of the Mississippi is charged with sediment of a different colour from that of the Arkansas and Red River, which are tinged with red mud derived from rocks of porphyry in "the far west;" and it has been noticed that the waters of the Uruguay, draining a granitic country, are clear and black, while those of the Parana are red.[1] Again, even if one stratum were spread over every sea floor, the lands exposed above the water would escape receiving it; and by the time it was their turn to be covered over, the rivers would be bringing down very dissimilar material.

This brings us to the question how the strata formed at the bottom of oceans, lakes, and estuaries ever came to be dry land; and by what process the chalk (for instance), after succeeding in getting itself exposed as dry land, should have the London clay and other strata deposited upon it? Were the British Isles to sink down bodily 600 feet, nearly the whole of England and Ireland would be submerged; while Scotland and Wales would be reduced in size through the encroachment of the waters on all their coasts. On the other hand, were the same islands with the neighbouring seas lifted 600 feet higher, the whole of the German Ocean, the Irish Sea, and the English Channel, would become dry land, so that the British Isles would all be united together and to the Continent.[2] Now there is evidence that the British Islands have experienced oscillations of level, and that subsidence and upheaval are continually going on in many parts of the world. Several large areas—some of them several thousands of miles in circumference—such as Scandinavia, the west coast of South America, and certain archipelagoes in the Pacific, are slowly rising at this day; while other regions, such as Greenland, and parts of the Pacific and Indian Oceans, in which atolls or circular coral islands are found, are as gradually sinking.

[1] Darwin's *Journal*, 10th thousand, p. 139.

[2] See the maps illustrating this in Sir C. Lyell's *Antiquity of Man*.

These elevations and depressions remind us that, besides the agency of water, there have been subterranean forces at work to remodel the face of the earth. The earthquake and the volcano, visiting in succession every zone, and filling the earth with monuments of ruin and disorder, are nevertheless the agents of a conservative principle essential to the stability of the system. We need not, however, go into any details concerning their operations.

From the fact that the materials for each new stratum of rock have been derived from previous strata, we may infer that the seas have never covered all the earth at one time, that there always has been land above water; and the truth of this inference is confirmed by the discovery of fossil trees and terrestrial plants imbedded in rocks of every age. Occasionally lacustrine and fluviatile shells, insects, or the bones of amphibians or land reptiles, point to the same conclusion.

What, then, is our conclusion from all these facts? It is that the earth has had a history extending through many millions of years; its physical geography, its land surfaces, its climates continually changing; one phase of things slowly dying into another, like pictures of a dissolving view. The picture we gaze on to-day is changing also, no exceptional character belongs to it; and as it is itself the outgrowth of all that went before it, so is it a stage of departure for new developments. There has not been a *cycle* of changes, returning to the starting-point, and then repeating itself; but through the constant action of the same forces as those now in operation, nature has been made to assume "beauty ever blushing, ever new."

A few words more will connect this section with the last, and show that the evolution of the earth's crust is but a part of that evolution which is universal. Assuming the truth of the Nebular-Hypothesis, all geologic changes are either direct or indirect results of the unexpended heat caused by nebular condensation. The earth, after becoming a separate globe, would be still fluid and incandescent, and the first thin "crust" of the earth would result from the slow cooling of the molten mass. On the view held by some geologists, that the interior is still in a melted state, and that earthquakes and volcanic action are to be traced to the perturbations of the molten ocean; the elevations and subsidences thus caused, the eruptions of volcanoes and the extrusions of igneous rock through strata, are shown to be indirect results of the original heat of the unformed solar system. And similarly with regard to aqueous agency: If we ask whence comes the power of the river current, bearing sediment down to the sea? the reply is, The gravitation of water throughout the tract which this river drains. If we ask, How came the water to be raised over this tract? the reply is, It fell in the shape of rain. If we ask, How came the rain to be in that position whence it fell? the reply is, The vapour from which it was condensed was drifted there by the winds. If we ask, How came this vapour to be at this elevation? the reply is, It was raised by evaporation. And if we ask, What force thus raised it? the reply is, The sun's heat. Just that amount of gravitative force which the sun's heat overcame in raising the atoms of water, is given out again in the fall of those atoms to the same level. Similarly with the winds that transport the vapours hither and thither: since atmospheric currents result from differences of temperature—between the equatorial and polar regions, or between the sea and the land, &c.—all such currents must be due to that source from which the varying quantities of heat proceed.[1]

We have thus illustrated the law of Evolution in the departments of astronomy and geology, because the facts of these sciences have a close bearing upon our special subject. It would have been still more easy to trace the operation of the law in the development of languages, or in the genesis of an individual animal from parents of the same kind.

[1] See H. Spencer's *First Principles*, p. 207. For most of the *facts* of this section the writer is indebted to Sir C. Lyell's *Principles of Geology*.

CHAPTER III.

THE LIVING THINGS OF THE PRESENT AND THE PAST.

§ 1. *Some Facts of Natural History.*

THE living creatures on the face of the earth are numbered by millions of millions—animal and vegetable; inhabitants of the land, the air, the waters, of visible size or microscopic—and no one is exactly like another. When we have to do with numerous objects, we find it convenient to classify them according to their resemblances and differences; but if their similarities and distinctions are numerous, a variety of arrangements becomes possible; and the question arises, Which arrangement is the best or most natural? In a library, a child may place books in the order of their sizes, or according to the styles of their bindings; and perhaps even in the alphabetical succession of the authors' names, so that any particular book may easily be found. The librarian, passing over such superficial resemblances, distributes them according to their subjects, putting together in one great division all works on history; in another, all biographical works; in another, all works that treat of science; in another, voyages and travels; and so on. Each of his great groups he separates into sub-groups; as when, having divided his scientific treatises into abstract and concrete, putting in the one logic and mathematics, and in the other physics, astronomy, geology, chemistry, physiology, &c., he goes on to sub-divide his books on physics into those which treat of mechanical motion; those which treat of heat; those which treat of light, of electricity, of magnetism. This arrangement, being according to combinations of attributes, is superior to the child's arrangement, which is in accordance with a single attribute; but it requires more intelligence to make it; and since the attributes, though fundamental, are not conspicuous, it requires analysis, and does not suggest itself till analysis has made some progress.[1]

The first step taken by the naturalist in the classification of living things, is to divide plants from animals. From the microscopic, formless dab of jelly, which constitutes the Amœba, up to the marvellously complex structure which we name Man, there is, underlying all diversities, a community of traits on which we found the group Animal. In classifying these diversities, we establish groups and sub-groups as indications of the degrees of unlikeness. When the animals differ but slightly, we group them as varieties; when they differ more, as species; when they are still more different, as genera; and so on through families, orders, classes, sub-kingdoms.

The examination necessary for this classification makes us acquainted with several important facts. In the first place, we find that *animals are not independently organized.* It is conceivable that every animal should have been constructed on a plan of its own, having no resemblance whatever to the plan of any other animal; and there is nothing in the nature of the case to lead us to suspect a community of organization between animals

[1] See H. Spencer's *Principles of Biology.* Chapter on Classification.

so different in habit and appearance as a porpoise and a gazelle, or a butterfly and a lobster. But, as a matter of fact, the different members of the animal kingdom, from the highest to the lowest, are marvellously connected. Every animal has a something in common with all its fellows, much with many of them, more with a few, and usually so much with several that it differs but little from them. The names by which we designate groups and sub-groups have, therefore, a fixed meaning; they point to morphological and structural resemblances in the things classified, and are a statement of the gradations of likeness observable.[1] But this similarity of structure, often masked under outward difference of form, suggests many questions. Why should the dog, the eagle, the snake, the frog, and the salmon each have an internal skeleton composed of bone or cartilage, and forming an envelope to the nervous centres? Why should insects so different in outward shape as the dragon-fly, the lady-bird, the butterfly, and the flea, have *this* in common with one another, and with crabs and lobsters, that there are primarily twenty segments to the body? It does not seem necessary, in the sense that no other number would have made a possible organism, and it cannot be by chance.

In the second place, we find that *it is difficult to determine what is a Species.* It must not be supposed that species, genera, orders, and classes are assemblages of definite values; that every genus is equivalent to every other genus in respect of its degree of distinctness; and that orders are separated by lines of demarcation that are as broad in one place as another. Small differences are observed between animals and their off-

[1] Huxley's *Classification of Animals.*

spring; greater differences are observed between varieties known to be sprung from a common stock; but the differences between what have been termed species are sometimes hardly greater than those between varieties owning a common origin. What is a species? Species has been defined as "a succession of individuals capable of reproducing themselves;" but the offspring are not exactly like the parents, and it is not always easy to say what the parentage has been. Species, says Mr Lewes, is a subjective creation, having no objective existence; it is an idea, not a thing; a systematic artifice, not a living entity.[1] In determining whether two or more allied forms ought to be ranked as species or varieties, naturalists are practically guided by the following considerations—namely, the amount of difference between them, the relation of such differences to few or many points of structure, their degree of physiological importance, but more especially their constancy or inconstancy. Still, the work of classification is not hereby freed from all difficulty, and disputes continually arise on the questions, Whether such and such organisms are specifically or generically distinct; and whether this or that peculiarity is, or is not, of ordinal importance? The little marine creatures, called Foraminifera, were divided by D'Orbigny, and other authors, into a number of clearly defined families, genera, and species; but the researches of Dr Carpenter and his colleagues have shown that the range of variation in the group is so great as to include not merely those differential characters which have been usually accounted specific, but also those upon which the greater part of the genera have been founded, and even, in some instances, those of

[1] *Fortnightly Review*, April 1868.

the orders. Mr Bates, who spent eleven years in the region of the Amazons, and carefully studied the variation and distribution of insects, has shown that many species of butterflies, which before offered no special difficulties, are, in reality, most intricately combined in a tangled web of affinities, leading by such gradual steps from the slightest and least stable variations to fixed races and well-marked species, that it is very often impossible to draw sharp dividing-lines. With plants there is the same kind of difficulty; and botanists are all at war about even the common bramble, some of them attempting to make out many species of it, and others maintaining that they are but many varieties of one species. If it be granted that such cases are exceptions to the rule—that ordinarily there is not much difficulty in distinguishing one species from another—it is maintained, on the other hand, that a true rule or law embraces all apparent exceptions; and that, therefore, it cannot have been Nature's intention to make sharply-defined species, with limits never to be transgressed.

In the third place, *a grand fact in natural history is the subordination of group under group.* The original idea in classification was to arrange animals in linear order according to the degree in which they possessed some single attribute, as books may be put in the order of their dates in single file, or grouped as works in one volume, works in two volumes, works in three volumes, &c. Linnæus grouped animals in six classes, calling them—

Cl. I. MAMMALIA. *Ord.* Primates, Bruta, Feræ, Glires, Pecora, Belluæ, Cete.

Cl. II. AVES. *Ord.* Accipitres, Picæ, Auseres, Gallæ, Gallinæ, Passeres.

Cl. III. AMPHIBIA. *Ord.* Reptiles, Serpentes, Nantes.

Cl. IV. PISCES. *Ord.* Apodes, Jugulares, Thoracici, Abdominales.

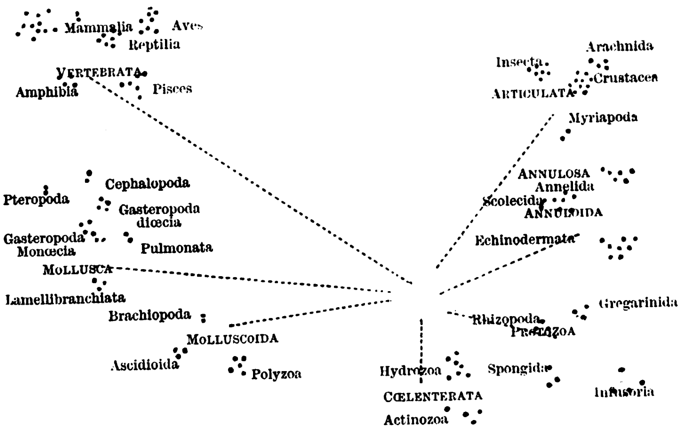
Cl. V. INSECTA. *Ord.* Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Diptera, Aptera.

Cl. VI. VERMES. *Ord.* Intestina, Mollusca, Testacea, Lithophyta, Zoophyta.

This arrangement is based on apparent gradations of rank; and the placing of the orders in the several classes similarly betrays an endeavour to make successions, beginning with the most superior forms, and ending with the most inferior. While the general and vague idea of perfection determines the leading character of the classification, its detailed groupings are determined by the most conspicuous external attributes. Not only Linnæus, but his opponents who proposed other systems, were under the impression that animals were to be arranged together in classes, orders, genera, and species, according to their more or less close external resemblance—a conception which survived till the time of Cuvier. Naturalists, says Agassiz, were bent upon establishing one continued uniform series to embrace all animals, between the links of which it was supposed there were no unequal intervals. The watchword of their school was, *Natura non facit saltum.* They called their system *la chaine des êtres.*[1] Now at length, after various improvements, associated with the great names of Cuvier, Lamarck, Von Baer, and others, naturalists have been gradually compelled to arrange living things in groups within groups, and we get the following representation of zoological affinities:[2]—

[1] Agassiz's *Essay on Classification,* and H. Spencer's *Principles of Biology.*

[2] Spencer, based on Huxley.



In the fourth place, *closely allied species are found in closely adjoining localities,* as though some attempt at a classification were being made by Nature herself. The naturalist, in travelling, for instance, from north to south, never fails to be struck by the manner in which successive groups of beings, specifically distinct, yet clearly related, replace each other. He hears from closely allied yet distinct kinds of birds, notes nearly similar, and sees their nests similarly constructed, but not quite alike, with eggs coloured in nearly the same manner. Humming birds which are confined to the great continent of America, with its adjacent islands, show us particular species adapted to every region where a flowering vegetation can subsist; and very often little groups of two or three allied species in the same or closely adjoining districts. The plains near the Straits of Magellan are inhabited by one species of Rhea, and northward the plains of La Plata by another species of the same genus; and not by a true ostrich or emeu, like those found in Africa and Australia under the same latitude. Each great river has its peculiar genera of fishes; and in more extensive genera its groups of closely allied species. The inhabitants of islands are commonly allied closely to those of the nearest mainland without being actually the same species. In the Galapagos Archipelago, between 500 and 600 miles from the shores of South America, almost every product of the land and water bears the unmistakable stamp of the American continent—the naturalist feels that he is standing on American land. There are twenty-six land-birds in the archipelago, and twenty-one of them, or perhaps twenty-three, are ranked as distinct species; yet the close affinity of most of these birds to American species in every character, in their habits, gestures, and tones of voice, is manifest. So it is with the other animals of these islands, and with nearly all the plants. Similarly throughout nature—every class and order of animals would supply instances; and the question is forced upon us, Why are these things so? Why are the genera of Palms and of Orchids in almost every case confined to one hemisphere? Why are the closely allied species of brown-backed Trogons all found in the East, and the green-backed in the West? Why are the Macaws and Cockatoos similarly restricted? Was there no law that regulated their creation and dispersion?[1]

In the fifth place, it is found that while every creature is suited to its station or habitat, *some habitats are not supplied with the highest forms of life they could nourish.* Some plants and animals can only live in the air, others

[1] See Wallace's *Natural Selection*, chap. i.

only in the water; and of the latter, some are restricted to salt-water and others to fresh-water. There are faunas and floras[1] peculiar to low regions, and others peculiar to high regions; a journey up a high mountain often carrying the traveller through zones of life resembling those passed through in going from the tropics towards the poles. The range of each kind of living thing is limited by climate; the temperature it requires is only found between certain isothermal lines; the requisite humidity or dryness of the air is only found in certain areas. Carnivorous animals, of course, cannot exist out of regions tenanted by creatures numerous and large enough to serve for prey; and granivorous animals are confined within tracts which produce plants fit for them to feed on. But the converse of these facts is not true: that is to say, there are many regions quite as well suited for the maintenance of certain living forms as the districts where those forms at present flourish, and yet those regions are peopled by inferior types. We need only refer to the extraordinary manner in which European productions have recently spread over New Zealand, and have seized on places which must have been previously occupied, thus proving themselves to be better fitted for the habitat than are the native productions. The English *dock* is to be found in New Zealand in every river bed, extending into the valleys of the mountain rivers, until these become mere torrents; the sow-thistle is spread all over the country; the water-cress threatens to choke the still rivers; in fact, the young native vegetation appears to shrink from competition with these more vigorous intruders. The

[1] The entire animal life of a district constitutes its fauna, the entire vegetable life its flora.

Maori saying is, "As the white man's rat has driven away the native rat, as the European fly drives away our own, and the clover kills our fern; so will the Maoris disappear before the white man himself." Similarly, within these few years an American water-weed has taken possession of our English ponds and rivers, and to some extent supplanted native water-weeds. A small kind of red ant, having habits allied to those of tropical ants, has of late overrun many houses in London. Rats and cockroaches have taken to infesting ships, and when the ships visit India, the oriental cockroach clears them of its European rival. Again, we may compare large tracts of land in Australia, South Africa, and Western South America, between latitudes 25° and 35°, where all the conditions are extremely similar, and yet the three faunas and floras are as dissimilar as it is possible for them to be.

There is a disposition on the part of all animals and plants to invade the territory occupied by others, and to establish themselves if possible; and, as in the case of human tribes, there are permanent conquests, temporary occupations, and occasional raids. It is not for want of adaptedness to other regions, nor for want of a disposition to push into them, that the organisms of a district are found where they are and nowhere else; it is because there is some physical barrier intervening—an impassable ocean or isthmus or mountain chain. No two marine faunas are more distinct, with hardly a fish, shell, or crab, in common, than those of the eastern and western shores of South and Central America;[1] yet these great faunas are separated only by the narrow isthmus of Panama. Nearly all the terrestrial productions of

[1] I write before the results of the *Hassler* expedition are published.

the New and Old Worlds differ greatly, excepting in the northern parts, where the land almost joins, and where, under a slightly different climate, there may have been free migration for the northern temperate forms, as there now is for the strictly Arctic productions. Frogs, toads, and newts seem peculiarly suited for a residence in islands—for frogs introduced into Madeira, the Azores, and Mauritius, have so multiplied as to become a nuisance; and yet these creatures are absent from oceanic islands in general.

"The character of a region, when unfavourable to any species, sufficiently accounts for the absence of this species, and thus its absence is not incongruous with the hypothesis that each species was originally placed in the regions most favourable to it. But the absence of a species from regions that *are* favourable to it cannot be thus accounted for. Were plants and animals localised wholly with reference to the fitness of their constitutions to surrounding conditions, we might expect floras to be similar, and faunas to be similar where the conditions are similar; and we might expect dissimilarities among floras and faunas proportionate to the dissimilarities of their conditions. But we do not find such anticipations verified."

Lastly, *many animals possess rudimentary organs which are apparently useless,* and which are sometimes fully developed in allied species. The whalebone whale has horny plates in its mouth, and no teeth; but the young fœtal whale, before birth, possesses teeth which never come to anything. Other whales, however, have well-developed teeth in both jaws. The horse has only one finger in his fore foot, and only one toe in his hind foot, each developed into a hoof, but it possesses rudimentary splint-like bones, which correspond with bones belonging to certain toes and fingers in man; and the rhinoceros, which is closely allied to the horse anatomically, has the extra toes well formed. The external ears are represented by mere vestiges in a Chinese breed of sheep, and in another breed the tail is reduced "to a little button, suffocated in a manner by fat." In tailless cats and dogs a stump is left; in polled Suffolk cattle rudiments of horns can often be felt at an early age; in certain breeds of fowls the comb and wattles are reduced to rudiments. If these aborted organs appeared only now and then in individuals, where the rest of the species had them well developed, we should not be surprised, but when they characterise entire species from generation to generation, and their full development is the rare exception, our curiosity is excited to know the cause.

§ 2. *Some Facts of Palæontology.*

It was shown in the section on the Evolution of the Earth's Crust, that the sedimentary rocks contain organic remains, which belonged to creatures existing when the rocks were forming. It must now be added that most of these fossils are of species that no longer exist, and many of them of genera that have passed away. An investigation of these buried forms brings out a number of facts analogous to those which we have just passed in review, in connection with the still living world.

First, it appears, as the late Edward Forbes often insisted, *that there is a striking parallelism between the distribution of life in time, and its distribution in space:* the laws governing the succession of forms in past times being nearly the same with those governing at the present time the differences in different areas. As we descend through the series of rocks, the forms of life change, as they change if we walk from one end of a continent to the other and pass on to new continents. The fauna of any great period of the earth's history is intermediate in general character between that which preceded and that which succeeded it. The names given to the sub-divisions of the tertiary strata were intended to indicate the proportions of existing shells to extinct species—Eocene, the dawn of recent forms; Miocene, a minor proportion of recent forms; Pliocene, a comparative preponderance of recent forms; the Pliocene being the uppermost of the three divisions.[1] Below the Tertiaries we get scarcely any forms precisely like those now extant; and although we still find species allied to them, the unlikeness increases as we go downwards. Past faunas differ from each other as well as from the present, and the differences between them are proportionate to their degrees of remoteness from each other in time, as measured by their relative positions in the sedimentary series. So that if we take the assemblage of organic forms living now, and compare it with the successive assemblages of organic forms that have lived in successive geologic epochs, we find that the farther we go back into the past, the greater does the unlikeness become; the number of species and genera common to the compared assemblages becomes smaller and smaller, and the assemblages differ more and more in their general character. The divergence is comparatively slow and continuous where there is continuity in the geological formations; but is

[1] ἠώς, *eōs*, dawn, and καινός, *kainos*, recent; μείων, *meiōn*, less; πλείων, *pleiōn*, more.

sudden and comparatively wide wherever there occurs a great break in the succession of strata. Stratigraphical breaks are due either to non-deposition, or to subsequent removal of deposits, and must consequently be local only, though we may not always succeed in finding intermediate strata (with intermediate forms of life) elsewhere. But we can say confidently, that as there never was a time when there were no land surfaces, so there has never been a break in the process of sedimentation, and in the succession of life. Speaking generally, the endurance of each species and group of species is continuous in time as it is in space; both in time and space species, and groups of species, have their points of maximum development; groups belonging either to a certain time or a certain area are often characterised by trifling characters in common, as of sculpture or colour; in looking to the long succession of ages as in looking to distant provinces of the existing world, we find that some organisms differ little, whilst others belonging to a different class, or to a different order, or even only to a different family of the same order, differ greatly.

The second fact—a corollary of the first—is, that *no group or species has come into existence twice.* It cannot be said that the present conditions of the earth are unsuited to the existence of all the living things that have passed away, any more than it can be said that the waters which wash the Isthmus of Panama on the Pacific side are incapable of sustaining the life which exists on the Atlantic side; but species have found barriers in the flow of time, as they find them in the stretch of space.

A third fact is, that just as all existing species are connected together by relationships of form and structure, so *all the faunas and floras of the past are related to one another, and to existing species.* Out of about 120 orders of animals, as animals are classified by the naturalist, you will not, at the outside estimate, find above ten or a dozen extinct, and the proportion of extinct plants is still smaller.[1] The whole fall into one grand natural system. "As Buckland long ago remarked, All fossils can be classed either in still existing groups, or between them. That the extinct forms of life help to fill up the wide intervals between existing genera, families, and orders, cannot be disputed. For if we confine our attention either to the living or to the extinct alone, the series is far less perfect than if we combine both into one general system. With respect to the Vertebrata, whole pages could be filled with striking illustrations from our great palæontologist Owen, showing how extinct animals fall in between existing groups. Cuvier ranked the Ruminants and Pachyderms as the two most distinct orders of mammals; but Owen has discovered so many fossil links, that he has had to alter the whole classification of these two orders, and has placed certain Pachyderms in the same sub-order with Ruminants; for example, he dissolves, by fine gradations, the apparently wide difference between the pig and the camel. In regard to the Invertebrata, Barrande (and a higher authority could not be named) asserts that he is every day taught that Palæozoic animals, though belonging to the same orders, families, or genera with those living at the present day, were not at this early epoch limited in such distinct groups as they now are."[2]

A fourth fact is, that *there exists a wonderful relation-*

[1] Huxley, *Causes of the Phenomena of Organic Nature.*

[2] *Origin of Species*, chap. x.

ship in the same continent between the dead and the living. The fauna now occupying each separate area of the earth's surface is very closely allied to the fauna which existed on that area during recent geological times. Mr Clift many years ago showed that the fossil mammals from the Australian caves were closely allied to the living kangaroo and other marsupials of that continent. The wombat is a characteristic Australian form of mammal, and no fossil wombat has been detected out of Australia and Tasmania. In South America a similar relationship is manifest; for while sloths and armadilloes exist in that continent, and nowhere else, large teeth and great pieces of tesselated armour are found, exactly like those of the living sloth and armadillo, except in size. In Europe, Asia, and Africa, the large mammals are at present rhinoceroses, hippopotamuses, elephants, lions, tigers, oxen, horses, &c.; and if you examine the newest tertiary deposits, which contain the animals and plants which immediately preceded these, you do not find gigantic specimens of ant-eaters and kangaroos, but you find rhinoceroses, elephants, lions, tigers, &c., closely allied to those now living, though still of different species. What do these facts mean? It cannot be an immutable law that pouched animals should be produced only in Australia; for we know that Europe, in ancient times, was peopled by numerous marsupials. It cannot be said that the old forms having become extinct, because of unfitness to some new external condition, the existing marsupials were specially created to fit the modified environment; for sundry animals found elsewhere are so much more completely in harmony with these new Australian conditions, that, when taken to Australia, they rapidly supplant the marsupials.

It is maintained by many naturalists that the difficulties and anomalies of natural history are lessened by these parallel facts in palæontology, and that by connecting the two the key may be found to both. With a larger number of forms to compare, they find less difficulty in classifying them; and, giving up all attempts at linear order or circular arrangement, the conception finally arrived at is, that an ordinary genealogical tree represents, on a small scale, a system of grouping analogous to that which exists among organisms in general—much as would be the case if they were descended from a common ancestor. The relationship in structure and form, the existence of rudimentary parts, the apparent gradation of species into species in some cases, the close relationship of species in adjacent areas, the absence from some habitats of the species best suited to them—with several other anomalies—are said to be just what they would be on the supposition of a genealogical connexion, with the first parents placed far back in time. The analogous palæontological facts—of closely allied species occurring in closely following strata, of no species living again, the community of structure of fossil forms among themselves and with existing creatures, the close alliance of living and recently extinct species on the same continent—are also what they would be on the supposition of genealogical connexion. The difficulties of arrangement resemble those which would be encountered in the endeavour to classify the branches and twigs of a tree: the highest form in a sub-kingdom is the extremity of a great branch, from which there is no access to another great branch except by going back to some place of bifurcation low down in the tree.

It is not pretended that every twig can be traced to its branch, and every branch to the trunk, down through the long succession of rocks; for there are but fragments, in many cases, where branches might be looked for. But our knowledge of the geological record is far from complete; the record itself is imperfect, and we have evidence of a pre-geologic era of unknown duration. Sedimentary strata, earlier than any we know, have been melted up, and the fossils they probably contained destroyed; two-thirds of the earth's surface are covered by water, and cannot be examined; a great part of the exposed land is inaccessible to the geologist, or at least untravelled by him; and the greater part of the remainder has been very imperfectly explored. The crust of the earth, with its embedded fossils, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals. Defective as are the layers of stone, the record of contemporaneous life which they contain is necessarily still more defective and fragmentary: jelly-fishes, and other creatures without hard parts, could not be expected to leave any traces; the bones of many creatures would be crushed by their devourers; and even the bones of large animals might be dissolved through the trickling of water containing a superfluity of carbonic acid. Still, as the experienced anatomist, starting with two or three bones, or perhaps only one, can accurately build up the entire skeleton, so (though in a lesser degree) it has become possible for science to reconstruct the life-tree of the globe.

CHAPTER IV.

THE THEORY OF THE EVOLUTION OF LIVING THINGS.

THE theory of Evolution, which we have seen to be true in Astronomy, Geology, and other sciences, and which is true of the individual organism developed from its parent, was sure to be applied sooner or later to the more general facts of Biology. Of the manner in which it has been so applied I shall now endeavour to give a faithful outline, without adding a word of criticism; for it is the Theory of the Evolution of Living Things, as put before us by its acknowledged exponents, which we have to make acquaintance with in the present chapter.

Until recent years the great majority of naturalists believed that each species of animal and plant had been separately created; that the species had always been as distinct from one another as they are now, and would always remain immutable. But during the first sixty years of the present century no fewer than thirty authors published views involving, in one form or another, the theory of the introduction of new species in accordance with some regular natural law.[1] At the beginning of this period we find Lamarck, and at the close of it Mr Charles Darwin; while, conspicuous in the intermediate space, stands the anonymous author of the *Vestiges of Creation.* It will not be necessary to consider the forms—always inadequate and sometimes grotesque—

[1] Darwin's *Origin of Species: Historical Sketch.*

which the theory took in the hands of its earlier propounders, but only that which it has assumed since it was treated by Darwin and Wallace. These naturalists —particularly Mr Darwin—have so transformed it as to make it almost a new thing, and have supported their views by so many facts and arguments, that they are meeting with very wide acceptance both in this country and abroad.

The Theory of the Evolution of Living Things has for its main object to show that all the phenomena of living things—all their wonderful organs and complicated structures, their infinite variety of form, size, and colour, and their instincts and involved relations to each other—may have been produced by the action of a few general laws of the simplest kind,—laws which are in most cases mere statements of admitted facts. It will be our business now to state and illustrate these laws.

§ 1. "*Natural Selection.*"[1]

The Origin of Species by Means of Natural Selection is the title of Mr Darwin's first book on this subject; but it is only by giving an enlarged sense to the words that they can be made to include the whole of his theory. It is in the larger sense that they are used at the head of this section.

The Law of Heredity.—Starting with the fact of life, and the great abundance of living forms, we observe that the individuals are subject to death, but that commonly they leave behind them offspring possessing the same form and characters, the likeness frequently extending to even the smallest individual peculiarities. Why like

[1] Where not otherwise stated in the notes, the *facts* of this section will be drawn from the works of Messrs Darwin and Wallace.

should produce like we do not know; but although the fact is as much a marvel as it would be for parents and offspring to be always widely dissimilar, we have come to regard it as the natural, and therefore the less wonderful course.

The Law of Variation.—If the first great fact regarding reproduction is that the offspring resemble the parents, it is a fact equally undeniable and remarkable that the resemblance is never complete. Children of the same parents are not all alike among themselves, nor exactly like either their immediate parents or remote ancestors, though they commonly resemble them more than they resemble strangers. The deviation from the parental type is not in one particular only, but the copies slightly differ from the original and from one another in every possible way—in form, in size, in complexion; in the structure of internal as well as of external organs; in those subtle peculiarities which produce differences of constitution, and in those which lead to modifications of mind and character.

This fact of variation is equally true of man, of all animals, and of all plants. Looking at our domestic animals, horses of the same parentage will differ in colour, size, strength, and speed; rabbits will be grey, brown, white, black, &c.; pigeons differ in size, colour, and habits—in the size and shape of the bill and the feet, the number of feathers in the tail, &c. With dogs and cats, the same law of variation holds true, as well as with sheep, and oxen, and poultry. Wild animals would supply us with fresh instances; as would also the vegetable world, whether we looked at wild or cultivated species, at fruits or flowers—there is absolutely no exception.

The Correlation of Variations.—Variations are frequently correlated or linked together in such a way that when one appears a second appears with it—a sort of Siamese twin companion inseparable from its brother. A sixth finger on one hand is usually accompanied by a supernumerary digit on the other; when the muscles of the arms depart in number or arrangement from their proper type, they do so in company, and almost always imitate those of the leg. It is observed that when white cats have blue eyes, they are generally deaf also; when pigeons have short beaks, they have also small feet; the naked Turkish dog has imperfect teeth, and this relation between hair and teeth seems to be general. With man several striking cases have been recorded of inherited baldness with inherited deficiency of the teeth, either complete or partial; and in those rare cases in which the hair has been renewed in old age, there has usually been a renewal of the teeth. Mr Crawford saw, at the Burmese Court, a man, thirty years old, with his whole body, except the hands and feet, covered with straight silky hair, which, on the shoulders and spine, was five inches in length, though at birth the ears alone were covered. This man did not arrive at puberty nor shed his milk teeth until twenty years old, and at this period only acquired the eight incisor teeth and one canine. Another case is that of Julia Pastrana, a Spanish dancer, who was a remarkably fine woman, but possessed a thick masculine beard and a hairy forehead, peculiarities which were accompanied by an irregular double set of teeth—one row within the other—both in the upper and the lower jaw. Turning for a moment to plants, we observe that in double flowers the stamens and pistils vary in the same manner, and assume the form and colour of the petals. In some cases the flowers and leaves vary together in tint; in all the varieties of the common pea which have purple flowers, a purple mark appears also on the stipules.

The Transmission of Variations.—The offspring, then, inheriting in general the characters and qualities of the parents, yet differs from the parents in many little ways; and now when it comes to produce offspring in its turn, it will tend to transmit its own (slightly altered) characters, and, owing to the law of variation, will not succeed perfectly even in that. Moreover, observation shows that peculiarities may be transmitted to the offspring of both sexes alike, or to one sex alone, and may show themselves at birth or at various later periods of life. In most species of parrots, both sexes are brilliantly coloured and undistinguishable. In woodpeckers also the two sexes are generally nearly alike. The equal transmission of characters to both sexes is the commonest form of inheritance. But characters are not rarely transmitted exclusively to that sex in which they first appeared. There are breeds of the sheep and goat in which the horns of the male differ greatly in shape from those of the female, and these differences, acquired under domestication, are regularly transmitted to the same sex. With tortoise-shell cats, the females alone, as a general rule, are thus coloured, the males being rusty-red. The long and magnificent train of the peacock contrasts with the short tail of the pea-hen, each sex inheriting its own. In the Spanish fowl the male has an immense comb; and while the comb of the female is also large, there is this difference, that the comb of the male is upright, but that of the female is apt to lop over. Variations occurring late in life tend to be transmitted exclusively to the same sex; whilst variations which first appear early in life, in either sex, tend to be developed in both sexes. If a new character appears in an animal whilst young, whether it endures throughout life or lasts only for a time, it will reappear, as a general rule, at the same age and in the same manner in the offspring. If, on the other hand, a new character appears at maturity, or even during old age, it tends to reappear in the offspring at the same advanced age. The pigeon offers a remarkable instance of this; there are breeds which do not acquire their characteristic colours until they have moulted two, three, or four times, and these modifications of plumage are regularly transmitted. With animals in a state of nature, innumerable instances occur of characters periodically appearing at different seasons, as, *e.g.*, the fur of Arctic animals becomes thick and white during the winter; and numerous birds acquire bright colours and other decorations during the breeding season alone. Another remarkable fact is, that characters, instead of simply lying dormant in the individual for a few months or years, and appearing at a certain stage of growth, may be transmitted through several generations without showing themselves, and then make their appearance in the descendants. Every one knows that insanity and consumption run in families, as also does the speed of the racehorse; and that such diseases and qualities will sometimes pass over the child and reappear in the grandchild. When the individual reproduces the characters of some remote ancestor, instead of those of its immediate parents—as when the Suffolk cattle, which have been hornless for more than a century, produce a horned calf—this is called a case of reversion.

The whole subject of inheritance is wonderful. Its laws appear to be extremely complex, and, as yet, are so little understood that their operation strikes us as capricious. Mr Darwin has sought to account for some of the facts by the aid of the hypothesis of Pangenesis, according to which every unit or cell of the body throws off gemmules, which are transmitted to the offspring of both sexes, and are multiplied by self-division. These may remain undeveloped during the early years of life, or during successive generations; their development into units like those from which they were derived, depending on their affinity for, and union with, other units previously developed in the due order of growth. This hypothesis is professedly only provisional, and may at any time be superseded by a better; still it may help us to remember the facts, and it is upon the wide foundation of the facts of inheritance, of variation, &c., &c., that the theory of natural selection is reared.

As stated above, the living thing having varied from its parent, produces offspring which vary again. The grandchild, in varying from its immediate parent, may revert to the grandparent in some particulars; or may take a second step in the same direction as its parent, so that its points of difference from the grandparent will be more pronounced; or thirdly, it may vary laterally, and show peculiarities which distinguish it from parent and grandparent equally. This will be repeated through all generations; and it is obvious that if the variations should happen to be continuously of the second kind—that is, in the way of adding up the variations in the same direction—the animal or plant at one end of the series will differ very widely from that at the other, from which, nevertheless, it is lineally descended. It would seem like denying that two and two are four, and that four and two are six, to deny this; and the only question is, Whether the variations do ever accumulate in one direction to such an extent as to lead naturalists to class ancestor and descendant as distinct species?

The Accumulation of Variations by Artificial Selection.—First, *methodically:* Variations which, as we have seen, are supplied by nature, have been made to accumulate by artificial selection or the choice of man, who adds them up in certain directions useful to himself or pleasing to his fancy. When a pigeon-fancier observes in a bird some peculiarity which he would like to preserve, he selects from among the offspring those individuals which show the peculiarity in the most conspicuous manner, carefully matches them, and selects from their offspring again, till in the course of successive generations he has obtained a new breed. The differences thus selected are commonly so slight as to be inappreciable by an uneducated eye, and it is only where a man is naturally gifted with accuracy of eye and judgment, and devotes his life to the study of the subject, that he succeeds in becoming an eminent breeder. The diversity of the breeds of pigeons is something astonishing. "Compare the English carrier and the short-faced tumbler, and see the wonderful difference in their beaks, entailing corresponding differences in their skulls. The carrier, more especially the male bird, is also remarkable from the wonderful development of the carunculated skin about the head; and this is accompanied by greatly elongated eyelids, very large external orifices to the nostrils, and a wide gape of mouth. The short-faced tumbler has a beak in outline almost like that of a finch; and the common tumbler has the singular inherited habit of flying at a great height in a compact flock, and tumbling in the air head over heels. The runt is a bird of great size, with long massive beak, and large feet; some of the sub-breeds of runts have very long necks, others very long wings and tails, others singularly short tails. The barb is allied to the carrier, but instead of a very long beak has a very short and very broad one. The pouter has a much elongated body, wings, and legs; and its enormously developed crop, which it glories in inflating, may well excite astonishment, and even laughter. The turbit has a very short and conical beak, with a line of reversed feathers down the breast; and it has the habit of continually expanding slightly the upper part of the œsophagus. The jacobin has the feathers so much reversed along the back of the neck that they form a hood; and it has, proportionally to its size, much elongated wing and tail feathers. The trumpeter and laugher, as their names express, utter a very different coo from the other breeds. The fantail has thirty or even forty tail-feathers, instead of twelve or fourteen—the normal number in all members of the great pigeon family; and these feathers are kept expanded, and are carried so erect, that in good birds the head and tail touch: the oil-gland is quite aborted. Several other less distinct breeds might be specified." Yet it is the common opinion of naturalists, that all these domestic varieties have descended from the wild rock-pigeon (*Columba livia*), a bird of a beautiful blue colour, with white crop, double black wing-bars, and barred and white-edged tail-feathers.

In a similar way it is certain that some of our eminent breeders have, even within a single lifetime, modified to a large extent some breeds of cattle and sheep. With poultry again, man has produced almost every variety of colour, curious modifications of plumage, and the capacity of perpetual egg-laying. Breeders habitually speak of an animal's organization as something quite plastic, which they can model almost as they please.

Of course the variations must occur before they can be selected, but they always do occur—size, speed, form and colour, instincts, habits, intelligence, have always varied, so as to admit of the production of the very races which the wants or fancies, or passions of men, may have led them to desire.

It is the same with plants as with animals. The experience of cultivators shows that when a sufficient number of individuals are examined, variations of any required kind can always be met with, and can be made to accumulate by selection, without materially affecting the other characters of the species. When fashion demands any particular change in the form or size or colour of a flower, sufficient variation always occurs in the right direction, as is shown by our roses, auriculas, and geraniums; and when, as recently, ornamental leaves come into fashion, sufficient variation is found to meet the demand, and we have zoned pelargoniums and variegated ivy. This variation is not confined to old and well-known plants, subjected for a long series of generations to cultivation; but the Sikim rhododendrons, the fuchsias and calceolarias from the Andes, and the pelargoniums from the Cape, are equally accommodating, their variations accumulating just where and when and how we require them.

These are but instances, but they are sufficient to indicate the power man possesses of modifying animal and vegetable forms, by methodically selecting those variations which naturally occur, and which he wishes to perpetuate and increase. The principle of Selection, observes Mr Youatt, is the magician's wand by means of which the agriculturist may summon into life whatever form and mould he pleases.

Secondly, *unconsciously:* Even more important than this methodical selection, is that kind of selection which may be called unconscious, and which results from every one trying to procure and rear the best animals he can, according to his skill and the prevailing standard of excellence. Thus, a man who intends keeping pointers naturally tries to get as good dogs as he can, and afterwards breeds from his own best dogs; but he has no wish to modify the breed: he does not look to the distant future, or speculate on the final result of the slow accumulation during many generations of successive slight changes. In this way there is reason to believe that King Charles's spaniel has been modified to a large extent since the time of that monarch. By a similar process of selection, and by careful training, the whole body of English race-horses have come to surpass in fleetness and size the parent Arab stock; so that the latter, by the regulations of the Goodwood races, are favoured in the weights they carry. Youatt gives an excellent illustration of the effects of a course of selection, which may be considered as unconsciously followed, in so far that the breeders could never have expected, or even have wished, to have produced the result which ensued—namely, the production of two distinct strains. The two flocks of Leicester sheep kept by Mr Buckley and Mr Burgess have been purely bred from the original stock of Mr Bakewell for upwards of fifty years. There is not a suspicion existing in the mind of any one at all acquainted with the subject, that the owner of either of them has deviated in any one instance from the pure blood of Mr Bakewell's flock, and yet the difference between the sheep possessed by these two gentlemen is so great that they have the appearance of being quite different varieties.

The Accumulation of Variations by Sexual Selection. —In many species of animals where the sexes are conspicuously different, the males appear to have the advantage: among cattle they have the stronger horns, among birds the brighter plumage and finer power of song; with certain species of beetle, again, they have the more powerful weapon, and with butterflies the gaudier wings. Many of these differences can be accounted for by the continuous operation of two processes, which may be called (1) the Choice of Mates; and (2) the Law of Battle, of which the first bears some analogy to methodical selection in man, and the second to man's unconscious selection: or perhaps it would be truer to say that *both* correspond to man's unintentional selection.[1]

(1.) *The Choice of Mates, or Contest of Beauty.*—Many of the lower creatures possess sufficient intelligence to show their preference for one mate rather than another at the breeding season. This is particularly the case with birds, and some instances from that class may suffice for our present purpose. As already intimated, when the sexes differ in beauty, or in the power of sing-

[1] More strictly, both correspond to sexual selection in man. But sexual selection in man is partly methodical and partly unconscious.

ing, it is almost invariably the male which excels the female; and apparently he is thus endowed for the purpose of charming or exciting the female. At the breeding season he elaborately displays his varied attractions, and often performs strange antics on the ground, or in the air, in her presence. It is stated on the authority of the Rev. Darwin Fox, that the common magpie used to assemble from all parts of Delamere Forest, in order to celebrate the "great magpie marriage," the ceremonies consisting in chattering, bustling, and flying about the trees, and sometimes in fighting. The whole affair was evidently considered by the birds as being of the highest importance; and shortly after the meeting they all separated, and were observed to be paired for the season. With Birds of Paradise a dozen or more full-plumaged males congregate in a tree to hold a dancing-party, as the natives call it. They raise their wings, stretch out their necks, elevate their exquisite plumes, and between whiles they fly across from branch to branch in great excitement, so that the whole tree is filled with waving plumes, in every variety of attitude and motion. These birds, when kept in confinement in the Malay Archipelago, are said to take much care in keeping their feathers clean; often spreading them out, examining them, and removing every speck of dirt. One observer, who kept several pairs alive, did not doubt that the display of the male was intended to please the female. The gold pheasant during his courtship not only expands and raises his splendid frill, but turns it obliquely towards the female, on whichever side she may be standing, obviously in order that a large surface may be displayed before her. The male Argus pheasant displays his elegant primary wing-feathers, and erects his ocellated plumes in the right position for their full effect. The peacock displays his gorgeous train, and struts about in all the pomp of pride, before the female. The goldfinch exhibits alternately his gold-bespangled wings; the common pigeon inflates his breast to show off his iridescent feathers to the best advantage.

As male birds display with so much care their fine plumage and other ornaments in the presence of the females, it is obviously probable that these appreciate the beauty of their suitors. Mr Hussey has described a tame partridge which seemed fond of gay colours, and states that no new gown or cap could be put on without catching its attention. In a state of nature, the female bird is pursued by many males, and so has the opportunity of exerting a choice. Audubon, who spent a long life in observing the habits of birds in the forests of the United States, speaking of a woodpecker, says that the hen is followed by half-a-dozen gay suitors, who continue performing strange antics, until a marked preference is shown for one. The same naturalist carefully observed the wild flocks of Canada geese, and gives a graphic description of their love-antics: he says that the birds which had been previously mated renewed their courtship as early as the month of January, while the others would be contending or coquetting for hours every day, until all seemed satisfied with the choice they had made; after which, although they remained together, any person could easily perceive that they were careful to keep in pairs. Many similar statements could be cited from the most eminent naturalists; and they seem sufficient to prove that the female bird exerts a choice, and receives the addresses of the male who pleases her most. It is not necessary to suppose that she consciously deliberates, that she studies each spot and stripe of colour, and appreciates fine shading and exquisite patterns; she is probably struck only by the general effect, and is excited and attracted by the most beautiful, melodious, and gallant of her suitors.

It will probably be admitted that the choice of mates —a form of sexual selection which is always at work— must result after sufficient lapse of time in modifications of plumage corresponding to those which man produces methodically, and still more perhaps to those which he produces unintentionally. It is considered that the enormous differences between the sexes in regard to plumage and song,—as, for instance, the superiority of the peacock to the peahen, and of the male canary to the female,—are the result of sexual selection, acting on the small differences constantly supplied by nature, the distinguishing marks being inherited by the male sex only; or, if tending to be inherited by the female also, being prevented by other causes from developing.

(2.) *The Struggle for Mates, or Law of Battle:* It was mentioned just now that magpies sometimes fight as well as chatter at the pairing season. Almost all male birds are extremely pugnacious, using their beaks, wings, and legs for fighting together, and this disposition shows itself most strongly at the breeding season. The males of the common water-hen, when pairing, struggle violently for the females, standing nearly upright in the water, and fighting with their feet. Two were seen to be thus engaged for half an hour, until one got hold of the head of the other, which would have been killed had not the observer interfered—the female all the time looking on as a quiet spectator. The males of many gallinaceous birds, especially of the polygamous kinds, are furnished with special weapons for fighting with their rivals, namely, spurs, which can be used with fearful effect. It has been recorded by Mr Hewitt that, in Derbyshire, a kite struck at a game-hen accompanied by her chickens, when the cock rushed to the rescue, and drove his spur right through the eye and skull of the aggressor. The males of some birds, as already mentioned, are ready to fight whenever they meet; but generally the season of love is that of battle, the suitors trying to drive away or kill their rivals before they pair. Of course in such struggles the larger and stronger bird, and the best furnished with weapons, has the advantage, secures the female, and leaves offspring which tend to inherit the same characters.

With mammals, the male appears to win the female much more through the law of battle than through the display of his charms. All male animals which are furnished with special weapons for fighting are well known to engage in fierce contests; and the most timid animals, not provided with special weapons, engage in desperate conflicts during the season of love. Two male hares have been seen to fight together until one was killed; male moles often fight, and sometimes with fatal results; male squirrels engage in frequent contests, and often wound each other severely; and male beavers struggle till hardly a skin is without scars. The courage and the desperate conflicts of stags have often been described: their skeletons have been found in various parts of the world with the horns inextricably locked together, showing how miserably the victor and the vanquished had perished. The law of battle prevails with aquatic as well as with terrestrial mammals. It is notorious how desperately male seals fight during the breeding season, both with their teeth and claws, their hides being often covered with scars.

Very little is known about the courtship of quadrupeds in a state of nature, but it is certain that domesticated animals often show strong individual preferences and antipathies; and it seems probable that, in a state of nature, the females are allured or excited by particular males who possess certain characters in a higher degree than other males. Any such characters would thus have the advantage, being selected for perpetuation, either methodically or unconsciously, and in the course of many generations would tend to accumulate in particular directions; that is to say, would tend to become more marked or conspicuous.

In the same manner as man can give beauty, according to his standard of taste, to his male poultry,—can give to the Sebright bantam a new and elegant plumage, an erect and peculiar carriage,—so it appears that in a state of nature female birds, by having long selected the more attractive males, have added to their beauty. In the same manner as man can improve the breed of his game-cocks by the selection of those birds which are victorious in the cockpit, so it appears that the strongest and most vigorous males, or those provided with the best weapons, have prevailed under nature, and have led to the improvement of the natural breed or species. Through repeated deadly contests a slight degree of variability, if it led to some advantage, however slight, would suffice for the work of sexual selection; and it is certain that secondary sexual characters are eminently variable.

The Accumulation of Variations by Natural Selection (or the Struggle for Existence).—The cases of selection thus far noticed—or rather the classes of cases—are, after all, only the fewer and less important of all those that occur. Man's selection, conscious and unconscious, so far as we have yet considered it, operates only with regard to the domestic races; sexual selection, as seen in the choice of mates and the law of battle, is of more importance, but operates chiefly at particular seasons. But living things have also to maintain a more constant struggle,—against other individuals of the same species who may be pugnacious; against other species which prey upon them or require the same kind of food; against the elements and the seasons, which may also deprive them of food, or hurt them by extremes of temperature, &c., &c. Those who survive in this struggle for existence do so because of some fitness in their organization or habits; and since any variations which render one individual more fit than another, in however slight a degree, are thus as it were selected, apart from man's interference, this process of nature is called Natural Selection. The expression of course is figurative, as it is not pretended that there is any choice exercised or volition shown in the inanimate elements, or that the animals concerned do their part in any more than a blind way; yet still it is sufficiently like that process which has been called man's unconscious selection, to justify the name which it has received, and is legitimate in the same way that it is legitimate for chemists to speak of elective affinity. Natural Selection, in a large sense, includes Sexual Selection, but it has been found convenient to treat of the two separately.

The Law of Multiplication.—All organized beings have enormous powers of multiplication. Even man, who increases more slowly than all other animals, could, under the most favourable circumstances, double his numbers every fifteen years, or increase a hundred-fold in a century. Many animals could increase their numbers from ten to a thousand-fold every year; and if unchecked would soon require all the world to themselves. A calculation made by Professor Huxley[1] shows that a single plant, having all the world before it with no rival, would, under favourable conditions, occupy every available spot of the globe before the end of the ninth year. Suppose all the dry land of the globe—which equals about 51,000,000 of square miles—to consist of the same kind of soil, and to have the same kind of climate, that the conditions are everywhere the same and exactly suited to the plant, and suppose that the plant produces annually fifty seeds (a moderate number), each requiring only one square foot of soil, the following figures will tell us the result:—

Plants.		Plants.
1 × 50 in 1st year	=	50
50 × 50 „ 2d „		2,500
2,500 × 50 „ 3d „		125,000
125,000 × 50 „ 4th „		6,250,000
6,250,000 × 50 „ 5th „		312,500,000
312,500,000 × 50 „ 6th „		15,625,000,000
15,625,000,000 × 50 „ 7th „		781,250,000,000
781,250,000,000 × 50 „ 8th „		39,062,500,000,000
39,062,500,000,000 × 50 „ 9th „	=	1,953,125,000,000,000
51,000,000 sq. miles—the dry surface of the earth × 27,878,400—the number of sq. ft. in 1 sq. mile	=	1,421,798,400,000,000
		Being 531,326,600,000,000

square feet less than would be required at the end of the ninth year.

The Law of Limited Populations.—Notwithstanding this tendency to increase in geometrical progression, the

[1] *Causes of the Phenomena of Organic Nature.*

number of living individuals of each species in any country, or over the whole globe, is practically stationary; so that the whole of this enormous increase must die off as fast as produced, excepting those individuals for whom room is made by the death of parents. As a simple but striking example, take an oak forest: every oak will drop annually thousands or millions of acorns, but till an old tree falls not one of these millions can grow up into an oak; they must die at various stages of growth. A single pair of birds, again, multiplying at the ordinary rate, would in fifteen years increase to more than 2000 millions; whereas we have no reason to believe that the number of birds in any country increases at all; so that every year as many must perish as are born. Which creatures shall die and which shall live depends upon circumstances now to be detailed.

The Struggle.—All carnivorous quadrupeds and other creatures of prey are furnished with suitable weapons of offence: the lion has his formidable teeth and claws, the eagle his claws and beak. On the other hand, every creature liable to be preyed upon possesses some means of defence: the tiger can oppose the lion with his own weapons, the hedgehog can roll itself into a ball, the tortoise is protected by a shelly carapace. Many beetles (of the family Curculionidæ) have the wing-cases and other external parts so excessively hard that you cannot put a pin through them without first drilling a hole, and this doubtless saves them from the attacks of birds, where butterflies and caterpillars fall a prey. An immense number of insects have stings, and some stingless ants (of the genus Polyrachis) are armed with long and sharp spines on the back, which must render them unpalatable to many of the smaller insectivorous birds.

In the struggle for existence also, as in human warfare, something is owing to fertility of resource, and something to discretion.

> "He that fights and runs away,
> Lives to fight another day."

The horse, the zebra, the antelope, the hare, and many other animals, are protected by their swiftness; foxes have holes, and birds hide in their nests; great numbers of insects hide themselves among the petals of flowers, or in the cracks of bark and timber; and finally, extensive groups have a disgusting smell or taste, which they either possess permanently, or can emit at pleasure.

It will be evident that, owing to these opposing endowments, a process of selection must be continually going on. The lion with the strongest teeth and swiftest foot is more likely to catch his prey than one less well endowed in these respects, and therefore in seasons of scarcity would be selected to be preserved while another might starve. The swiftest hares and antelopes will escape their foes, and leave offspring who inherit their speed of foot; the animals with shorter or weaker legs must necessarily suffer more; the passenger pigeon with less powerful wings will sooner or later fail to procure a regular supply of food, and in consequence its numbers will diminish.

When the accustomed food of some animal becomes scarce, or totally fails, the creature can only exist by emigrating, or by becoming adapted to a new kind of food—a food perhaps less nourishing and less digestible. Natural selection will now act upon the stomach and intestines, and all individual variations favourable to the new state of things will be taken advantage of to modify the race into harmony with the conditions. In many cases, however, it is probable that this cannot be done; the internal organs may not vary quick enough, and then the animal will decrease in numbers, and finally become extinct. If a larger or more powerful beast is to be captured and devoured—as when a carnivore, which has hitherto preyed on antelopes, is obliged from their decreasing numbers to attack buffaloes—it is only the strongest who can struggle with and overcome such an animal—those with the most powerful claws and formidable canine teeth. Consequently, any variation in these respects will be selected; that is, it will give its possessor a better chance of life than his fellows of the same species, and among his offspring will probably be found some who inherit his peculiarities, perhaps in a more marked degree.

Let us suppose that a certain animal is exactly fitted to secure its prey, to escape from its enemies, to resist the inclemency of the seasons, and to rear a numerous and healthy offspring, all goes well so long as the outward conditions remain unchanged. But a series of cold winters comes on, making food scarce, and bringing an immigration of some other animals to compete with the former inhabitants of the district. The new immigrant is swift of foot, and surpasses its rivals in the pursuit of game, the winter nights are colder and require a thicker fur as a protection, and more nourishing food to keep up the heat of the system. Our supposed perfect animal is no longer in harmony with its environment, it is in danger of dying of cold or starvation; but among its offspring there may be some swifter than others, who will still manage to catch food enough; some hardier and more thickly furred, who can manage to keep warm enough: while the slow, the weak, and the thinly clad will soon die off. Again and again, in each succeeding generation, the same thing takes place; and by this natural process, which is so inevitable that it cannot be conceived not to act, those best adapted to live do live, and those least adapted die.

These are comparatively simple instances, but very often the interaction of climate, food supply, animal organization, conditions of plant life, &c., is intricately interwoven, and plants and animals most remote in the scale of nature are bound together by a web of complex relations. It would hardly be thought credible that the presence of a feline animal in large numbers in a district should determine the frequency of certain flowers in that district; yet this appears to be the case. The heartsease and red clover are dependent for their fertilization, and therefore their perpetuation, on the visits of humble bees; for other bees do not visit these flowers, not being able to reach the nectar. Hence we may infer, that if the whole genus of humble bees became extinct, or very rare in England, the heartsease and red clover would become very rare, if they did not wholly disappear. The number of humble bees in any district depends in a great degree on the number of field mice, which destroy their combs and nests, so much so that Mr H. Newman, who has long attended to the habits of humble bees, believes that more than two-thirds of them are thus destroyed all over England. The number of mice, again, is largely dependent, as every one knows, on the number of cats; and Mr Newman says, "Near villages and small towns, I have found the nests of humble bees more numerous than elsewhere, which I attribute to the number of cats which destroy the mice." So then, the more cats the fewer mice; the fewer mice the more bees, the more bees the more heartsease and red clover,—that is, the more cats the more of these flowers! And of course in all these struggles the quickest cats and quickest mice will have the advantage, and the bees with the longest probosces, and the flowers whose nectar is most easily reached; and therefore variations in these directions will be selected and perpetuated.

Protective Resemblances.—When Jehoshaphat accompanied Ahab in the war against Ramoth Gilead, the King of Judah put on his robes, and in consequence was singled out by the Syrian captains, and nearly lost his life; but Ahab *disguised* himself and went into the battle, and although an arrow struck him, it was a chance shot not aimed at him especially. It is often urged that the red coat of the British soldier renders him too conspicuous an object to the enemy, and that to escape unnecessary danger the clothing should be green or grey, assimilated to the colour of the ground he walks on, or the foliage among which he moves. The disguise which would save the soldier from the observation of his enemy would serve him also in another way, for it would quite as much enable him as an assailant to steal upon the foe unperceived. Nearly all birds and insects have enemies who are similarly capable of being deceived; the hawk, for instance, is so much guided by eyesight in taking its prey, that on parts of the continent persons are warned not to keep white pigeons, because they are the most liable to be seen and destroyed. When, therefore, we see leaf-eating insects green, and bark-feeders mottled grey, the alpine ptarmigan white in winter, the red grouse the colour of the heather, and the black grouse that of peaty earth, we must believe that these tints are of service to these birds and insects in preserving them from danger. Another step in advance, and we have insects which are formed as well as coloured so as exactly to resemble particular leaves, or sticks, or mossy twigs, or flowers; and in these cases very peculiar habits and instincts come into play to aid in the deception, and render the concealment more complete. Probably the reader has seen in some museum a specimen of the "walking-leaf," in which not only are the wings perfect imitations of leaves in every detail, but the thorax and legs are flat, dilated, and leaf-like, so that when the living insect is resting among the foliage on which it feeds, the closest observation is often unable to distinguish between the animal and the vegetable. The whole family of the Phasmidæ or Spectres, to which this insect belongs, is more or less imitative, and a great number of the species are called "walking-stick insects," from their singular resemblance to twigs and branches. Some of these are a foot long and as thick as one's finger, and their whole colouring, form, rugosity, and the arrangement of the head, legs, and antennæ, are such as to render them absolutely identical in appearance with dead sticks. They hang loosely about the shrubs in the forest, and have the extraordinary habit of stretching out their legs unsymmetrically, so as to render the deception more complete. One of these creatures, obtained by Mr Wallace in Borneo, was covered with foliaceous excrescences of a clear olive green colour, so as exactly to resemble a stick grown over by a creeping moss or jungermannia. The Dyak who brought it to him assured him it was thus grown over, although alive, and it was only after minute examination that he could convince himself it was not so.

There can be no doubt that many birds have their colours assimilated to those of surrounding objects, so that they may escape the notice of their enemies, or may approach their prey unobserved. Mr Wallace remarks that it is only in the tropics, among forests which never lose their foliage, that we find whole groups of birds whose chief colour is green. In regard to birds which live on the ground, how difficult it is to see a partridge, snipe, woodcock, or certain plovers, larks, and night-jars, when crouched on the soil. Animals inhabiting deserts offer striking instances of this imitation, for the bare surface affords no concealment, and all the smaller quadrupeds, reptiles, and birds, depend for safety on their colours. Mr Tristram has remarked, in regard to the inhabitants of the Sahara, that all are protected by their isabelline or sand colour.

Time would fail us to go through the whole list of creatures "protected"—birds, snakes, toads, beetles, butterflies, caterpillars, &c., &c. No one can behold the upper surface of a flounder and overlook its resemblance to the sandy bed of the sea on which it lives. There are now (1870) in the aquarium of the Zoological Society some slender green pipe-fish, which fasten themselves to any object at the bottom by their prehensile tails, and float about with the current, looking exactly like some simple forms of sea-weed. In the same Zoological Gardens, how difficult it is sometimes to catch sight of the little green tree-frogs sitting on the leaves of a small plant enclosed in a glass case; yet how much better concealed must they be among the fresh green damp foliage of a marshy forest! The most arboreal lizards, the iguanas, are as green as the leaves they feed upon, and the slender whip-snakes are rendered almost invisible as they glide among the foliage, by a similar coloration.

Thus we see that protective resemblance realizes the talisman of the fairy tale, and gives its possessor the power of rendering himself invisible. It requires no argument to show that those who possess it in the highest degree will oftenest escape their foes and catch their own prey, and that therefore every variation that tends to perfect it will be preserved, while variations which are not useful will be neglected and suffered to disappear.

Mimicry.—We now come to creatures whose colours neither conceal them nor make them to look like vegetable or mineral substances; who, on the contrary, are conspicuous enough, but so completely resemble creatures of a quite different group, that ordinarily they are mistaken for them. They remind us of masqueraders dressed up and painted for amusement, or of swindlers passing themselves off for respectable members of society. If this were done with conscious intention, it would be mimicry, strictly so called; but as we do not suppose that butterflies and birds put on the dress of others by voluntary imitation, the word is used only in a figurative sense. The term was adopted by Mr Bates, who first discovered the object of these curious imitations, and explained them as a result of natural selection.[1] In the Brazilian forests, there are great numbers of birds which catch insects on the wing, and destroy, among others, many butterflies; but among the wings of butterflies found on the ground where the bodies have been devoured, you will not detect any of the Heliconidæ—butterflies, which are sandy in colour and slow in flight

[1] *Transactions, Linn. Soc.*, vol. xxiii. 1862, p. 495.

—though you find some of the large Nymphalidæ, which fly more swiftly. Or if you watch the birds bringing butterflies to their nests to feed their young, you will not find Heliconidæ among them, though they are flying lazily about in great numbers, and could easily be caught. The secret is that these butterflies have a strong and disagreeable odour, which renders them distasteful to the birds; and any young bird, after a few trials, would give up catching them. Under these circumstances, it is evident that any other butterfly of a group which birds were accustomed to devour would be almost as well protected by resembling a Heliconia as by resembling a leaf or a twig, always supposing that there were only a few of them among a great number of the Heliconias. Now, it is actually the case that among the white butterflies, forming the family Pieridæ, is a genus of rather small size (Leptalis), some species of which are white like their allies, while the greater number exactly resemble the Heliconidæ, not only in the colouring of the wings, but also in their form. In structural characters, the Pieridæ are as easily distinguishable from the Heliconidæ as buffaloes are from bears; but externally there is this resemblance, fitted to deceive the eye of a bird; nay, every length and shape of wing, every stripe and shade of colour, every band and tint and spot, are so much the same that only the close examination of a naturalist can make out the difference. It is intelligible, then, that when variations occur in the white butterflies, a slight approach in colour and form to the Heliconidæ will be some slight advantage, tending to deceive a bird at a long distance, and so secure a longer lease of life; which, though it be but one additional day, may suffice in many cases for laying eggs and leaving offspring. Among the offspring many will inherit the peculiarity which has been the safeguard of their parent, and if any exhibit it to a greater extent they will benefit by it all the more.

One of the most remarkable cases of mimicry is that of *Charis melipona*, a South American longicorn beetle, which has been so named from its resemblance to a small bee of the genus Melipona. The thorax and body are densely hairy, like those of the bee, and the legs are tufted in a manner most unusual in the order Coleoptera. Another longicorn (*Odontocera odyneroides*) has the abdomen banded with yellow, and constricted at the base, and is altogether so exactly like a small common wasp of the genus Odynerus, that Mr Bates informs us he was afraid to take it out of his net with his fingers, lest he should be stung. No doubt many a hungry bird had declined the morsel, being similarly deceived by the beetle's disguise. Nor is mimicry confined to insects. In the island of Bouro, and again in the adjacent island of Ceram, Mr Wallace discovered birds which he constantly mistook for each other, though they belonged to distinct families—orioles mimicking honeysuckers, and no doubt benefiting by the hypocrisy, since the orioles are weak birds, with small feet and claws, while the honeysuckers they resemble are strong, well-armed, pugnacious, and able to defy the hawk.

The Origin of New Species through the Accumulation of Variations.—It is abundantly clear that, in every species of animal and plant, variations are constantly occurring, and that through the agency of "selection" they are sometimes made to accumulate in definite directions till they constitute new breeds or varieties;

but now we have to inquire whether the difference ever becomes so great that the progenitor and the descendant must be classed as distinct species? To our minds, two species of plant or animal are separate pictures, as distinct from one another as a picture of St Peter's at Rome and St Paul's in London: Can the one pass into the other like the slow gradation of a dissolving view? Our authors say it can, and that in several ways.

First, by Artificial Selection, both conscious and unconscious. Of pigeons—the breeds of which are methodically produced—at least a score 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. "Moreover," says Mr Darwin, "I do not believe that any ornithologist would place the English carrier, the short-faced tumbler, the runt, the barb, the pouter, and fantail in the same genus; more especially as in each of these breeds several truly-inherited sub-breeds, or species, as he might have called them, could be shown him." Yet, as before stated, it is the common opinion of naturalists that all have descended from the rock-pigeon; and if we could collect all the pigeons which have ever lived, from before the time of the Romans to the present day, we should be able to group them in several lines, diverging from the parent bird. Each line would consist of almost insensible steps, occasionally broken by some slightly greater variation or sport, and each would culminate in one of our present highly-modified forms.

Amongst dogs the selection exercised by man—sometimes purposely, sometimes unconsciously—has produced changes of form, of size, and of speed greater than those which distinguish different species. The greyhound differs much more from the wolf or the dingo than the racer does from the wild Arabian. The smallest dog is probably no bigger than the head of the largest. No wild dog, fox, or wolf is so small as the tiniest spaniel, or so large as the biggest Newfoundland dog; and no two wild animals of the family differ so widely as the bull-dog and the greyhound. The known range of variation, therefore, is more than enough for the derivation of all the forms of dogs, wolves, and foxes, from a common ancestor.

There is one great difference, indeed, between these apparent species produced artificially, and species not so produced: the hybrids of the former are fertile with one another, while those of the latter are sterile. That is to say, while, if the horse is crossed with the ass, the resulting mules produce no offspring when paired together; the case is different with dogs and pigeons, for the carrier and fantail, or any other two pigeons, will produce mongrels which are as fertile between themselves as carriers are with carriers. This is certainly a great difference, but it is not fatal to the theory; because, although sterile hybrids have not yet been produced artificially, nobody has proved that such production is impossible, and future experiments, when the causes of sterility are better known, may be successful.[1]

[1] Mr G. H. Lewes (*Fortnightly Review*, April 1868) states, that the European guinea-pig is believed to have descended from the American, but that the two will not couple together.

It occurs to the writer that sterile hybrids might perhaps be produced if the breeder directed his sharp eye to the food preferences of an animal, instead of selecting peculiarities of external structure. Sterility must depend on peculiarities of constitution not manifest externally, but correlated with the animal's diet. Let a number of pigeons be taken, let every variety of food be

Secondly, by Sexual Selection. The modifications acquired through this agency are often so strongly pronounced, that the two sexes have frequently been ranked as distinct species, or even as distinct genera. Two humming birds belonging to the genus Eustephanus, which inhabit the island of Juan Fernandez, were long thought to be specifically distinct, but are now known, Mr Gould says, to be the sexes of the same species. Among butterflies, the females of *Papilio memnon* and *Diadema auge* consist of scores of such different insects, that they have over and over again been described as distinct species, but in both cases the males are very constant. Bearing these facts in mind, and remembering the marked results of man's unconscious selection, it seems certain that if the individuals of one sex were during a long series of generations to prefer pairing with certain individuals of the other sex, characterised in some peculiar manner, the offspring would slowly but surely become modified in accordance, and it is difficult to assign any limit to the amount of change.

Thirdly, since man has produced a great result by his methodical and unconscious selection, what may not Natural Selection effect? Man can only act on external and visible characters; nature acts on every internal organ, on every shade of constitutional difference, on the whole machinery of life. Man selects only for his own good; nature only for that of the being which she tends. Every selected character is fully exercised when nature alone is superintending, and the being is placed

offered them, and those that show any slight preference for one kind above another be set apart and nourished as exclusively as possible on that kind, and the process repeated with their offspring.

under well-suited conditions of life. Man keeps the natives of many climates in the same country, exposes sheep with long and short wool to the same conditions, feeds a long and a short beaked pigeon on the same food. He does not exercise a long-backed or long-legged quadruped in the peculiar manner its structure demands; he does not allow the most vigorous males to struggle for the females; he does not destroy all inferior individuals. He begins his experiments, and dies while they are in progress; but nature never dies, nor sleeps, nor forgets to work, silently and insensibly improving each organic being in relation to its conditions of life. We observe nothing of these slow changes while in progress—slow like the minute-hand of a clock; but when the hand of time has marked the long lapse of ages, we see that the forms of life have become different from what they formerly were. How fleeting are the wishes and efforts of man! how short his time! and consequently how poor will his products be compared with those accumulated by nature during long geological periods!

The Origin of Man.—Man is an animal built up on the same plan as other animals of the class Mammalia, and all the bones in his skeleton can be compared with corresponding bones in a monkey, a bat, or a seal. So it is for the most part with his muscles, nerves, blood-vessels, and internal viscera; while every chief fissure and fold of his brain has its analogy in that of the orang. Many modern naturalists, following Linnæus, have placed him in the same order with the Quadrumana; and Professor Huxley declares that the structural differences which separate man from the gorilla and chimpanzee are not so great as those which separate the gorilla from the lower apes.[1] Man passes through the same phases of embryological development with other vertebrates, so that at an early stage his embryo can hardly be distinguished from theirs. Many muscles regularly present in apes and other quadrupeds appear in man occasionally, and numerous rudiments occur of structures characteristic of lower forms, but altogether useless in him. The internal and external parasites of man and the lower animals are of the same families and genera, and he is able to receive some animal diseases (as glanders and hydrophobia), showing a close similarity in blood and tissues. But if man be separated by no greater structural barrier from the brutes than they are from one another, then it seems to follow that if any process of physical causation can be discovered by which the genera and families of ordinary animals have been produced, that process is amply sufficient to account for the origin of man.[2]

A multitude of facts prove that man is liable to numerous slight and diversified variations, which are induced by the same general causes, and are governed and transmitted in accordance with the same general laws, as in the lower animals. He tends to increase at a greater rate than his means of subsistence, and consequently is occasionally subjected to a severe struggle for existence, combating with the elements, with the brute creation, and with men of other tribes; so that natural selection comes into play, and of course effects whatever lies within its scope.

From a thorough consideration of these facts, and others allied to them, Mr Darwin infers that man is de-

[1] Huxley : *Man's Place in Nature*, p. 103.
[2] *Ibid.*, p. 105.

scended from a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in its habits, and an inhabitant of the Old World. This creature, if its whole structure had been examined by a naturalist, would have been classed amongst the Quadrumana, as surely as would the common and still more ancient progenitor of the Old and New World monkeys.

§ 2. *The Cause of Variations.*

The gradual lapse of time has now separated us by more than a decade from the date of the *Origin of Species;* and whatever may be thought or said about Mr Darwin's doctrines, or the manner in which he has propounded them, this much is certain, that in a dozen years the *Origin of Species* has worked as complete a revolution in biological science as the *Principia* did in astronomy; and it has done so because, in the words of Helmholtz, it contains "an essentially new creative thought."[1] But the theory of Natural Selection is not a complete theory of the evolution of living things. Natural Selection accounts for the preservation and accumulation of useful variations, till new species are thereby evolved; Evolution seeks in addition to show the causes of the variations themselves, and the manner of origin of living things in the first instance. Natural Selection is a part, Evolution is the whole, and the part falls into its right place when the whole scheme is expanded.

One of the most frequent objections made to the Darwinian theory has been, that it does not account for the origin of the "variations" which are afterwards "selected," and that unknown laws or tendencies must be at work within the organism, or without. It has

[1] Professor Huxley : *Contemp. Rev.*, Nov. 1871.

been said that Natural Selection manifestly does not *produce* the variations, nor does it even suggest the law under which, or by which, or according to which, new forms are introduced.[1] Natural Selection has nothing to do with the creation of any favourable addition to nature; it is only the removal of those who do not possess the addition.[2] The facts suggest to the mind the idea of some creative law, almost as certainly as they convince us that we know nothing of its nature, or of the conditions under which it does its glorious work.[3] It seems probable that new species may arise from some constitutional affection of parental forms—an affection mainly, if not exclusively, of their generative system.[4] It is not only possible, but highly probable, that an internal power or tendency is an important, if not the main, agent in producing the manifestation of new species on the scene of realised existence.[5]

Mr Darwin is so fully aware that his theory does not account for the initial variations, that he over and over again ascribes them to "unknown causes;" and the objections are so far from being valid against Natural Selection that they only ask to have the doctrine supplemented. This supplement to Natural Selection—or rather this complement, for the two together constitute a tolerably complete theory—is supplied in Mr Herbert Spencer's teaching, that the changes in an organism are produced by the changing conditions of its environment, which are traceable ultimately to the laws of matter and

[1] *Reign of Law*, by the Duke of Argyll, 2d ed., pp. 230, 255.
[2] *Quart. Rev.*, July 1869, p. 162.
[3] *Reign of Law*, p. 249.
[4] Mr St George Mivart : *Genesis of Species*, 2d ed., p. 263.
[5] *Ibid.*, p. 278.

motion. It is but fair to Mr Darwin that we should say he seems to be quite aware of the existence of this theory, though too cautious to commit himself fully to it; and it is but fair to the theory to say, that Mr Darwin adduces many facts which give it support. A few of these facts may here be brought together.

Mr Darwin expresses his opinion that the great variability of animals and plants under domestication is simply due to their having been raised under conditions of life, not the same and not so uniform as those to which the parent species have been exposed under nature. In conformity with this, when the artificial conditions are removed, and the animals return to the natural world of their ancestors, those which survive appear often to resume the ancestral peculiarities. Thus the horses which have run wild in South America are generally brownish-bay, and in the East dun-coloured; while their heads have become larger and coarser. When variously-coloured tame rabbits are turned out in Europe, they generally re-acquire the colouring of the wild animal. The pigs which have run wild in the West Indies, South America, and the Falkland Islands, have everywhere acquired the dark colour, the thick bristles, and great tusks of the wild boar, and the young have longitudinal stripes.[1] This is the rebounding of the spring when the pressure is taken off, and goes to prove that the spring will yield to every form of pressure; and that when external conditions put the same kind of pressure on many individuals at once, they will all tend to vary in the same direction.

There is, Mr Darwin thinks, some probability in the view propounded by Andrew Knight, that the variability

[1] *Animals and Plants under Domestication*, ii. 33.

of animals and plants under domestication may be partly connected with excess of food.[1] The long-continued use or disuse of organs would also have its effect, as in our domestic quadrupeds, which are all descended, so far as is known, from species having erect ears; but being no longer under the same necessity as wild animals to catch every passing sound and ascertain the direction whence it comes, have, many of them, lost the power to erect the ears. Cats in China, horses in parts of Russia, sheep in Italy and elsewhere, the guinea-pig in Germany, goats and cattle in India, rabbits, pigs, and dogs in all long-civilised countries, have drooping ears. This is the converse case to that of the blacksmith's arm becoming stronger through continual exercise, excepting that the effect has accumulated from generation to generation. Some amount of variation, it is thought, may be attributed to the effects of mechanical pressure of one part on another, some authors believing that the diversity in the shape of the pelvis in birds causes the remarkable diversity in the shape of their kidneys, and that the shape of the pelvis in the human mother influences by pressure the shape of the head of the child.

The effects of "station," climate, &c., are not left out of view by Mr Darwin. There can be no doubt, he says, that horses become greatly reduced in size and altered in appearance by living on mountains and islands: every one knows how small and rugged the ponies are on the northern islands and on the mountains of Europe; and this apparently is due to want of nutritious and varied food. It would appear that climate to a certain extent directly modifies the forms

[1] *Origin of Species*, chapter i.

of dogs. English bull-dogs imported into India have been known to pin down even an elephant by its trunk; but after two or three generations not only fall off in pluck and ferocity, but lose the under-hung character of their lower jaws, and attain finer muzzles and lighter bodies. Several accounts have been published of the change which sheep imported from Europe undergo in the West Indies: great heat seems to act directly on the fleece. Dr Nicholson of Antigua informed Mr Darwin that after the third generation the wool disappears from the whole body, except over the loins, and the animal appears like a goat with a dirty door-mat on its back.[1]

All those, says Mr Darwin, who have closely attended to the subject, insist on the close adaptation of numerous varieties of wheat to various soils and climates, even within the same country. Thus, Colonel Le Conteur says, "It is the suitableness of each sort to each soil that will enable the farmer to pay his rent by sowing one variety, where he would be unable to do so by attempting to grow another of a seemingly better sort." We must not forget that at each successive period the state of agriculture, and the quantity of manure supplied to the land, will have determined the maximum degree of productiveness; for it would be impossible to cultivate a highly productive variety, unless the land contained a sufficient supply of the necessary chemical elements. The effect of the climate of Europe on the American varieties of maize is highly remarkable. Metzger, who cultivated maize in Germany, observed the following changes with a tall kind brought from the warmer parts of America. During the first year the

[1] *Animals and Plants under Domestication*, i. 37, 52, 53, 91, 92, 98, 99.

plants were twelve feet high, and few seeds were perfected; the lower seeds in the ear kept true to their proper form, but the upper seeds became slightly changed. In the second generation the plants were from nine to ten feet high, and ripened their seed better; the depression on the outer side of the seed had almost disappeared, and the original beautiful white colour had become duskier; some of the seeds had even become yellow, and in their now rounded form they approached common European maize. In the third generation, nearly all resemblance to the original and very distinct American parent-form was lost; in the sixth the maize perfectly resembled a European variety, described as the second sub-variety of the fifth race. Analogous results were obtained by the cultivation of another American race, the "white-tooth corn," in which the tooth nearly disappeared even in the second generation.[1]

Such instances might be indefinitely added to from Mr Darwin's works; and that he had a perception of their meaning may be inferred from passages like the following: Changes of any kind in the conditions of life, even extremely slight changes, often suffice to cause variability. Excess of nutriment is perhaps the most efficient single exciting cause. The causes which induce variability act on the mature organism, on the embryo, and, as we have good reason to believe, on both sexual elements before impregnation has been effected.[2] As geology plainly proclaims that each land has undergone great physical changes, we might have expected that organic beings would have varied under nature, in the same way as they generally have varied under the

[1] *Animals and Plants under Domestication*, i. 316, 322, 325.
[2] *Ibid.*, ii. 270.

changed conditions of domestication. Why, if man can by patience select variations most useful to himself, should nature fail in selecting variations useful, under changing conditions of life, to her living products?

As, however, Mr Darwin says—in almost his latest work[1]—that "with respect to the causes of variability we are in all cases very ignorant," we must not make him responsible for this part of the theory of Evolution, but must look to Mr Spencer.[2]

Mr Spencer's view of the cause of variations may be epitomised as follows: The sum of the forces within an organism must balance the sum of the forces which press upon it from without, or else disintegration and death will ensue; but the outward forces continually vary (necessitating corresponding inward variation), and life may be defined as the continuous adjustment of internal relations to external relations; that is to say, the variations in the environment *produce* the organic variations, the organism in its turn reacting on the environment.

(1.) *Inward forces balance outward forces.*—There is invariably and necessarily a conformity between the vital functions of any organism and the conditions in which it is placed, between the processes going on inside of it and the processes going on outside of it. A fish cannot live in the air, nor a man in water. Oaks do not grow in the ocean, nor sea-weeds on the top of a hill. Every animal is limited to a certain range of climate, every plant to certain zones of latitude and elevation. Of the marine fauna and flora, each species is found exclusively between such and such depths.

[1] *Descent of Man*, i. 111.

[2] Herbert Spencer: "*First Principles*," *and* "*Principles of Biology*."

Some blind creatures live only in dark caves; the limpet only where it is alternately covered and uncovered by the tide; the red-snow alga rarely elsewhere than in the Arctic regions or among alpine peaks.

Among the forces external to the organism, and playing upon it, are heat and light, the elements contained in the water or air in which the organism lives, or the soil in which it may be rooted, the food taken into the stomach, the enemies with which it comes into collision, &c. Of course the external conditions could not do their work unless the organism were fitted to respond—there must be the malleable iron, as well as the hammer which strikes; and the iron re-acts on the hammer. As Mr G. H. Lewes says, the action of the medium on the organism is assuredly a potent factor, which biology cannot ignore; but the organism itself is a factor, and according to its nature the influence of the medium is defined.[1] Moreover, if we fix attention on one part or organ of a living creature, all the other parts may be considered as external to it; every part influences every other part, as every particle of matter in the globe attracts every other particle, while still the globe as a whole has a gravitative relation to the sun and planets. Though every variation in an organ comes ultimately from the external conditions, the immediate cause is often to be sought in the other parts of the organism itself. "No one, I imagine," says Huxley, "would dream of seeking in the direct external conditions of his life for the cause of the development of the sixth finger and toe in the famous Maltese."[2]

[1] *Fortnightly Review*, Nov. 1868.

[2] *Academy*, Oct. 1869. Gratio Kelleia, the individual referred to, possessed six fingers on each hand and six toes on each foot; but there was nothing peculiar in his parents.

All the forces without and within—all the forces of the universe—are indestructible forces; but they are correlated and interchangeable. Gravity or pressure can be changed into heat, heat into chemical affinity, chemical affinity into electricity. From electricity we can get magnetism, from magnetism mechanical motion, &c.; all are resolvable into motion, all are different modes of motion, the motion being indestructible, and its amount measurable.[1] Therefore, force in any form acting on an organism may give rise to changes of relative position among its molecules, such as by accumulating will become palpable change of structure and function. Reasons are shown by Mr Spencer for believing that organic matter is built up of molecules, so very complex, and therefore so very unstable, that the slightest variation in their conditions destroys their equilibrium, and causes them either to assume altered structures or to decompose. But a substance which is, beyond all others, changeable by the actions and reactions of the forces liberated from instant to instant within its own mass, must be a substance that is, beyond all others, changeable by the forces acting on it from without. All the inward forces balance all the outward forces, not as opposing pressures produce fixity and stillness, but as the antagonist forces in the solar system preserve a moving equilibrium.

If, then, there exists this state of moving equilibrium among a definite set of internal actions, exposed to a definite set of external actions, what must result if any of the external actions are changed? Of course there is no longer an equilibrium. Some force which the organ-

[1] See Grove's *Correlation of Forces*, and Tyndall's *Heat as a Mode of Motion*.

ism habitually generates is too great or too small to balance some incident force, and there arises a residuary force exerted by the environment on the organism, or by the organism on the environment. This residuary force —this unbalanced force—of necessity expends itself in producing some change of state in the organism; and the change must be some alteration of functions, ending in the establishment of a new moving equilibrium, or else the organism will die.

The external forces, as already mentioned, are light, heat, food, &c. Living things have the power to imbibe water, and along with it the materials which work transformations; and through the agency of heat the water is evaporated, and makes room for a fresh supply. Light—which works those chemical changes utilized in photography, which causes the combinations of certain gases, and alters the molecular arrangement of many crystals—may be expeeted to produce marked effects on substances so complex and unstable as those which make up organic bodies. Experiments have shown that when the sun shines on living leaves they begin to exhale oxygen, and to accumulate carbon and hydrogen. —results which are traced to the decomposition by the solar rays of the carbonic acid and water absorbed. A permanent difference in the quantity of light or heat affects, day after day, the processes going on in the leaves. Habitual rain or drought alters all the assimilative actions, and appreciably influences the organs that carry them on. Some particular substance, by its presence in the soil, gives new qualities to some of the tissues, causing greater rigidity or flexibility, and so affecting the general aspect. Here, then, we have in plants changes tending to bring about modified arrangements of functions and structures, in equilibrium with modified sets of external forces. In terrestrial animals heat similarly aids the changes that are going on. The exhalations of vapour from the lungs and the surface of the skin, forming the chief escape of the water that is swallowed, conduces to the maintenance of those currents through the tissues, without which the functions would cease. For though the vascular system distributes nutritive fluids in ramified channels through the body, yet the absorption of these fluids into tissues partly depends on the escape of fluids which the tissues already contain. How readily vegetal and animal substances are modified by other substances put in contact with them we see illustrated every day. Besides the many compounds which cause the death of an organism into which they are put, we have the much greater number which work those milder effects termed medicinal; and most important of all, there are the substances which constitute food and the material for respiration. The substances of which the animal body is built up enter it in a but slightly oxidised and highly unstable state; while the great mass of them leave it in a fully oxidised and stable state. The union of oxygen with nitrogenous and other matters in the body produces animal heat; and just as in a burning piece of wood the heat given out by the portion actually combining with oxygen raises the adjacent portion to a temperature at which it also can combine with oxygen; so in a living animal the heat produced by oxidation of each portion of tissue maintains the temperature at which the unoxidised portions can be readily oxidised. In addition to heat, light, humidity, food taken into the stomach, and air breathed by the lungs or gills, animals are affected by the exercise they give their bodies, the strain when they struggle with foes, the mechanical pressure of external substances, &c., &c.

To illustrate the way in which Natural Selection may be supposed to work in connexion with the external conditions which first of all give rise to the variations, let us take a simple case. The callosities on the knuckles of the gorilla are adapted to that creature's habit of partially supporting itself on its closed hands when moving along the ground, as the horny hand of a workman is adapted to his continual use of a hammer. The gorilla will transmit the callosities to its offspring, and the individuals in which they are the most developed will have the better chance so far in the struggle for life. But the contact of the knuckles with the ground is fitted to cause hardness of skin, and is probably the external condition which, in the course of many generations, has actually produced the callosities. With the first gorillas who resorted to that mode of progression the result might be trifling; but if it were in any degree inherited, together with the habit of walking in that way, the second generation would add to it, and so on till it became what it is.

(2.) *Outward forces vary.*—But all these conditions of a creature's environment are continually altering, or the organism is thrust by pressure of population into a new habitat. Besides the variations in the daily supply of light and heat, and further variations in the annual supply—all responded to by variations in the functions of living things—there are variations which complete themselves in 21,000 years, through the altered position of the earth's poles with respect to the sun; and variations, whose cycle is millions of years, through the changing excentricity of the earth's orbit. The earth goes through a cycle of temperate seasons, and seasons extreme in their heat and cold; and this cycle (of 21,000 years) itself undergoes exaggeration and mitigation during epochs that are far longer. If, then, the yearly change of seasons produces changes in organisms, and prompts or compels the migration of birds to other zones, and of fishes from one part of the sea to another, or from salt water to fresh, these alternations of temperate and intemperate climates must produce great structural changes, and give rise to extensions and restrictions of habitat.

The power of geological actions to modify everywhere the circumstances in which plants and animals are placed is conspicuous. In each locality denudation slowly uncovers different deposits, and slowly changes the exposed areas of deposits already uncovered. The inclinations of land surfaces, and their directions with respect to the sun, are at the same time altered, and the living things existing on them are thus subjected to continual alteration in their supply of heat as well as their drainage. Igneous action, too, complicates these gradual modifications; for a flat region cannot be step by step thrust up into a protuberance, without dissimilar climatic changes being produced in its several parts by their exposures to different aspects. In like manner, alterations in the earth's crust cause new combinations of conditions to living things inhabiting the ocean. Here the water is being deepened by subsidence, and there shallowed by upheaval. The mineral character of the submerged surface on which sea-weeds grow and molluscs crawl, is changed by the addition of material from an adjacent shore, or the accumulation of organic remains—pteropods or foraminifera. Each modification in the outlines of neighbouring shores makes the tidal streams vary in their directions or velocities, or both, and so alters the circumstances in which marine organisms live. These and other geologically-caused changes in the physical characters of each environment occur in ever-new combinations, and with ever-increasing complexity.

Changes in the astronomical conditions, joined with changes in the geological conditions, bring about others of a meteorological character. While yet the highest parts of an emerging surface of the earth's crust exist as a cluster of islands, the plants and animals which in course of time migrate to them have climates that are peculiar to small tracts of land surrounded by large tracts of water; but as, by successive upheavals, greater areas are exposed, there begin to arise sensible contrasts between the states of their sea-board parts and their central parts. The sea and land breezes which daily moderate the extremes of temperature near the shores cease to affect the interiors; and the interiors, less qualified also in their heat and cold by such ocean currents as bathe the shores, acquire more decidedly the characters due to their latitudes.

Besides changes in the incidence of inorganic forces, there are equally continuous and still more involved changes in the incidence of forces which organisms exercise on one another. The plants and animals inhabiting each locality are held together in so entangled a web of relations that any considerable modification which one species undergoes acts indirectly on many other species, and eventually changes in some degree the circumstances of nearly all the rest. If an increase of heat, or modification of soil, or decrease of humidity, cause a particular kind of plant either to thrive or dwindle, an unfavourable or favourable effect is wrought on all such competing kinds of plants as are not immediately influenced in the same way. The animals which eat the seeds or browse on the leaves of any of these plants are severally altered in their states of nutrition and in their numbers; and this change presently tells on various predatory animals and parasites.

There is no need of pursuing the subject into further detail. When the astronomic, geologic, meteorologic, and organic agencies that are at work on each species of organism are contemplated as becoming severally more complicated in themselves, and at the same time as co-operating in ways that are always more or less new, it will be seen that throughout all time there has been an exposure of organisms to endless successions of modifying causes, which gradually acquire an intricacy that is scarcely conceivable. Every kind of plant and animal may be regarded as for ever passing into a new environment—as perpetually having its relations to external circumstances altered, either by their changes with respect to it when it remains stationary, or by its changes with respect to them when it migrates, or by both.

Thus does Mr Spencer's doctrine that variations in an organism are caused by variations in its environment—by the conditions in which it is from moment to moment placed—give completeness to the theory of the evolution of species, and meet the objection that the initial variations are not accounted for. It could also be made to supply some answer to most other objections that have seemed to have any weight against Mr Darwin's hypothesis, as, *e.g.*, that many individuals must vary simultaneously if they are to perpetuate the variation;[1] that variation cannot have been always slow and minute;[2] that it cannot have been fortuitous, but must have been in definite directions;[3] that it is determined by inward tendencies;[4] that it only oscillates about a normal line, and never transgresses the limits of species;[5] and that it would require more time than astronomy can allow to geology.[6] Climatal and other conditions, being nearly uniform over considerable areas, would cause similar variations in similar organisms; and being nearly uniform, or uniformly progressive through considerable periods, would keep the variations in definite lines; while the organism itself being a factor, there would be room to speak of innate tendency. When the changes were more sudden or more rapid than at present (as it is argued, by way of objection, that they have sometimes been[7]) the variations might be more sudden and considerable—always supposing that the changes were not violent enough to kill the organisms—and this more rapid change at some periods would lessen the demand on geological time. The variations may do little more than oscillate when the conditions are nearly

[1] *North Brit. Rev.*, June 1867, p. 289. Mivart: *Genesis of Species*, p. 271.

[2] *Edin. Rev.*, July 1871, pp. 202, 223, 227. *North Brit. Rev.* June 1867, p. 292. *Reign of Law*, p. 225. *Genesis of Species*, pp. 110, 117, &c.

[3] Mivart: *Genesis of Species*, p. 143. *Reign of Law*, p. 273.

[4] Prof. Owen: *Anatomy and Physiology of Vertebrates*. Mivart: *Genesis of Species*.

[5] *North Brit. Rev.*, June 1867, p. 281.

[6] *North Brit. Rev.*, June 1867, p. 281. Sir W. Thomson: *Trans. of Geol. Soc. of Glasgow*, vol. iii. J. J. Murphy: *Habit and Intelligence*, i. 344.

[7] *Genesis of Species*.

uniform, but the inevitable change in the cycle of external phenomena eventually carries the limits bodily forward, as the earth carries forward the lunar orbit and gives its apogee and perigee new absolute positions in space.

§ 3. *The Evolution of Organic Matter.*

The theory of Natural Selection derives Man from some lower animal, and derives all animals and plants from antecedent organisms greatly different from them, but does not take us back to the origin of living matter. Mr Darwin believes that animals have descended from at most only four or five progenitors, and plants from an equal or lesser number, but considers the question of their first origin to be at present quite beyond the scope of science. He says that on the principle of Natural Selection with divergence of character, it does not seem incredible that both plants and animals may have been developed from some low intermediate form, such as the spore of an alga—and if we admit this, we must admit that all the organic beings which have ever lived on this earth may have descended from some one primordial form—but this inference is chiefly grounded on analogy, and analogy may be a deceitful guide.[1]

With regard to the origin of species, if we do not accept the theory of Natural Selection, or some other theory which derives one from another through the agency of natural law, we have to believe in the creation of each separate species out of nothing (which is inconceivable), or, in its being called into existence out of the inorganic elements. When we ask the origin of

[1] *Origin of Species*, chap. xiv.

organic matter, we are limited to these last alternatives, and can only conceive of it as arising out of matter which was previously inorganic. This assumption, as Haeckel says, is a necessary part of the doctrine of Evolution. The controversy on so-called "spontaneous" generation has been a long one,[1] but the question discussed has usually been whether organisms having definite structures, and identifiable as belonging to known genera and species, may not be produced in a few hours in the absence of germs derived from antecedent organisms of the same genera and species. That this should be the case is incredible: not only the established truths of biology, but the established truths of science in general, negative the supposition. In the words of Mr Spencer, "If there can suddenly be imposed on simple protoplasm the organization which constitutes it a *Paramœcium*, I see no reason why animals of greater complexity, or indeed of any complexity, may not be constituted after the same manner. In brief, I do not accept these alleged facts as exemplifying evolution, because they imply something immensely beyond that which evolution, as I understand it, can achieve." What, then, is the view indicated by evolution with regard to the stages of the change from inorganic matter to organic?

It is no more needful to suppose an "absolute commencement of organic life," or a "first organism," than it is needful to suppose an absolute commencement of social life and a first social organism. The assumption

[1] For the literature of the subject, see Prof. Huxley's *Address to the Brit. Assoc.*, 1870; and the *Edin. Review*, April 1867. For recent discussion in this country, Mr Bentham's *Address to the Linnean Society*, May 1872.

of such a necessity in this last case, made by early speculators with their theories of "social contracts" and the like, is disproved by the facts; and the facts, so far as they are ascertained, disprove the assumption of such a necessity in the first case. That organic matter was not produced all at once, but was reached through steps, we are well warranted in believing by the experiences of chemists. Organic matters are produced in the laboratory by what we may literally call *artificial evolution.* Chemists find themselves unable to form these complex combinations directly from their elements; but they succeed in forming them indirectly, by successive modifications of simpler combinations. Beginning with some binary compound such as ammonia, which consists of one atom of hydrogen and three of nitrogen, they can, by substituting an atom of methyl for one of the hydrogen atoms, generate a ternary compound called methyl-amine. From this, again, a still more compound substance is reached, and eventually, by modifications upon modifications, very highly complex substances. We can scarcely doubt that in the early world, as in the modern laboratory, simple combinations preceded complex ones, and inferior types of organic substances evolved the superior types, by their mutual actions under fit conditions. The moulding of such organic matter into the simplest types of living things must have commenced with portions of protoplasm more minute, more indefinite, and more inconstant in their characters than the lowest Rhizopods—less distinguishable from a mere fragment of albumen than even the Protogenes of Professor Haeckel. The evolution of specific shapes must, like all other organic evolution, have resulted from the actions and reactions between such incipient types and their environments, and the continual survival of those which happened to have specialties best fitted to the specialties of their environments. To reach by this process the comparatively well-specialised forms of ordinary *Infusoria* must have taken an enormous period of time.[1]

It seems obvious that this view would open the way for some modification of Mr Darwin's theory, in the direction indicated by Mr G. H. Lewes—that organic substance has been evolved at a thousand different points of the globe.[2] But whether by one origin or a thousand, the evolution theory points to the production of organic matter from inorganic by the operation of natural law. And whether the first forms originated at one spot or many, subsequent forms would be evolved through the agency of natural selection.

[1] *Principles of Biology.* Appendix.
[2] *Fortnightly Review*, November 1868.

CHAPTER V.

EVOLUTION THE METHOD OF CREATION.

WE now have before us an outline of the Theory of the Evolution of Living Things, and it is sufficient to show us that the various forms of life which people the earth owe their existence to natural causes; that species are evolved from species as individuals are born of individuals; and that there is no more reason for saying that God created any existing species than there is for saying that He created the writer or the reader of this essay. On the other hand, there is *no less* reason for saying so; and every one who has answered the question, "Who made you?" by naming the Deity, may answer in the same way the question, "Who caused the evolution of each species of living things?" It puzzles one to see what difficulty is involved in the one question and answer, which is not found also in the other; yet it seems to be assumed, both by the advocates and the opponents of Evolution, that if natural processes are shown to have produced the results, Divine action is excluded;[1] if we can see the machinery, the machinery has done it all.

Mr Darwin says, "Nothing at first can appear more

[1] See Darwin: *Origin of Species*, p. 492. Wallace: *Nat. Sel.*, p. 268. Lionel Beale: *Life Theories*, p. 9. *Edin. Rev.*, July 1871, p. 195.

difficult to believe than that the more complex organs and instincts should have been perfected, not by means superior to, though analogous with, human reason, but by the accumulation of innumerable slight variations, each good for the individual possessor." In this passage it is assumed that the accumulation of variations till a new species is formed is a process not analogous to man's processes, but to be contrasted with the latter; yet the experimental argument which lies at the very base of Mr Darwin's theory is, that man's process in forming new breeds of pigeons is the analogue of nature's process in evolving new forms from old—the one is artificial selection, the other natural selection. Mr Darwin's true line, as remarked by Dr Asa Gray, should be that his hypothesis concerns the *order* and not the *cause*, the *how* and not the *why*, of the phenomena, and so leaves the question of design just where it was before.[1]

It is shown by evolutionist writers that the human race has had an origin as corporeal and as derivative as that of the individual man; and the existence of *every* species of animal and plant is the result of *causes* fitted to produce it—the immediate cause being the action of external conditions on organisms not greatly different from the new species, the remote causes being the laws of matter and motion, and the persistence of force or energy in the universe. The effects never come without the natural causes; the causes are equal to the effects; every new result is but a transformation of previously existing energy; the energy cannot be destroyed nor increased in amount, and all its changes of form are

[1] *Natural Selection not Inconsistent with Natural Theology.* By Asa Gray, M.D., p. 38.

in accordance with unalterable "law." There is no appearance of a power extra to force and matter, destroying the one or the other, creating the one or the other, altering or suspending any law; nor is it possible that law should be suspended or altered, or that matter and force should bo increased or diminished in amount. Very well. But all this is true, whether we talk of natural productions or of man's productions; and what would it prove of man's productions—of a steam-engine, a cotton machine, or a page of printed matter? The printed page is a result showing design; it is also the product of the printing machine, which is itself a result showing design; and to this extent it bears some analogy to organisms, in which we think we see design, notwithstanding that they are shown to be produced from other organisms with similar marks about them. When it is contended that the printed page shows marks of design, is it at all to the point to insist on the undoubted fact that it is the product of something else; that so much energy or force was used in producing it; that this force previously existed in another form; that it is impossible to create or destroy, or alter the amount of force; that certain laws of motion, pressure, and leverage came into play in producing the sheet, and that these laws are unalterable? Nobody disputes these things, and you have not shown that the printed sheet is not the result of a set purpose steadily carried out. Is it any more to the point to talk in the same way when it is contended that the human body, for instance, is a designed structure; when we are not speaking of the creation of matter or force, or of the annihilation of either, but only of their re-arrangement; when we are not contending that any law of nature is violated or altered or suspended, but only that they are made to operate in a certain way? It is not to the point, except on the assumption that Divine action must differ essentially from human action—an assumption which we believe to be a mistaken one, and which seems to result from metaphysical views of the Deity, which the facts of nature do not support. In the case of man's works, the objection only shows the means by which designed results have been effected, and proves that matter, force, and "law" are necessary pre-requisites if they are to be effected at all. In the case of the works of nature, the objection, in our opinion, does but prove the same thing.

What is meant by the term "creation," as applicable to the origin of living things? Not the calling into existence out of nothing, for that the evolutionists declare to be inconceivable, and their opponents cannot show any reason for holding.[1] All the living forms of the world have come to be from the dust of the earth—from the oxygen, hydrogen, nitrogen, carbon, which, by complex combination, make the original protoplasmic matter. It is now proved to us that the process was not instantaneous, but has occupied myriads of ages; one species being slowly evolved from another by natural causes. The question, therefore, is reduced to this, Has the course of evolution been designed and guided, or not? In either case it is evolution; but if it has been guided it is creation also, and evolution is the method of creation. As this question relates only to the redistribution

[1] The Hebrew word בָּרָא (*Bara*), Genesis i. 27, means, according to Gesenius, to carve out, to form by cutting. By comparison of Gen. i. 27 with Gen. ii. 7 and 22, it will be seen that the carving or creating is from pre-existing material.

of matter and energy, so as to form living things, we must start with the existence of matter and energy; and as all forms of energy are resolvable into motion, we start with matter and motion.

A first lesson in astronomy convinces us that celestial phenomena result largely from motion; the earth's rotation giving day and night, its revolution in conjunction with the parallelism of its axis giving the seasons. The heat and light of the sun, which are as needful as these motions, are themselves proved to result from smaller motions in the particles of the sun or its envelope, propagated in millions of small waves across all the intervening gulf. In the same way, all the light and colours, the temperatures and sounds of earth, are reduced by modern physicists to forms of motion; the rose is red, the live coal is hot, the harp-string sounds, because of a peculiar agitation imparted to the particles—the same agitation always for the same result to the same eye, and hand, and ear. With light and heat go electricity, magnetism, and chemical affinity; all these forces being so related between themselves, and all of them so connected with motion, that they may safely be regarded as modifications of each other, and as modes of motion. Sulphuric acid owes its properties to the motions of its particles, and the same is true of soda; when these two bodies come into contact, the clashing of the two sets of particles generates a new series of motions, and the resulting sulphate of soda has new properties. Nor can we stop short of the world of life: animal and vegetal bodies are built up of molecules, of wonderful complexity indeed, but the same in their elements as those of the inanimate world, and having properties resulting from their collocations and motions.

Hypothetic fluids, imponderable matters, specific ethers, and other inventions, says Mr Grove, are passing away, and the day is approaching when the two fundamental conceptions of matter and motion will be found to explain physical phenomena.[1]

The laws of motion are as necessary and immutable as the fact of the existence of space; and as soon as matter moves, the laws are exemplified, and phenomena begin to fall out. The first law of motion is, that a body continues in its state of rest, or of uniform motion in a straight line, unless operated upon from without. The second law is, that the change of motion is proportioned to the force impressed, and is produced in the same right line in which that force acts. The third law is, that reaction is equal to action, and in the contrary direction. These are the laws which the particles, molecules, or atoms of matter must necessarily observe in all their travels and collisions. Pushed out of one path they must take some other, but the new states and relations will always spring out of those immediately preceding, and everything is brought about by way of natural consequence.

All this being so, it is clear that a redistribution of matter and energy is all that takes place in the building up of any structure, whether it be a printing-press, an animal body, or a planet. "Give me matter," says Kant, "and I will build the world." It is clear also, that whatever intelligence or will-force may be exerted to direct the course of the redistribution—man's or that of some higher being—the laws or principles concerned are the same, and therefore the method of

[1] *Discourse on Continuity.* By W. R. Grove, Q.C., &c. Longmans, 1867, p. 311.

action must be the same in principle. If, therefore, a Creator works in the universe, He works essentially as man works—man is a creator—and so the question becomes this, Does the world present us with any appearances like those which man's intelligence produces? And we contend that it does; as, *e.g.*, in its animal structures.

Mr Spencer we know would object to this argument of parallelism. He says,[1] "The artizan does not make the iron, wood, or stone which he uses, but merely fashions or combines them. If we suppose suns and planets and satellites, and all they contain, to have been similarly formed by a 'Great Artificer,' we suppose merely that certain pre-existing elements were thus put into their present arrangement." This is no doubt so. "But whence the pre-existing elements?" he asks. With this we contend we have nothing to do. He proceeds, "The comparison helps us not in the least to understand that; and unless it helps us to understand that it is worthless. The production of matter out of nothing is the real mystery, which neither this simile nor any other enables us to conceive; and a simile which does not enable us to conceive this, may just as well be dispensed with." If our inquiry is how matter was produced out of nothing, such a simile had better be dispensed with; but if we are asking how the present dispositions of matter came about, and especially how matter came to have those forms which we see in living bodies, so many of which forms lead all writers on the subject to talk of mechanism and contrivance (if only for convenience and to make themselves understood), then the simile is quite to the purpose. The production of matter out of

[1] *First Principles*, p. 34.

nothing may be the real mystery; but because we cannot fathom that, we are not going to sit down in contented ignorance of God. We have seen that the question, whether living forms have been created? has nothing whatever to do with the creation of matter and energy, and of the laws which govern them. These are the materials without which the work would be impossible; but it is only of the work itself that we affirm design. It seems to be assumed that the proper work of Deity is to create matter out of nothing, impose certain laws upon it, and then leave it to find its balance; whereas the fact seems to be that the very existence of matter implies certain properties in it, and its bare motion in space carries with it "law" as a necessary correlate.

If this fact were recognised, viz., that the so-called laws of matter and motion are as necessary as the laws of mathematics—not purposely imposed, not admitting of abrogation so long as matter exists, and that all intelligent action in the universe is concerned with composing, decomposing, recomposing, throwing matter into new arrangements, giving energy new distributions—a great deal of misconception would be got rid of, and the character of the Deity would be freed from the appearance of harshness. Misled by the term "law," writers on the one side appear to think that free action in the universe is impossible, and writers on the other speak of the Lawgiver who can suspend the laws He has imposed. The word *law* is used in different senses—in at least five different senses, says the Duke of Argyll—and "in its primary signification is the authoritative expression of human will enforced by power."[1] Using the word in

[1] *Reign of Law*, p. 64.

this primary and only proper sense, law implies a law-giver; but in all cases as applied in science it is a metaphor, so that its use does not imply that God orders matter to move as it does, and compels it to obey through fear of the penalties His power could enforce. Since therefore in the two phases, "a law of the British Legislature," and "a law of nature," the idea is not the same, it should not in the second case be expressed by the same term as in the first. If we would say *methods* of nature with Mr G. H. Lewes,[1] we should be less likely to deceive ourselves with words. It is common to say that the regularity of natural law is an expression of the unchanging Divine will; that the laws of the Deity are inflexible; that if you take oxalic acid in mistake for Epsom salts (the crystals are very similar), you must die because you have broken His law. Of Hugh Miller, whose long-continued disregard of the conditions of health induced a diseased brain, which led him to commit suicide, the *Spectator*, of 3d January 1867, said—"Miller broke down because he was disobeying the laws of the creation in which he lived. . . . Whether understood or not in the critical sense, the law goes on relentless, and all who stand across its path are mowed down." The *Spectator's* theory had not altered in the course of ten years following, for in its issue of December 12th, 1868, it says, concerning the execution of Monti and Tognetti—who blew up some Zouaves by a device very similar to that employed to shatter Clerkenwell prison—"The sentence was either just or unjust. If just—and nobody disputes their guilt—surely a Pope is of all men most bound to see justice done. He is the vicegerent of Heaven, say the Italians. Well, and the

[1] Comte's *Philosophy of the Sciences*. By G. H. Lewes.

laws of Heaven are, of all laws, those which pay least respect to motive. If a saint puts his finger into the fire, the fire burns the finger." If this is a true view—that Heaven pays no respect to motive, that the child who eats hemlock in mistake for wild celery must be punished with death—it is difficult to see that God is either loving or just. The difficulty disappears on the view we are maintaining, which may be again briefly stated as follows:—Matter is non-intelligent, dead, and cannot obey law (primary and only true sense of "law;") for obedience, equally with legislation, implies intelligence. Matter exists in space, and its parts are related to one another by position; it admits of being moved, and, when in motion, may strike against other matter in its path, and set that in motion, in this direction or that, and swiftly or slowly, according to its mass and the direction of the blow. As soon as the first matter is set agoing, and its mass, velocity, and line of motion are observed, all results may be mathematically deduced, for they are as necessary as that the three angles of a triangle should be equal to two right angles. These results are natural phenomena, and our philosophers are showing us that all the phenomena of the physical world result from the motion of matter. The so-called "laws" are neither of man nor of God; but matter exists, and motion is possible, and the consequents are necessarily the same for the same antecedent motions. The "laws" are necessarily coeval with the existence of moving matter, and therefore cannot in their nature be abrogated, suspended, or altered for a single moment; at least the only conceivable case of their suspension—and that would be seeming rather than real—would be in the absolute *stillness* of all matter everywhere—a universe of death. The volition of man, however, has power to originate motion in matter—or, more strictly, since probably every particle of matter is always in motion—has power to accelerate, retard, or rather to change the direction of moving matter, and so occasion other phenomena than those which would have fallen out, while yet the newly-educed motions are as "natural" as any other, and depend entirely on the character and strength of the motion-producing effort, in conjunction with the previously existing motion-states and space-relations of the parts of matter affected. Man effects his purposes, matter and motion and "law" being his means; he works on to his results, using motion and "law" as his tools, and matter, of course, as his material. An artificer possessing a good knowledge of the capabilities of his tools and material can effect more than the workman who is ignorant. The man of science is a better artificer than others, as a visit to the Royal Institution or any laboratory would convince us. Power over matter is proportionate to knowledge. The Creator must be supposed to have all knowledge of matter's capabilities, and of the phenomena possible as results of various complicated motions; and by His marvellous science (omni-science) He fashions worlds and trees and human bodies. On this view the forces of nature may tend relentlessly to mow us down; but God is on our side; fire is fitted to burn, not of His arrangement, but naturally, and He spreads the nerves of feeling over the surface of the body to give us warning pain; oxalic acid is fitted to kill, but by no law of His imposing, and He is not cruelly inflexible.

On this view also, it becomes evident that every work of creation must have incidental results, which may or may not be desirable—as the sculptor who chisels a statue must put up with the chippings on the floor—and that thus what looks like imperfection, or blundering, or maleficence, may perhaps be accounted for, partial evil being general good, the positive pole in the battery having a negative as its necessary correlate. Sir Benjamin Brodie remarks,—"In a machine of human invention effects arise which are truly incidental; that is, which were never contemplated or intended by the inventor. For instance, it was casually discovered that an abundance of electricity may be obtained from the steam supplied by the boiler of a steam-engine. But such a result had never been anticipated by those to whom we are indebted for this great invention. Does anything like this happen with regard to the machinery of the universe? Is it not more probable that everything that occurs has been anticipated, and has its definite and appointed purpose?"[1] On this it seems necessary to remark, that effects may be incidental although they are anticipated, may be clearly foreseen as sure to arise if a certain course is taken, and yet that course may be taken as being the best on the whole. An occasional eclipse of the sun may be either a good thing or a bad, but it scarcely has the appearance of being designed: it is an incidental result of the relation given to the moon's orbit with respect to the earth's orbit; a relation which, if it were purposely altered, might involve other effects not directly aimed at, though clearly foreseen. The different distance of each planet from the sun entails difference in the amount of light and heat received, and in the time it takes for the rays to reach them; besides a difference in

[1] *Psychological Inquiries*, first part, p. 157.

in the periods of revolution, which appears from the law of gravitation to be an inevitable correlate of distance.

In biology the relations of organ to organ, and of organisms to one another and to external conditions, are more complicated than the relations of sun and planets, and we may expect in this department a more frequent occurrence of undesirable concomitants. If the human skin is made thin and soft, it will not repel bullets nor be impervious to swords; but if this class of dangers is guarded against by giving man the hide of a hippopotamus, there will be entailed inconveniences of another sort. "The burrowing habits of the common mole, leading to an almost exclusive use of the fore limbs, have entailed a dwindling of the hind limbs, and a concomitant dwindling of the pelvis, which, becoming too small for the passage of the young, has initiated still more anomalous modifications."[1] Why should we see any difficulty in this? we cannot make things larger by cutting them in two, we cannot convert the same drop of water into ice and into steam at the same time, we see clearly the incompatibility of contradictions in physics as well as in mathematics, and all our difficulty arises from not applying the same rule to the Divine mind and the Divine action as to our own. Can the Creator reconcile absolute contradictions? If so, there is no such thing as truth. And if He cannot do so, then He can only work in nature on the principles man works on, and with the same liability to incidental results; for He works with the same material, which has its unalterable properties.

Agassiz, having studied the formation of radiate

[1] Spencer: *Principles of Biology*, ii. 384.

animals, and found them all referable to three plans of structure, referred to a celebrated mathematician the following question:—"How to execute with the elements given, with a vertical axis around which are arranged parts of equal value, all the possible variations involved in that plan without introducing *new* elements?" "The mathematician appealed to was entirely ignorant of natural history, and could not, therefore, have obtained his knowledge from the animal structures; and yet he at once devised these three as the only essential plans which could be framed, upon the idea of a radiated structure around a vertical axis."[1] That is to say, the mathematical necessities of the case allow variety within certain limits only, and the limits are actually filled out, but of course not transgressed.

The materials, if left to themselves, must of course have *some* form, as iron-ores have their properties and occupy a portion of space *before* man melts them up and runs the metal into "pigs," as well as after. The web of the universe, touched in one part, vibrates to its circumference, but has a self-adjusting power, as Mr Wallace maintains:[2] not however that this accounts for "arrangements" and "contrivances"—it only means that unaided law would effect a balance of some sort, which would probably differ as much from the present arrangement as shapeless clays differ from a palace. "Were the particles of our planet distributed in a manner ever so chaotic and meaningless, matter and force might be, grain for grain, foot-pound for foot-pound, property for property, as in the existing order of things. But the mighty differences between the sup-

[1] Agassiz: *Structure of Animal Life*, p. 115.

[2] *Natural Selection.* Chapter on Creation by Law.

posed and the present condition of things could not be expressed in force or property terms."[1] The writers who maintain that unguided law would produce chaos, are not wrong if chaos be explained to mean a world without collocations suggestive of contrivance and design, without structures which we feel obliged to call mechanism, though such a world might exhibit some variety and possess some accidental beauty. It is but a poet's conception that—

> "Then each atom,
> Asserting its indisputable right
> To dance, would form a universe of dust;"[2]

but we may believe that unguided forces would no more work towards an intelligent destination, than would a locomotive engine off the rails. Purpose can be effected, just because the forces of the universe are self-adjusting; for if interference at one point threw the whole into irremediable disorder, men would only bring destruction to themselves by ploughing the fields, and smelting metals, and vaporizing water in their engines.

We do not see design in everything. The creation of matter out of nothing being inconceivable, and design only becoming apparent where parts are put together for a purpose, the bare existence of a grain of sand proves nothing to us. The universe being incomprehensible in its infinite extent, we can neither affirm nor deny design of it as a universe. But when Professor Huxley shows that a death-watch in a clock-case, reasoning about the purpose of the clock as a whole, would probably be wrong in his conclusions,[3] he seems to

[1] Lionel S. Beale, M.B., F.R.S. *Life Theories*, p. 11.

[2] Young's *Night Thoughts:* Night ix.

[3] *Academy*, October 1869.

forget, that had the inquiry been limited to the purpose of the pendulum or hammer, the problem would have been less difficult. Whether the universe be one structure, justifying Huxley's comparison, we do not know; but we do see that it contains many subordinate structures, about which we can reason. When we limit our view, and consider that which is comprehensible, we believe we can see design in many things, though not in all. If it existed in all, the argument would lose its force; for there would be no contrast between designed and undesigned, no relation such as now exists, no knowledge of the same kind. Mr Wallace points to the Dead Sea as "a positive evil, a blot upon the harmony and adaptation of the surface of the earth;" he points also to desert wastes, and he reminds us that the channel of a river, which looks as if made *for* the river, is made *by* it.[1] We repeat, that we do not see design in everything. It may exist in some cases where we do not see it, but we scarcely think it can be absent where we do see it; and we see it in the living things of the world. Many of these are plainly comparable with machinery; and although accident may smash a machine, and dust may injure it if the mechanism is delicate, accident and dust cannot make machines. The whole of Paley's work ought to be thrown in at this point to give force to our argument; but we must assume the reader to be acquainted with it, and will only add, that if animal bodies *are* machines, or do contain mechanism, it is enough—the machinery may have been made by the process called evolution, but that it should be made by *some* process was inevitable.

Nor would it be fair to call upon us to point out

[1] *Natural Selection*, pp. 278, 281.

where the Creator may be seen standing in bodily form, like a human potter, and moulding the clay into trees and men; we do not see the human mind in any of its occupations, but only infer its existence and its intentions from the analogy of certain phenomena with results produced by ourselves. The true analogy is not that of the potter, but that suggested by Mr Darwin when he talks of artificial selection and natural selection. If the Deity has created living matter, He has done it on the principles followed by the chemist, when he sets substance to play upon substance to build up complex molecules; if He has created the human species, He has done so by causing a certain amount of variation to occur in a species that approached the human; and since variations are caused by the conditions of the environment, the action would have to be on these; and how remote their springs from human view we have no means of telling. Moreover, with regard to the mode of action of the Divine mind, at whatever stage it operates, the true analogy is not even that of the human hand touching a visible spring, but rather of the human volition which touches matter we know not where and operates we know not how, but effects its purposes nevertheless.

Whether a purpose has been entertained and carried out, we must judge from the results—it is simply a question whether, with our knowledge of causes and effects, we can account for the highest results of evolution by the operation of natural causes simply; or whether, while those causes have undoubtedly operated, we feel obliged to suppose an intelligent direction of the natural forces analogous to that which man is able to give by the exercise of his mysterious *will?*

An eccentric philosopher once proposed that enormous geometrical figures should be built in the great plains and steppes of the earth, to attract the attention of the inhabitants of the moon; and it was argued that if this were followed by the appearance of other geometrical figures on the surface of our satellite, we should know that there were lunar inhabitants, and that they were of sufficient intelligence to understand mathematics. Nobody doubts it. We should not see them building up the figures, and they would not see us; but the truths of geometry being the same for all worlds, we should infer corresponding intelligence from corresponding results. It should be no less convincing to us when the Lord of all Worlds has displayed His mechanics and chemistry before us in the countless organic forms which have been slowly evolved by natural processes, though we cannot see Himself, and "His footsteps are not known!"

CHAPTER VI.

THE WISDOM OF THE ALMIGHTY SEEN IN EVOLUTION.

§ 1. *Grandeur in the View.*

CARRYING in our minds a correct idea of what is meant by creation, have we lost anything by adopting the Theory of Evolution? Mr Darwin says, There is grandeur in this view of life with its several powers having been originally breathed by the Creator into a few forms, or into one; and that whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning, endless forms, most beautiful and most wonderful, have been and are being evolved.[1] If this view of the origin of the first living forms were the only one to which the theory of evolution could point, there would at least be no difficulty in the way of our argument; for, as pointed out by a Quarterly reviewer,[2] it would be impossible to suppose that the Creator of the rudimental germ, which was to produce as its issue this existing world, could, after myriads of years, awake out of sleep and be astonished at the actual result. The primary design must be credited with the whole of the final issue; intention in nature having once existed, the test of the amount of that intention is not the commencement, but the end; not the first low organism,

[1] *Origin of Species.* Conclusion.
[2] *Quart. Rev.*, July 1869; art. "The Argument of Design."

but the climax and consummation of the whole. But though Mr Darwin's view of the origin of life on the globe is consistent with the origin of species by Natural Selection, it can have no place in the general doctrine of Evolution, unless it be explained so as to mean that the first living forms were evolved from inorganic matter. Let us suppose that they were so evolved; and besides admitting that species are formed through the gradual accumulation of variations, let us admit that the origin of the variations is found ultimately in external conditions, and then—What is to be said for design? Surely we have gained rather than suffered; for whatever can be said of the appearances of design in things as they exist, can be said of the "conditions" which were their necessary prelude, the means of their production, and said with greater multiplication the more the stages and the longer the process. For instance, if the fitnesses and adaptations which make an animal body to be an exquisite piece of machinery are every one traceable to outward conditions, the outward conditions must have been exactly fitted to produce the inward modifications, and therefore the mutual relation between the parts of the structure has had its counterpart in the mutual relation of the conditions. If two organs, A and B, are correlated together, or a certain variation in A is correlated with a variation in B, then the external cause of the variation in A must be correlated with the external cause of the variation in B in a corresponding manner: like causes produce like effects, similar causes produce similar effects, related causes produce related effects of the same degree of relation. Whatever appearance of design exists in living structures, would have its corresponding appearance in the causes, if the causes could all be seen; and whatever reason there is for using the term "machinery" of the one, exists also for using it of the other. It is obvious that this argument will not be weakened if the causal conditions are themselves traced back to prior causes, and those to others, till we come to the original nebulosity; every link is similarly forged, and similarly supports its fellow; our wonder increases with the length of the chain, and the highest link of nature's chain is attached to Jupiter's chair. Huxley admits this, when he says that if the doctrine of Evolution be true, it is no less certain that the existing world lay, potentially, in the cosmic vapour; and that a sufficient intelligence could, from a knowledge of the properties of the molecules of that vapour, have predicted, say the state of the Fauna of Britain in 1869, with as much certainty as one can say what will happen to the vapour of the breath in a cold winter's day.[1] Consider a kitchen clock, he proceeds to say, which ticks loudly, shows the hours, minutes, and seconds, strikes, cries "cuckoo!" and perhaps shows the phases of the moon. When the clock is wound up, all the phenomena which it exhibits are potentially contained in its mechanism, and a clever clockmaker could predict all it will do after an examination of its structure. If the evolution theory is correct, the molecular structure of the cosmic gas stands in the same relation to the phenomena of the world as the structure of the clock to its phenomena. This admission from so clear-headed a thinker is important; for although we may not think his simile perfect, yet it leaves us room to say that the molecular mechanism had a designer; that the great cosmic clock, if it can readily run down of itself, requires a being first

[1] *Academy*, October 1869.

to wind it up. In this respect, then, design stands as well as it did before, and wisdom receives new illustration.

How vast the conceptions to which the subject introduces us! Natural history is no longer the mere classifying and cataloguing of a fixed number of forms, which remain always the same; the history of life is no longer comprised within a few thousands of years. Almost like the limitless spaces of the astronomer are the ages behind ages of the palæontologist; the boundary that hemmed us in is removed, and in both cases we breathe a freer air. The vista of the theatres of life through long ages past; the successive series of plants and animals—vital wave following vital wave—extending through millions of years! Only dimly can we guess at the beginning, for the earliest strata have disappeared, and calculations concerning the age of the sun are as yet somewhat vague. Sir W. Thomson's investigations lead him to the conclusion that the sun may have illuminated the earth for "a hundred million years past —almost certainly *not* for five hundred millions of years"—one hundred millions is the lower limit, and life on the earth may have originated we know not how soon after that. Once rooted, the life maintained its place; when the conditions changed, it responded to the stimulus, and suited itself to the new circumstances; when continents were going down, it migrated; when its own multiplying forms induced competition, it grew stronger by the struggle; and now, after all the multiplied centuries, here it is to-day, in its variety, beauty, and vigour! "When I view all beings, not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the

Silurian system was deposited, they seem to me to become ennobled."[1]

Placing the origin of life at such a distance in the past does not at all diminish the marvel of it, and lengthening out the process does not destroy creation. In the wheat-straw, sugar-cane, and other endogenous plants, we observe certain divisions of the stem which are called *nodes* or knots, and the space between an *internode*. In exogens the nodes are not always so perceptible, but they may be regarded as always existing, and may be observed in the young shoots of the vine. The leaves originate at the nodes, and have a spiral or cork-screw arrangement round the branch, being more or less distant above one another, according to the length of the internode. Sometimes the internode is not developed, and then we may get *two* leaves opposite one another at the node; or if several internodes are undeveloped, a complete circle or *whorl* of leaves. The leaves which constitute a regular flower are made up of several whorls, and are brought together by the dwarfing of the intermediate part of the axis, like several rings of a spiral spring pressed down on one another. Were it possible that we should be eye-witnesses of the complete process of the evolution of living things on the earth—if all the species and individuals that have lived, and all that live now, were to blossom into life in the course of a single hour, like the splendid leaves of a gigantic flower, spending no time in the development of internodes, we should marvel and call it *creation*. Is it any the less creation when the process is the same, but the internodes are drawn out, when the leaves of life are ranged around branches which have their root in

[1] Darwin: *Origin of Species*, Conclusion.

deeper than Silurian strata, but draw their nourishment from the same source? "When we no longer look at an organic being as a savage looks at a ship, as at something wholly beyond his comprehension; when we regard every production of nature as one which has had a history; when we contemplate every complex structure and instinct as the summing up of many contrivances, each useful to the possessor, nearly in the same way as when we look at any great mechanical invention as the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen; when we thus view each organic being, how far more interesting, I speak from experience, will the study of natural history become!"[1]

If we are to have the complex structure, the *process* of formation is evidently necessary, and for anything that we know, there is some necessity for its being long. It may be that Minerva cannot spring full-grown from Jupiter's head, any more than houses can be built without bricks, or books printed before the type is set up. Equally certain does it seem that without the highly differentiated and intricate animal machinery there cannot be any high form of life, any more than civilisation can advance without division of labour. For the superior life there must be the more elaborate organization, and the highly elaborate organization must be preceded by the less elaborate and the simple. One of the lowest creatures in the animal scale is the sponge, of which the parts are so little differentiated that they may be likened to the members of a rude community, where each individual catches and cooks his own food, and makes his own rude clothes, rendering no service to the

[1] Darwin: *Origin of Species*, Conclusion.

society, and receiving none from it. From the sponge we pass upwards, through creatures in which there is an increasing multiplication of parts having unlike actions, and an increasing closeness in their mutual relationships, until we come to structures like our own, where the functions are numerous and the division of labour is carried so far that the heart cannot say to the brain, I have no need of thee; and the lungs cannot say to the heart, I have no need of thee. That the greater differentiation of functions is accompanied by a closer interdependence of them is quite clear. From the sponge a piece may be cut off without interfering in any appreciable degree with the activity and growth of the rest; the hydra may be cut in two, and will still live; but a fish cannot afford to be so divided; and when we arrive at man, a slight change initiated in one part will instantly and powerfully affect all other parts—will convulse an immense number of muscles, send a wave of contraction through all the blood-vessels, awaken a crowd of ideas with an accompanying gush of emotions, affect the action of the lungs, of the stomach, and of all the secreting organs. The pre-eminence of enjoying a highly specialized organization is not without some concomitant disadvantages: the crab may lose a limb and replace it, where a man must put up with the loss; the frog can dispense with air for a long time, but a man would soon die of suffocation. These evils attending the greater differentiation of function appear to arise from the nature of the case, and are not of such weight as to be set against the advantages: it is better to be a man than a frog, or a fish, or a kangaroo, or a monkey—man is the higher animal. But the higher animal could not come upon the stage of life before the lower;[1] the more highly differentiated must be evolved from the less differentiated, just as man must make simple tools before he can make complex engines, the simple having to be used in the manufacture of the complex.

In this consideration, perhaps, we have the answer to the question why—during those immeasurable epochs which geology records—have there existed none of those highest organic forms which have now overrun the earth? why, during untold millions of years, were there no beings endowed with capacities for wide thought and high feeling? The answer that the earth was not, in remote times, a fit habitation for such a creature is not warranted by the evidence; besides which it suggests the question, Why, during such vast periods, did the earth remain fit only for inferior creatures? On the hypothesis of Evolution the difficulty is removed, and there is no room to doubt the wisdom of the arrangement: the lower types come first, because they have to give birth to the higher, as simple mechanism is used in the manufacture of mechanism more complex and intricate.

It would seem probable, then, that Man came upon the stage of existence as soon as all the necessary preparative processes had gone through their course. It will be admitted by every Evolutionist, that an Omniscient Being must have foreseen man's advent. Is it too much to say that such a crowning glory of Evolution

[1] This must not be understood to imply that Palæontology shows any uniform progression in the types of past life. There were some highly organized animals in early times. But the records of the earliest times are lost. See Huxley on *Persistent Types of Life*.

was *intended*, and that the necessary processes were started by the Divine *Will* initiating the motions in the original nebulous mass, or at any rate impinging on matter at the appropriate points in the appropriate instant, if not at many different stages of the process? This would not imply that the series of structures, linking man with the first speck of living matter, were *mere* instruments for the evolution of man, and were not also ends in themselves; nor would it imply that any imperfection attached to them because a higher form was to come afterwards. If they were the highest that were possible in their time, taking *every* circumstance into consideration, it would not be proper to call them imperfect; and if they were ends in themselves, the Creator delighting to evolve their life, there was the more wisdom in making them subserve a further purpose. Professor Huxley says, that the teleology which supposes that the eye, such as we see it in Man or one of the higher *Vertebrata*, was made with the precise structure which it exhibits, for the purpose of enabling the animal which possesses it to see, has undoubtedly received its death-blow at the hands of Mr Darwin.[1] If this means that the human eye was not formed by direct creation for man's special benefit, but has been evolved from the eye of some lower creature, which in its day was also able to see more or less perfectly, it appears to be true. But if we deny purpose in the formation of man's eye, because he gets it through lower vertebrate animals, and deny it in the lower vertebrates, because they inherit the eye from still lower creatures, we come at last to the creatures that have no eyes at all, having denied teleology at every step. We may do the same with the human ear and every other

[1] *Academy*, October 1869.

organ; and, in fine, shall get back to the original nebulosity, having left no crevice for teleology to creep through; and this would be contrary to Professor Huxley's own admission, that the teleologist can always defy the evolutionist to disprove that the primordial molecular arrangement was not intended to evolve the phenomena of the universe. The only reasonable alternative is to say, that there is purpose at every stage of the process, a double or multiplied purpose; that the eye of the fish is intended both to serve the purpose of the fish, and to be instrumental in the evolution of more perfected organs. The perfect steam-engine was preceded by the steam-engine in ruder forms; the inventive genius of man induced variations on the earlier forms; the forms best fitted to survive were selected by manufacturers, and in time gave birth to still higher forms. It could not be said of the existing steam-engine, that the man who effected the last improvement invented the engine, for it owes its birth to a preceding form; in like manner, the preceding form was not invented when it received the last touch, which made it what it was; and as to the inventor of the first rude form, if he and it could be discovered and defined, manifestly *he* did not invent the highly perfected engine of to-day. The steam-engine, therefore, has had no inventor: and yet there has been mind at every step! This analogy is good for what it is intended to show—viz., that a complex instrument like the human eye does not come into existence without the exercise of mind: and if it be objected that steam-engines are not begotten but invented—the addition which constitutes the improvement always coming from without—the objection is not to the point. Moreover, the analogy does not fail even in the point indicated by the objection: for as the pattern of a previous engine is slavishly copied, where there is no inventive power to effect an improvement, so an animal can only transmit the characters it possesses unless *variation* is induced; and the ultimate cause of variation in a living structure, as well as in a steam-engine, is always from without. Should it be said that the inventor of the first rude form of steam-engine, say Hero of Alexandria, did not design or foresee the engine of to-day, the reply is, that the mental power exercised to effect each improvement has been of the same kind, or it would not be able to accept the work done by preceding minds, and build further upon the same foundation; and therefore it is all the same as though one human mind had first planned the engine, and afterwards invented all the successive improvements. If this latter mind be compared with the Divine mind there will be one obvious difference, arising from omniscience: when the end is seen from the beginning, the intermediate steps cannot be regarded as trials and experiments, but may be understood as necessary preparative processes, or as ends in themselves.[1]

Man, then, we may be allowed to say, was foreseen and intended from the first; and if this be so, how great the foresight to look onward through a hundred millions of years! How vast the wisdom which could touch the springs, and initiate the molecular motions which would set atom clashing with atom, and molecule combining with molecule, through millions of leagues of space, and millions of ages of time, to build up life from stage to stage, allowing for all outward conditions, and all

[1] Huxley's attempted demolition of Paley's illustration of the watch (*Lay Sermons*, p. 301) is answered by the above argument.

inward actions, and the antagonism of species with species, till there should be evolved at last a creature having a bodily organization wondrously fitted together, and endowed with large capacities for knowledge and happiness! How great the patience which, because the process was a necessary preliminary, could touch the first springs and see the work begin, and calmly wait a hundred million years for the result! And even man, as he is at present, is not the last result—even now the end foreseen is not finally accomplished—but the Creator, while satisfied, we may suppose, that in the time now present the results are what they are, is waiting for the result that shall be—

> "The one far-off, divine event,
> To which the whole creation moves."

§ 2. *Difficulties and Apparent Mistakes Explained.*

We accept Evolution because of its truth, and immediately find that truth has superior charms to error, possessing the master key which opens secret chambers, and reveals what had been mysteries. Certain facts of biology, which had been difficulties on every other hypothesis, looking like mistakes incompatible with creative wisdom, at once receive an explanation.

Evolution v. *Special Creation.*—Naturalists used to suppose that new species were miraculously originated in full-grown perfection; but the scene of the new creation was always placed in some region remote from human observation: nobody stood by as a witness while the elemental atoms flashed into living tissues, or an elephant descended from the sky. As Mr Spencer points out, the special creation of new species is inconceivable: we can neither represent to our thoughts the creation of new matter out of nothing, nor the rushing together of a myriad atoms, previously dispersed through the neighbouring air and earth, and held in various chemical combinations. To assume a myriad supernatural impulses, differing in their directions and amounts, given to as many different atoms, is a multiplication of mysteries rather than the solution of a mystery. For every one of these impulses, not being the result of a force locally existing in some other form, implies the creation of force; and the creation of force is just as inconceivable as the creation of matter.[1] But creation by evolution can be conceived.

Evolution teaches that all nature is so connected that a change in one thing implies a change in some other thing, if not in all other things; and so points the way to discovery, and opens up new and grand fields for research. Mr Wallace, after studying carefully the natural history of the Island of Celebes, expresses his belief that none of the phenomena, however apparently isolated or insignificant, can ever stand alone; that not the wing of a butterfly can change in form or vary in colour except in harmony with, and as a part of, the grand march of nature. The island stands in the very centre of the Malay Archipelago, surrounded with islets which seem to afford the greatest facilities for communication with Borneo, Java, &c., and yet presents remarkable peculiarities in its productions. Among its zoological characteristics are a tailless ape, allied to the baboons; a straight-horned antelope of obscure affinities, but quite unlike anything else in the whole archipelago, or in India; and an altogether abnormal wild pig. In birds and insects it is equally peculiar, and a large number of

[1] *Principles of Biology*, i. 337.

its butterflies are distinguished by superiority of size and a characteristic modification in the form of the wings, which stamp upon the most dissimilar insects a mark distinctive of their common birthplace. "What," asks the naturalist, "are we to do with phenomena such as these? Are we to rest content with the very simple, but, at the same time, very unsatisfying explanation, that all these insects and other animals were created exactly *as* they are, and originally placed exactly *where* they are, by the inscrutable will of their Creator, and that we have nothing to do but to register the facts and wonder? Was this single island selected for a fantastic display of creative power merely to excite a child-like and unreasoning admiration? Is all this appearance of gradual modification by the action of natural causes —a modification the successive steps of which we can almost trace—a delusion? Is this harmony between the most diverse groups—all presenting analogous phenomena, and indicating a dependence upon physical changes of which we have independent evidence—all false testimony? If I could think so, the study of nature would have lost for me its greatest charm. I should feel as would the geologist, if you could convince him that his interpretation of the earth's past history was all a delusion—that strata were never formed in the primeval ocean, and that the fossils he so carefully collects and studies are no true record of a former living world, but were all created just as they are, and in the rocks where he now finds them."[1]

The Theory of Evolution explains all the difficulties and anomalies referred to in the third chapter of this essay. As all organic beings, extinct and recent, which

[1] Wallace: *Natural Selection*, p. 197.

have ever lived on this earth, have to be classed together, and the best arrangement is like that of a genealogical tree, we may believe that *descent* is the hidden bond of connection which naturalists have been seeking under the term of the natural system. The facts of morphology (or the *forms* of living things) become intelligible, whether we look to the same pattern displayed in the homologous organs of the different species of animals (such as the hand of a man and the wing of a bat), or to the homologous parts constructed on the same pattern in each individual (as, *e.g.*, the arm of a man and his leg). On the view that species are only strongly marked and permanent varieties, and that each species first existed as a variety of some other species, we can see why it is that naturalists have had such difficulty in defining species, and drawing lines of demarcation between species and varieties. On this view we can understand how it is that, in the eyes of most naturalists, the structure of the embryo is even more important for classification than that of the adult; for the embryo is the animal in its less modified state; and so far it reveals the structure of its progenitor. As natural selection acts by competition, it adapts the inhabitants of each country only in relation to the degree of perfection of their associates; so that we need feel no surprise at the inhabitants of any one country, although on the ordinary view supposed to have been specially created and adapted for that country, being beaten and supplanted by the naturalized productions from another land. Rudimentary or atrophied organs, though of no use to their possessor, are retained through the force of inheritance, and are reminiscences of more fully-developed structures in the ancestors. The fact of the fossil remains of each formation being in some degree intermediate in character between the fossils in the formations above and below, is simply explained by their intermediate position in the chain of descent. Old forms are supplanted by new ones, and neither single species nor groups of species re-appear when the chain of ordinary generation has once been broken. The grand fact that all extinct organic beings belong to the same system with recent beings, falling either into the same or into intermediate groups, follows from the living and the extinct being the offspring of common parents. As the groups which have descended from an ancient progenitor have generally diverged in character, the progenitor, with its early descendants, will often be intermediate in character in comparison with its later descendants; and thus we can see why the more ancient a fossil is the oftener it stands in some degree intermediate between existing allied groups. Lastly, the law of the long endurance of allied forms on the same continent—of marsupials in Australia, of edentata in America, and other such cases—is intelligible, for within a confined country the recent and the extinct will naturally be allied by descent.[1]

Evolution v. *Plan.*—We have seen that the members of the same class, independently of their habits of life, resemble each other in the general plan of their organization: the hand of a man, formed for grasping; that of a mole, made for digging; the leg of the horse, the paddle of the porpoise, and the wing of the bat, are all constructed on the same pattern, and include similar bones in the same relative positions. Why should this

[1] *Origin of Species*, chap. xiv.

be, when the limbs are used for such totally different purposes? Why should the sepals, petals, stamens, and pistils in any individual flower, though fitted for such widely different purposes, be all constructed on the same pattern? Why, under the down-covered body of the moth, and under the hard wing-cases of the beetle, should there be discovered the same number of divisions as in the calcareous framework of the lobster —just twenty segments in hundreds of thousands of species? Some naturalists have been satisfied with saying that the Creator chooses to work on a certain plan of organization, an ideal type, to which He makes the structure of many creatures to conform for the sake of uniformity, even when no useful purpose is served by it. For instance, the vertebrate form in general is conceived to exist as an "idea" or "archetypal exemplar," on which it has pleased the Creator to frame certain of His creatures. But there are difficulties in the way of accepting this solution. "When we discover that the possession of seven cervical vertebræ is a general characteristic of mammals, whether the neck be immensely long, as in the giraffe, or quite rudimentary, as in the whale, shall we say that though, for the whale's neck, one vertebra would have been equally good, and though, for the giraffe's neck, a dozen would probably have been better than seven, yet seven was the number adhered to in both cases, because seven was fixed upon for the mammalian type? And then when it turns out that this possession of seven cervical vertebræ is not an absolutely universal characteristic of mammals, shall we conclude that while, in a host of cases, there is a needless adherence to a plan for the sake of consistency, there is yet, in some cases, an inconsistent abandonment of the plan?

I think we may properly refuse to draw any such conclusion."[1]

And with regard to segmented animals, it cannot be by chance that the dragonfly, the lady-bird, the butterfly, and the crab should each have just twenty divisions of the body (as they have, either distinctly marked, or so fused together that sometimes it is difficult to detect them); nor is there any reason to think it was *necessary* in the sense that no other number would have made a possible organism; and to say that the Creator followed this pattern throughout, merely for the purpose of maintaining the pattern, is to assign a motive which, if avowed by a human being, we should call whimsical. No rational interpretation of this, and hosts of like morphological truths, can be given except by the hypothesis of evolution; and from the hypothesis of evolution they are corollaries. We may accept Mr Spencer's view thus far without believing with him that the rejection of the archetypal idea is the rejection of *design*. The design is certainly not to give twenty segments for the sake of uniformity—they seem to be present through the force of inheritance—but can we say that there was no design to create segmented animals by evolution, and to cause the offspring to retain the parental characters?

Embryology.—The embryos, or unborn offspring, of animals, within the same class, are often strikingly similar, and those of distinct classes are in their earliest stages exceedingly like one another; so much so that, except by their size, it is impossible to distinguish the embryos of mammal, bird, lizard, or snake. "In my possession," says Von Baer, "are two little embryos in spirit, whose names I have omitted to attach, and at

[1] *Principles of Biology*, i. 309, 381.

present I am quite unable to say to what class they belong. They may be lizards or small birds, or very young mammalia, so complete is the similarity in the mode of formation of the head and trunk in these animals. The extremities, however, are still absent in these embryos. But even if they had existed in the earliest stage of their development we should learn nothing, for the feet of lizards and mammals, the wings and feet of birds, no less than the hands and feet of man, all arise from the same fundamental form. . . . The special type is always evolved from a more general type." The special type is not always completely elaborated even at birth, but a trace of the law of embryonic resemblance sometimes lasts till a rather late age; thus birds of the same genus, and birds of closely allied genera, often resemble each other in their first and second plumage, and very young pigeons of widely different breeds show incomparably less proportional differences than the grown birds.

If Mr Darwin's views be correct, the forms of life in ancient geologic periods were not so distinctly separated as they are now, because, as time has gone on, the life-tree has sent out branches diverging more and more from the original trunk. In this respect there is a close correspondence between the general development of living forms and the development of a mammalian embryo at the present day. Von Baer says of the embryo, that in its earliest stage every organism has the greatest number of characters in common with all other organisms in their earliest stages; that at a stage somewhat later, its structure is like the structures displayed at corresponding phases by a less extensive multitude of organisms; that at each subsequent stage traits are acquired which successively distinguish the developing embryo from groups of embryos that it previously resembled—thus step by step diminishing the class of embryos which it still resembles; and that thus the class of similar forms is finally narrowed to the species of which it is a member. Thus the embryological tree, expressing the developmental relations of organisms, will be similar to the tree which symbolizes their classificatory relations. Agassiz, an eminent naturalist who does not accept the Evolution hypothesis, insists strongly that the more ancient animals resemble the embryonic forms of existing species. Describing the embryo of a starfish, he says the little being is attached to a "stem or prong, with branches above, forming a kind of cup. It resembles those echinoderms first born on the surface of the earth—the crinoids—the type of which has become extinct with one exception (the *comatula*); and just as we find geologically that after a certain period starfishes with stems no longer exist, so we find this embryonic starfish casts off its stem, becomes free, and assumes the form of its parent!"[1] On the hypothesis of Evolution this parallelism has a meaning; for the embryo would continue, through force of inheritance, to repeat the stages passed through by its ancestors.

Some of the secondary phenomena of embryology presented great difficulties on the hypothesis of special creation, appearing to show waste of time and energy, and want of ability to effect a purpose in the directest way; but these difficulties disappear on the hypothesis of Evolution. There are cases where the embryo, during its earlier stages of development, possesses organs that

[1] Quoted by Dr Bree: *Fallacies of Darwinism.* For other instances, see *Seaside Studies*, by E. C. and A. Agassiz.

afterwards dwindle away, as there arise other organs to discharge the same functions; and there are cases where organs make their appearance, grow to certain points, have no functions to discharge, and disappear by absorption. "We have a remarkable instance of the substitution of one organ for another in the successive temporary appliances for aërating the blood, which the mammalian embryo exhibits. During the first phase of its development the mammalian embryo circulates its blood through a system of vessels distributed over what is called the *area vasculosa*—a system of vessels homologous with one which, among fishes, serves for aërating the blood until the permanent respiratory organs come into play. After a time there buds out from the mammalian embryo a vascular membrane, called the allantois, homologous with one which, in birds and reptiles, replaces the first as a breathing apparatus. But while in the higher oviparous vertebrates the allantois serves the purpose of a lung during the rest of embryonic life, it does not do so in the mammalian embryo. In implacental mammals it aborts, having no function to discharge; and in the higher mammals it becomes 'placentiferous, and serves as the means of intercommunication between the parent and the offspring'—becomes an organ of nutrition more than of respiration. Now since the first system of external blood-vessels, not being in contact with a directly oxygenated medium, cannot be very serviceable to the mammalian embryo as a lung, and since the second system of external blood-vessels is, to the implacental embryo, of no greater avail than the first; and since the communication between the embryo and the placenta among placental mammals might as well or better have been made directly, instead of by metamorphosis of the allantois, these substitutions appear unaccountable as results of design."[1] In the embryo of a mammal or bird the substance of the vertebral column is at the outset continuous. The segments that are to become vertebræ arise gradually in the midst of this originally-homogeneous axis. Equally in those parts of the spine which are to remain flexible, and in those parts which are to grow rigid, these segments are formed; and that part of the spine which is to compose the sacrum, having passed out of its original unity into disunity, by separating itself into segments, passes again into unity by the coalescence of these segments. To what end is this construction and reconstruction?[2]

Mr Lewes gives another instance. The *Salamandra atra* never lives in the water, but dwells high up among the mountains, and brings forth its young full-formed, and adapted therefore to the same mode of life: "yet if we open a gravid female, we find tadpoles inside her with exquisitely feathered gills; and (as I have witnessed) these tadpoles, 'when from the mother's womb untimely ripped,' if placed in water, swim about like the tadpoles of water newts. Obviously this aquatic organization has no reference to the future life of the animal, nor has it any adaptation to its embryonic condition."[3]

The guinea pig has teeth which are shed before it is born, and hence can never subserve the purpose for which they seem contrived; and in like manner we find

[1] Spencer: *Principles of Biology*, i. 369.
[2] *Ibid.*, i. 383.
[3] *Fortnightly Review*, June 1868.

teeth in fœtal whales, which, when grown up, have not a tooth in their heads. It has even been stated on good authority, says Mr Darwin, that rudiments of teeth can be detected in the beaks of certain embryonic birds. Not even temporary functions can be assigned for these organs that are first built up and then pulled down again: they appear to be absolutely useless, their formation absolutely superfluous, and, on the hypothesis of special creation, seem to reflect upon the wisdom of the Creator. On the hypothesis of a Plan which pre-arranged the organic world, Mr Lewes thinks nothing could be more unworthy of a Supreme Intelligence than this inability to construct an organism at once, without previously making several tentative efforts, undoing to-day what was so carefully done yesterday, and repeating for centuries the same tentatives and the same corrections in the same succession. "What should we say to an architect who was unable, or, being unable, was obstinately unwilling, to erect a palace except by first using his materials in the shape of a hut, then pulling it down and re-building them as a cottage, then adding storey to storey, and room to room, *not* with any reference to the ultimate purpose of the palace, but wholly with reference to the way in which houses were constructed in ancient times? What should we say to the architect who could not form a museum out of bricks and mortar, but was forced to begin as if going to build a mansion; and after proceeding some way in this direction, altered his plan into a palace, and that again into a museum? Would there be a chorus of applause from the Institute of Architects, and 'favourable notices in the newspapers' of this profound wisdom? Yet this is the sort of succession on which organisms are constructed. The fact has long been familiar; how has it been reconciled with Infinite Wisdom." [1] But such reminiscences of earlier forms are intelligible on the supposition that originally the later form was a modification of the earlier, that the embryo is the animal in its less modified state, and reveals in a measure the structure of its progenitors.

Not only is the case intelligible, but the appearance of unwisdom is entirely removed, as may be shown by an illustration. Suppose we inquire into the water supply of some town, tracing the course of the main pipe, and all the branches ramifying from it; and suppose that on one side of the town we find a pipe diverging half a mile into the country, and then bending round and returning like the winding of some river. We ask, where is the wisdom of carrying the water through this mile of pipe when it might go by the short cut? Why waste the tubing and waste the time, and do what has to be undone immediately, in sending the stream to a point from which there is no course but to return? On the supposition that the town was originally built as it now stands, every street and square having the position they now have, and not a house more nor less—our objection is valid. But if we learn that the diverging bend of pipe follows the route of streets which formerly existed, and that although the shorter cut would now seem better, yet it would cost more to take up the old pipes from the long route, and lay down pipes on the short route, than could possibly be gained by the process, we see the wisdom of leaving the arrangement as it is; and we read in the existence of the bend of pipe a page of the past history of the town. We have seen before that

[1] *Fortnightly Review*, June 1868.

there is an apparent necessity for the more highly differentiated organisms to be preceded by the less highly differentiated, the last mentioned being the apparatus with which the former are elaborated. It may be, then, that these apparatus can only work in the way they have been accustomed to do, and must be allowed to continue their roundabout processes because it would take æons of time to fit them more directly for the work now required. The process by which England keeps abreast of the times in the matter of war-ships, cannon, and small arms, may be likened to that of an organism somewhat rapidly varying in structure and function to adapt itself to changing conditions—to make the inward forces balance the outward forces, so that life may not be crushed out of it. Now, suppose there is a sudden demand for breech-loading rifles: we take a number of muzzle-loaders and convert them. Suppose further, that the men who have hitherto made muzzle-loaders can do nothing else, and that the men who have hitherto converted the one form into the other are not equal to the task of making the breech-loader from its first elements, what course would wisdom dictate? We should go on making breech-loaders by the roundabout process. With regard also to the substitution of one organ for another, and the metamorphosis of the allantois in placental mammals, making it serve the purposes of nutrition instead of removing it altogether, there is no unwisdom, when you have used elaborate scaffolding in the erection of a building, to make it serve some further end before destroying it.

Rudimentary or Aborted Organs.—Another important fact, allied to the facts of embryology, and presenting similar difficulties, is the existence of organs which never come to perfection, never serve the end for which they seem intended, and therefore on a superficial view appear indicative of incompetence or unwisdom. Organs or parts in the rudimentary or atrophied condition are extremely common throughout nature. For instance, rudimentary mammæ are very general in the males of mammals, and birds possess a 'bastard wing' which is considered to be a digit in a rudimentary state. Certain snakes have hind legs hidden beneath the integument; in many insects the wings are so reduced in size as to be utterly incapable of flight, and in beetles they not rarely lie under wing-cases firmly soldered together! The eyes of moles and of some burrowing rodents are rudimentary in size, and in some cases are quite covered up by skin and fur; fishes and other animals living in caves are mostly blind, though the eyeball remains; and in some of the crabs the footstalk for the eye remains, though the eye is gone—the stand for the telescope, though the telescope with its glasses is not present! Nothing would appear to be clearer than that eyes were intended to see with, and wings to fly with; what wisdom therefore—on the hypothesis of special creation—could there be in putting wings under hard cases which prevent their use, and giving eye-balls without the use of sight?

Now there is observable in living things a compensation or balancement of growth—parts which are no longer of service are reduced in size—"Nature," as Goethe expressed it, "in order to spend on one side, is forced to economise on the other." This seems to hold true, to a certain extent, with our domestic productions: if nourishment flows to one part or organ in excess, it rarely flows, at least in excess, to another part.

Thus it is difficult to get a cow to give much milk and to fatten readily at the same time. On this principle rudimentary organs, if they are the remnants of organs which once were fully developed, but have ceased to be useful through the altered habits of the creatures, ought to dwindle and disappear. How is it that they persist in existence? They are what Haeckel calls the purposelessnesses of nature. I confess, however, says Huxley, it has often appeared to me that the facts of Dys-teleology cut two ways. If we are to assume, as evolutionists in general do, that useless organs atrophy, such cases as the existence of lateral rudiments of toes in the foot of a horse place us in a dilemma. For either these rudiments are of no use to the animal, in which case, considering that the horse has existed in its present form since the pliocene epoch, they surely ought to have disappeared; or they are of some use to the animal, in which case they are of no use as arguments against Teleology. A similar but still stronger argument may be based upon the existence of teats, and even functional mammary glands, in male mammals. Numerous cases of "Gynaecomasty," or functionally active breasts in men, are on record, though there is no mammalian species whatever in which the male normally suckles the young. Thus there can be little doubt that the mammary gland was as apparently useless in the remotest male mammalian ancestor of man as in living men, and yet it has not disappeared. Is it then still profitable to the male organism to retain it? Possibly; but in that case its dys-teleological value is gone.[1] Sir J. Paget, also, in his Hunterian Lectures, had argued that the rudimentary organs might be necessary to

[1] Huxley: *Academy*, October 1869.

withdraw from the blood some element which, if retained in it, would be injurious; but Mr Darwin brings instances in refutation, and says—When a man's fingers have been amputated, imperfect nails sometimes appear on the stumps: I could as soon believe that these vestiges of nails have appeared, not from unknown laws of growth, but in order to excrete horny matter, as that the rudimentary nails on the fin of the manatee were formed for this purpose.[1] Let us suppose that Mr Darwin is right, and then ask what explanation can be given of these structures that shall not conflict with the Divine wisdom. Agassiz asks, Does not the existence of a rudimentary eye in the blind-fish show that these animals, like all others, were created with their peculiarities by the fiat of the Almighty; and that this rudiment of eye was left them as a remembrance of the general plan of structure of the great type to which they belong?[2] This explanation would land us in all the difficulties we have already tried to meet; and Darwin asks concerning it, Would it be thought sufficient to say, that because planets revolve in elliptic courses round the sun, satellites follow the same course round the planets, for the sake of symmetry, and to complete the scheme of nature? Mr Spencer points out the further objection that the rudimentary teeth in the embryos of whales and calves disappear before the animals are born, so spoiling the typical resemblance. Neither special creation, nor any law of fixed types, explains the facts, nor frees them from the appearance of unwisdom; but while to all other hypotheses they are stumbling-blocks, they yield strong support to the hypothesis of evolution; and that hypothesis shows why

[1] *Origin of Species*, p. 486. [2] *Essay on Classification.*

the facts should be what they are. If the rudiments relate to a former condition of their possessor, and have been retained by inheritance, they may be compared with the letters in a word, still retained in the spelling, though useless in the pronunciation, but which serve as a clue in seeking its derivation. In the ancestors they were fully developed, and constantly used; in the descendants they are not wanted, and continued disuse has reduced their size, allowing the material of nutrition to flow to other parts. The eyes of animals dwelling in the caves of Styria and Kentucky have become rudimentary, because for generations the animals have lived in the dark; birds inhabiting oceanic islands have seldom been forced to take flight, and have ultimately lost the power of flying; the beetles of small and exposed islands, when they sought to cross the sea, were lost and only those which had no roaming propensity were preserved, their wings shrivelling at last through disuse. On this view we see a beautiful adaptation of each species to its new circumstances—a power of self-adjustment between the animal organization and the environment which affects it, such as must increase our admiration of the wisdom of God, unless we are deluded by the notion that what can be explained by secondary causes has no first cause. As to the retention of even the rudiment, and spending the powers of nutrition on that when it has become utterly useless, the analogy used before will serve us here—the water-supply having once been laid down to a line of houses, it may cost more to remove the pipes than to leave them where they are. There is a disposition to cut out the "rudimentary" letters of words that have a history—to spell *favour* without the *u*, and *develope* without the final *e*—and some people wish us to adopt the phonetic spelling with all our words. What do we say to them? We tell them it might be very well if we were seeking to make a perfect language *de novo;* but that, as a matter of fact, the English language has *grown* into its present shape, and cannot be easily altered.

Monstrosities and Malformations.—"One of the most important facts which speaks against the theory that nature acts with conscious design, is the production of monstrosities. The unsophisticated human mind could so little reconcile these phenomena with the belief in a Creator acting with design, that they were formerly considered as indicative of the wrath of the gods; and they are, even at present, not unfrequently looked upon as punishments from heaven. The author saw, in a veterinary cabinet, a goat fully developed in every part, but born without a head. Can we imagine anything more absurd than the development of an animal, the existence of which is impossible from the beginning? Professor Lotze of Göttingen surpasses himself in the following remarks on monstrosities:—'If the fœtus is without a brain it would be but judicious, in a force having a free choice, to suspend its action, as this deficiency cannot be compensated. But, inasmuch as the formative forces continue their action, that such a miserable and purposeless creature may exist for a time appears to us strikingly to prove that the final result always depends upon the disposition of purely mechanical definite forces, which, once set in motion, proceed straight on according to the law of inertia, until they meet with an obstruction.'"[1]

[1] L. Büchner: *Force and Matter*, p. 98.

To have all the strength of the objection before us, let us quote two or three more instances. Is it by design, we are asked, that a fœtus should fix itself and become developed in any other but its natural place, the uterus? —a case which frequently occurs, and conduces to the death of the mother. Or even that in such extra-uterine pregnancies, after the lapse of the normal time, pains are felt in the uterus, though nothing is to be expelled?[1] One of Mr Lewes's tritons bit off the leg of his female, and the leg which replaced it was much malformed and curled over the back so as to be useless; whereupon Mr Lewes asks, Was this according to the Idea? He cut off the leg and examined it, finding all the bones present, but the humerus twisted and of small size. In a few weeks a new leg was developed, and this leg was normal. Mr Lewes asks, If the Idea as a ruling power determined the growth of this third leg, what determined the second which was malformed?[2] Valentin, says Darwin, injured the caudal extremity of an embryo, and three days afterwards it produced rudiments of a double pelvis and of double hind limbs. Hunter and others have observed lizards with their tails reproduced and doubled. When Bonnet divided longitudinally the foot of the salamander several additional digits were occasionally formed. Where, we are asked, is the evidence of the Idea in these cases?

It may be admitted that monstrosities and malformations are a difficulty on the hypothesis of Plan or that of Special Creation; but with the view of creation set forth in this essay they are perfectly consistent, and do

[1] L. Büchner : *Force and Matter*, p. 98.
[2] *Fortnightly Review*, June 1868.

not reflect in the least on the Divine wisdom. Geoffrey St Hilaire's experiments show that unnatural treatment of the embryo causes monstrosities; and Büchner asks, Can the idea of a conscious power acting with design be reconciled with such a result? Is it possible that the hand of the Creator should thus be bound by the arbitrary act of man?[1] On our view it is quite possible. There is a nature of things; the ultimate properties and relations of matter spring out of its very existence and its location in space; and these facts are not hindrances in the way of design and work, but are the conditions of all work. Nevertheless they imply the possibility of concomitants which may not be desired; the possibility of occasional mishap and deviation from the right line, if interfering forces are not guarded against; and especially they leave room for other intelligences of the same essential nature as the Great Intelligence, and having the same essential relations to the world of matter, to use their power diabolically, and give the natural forces a wrong impulse.

Imperfect Adaptations.—We have been accustomed to believe that the organization of every creature is exactly fitted for its mode of life, and we have thought we saw in this a display of the wisdom and beneficence of the Almighty. The general fitness of things is indeed undoubted, and the writers of the *Bridgewater Treatises* have not entirely wasted their time in following out its details. Even some apparent instances of want of adaptation have been explained and turned to the discomfiture of the objectors; as, *e.g.*, when Buffon bestowed his pity on the sloth as an animal whose existence must be a burden to it, and even Cuvier regarded it as imper-

[1] *Force and Matter.*

fect and grotesque; but Dr Buckland showed it to have habits perfectly adapted to its organization. It is formed to live and die in trees, and not *on* the branches, like the squirrel or monkey, but under them; whereas the naturalists had only seen it on the ground. Notwithstanding this, however, there appear to be many undoubted cases of imperfect adaptation, which can no more be shown to be perfect than all nebulæ can be resolved into stars; and we must look at a few instances, to see how they are reconcilable with the wisdom of the Creator. We can hardly believe that the webbed feet of the upland goose, or of the frigate-bird, are of special use to these birds; but to their progenitors they were no doubt as useful as they now are to the most aquatic of existing birds. How strange it seems that a thrush should have been created to dive and feed on sub-aquatic insects; and that a petrel should have been created with habits and structure fitting it for the life of an auk. But on the view of each species constantly trying to increase in number, with Natural Selection always ready to adapt the slowly varying descendants of each to any unoccupied or ill occupied place in nature, these facts cease to be strange, or perhaps might even have been anticipated.[1] The seal is an animal which habitually swims like a fish, and cannot use his hind limbs, except as a rudder to propel him through the water; but instead of having a fish-like tail, he has two legs flattened together and nails on the toes—toes and nails being obvious superfluities. To say that the limbs, in spite of their non-adaptation, were directly created in their present form or in rigid adherence to a Plan, would seem to reflect upon the wisdom of the Almighty;

[1] Darwin: *Origin of Species*, p. 505.

but if they have been inherited from an ancestor who used them as legs, and have become gradually modified by the fish-like habits of the seal, we may believe that the legs were an end in the progenitors, and may admire the wisdom which, through the agency of changing conditions, converts them into an instrument more useful to the descendant. Many remarkable little facts could be given with respect to the inhabitants of remote islands. For instance, in certain islands not tenanted by mammals, some of the endemic plants possess beautifully hooked seeds; yet few relations are more striking than the adaptation of hooked seeds for transportal, by the wool and fur of quadrupeds. This case presents no difficulty on Mr Darwin's view, for a hooked seed might be transported to an island by some other means; and the plant then becoming slightly modified, but still retaining its hooked seeds, would form an endemic species, having as useless an appendage as any rudimentary organ—for instance, as the shrivelled wings under the soldered elytra of many insular beetles.[1] The reason for the creation of the hooks was their utility to the seed; the reason for their continuance when no longer useful is that laws of inheritance are not easily altered.

§ 3. *Direct Marks of Wisdom.*

In the action of Conditions.—We have seen that Evolution ascribes the origin of species to the natural selection of variations, and the ultimate origin of the variations to changes in the external conditions. Outward changes therefore were necessary if there was to be the grand procession of life which the records of the

[1] Darwin: *Origin of Species*, p. 423.

past reveal; and, as we have seen, the procession of life was necessary as a prelude to the life now existing, being the strong stem which bears its weight of flower and fruit. Not only so, but it would appear that as the life of an individual is a succession of changes, and perfect equilibrium would be death, so the life of a species is only maintained by the ever-varying action of outward forces, and an absolutely uniform species, having all its members exposed to identical influences, would cease to exist. The changing conditions which ultimately lead to the formation of new species are a primary necessity of continued life in any form.

When outward changes take place too rapidly species are sometimes extinguished; and therefore we ought to admire the arrangement which makes climatal and geological changes proceed slowly, so that slight variations in living things may suffice, and no wrench be given to their organization. It is imaginable that the outward changes should be in the way of constant small oscillations, tending to undo one day what they did the day before, and possibly in these circumstances species would remain nearly uniform; but the continued onward march of "conditions," carrying living things with them by adding up their variations in definite directions, is surely grander. It is conceivable that the conditions should show great variations within small areas, modifying every individual differently, instead of being nearly uniform for large portions of the earth's surface; and then there would really be force in the objection made against Natural Selection, that unless many individuals were similarly modified simultaneously the new forms would soon be swallowed up by commingling with the old. It may be observed also, that but for changing geological and meteorological conditions the world would never have presented the varied beauty which it exhibits—the mountain, the river, the lake, the valley, headlands and islands, crags and cliffs and caves.

A whole chapter might be inserted in this place showing the wonderful development of organisms through the action of outward forces, including heat and light, soil, water, air, food taken into the stomach, and the mutual action of the organs and parts of a body on one another. The development of each individual organ, including the complicated apparatus of the human ear, and the almost perfect instrument of the human eye, would only seem the more admirable when the stages and means of their progress were made manifest. But time fails us.

In the effects of Use and Disuse.—Among the external conditions affecting an organism are those stimuli which lead to an increased use of any organ. The fact that unused organs degenerate and become rudimentary has its converse in the circumstance, that when organs are much exercised (if not *over* wrought) they become stronger. The blacksmith's arm is a familiar instance, to which may be added the fact, that bones subject to greater strains acquire greater massiveness: it is well known that variations in the muscular strains call forth by reaction variations in the strength of the bones. The great and inherited development of the udders in cows and goats in countries where they are habitually milked, in comparison with the state of these organs in other countries, is another instance of the effect of use.

What arrangement could be simpler or more beautiful than that the increased strain to which an organ is subject to-day, should increase its power to resist strain to-morrow—that the demand should create the supply in the very region where the demand is made, and within reasonable limits, to the extent to which it is made? It is like the fire in Bunyan's house of the Interpreter, whose blaze increases with every effort to put it out, because there is a secret supply of oil from behind, more than compensating for the stream of water in front. And observe, that the increment of strength would be useless unless the circumstances of a creature's environment were kept moderately uniform for some length of time, so that the same demand on the same organ should be made again and again.

The material for the strengthening of a muscle or a bone must, however, come from somewhere; and as the organism is a whole, and nature has a disposition to economise, a certain balance is sometimes observed, as though the new supply of nutriment were merely a transfer from some other part of the body. In our poultry, a large tuft of feathers on the head is generally accompanied by a diminished comb, and a large beard by diminished wattles; and perhaps the entire absence of the oil gland in fantail pigeons may be connected with the great development of their tails. The difficulty of finding very many plain cases is perhaps an indication that this is not nature's usual method; and that when she resorts to it, it is because there is not at the moment a sufficient supply of food finding its way to the organism from without, or because the parts drawn upon can bear the drain, not being themselves of much use to the individual. If this be so, we may find an analogy in the diversion of the China expedition under Lord Elgin, to meet the sudden and pressing demands of the Indian mutiny: by this means India was saved, and by means of compensation of growth nature saves the body.

Evolution of living matter.—Oxygen, hydrogen, carbon, and nitrogen, are all lifeless bodies. Oxygen and hydrogen, by their chemical union, form water; oxygen and carbon combined in certain proportions constitute carbonic acid; hydrogen and nitrogen by uniting give rise to ammonia: but these compounds are as lifeless as the elementary bodies of which they are composed. When, however, these three compound bodies are brought under the influence of living protoplasm, they become living protoplasm themselves! How this comes about is quite unintelligible to us; the marvel of life is not understood, nor the marvel that living matter should be able to make other living matter. Not all the chemists of Germany can so put together the elements as to make a speck of protoplasm: and even if they should some day succeed in doing so, the natural wonder will not be diminished—man will be treading the track of the Creator, "thinking His thoughts after Him," but it will remain the fact, that what the 19th century with difficulty accomplished was thought and done with ease in the beginning.

Heredity.—The marvel is multiplied a million fold when animals high in the scale of being produce offspring resembling themselves. The one end to which, in all living beings, the formative impulse is tending—the one scheme which the Archæus of the old speculators strives to carry out, seems to be to mould the offspring into the likeness of the parent. It is the first great law of reproduction, that the offspring should resemble its parent or parents more closely than anything else; and the rule is so seldom departed from, that the human child which did not resemble either the paternal or the maternal side of the house would be regarded as a kind of monster. The marvel is none the less because it occurs often; and should science one day show us the reason of its occurrence, the fact will be what it is at present, and the process may call for additional admiration.

At present the laws governing inheritance are quite unknown. No one can say why the child resembles his parents; no one can say why a *peculiarity* in an individual is sometimes inherited and sometimes not, why the child often reverts in certain characters to its grandfather or grandmother, or some more remote ancestor; nor why a peculiarity is often transmitted from one sex to both sexes, or to one sex alone—more commonly, but not exclusively, to the like sex, the mother's peculiarity to the girl, the father's to the boy. When these things come to be understood, the wisdom of the Creator will probably receive new illustration.

Variation.—Through geological and other changes the circumstances of a creature's environment are continually being altered, and yet the condition of existence is, that an organism shall be adjusted to its environment, the inward forces balancing the outward forces. Therefore, given the external changes as a fact, and living things must vary, or else they will die. The arrangement is beautiful from whichever side we view it: if it is good that creatures should live, and change is necessary to life, and variations in the environment are fitted to produce change in the organism, everything is admirable; or if cosmical and geological changes are a matter of necessity, and organisms must be adjusted to them, and the external changes call forth the suitable organic changes, all is admirable again.

Since the variation produced in any individual is usually but slight—perhaps from the necessity of the case—creatures adapted to one set of conditions would never overtake increasing change in their environment if every individual were born exactly like its parent who was suited to the less altered state of things. The case would be a little like that of some dogs who become very knowing through contact with man, but keeping no records, and being unable to hand down their experience by oral tradition, leave their descendants to learn the same lessons for themselves. But the law of heredity comes to the aid of the law of variation: the offspring inherits the modified constitution of the parent, begins where its parent has left off, and on its own account takes another step forward. The second variation added to the first (we are talking of variations in the same direction) gives a double advantage to the offspring, and the whole working of the law is comparable to that in virtue of which the literature and civilisation of one generation descend to the next, and we of the nineteenth century are "the heirs of all the ages." To name here a single instance of the inheritance of useful variations, it may be mentioned that whereas the skin on the palms of the hands and the soles of the feet is thickened by hard work and by walking, children have these parts hard before they are born.

It has been urged against the hypothesis of Natural Selection that it does not account for the preservation of incipient variations, such as the first approach in an insect to the form and colour of a leaf, before a bird could be deceived by the resemblance; or the earliest growth of whalebone in a whale's mouth, before it attained the dimensions which would make it useful. Probably the continued action of the same conditions, and their nearly uniform action on many individuals simultaneously, would quite meet the difficulty; but even if it were otherwise, we are not concerned in this essay with the minutiæ of the theory of evolution; and whatever the explanation may be, it is enough for us that the variations *have* been guarded and preserved through their incipient stages. If Natural Selection could not preserve them, some other law or power has done so; their preservation was wanted if there was to be the march of life, as the guardianship of helpless infants is necessary for the continuance of the human race—and it has been effected!

Natural Selection, as we have seen, does not originate variations, but only adopts them when they arise; and Mr Darwin has been asked where he gets that succession of favourable variations necessary for the ultimate formation of a regular and highly organized species?[1] It is obvious that not one or two which chance might give him are enough for the purpose, but that a succession is wanted, and a long succession in a definite direction. Take a single intricate organ, such as the heart or the lungs or the eye: the necessity of accounting for such a work of construction is exactly the same upon the theory of transition and that of direct creation, and some other principle than chance is as much called for upon one hypothesis as upon the other. Mr Darwin, of course, does not believe in chance: he tells us very plainly that all is governed by law, but that he considers the laws of variability to be almost wholly unknown.

[1] *Quarterly Review*, July 1869.

In their detailed operation they are so; but if we follow Mr Spencer we must believe that they depend ultimately on the action of external conditions. Still the feeling of the reviewer is right, and there must be design *as well as* law: that the two *can* go together we see in every human plan and contrivance; and when the human eye is under consideration, Mr Darwin himself speaks of its "inimitable contrivances"—figuratively, we know; but to us at least it appears plain that whatever other forces have been at work in this case, there is intelligent *will* force in addition. With Mr Babbage's machines in our thought we can imagine it possible that an automation type-setter should be invented, capable, when the manuscript was placed before it, of setting it up, and by a further movement printing it off, so that an epic or a philosophical discourse could be read. Natural Selection may be allowed as much accuracy as this, in picking up and setting together all the favourable variations which build up, after some ages, a new and beautiful species: but in both cases we are impelled to ask, Who is the author?

Mr Wallace, who has done so much to illustrate the working of Natural Selection, does not think it will account for the naked skin of man, for the perfection of his hand, his voice, his brain, for the origin of his mental faculties and moral sense, &c., and draws the inference that a superior intelligence has guided the course of variation in a definite direction, and for a special purpose, just as man guides the development of many animal and vegetable forms. He reminds us that man's intelligence has been concerned in the production of wheat and maize, of such fruits as the seedless banana and bread-fruit, and such animals as the Guernsey milch cow and the London dray horse: the laws of evolution alone would perhaps never have produced these, and yet they closely resemble the unaided productions of nature. Therefore, "if we are not the highest intelligences in the universe, we must admit the possibility that some Higher Intelligence may have directed the process by which the human race was developed, by means of more subtle agencies than we are acquainted with."[1] The question occurs, Why the same may not be said of the production of the lion or tiger, with their wondrous bodily organization—heart and lung and muscle, eye and ear, tooth and claw; and why it may not be said of *every* organism that is comparable to a machine, that exhibits any marks of the action of *will* force? To draw the line immediately below man is unphilosophical—man is too closely allied to the lower animals to admit of it—either he is outside the pale of Divine superintendence along with them, or they are within the pale along with him: we agree with Mr Wallace that unguided forces would never have evolved man, and we feel obliged to extend the statement to the lower animals. Our philosophy then attains unity and consistency. Gerald Massey, speaking of the leaf-like *mantis*, and the uneatable caterpillar "coloured, as chemists colour poisons, by way of warning to birds," says, and we agree with him: "Here is a subjective intention, which is not the creature's; so manifest, it is like a lightning-flash of revelation that almost features the face of the Creator for a moment. Sooner might we compose the *Iliad* by tossing out the letters of the alphabet at random on the air, than such a result would be attained without the presence of a mind determinedly fulfilling an intention. So is it all through."[2]

[1] *Natural Selection*, p. 359. [2] *Concerning Spiritualism*, p. 57.

The truth adduced by Mr Wallace, viz., that man often guides the evolution of animal and vegetable forms—and his inference from it, viz., that a Higher Intelligence may do the same—deserve more attention. Mr Darwin, arguing against the view that the variations which Natural Selection is concerned with are intentionally ordered by the Creator, asks, Does He ordain that the crop and tail-feathers of the pigeon should vary, in order that the fancier might make his grotesque pouter and fantail breeds? Did He cause the frame and mental qualities of the dog to vary, in order that a breed might be formed of indomitable ferocity, with jaws fitted to pin down the bull for man's brutal sport? But if we give up the principle in one case—if we do not admit that the variations of the primeval dog were intentionally guided in order that the greyhound, for instance, that perfect image of symmetry and vigour, might be formed—no shadow of reason can be assigned for the belief that variations, alike in nature, and the result of the same general laws, which have been the ground-work through Natural Selection of the formation of the most perfectly adapted animals in the world, man included, were intentionally and specially guided.[1] Mr Wallace, in refuting the Duke of Argyll's view of creation by birth, adopts the same line of argument. He says, To be consistent in their views, our opponents must maintain that every one of the variations that have rendered possible the changes produced by man have been determined at the right time and place by the will of the Creator. Every race produced by the florist or the breeder, the dog or the pigeon-fancier, the rat-catcher, the sporting man, or the slave-hunter, must have been provided for by varieties

[1] *Variation of Animals and Plants*, ii. 431.

occurring when wanted; and as these variations were never withheld, it would prove that the sanction of an all-wise and all-powerful Being has been given to that which the highest human minds consider to be trivial, mean, or debasing.[1] Here there seems to be some confusion of thought. As well say when a university student, bent on a freak, finds an elaborate calculation on a professor's desk, and chooses to meddle with it, multiplying the result by two, or dividing it by three, that the fact of such meddling being possible proves that this is no calculation made by a professor. It only proves that the laws of numbers are the same for professors and for students. And because we refuse to believe that the professor worked out the result *in order* that a student might multiply it by two, we do not give up any principle, nor admit that "no shadow of reason can be assigned for the belief" that a process like that of multiplication was made use of by the professor in his calculation. Variation may have its law, as immutable as the laws of numbers, the same for Deity and for man: it may be induced by outward conditions; yet the conditions, in their initiation, may be under control, and at every stage may admit of being directed by intelligence. The law of variation is one thing, the use made of it is another; every good thing admits of being abused, and man's abuse of the capacity for variation in domestic animals is no proof that the animals were evolved without Divine guidance. Nobody doubts that a slave-holder, with a sufficient number of human creatures at his command, could produce "varieties;" and it is certain that meddling with the human fœtus will produce monstrosities; yet Mr Wallace, who refers

[1] *Natural Selection*, p. 290.

us to the slave-hunter, believes that in man's case the variations have been guided by some superior intelligence. Because we decline to believe that canine variation was ordained for the express purpose of enabling man to form the breed of the bull-dog, we do not give up the principle of guidance. Variations may have been guided for whole geologic periods, in order to form at last both dogs and men, and yet man may try his hand on the same plastic material. Matter and its laws are material for him as well as for the Creator, just as triangles and their properties are the same to both; and even when the Creator has moulded a vessel man may mar it. If our use or abuse of variation is only in the way of guiding the operation of a "law," it shows that intelligence acquainted with law can interpose to bring about the results it desires, and does not at all prove that no other intelligence has been at the same work before us. The whole mistake appears to arise from the notion that the Creator has imposed laws on matter; and the difficulty disappears when we think of an Intelligence of a nature similar to our own, working upon matter which has its own simple but unalterable properties, knowing all its "laws," though sometimes leaving them to their own working, but interposing the force of His own will where He pleases.

Correlation of Variations.—It is a familiar fact that certain complexions go with certain temperaments, and that, roughly, something of a man's character may be told from the shape of his head, his nose, or perhaps from most parts of his body. The "sympathy" which the most distant parts of an organism show with each other, when one of them is affected by disease, is well known, though not fully accounted for. The whole organization is tied together with hidden strings; every part is related to every other part, in the same way that the whole is related to the sum of the forces without. Consequently, a change in one part of the body calls for a change in some other part, and eventually in every other part. Suppose the head of a mammal becomes very much more weighty, what must be the indirect results? The muscles of the neck are put to greater exertion, and become larger; the bones of the neck feel additional strains, and grow stronger; the heavier head and neck affect the breast and fore-legs, and so on. Any one who compares the outline of the bison with that of its congener, the ox, will clearly see how profoundly a heavier head affects the entire frame.

Correlation of parts, carrying with it correlation of their growth and their variations, would thus seem to be in some cases a necessity; though it is not easy to see why deafness should accompany blue eyes in white cats, why pigeons with short beaks should therefore have small feet, and those with long beaks large feet; or why the hair and teeth should be related in the naked Turkish dog. It may be that the relation is always a necessary one, if we knew what are true correlations; it may be that it is sometimes necessary and sometimes not. In either case, when a good purpose is served by it, the view of creation taken in this Essay enables us to see design, and to admire the wisdom displayed. Correlation in a structure formed for use, and in which the structure or development of one part would be of *no* use unless other parts concurred with it—fitting like the two parts of a hinge, or like a piston to both cylinder and crank—has so obviously the look of an arrangement that Paley adduces it as one of the proofs of Design.

Lest Paley should be thought antiquated, let us take a living author who agrees with him. Professor Owen, speaking of the egg of a fowl—its dome-like shape, fitted to bear the weight of the sitting bird, the arrangement which keeps the germ uppermost, however much the egg is rolled about, the porosity of the shell, which admits air to the young chick, and the hard knob upon the end of the upper beak, which, after being used by the chick to break the shell, disappears—expresses his view of such correlations as follows:—You may think it strange that any mind capable of tracing and comprehending the relations of these structures and their effects—what in physiology we term their "uses" or "functions," in the inability to make the matter understood by any other phraseology—that any competent anatomist should ignore the adaptive relations or the purpose of all these correlated structures! It reminds one, does such a case, of some congenital defect akin to colour-blindness.[1]

Not only are the several parts of the same organ, as in the human ear, correlated together for the production of desired results, but in all highly-organized creatures the several organs of the entire organism are necessary parts of a whole. The ant-eater is a hairy quadruped without teeth, but possessing a narrow, almost tubular mouth, through which slides backwards and forwards a long, slender, cylindrical tongue, suited for licking up white ants by scores at a time. Along with this tongue go salivary glands as big as the creature's liver, accompanied by an apparatus for absorbing the watery part of the saliva, and leaving it more dense and sticky, so that the tongue may be lubricated, and the ants adhere to it.

[1] Prof. Owen: "*The Power of God in His Animal Creation.*"

But the ants live in strong castles, and the soldiers and workers must be made to rush out and put themselves in the way of being licked up; accordingly the fore-paws and claws of the beast are of great strength, and so it is able to effect a breach in the fortress. In the absence of teeth digestion is aided by a gizzard-like stomach, which grinds the insects to a pulp with the help of the sand swallowed with them; the gastric organ of the bird seems to be borrowed, because, like the bird, the creature has no teeth in its jaws. "I look upon the tongue," says Professor Owen, "with all its concomitant mechanism, as having been made such as it is for its ant-catching office. I view the huge salivary glands and their bladders as correlated in function with the tongue; the mouth is modified to be a sheath or case for the tongue; the stomach is made a gizzard because no grinders exist in the mouth. I don't say that the final purpose is the sole condition of what I see; but I recognise it plainly as one, perhaps the chief, cause."[1] This case reminds us that, in addition to the correlations which lie within the limits of the organism, there are those which constitute its fitness towards outward things; and the first of these two would be useless without the last. Professor Tyndall, in speaking of the correlation of the retina to the ethereal vibrations concerned in sensations of sight, points out that rays above or below certain limits of rapidity are not luminous, and says, "The retina is attuned, if I may use the term, to a certain range of vibrations, beyond which in both directions it ceases to be of use." The ether existed first, the eye came afterwards; and, of course, if it were not attuned to *any* of the vibrations

[1] *The Power of God.*

it would be useless altogether, though its own parts might be as admirably correlated among themselves as they are at present: and it is partly on this account that the Duke of Argyll considers the correlation with outward things the higher correlation of the two, involving an idea which lifts us at once from a lower to a higher region of thought, indicating a mental purpose, a creative will giving to organic forces a foreseen direction.[1]

When two or more parts are correlated to effect one purpose, a variation in one can scarcely be of much use unless there be a simultaneous variation in the others; while it is obvious that the greater the number of the variations which are needed in order to effect an improvement, the less will be the probability of their all occurring at once by any sort of accident. When, therefore, we reflect that in the higher animals each separate organ is a complicated structure, and each organism a complication of related organs, and that the whole has many relations with the external world, we can see it to be as unlikely that improvements should be effected by blind fortuity as that the upsetting of a box of types should produce a poem or a mathematical proposition. Mr Murphy has calculated that if we suppose a single favourable variation to occur once in 1000 times, and that ten variations must concur in order to make an improvement, the probability against the improvement occurring is about 10,000 times as great as the number of waves of light that have fallen on the earth since historical times began.[2]

[1] *Reign of Law.*

[2] *Habit and Intelligence*, chap. xxiv. The slowest waves are 40,000 in the *inch*, and light falls with a velocity of 185,000 *miles* per second.

One fact which influences Mr Wallace in his view that the course of variation in man has been superintended by some power distinct from that which has guided the development of the lower creatures, is the possession by the savage of a brain apparently beyond his needs. Mental power is so intimately connected with size of brain that whenever an adult European has a skull less than 19 inches in circumference, has less than 65 cubic inches of brain matter, he is invariably idiotic. The average internal capacity of the cranium in the Teutonic family is 94 inches; but the Esquimaux have as much as 91 inches; Negroes, 85 inches; Australians and Tasmanians, 82 inches; and Bushmen, 77 inches; so that the absolute bulk of brain is not much less in savage than in civilised man. The Engis skull, also, perhaps the oldest known—"contemporary with the mammoth and cave bear"—is a fair average skull, which, in the opinion of Professor Huxley, might have belonged to a philosopher, or might have contained the thoughtless brains of a savage. On the other hand, the adult male orang-utan—as bulky as a small-sized man—has only 28 inches of brain; and the gorilla, who is above the average weight and bulk of a man, has only from 30 inches to 34½ inches. In the opinion of Mr Wallace — whose acquaintance with barbarous races is considerable—"a brain slightly larger than that of the gorilla would, according to the evidence before us, fully have sufficed for the mental development of the savage; and we must therefore admit that the large brain he actually possesses could never have been solely developed by any of those laws of evolution whose essence is, that they lead to a degree of organization exactly proportionate to the wants of each species, never beyond those wants—that no preparation can be made for the future development of the race—that one part of the body can never increase in size or complexity, except in strict co-ordination to the pressing wants of the whole." "Whether we compare the savage with the higher developments of man, or with the brutes around him, we are alike driven to the conclusion that, in his large and well-developed brain, he possesses an organ quite disproportionate to his actual requirements—an organ that seems prepared in advance, only to be fully utilized as he progresses in civilisation."[1] Professor Huxley makes some reply to this, but only with the effect of showing, that "if Mr Wallace's doctrine holds good, some higher power must have superintended the breeding up of wolves from some inferior stock, in order to prepare them to become dogs."[2] This may be good against Mr Wallace, but would be anything but a *reductio ad absurdum* on the view of creation advocated in these pages. The suggestion we have to make is this:—A reviewer has remarked that "the accumulation of minute brain differences *not* demanded by the circumstances of life is contrary to the very first principles of Natural Selection, and indicates some other principle at work."[3] May not this other principle be correlation? Mr Darwin admits that in flowers, at least, the forces of correlated growth do "modify important structures independent of utility, and therefore of Natural Selection;" and again, "Correlation of growth has no doubt played a most important part, and a useful modification of one part will often have entailed on other parts diversified changes of no direct use."[4] This being so, and admit-

[1] *Natural Selection*, p. 343.
[2] *Contemp. Rev.*, Nov. 1871.
[3] *Edin. Rev.*, July 1871.
[4] *Origin of Species*, p. 219.

ting that a Superior Intelligence either initiated at first, or superintends the course of Evolution, it seems reasonable to suppose that the overplus of brain in the savage, which Natural Selection would never have taken pains to accumulate, was correlated with some part or organ of immediate use, so that every improvement in the latter carried with it an addition to the former, a sort of indirect tax paid by the organ whose increasing wealth could afford it, and stored up in the national exchequer for future use. It may be the case in regard to the brain, that we must first get the quantity before any part of it can become of excellent quality, as it is the case with the animal kingdom that a great mass of life must precede the evolution of a highly differentiated organism. That an organ thus quietly built up, and apparently useless during the process, might almost suddenly come into activity, and constitute an era in the life of the species, is illustrated by Professor Huxley, when he reminds us that two watches may be alike in structure and function, except that a minute difference in the bearings of the balance-wheel, or the angle of the teeth of the escapement, will make all the difference between going and not going.[1] Huxley's amusing historical illustration of Natural Selection would serve still better if applied to the kind of correlation we are supposing. It relates to the retreat of the French troops under Napoleon from Moscow. Worn out, tired, and dejected, they at length came to a great river, over which there was but one bridge for the passage of the vast army. Disorganized and demoralized as that army was, the struggle must certainly have been a terrible one—

[1] *Causes of the Phenomena of Organic Nature.* Hardwicke, 1863, p. 154.

every one heeding only himself, and crushing through the ranks and treading down his fellows. The writer of the narrative, who was himself one of those who were fortunate enough to succeed in getting over, and not among the thousands who were left behind or forced into the river, ascribed his escape to the fact that he saw striding onward through the mass a great strong fellow—one of the French cuirassiers, who had on a large blue cloak—and he had enough presence of mind to catch and retain a hold of this strong man's cloak. He says, "I caught hold of his cloak, and although he swore at me, and cut at and struck me by turns, and at last, when he found he could not shake me off, fell to entreating me to leave go, or I should prevent him from escaping, besides not assisting myself, I still kept tight hold of him, and would not quit my grasp until he had at last dragged me through."[1] This is exactly what we are supposing—some organ or part of the body strong in its hold on life because Natural Selection is constantly making it stronger, has the as yet weak brain attached to it by correlation, and both saves itself and that which clings to it.

If this argument from correlation is good for the brain, it is good for the perfection of the hands and feet, for the naked skin and all the other peculiarities of man which Mr Wallace considers Natural Selection incapable of accounting for; and for the faculty of speech itself, which distinguishes man from the whole brute world. But the time at our command will not permit us to follow out the subject: it is sufficient if we have called attention to what is perhaps one of the finest examples of wise working which Evolution furnishes.

Multiplication and Limited Populations.—The rate of

[1] *Causes of the Phenom. of Organic Nature*, p. 128.

multiplication among living things is, speaking generally, in an inverse proportion to their height in the scale of life, and regulates itself. The minutest organisms multiply by millions; the small compound types next above them multiply by thousands; while larger and more compound types multiply by hundreds, by tens, or by lesser numbers. Conversely, those which multiply most slowly are a billion or a million times the size of those which multiply with greatest rapidity; and are a thousand times, or a hundred times, or ten times the size of those which multiply with less and less rapidity. A certain animalcule, calculated to generate 170 billions in four days, is so minute that only the highest magnifying power renders it visible, and one drop of water would contain as many individuals as there are of human beings on the globe.[1] Very few birds produce less than two young ones each year, while many have six, eight, or ten; and it would be below the average to reckon four broods to the same pair in the course of their life. Man increases more slowly than any other animal. Progress in bulk, complexity of organization, and activity of habit, involve a lessening of fertility; and *vice versa.* Like other natural phenomena, these facts admit of an explanation, and science may trace the effects back to their causes; but the existence of causes is no stumbling-block to us, when we keep in mind that all the acts of man's intelligence have their natural causes also.

We can see why the arrangement should be such as it is, when we view it in connection with that other arrangement of nature that life should feed on life, the larger animals generally on the smaller, and all, directly

[1] H. Spencer: *Principles of Biology*, ii. 423.

or indirectly, on the vegetable world. The number of living individuals of each species is practically stationary; and therefore bears a less and less proportion to the numbers produced as we descend in the scale of life. If there be reason why the higher should consume the lower, the lower will become extinct unless they multiply faster than the higher; and this will be more and more the case the lower we go, and the smaller the prey in comparison of the eater of it. If the whole machinery is self-regulating, this need not shake our faith in a Designer, for it is in that respect more perfect than machinery which is not so—as we always think when viewing the works of man.

The Balance of Species.—How wonderful are the adjustments of nature, especially in the organic world! Every *planet* is held in its course by the action of opposing forces; and between the tendency to fly off at a tangent and the disposition to fall straight into the sun, finds out the golden mean of equilibrium. The living forms of the animal and vegetable world are subject to two sets of forces: each organic being is striving to increase in a geometrical ratio, each meets with resistances whose tendency is to crush it out of life altogether; and between the two it maintains an even existence, and on the whole leaves room for others to do the same.

If the balance of the planets is admirable, how much more admirable is the balance of species. The laws of the one are understood; those of the other are not, just by reason of the marvellous intricacy of their complication. If we placed a plant or animal in a new country amongst new competitors, and wished so to modify it as to fit it to keep its place, probably in no instance should we know what to do, so great is our ignorance of the mutual relations of all organic beings. "Every one has heard that when an American forest is cut down, a very different vegetation springs up; but it has been observed that ancient Indian ruins in the Southern United States, which must formerly have been cleared of trees, now display the same beautiful diversity and proportion of kinds, as in the surrounding virgin forests. What a struggle between the several kinds of trees must here have gone on during long centuries, each annually scattering its seeds by the thousands! What war between insect and insect—between insects, snails, and other animals with birds and beasts of prey—all striving to increase, and all feeding on each other, or on the trees or their seeds or seedlings, or on the other plants which first clothed the ground, and thus checked the growth of the trees! Throw up a handful of feathers, and all must fall to the ground according to definite laws; but how simple is the problem where each shall fall, compared to that of the action and reaction of the innumerable plants and animals which have determined in the course of centuries the proportional numbers and kinds of trees now growing on the old Indian ruins!"[1]

What we have to say upon all this is, that as we have been accustomed to admire the power and wisdom of God in the nice balancings of the orbs of heaven, though perfectly well aware ever since the time of Newton, that the unerring "law" of gravitation accounts for their movements; so when we are brought face to face with phenomena, whose chief essential difference from celestial phenomena consists in there being a larger number of forces at work, with a hundredfold increase

[1] Darwin: *Origin of Species*, p. 78.

in their complexity, *while still the balancement is effected*, our admiration should not be destroyed, but rendered vastly greater.

The Struggle for Existence.—Regarding the balancement of living beings we encounter an element of difficulty which we do not find in the equal poising of the planetary orbs : to a celestial body it makes no conscious difference whether it wheels in even courses round the sun, or wanders more widely, or rushes crashing on the centre; but the organic antagonism is a struggle for existence. A struggle inevitably follows from the rule, to which there is no exception, that every organic being naturally increases at so high a rate that if not destroyed the earth would soon be covered by the progeny of a single pair. The conflict is with individuals of the same species who want the same food, or with individuals of another species who want the same food, or may themselves be eaten if captured, or may become the eaters; or it is with the physical conditions of life. It is, says Darwin, the doctrine of Malthus applied with manifold force to the whole animal and vegetal kingdoms; for in this case there can be no artificial increase of food, and no prudential restraint from marriage. With plants there is a vast destruction of seeds, but it seems to be the seedlings which suffer most, from germinating in ground already thickly stocked with other plants. Seedlings are also destroyed in vast numbers by various enemies. For instance, on a piece of ground three feet long and two feet wide, dug and cleared, and where there could be no choking from other plants, Mr Darwin marked all the seedlings of our native weeds as they came up, and out of the 357 no less than 295 were destroyed, chiefly by slugs and insects. Previous mention has been made of the walking-stick insect brought to Mr Wallace by a Dyak, covered over with foliaceous excrescences of a clear olive green colour, so as exactly to resemble a stick grown over by creeping moss or jungermannia. In this case, as remarked by Mr Chauncey Wright, four distinct forms of life, of widely diverse origin, or very remotely connected near the beginnings of life itself, like four main branches of a tree, have come together into closest relations, as parts of the foliage of the four main branches might do. These are certain insectivorous birds, certain higher vegetable forms (the imitated sticks or leaves), certain vegetable parasites on them, and the mimicking insects. But the main phenomenon is the neck-and-neck race of variation and selection between the powers of hiding in the insect and the powers of finding in the bird.[1] Every plant has multitudinous enemies preying upon it, and these have other animals preying upon them. The bird preys on the insect, and is itself killed by a larger bird. The tiger depends on his teeth and claws, and his victim seeks to escape by speed of foot. All the earth is a battle-field, and there is no truce in the air or in the waters. The struggle is intense; many are overpowered and crushed, many escape through the slightest accident, and on the whole the most vigorous remain masters of the field. What can be said to all this?

Some of our old views will have to be modified. It is no sufficient explanation of the existence of cats to say that they were intended to keep down mice; for this leaves the existence of the mice unaccounted for, unless we say that they were intended as food for cats; and then it is evident that if each is unnecessary except on

[1] *Darwinism:* by Chauncey Wright, Esq., p. 31.

account of the other, it would have been simpler not to have created either. Mr Spencer puts a difficulty,— Should any one allege, in conformity with the old method of interpretation, that there is in each case a providential interposition to rectify the disturbed balance, he commits himself to the supposition, that of the millions of species inhabiting the earth, each one is yearly regulated in its degree of fertility by a miracle; since in no two years do the forces which foster, or the forces which check, each species, remain the same; and therefore in no two years is there required the same fertility to balance the mortality. Few if any will say that God continually alters the reproductive activity of every parasitic fungus and every tapeworm or trichina, so as to prevent its extinction or undue multiplication; which they must say if they adopt the hypothesis of a supernatural adjustment.[1]

To all this we would say, in the first place, that the sort of perspective view of the struggle for existence necessarily given us in works like those of Mr Darwin and Mr Wallace, crowds the difficulties too closely together. When we rise up from reading the history of Europe, we have an uneasy feeling that the nations have done nothing but fighting; but this results from the way in which history is written—all the horrors of many centuries compressed into a few hundred pages. In reality, there were long intervals of peace for each nation, when the arts flourished, and people pursued literature and enjoyed domestic comfort; and even when war was raging, every nation was not engaged in the struggle, and of those which were so there were still many individuals remaining in their homes. It is much the same

[2] *Prin. of Biol.*, ii. 398.

with nature: the battle is not usually more intense than we see it to-day; and we know that the bees sip their nectar, the birds carol their joy, and many animals live to a good old age. When we reflect on this struggle, as remarked by Mr Darwin himself, we may console ourselves with the belief that the war of nature is *not* incessant, that no fear is felt, that death is generally prompt, and that the vigorous, the healthy, and the happy survive and multiply.

The creature that struggles is often stronger for the conflict—improved in every faculty and power—becomes almost a new animal, and transmits the improvement to its offspring. The cause of this struggle, the occasion of this improvement, is the scarcity of food; for if every creature could procure without effort an abundant supply of nutriment it would not exert itself, and there would be no competition of individual with individual, of species with species. Perhaps it may not seem impossible to conceive that all animals should have been exclusively vegetable feeders, and that the vegetation should have been sufficient for all, at any-rate if their powers of multiplying had been restricted; but then the various species would never have improved; or rather, as species originate through Natural Selection, none but the very lowest types would ever have been formed at all. Whatever reason therefore existed for the immense distribution of life through space and time, existed also for creating competition and struggle, and for that restriction in the food supply which leads to the struggle. Thus, even from the apparent difficulty of hunger and conflict, we extract an evidence of wisdom and a proof of beneficence.

Death.—Because of the manifold sorrows and calamities of life, and the universal reign of death, the German philosopher, Arthur Schopenhaur, maintains that this is the worst of all possible worlds.[1] It is not, however, the mere whim of an eccentric philosopher which in the present day has raised a renewed attention to this problem. To reconcile the imperfection of the world—its suffering and death—with faith in an almighty, all-wise, and infinitely perfect God, has been long aimed at by the dogmatic theology of the Christian Church; but the solutions offered are now found to be inadequate—they cannot stand before the lessons of philosophy, and the discoveries in geology and palæontology. Mr Spencer puts the difficulty strongly—"Omitting the human race, whose defects and miseries the current theology professes to account for, and limiting ourselves to the lower creation, what must we think of the countless different pain-inflicting appliances and instincts with which animals are endowed? Not only now, and not only ever since men have lived, has the earth been a scene of warfare among all sentient creatures; but palæontology shows us that, from the earliest eras geologically recorded, there has been going on this universal carnage. Fossil structures, in common with the structures of existing animals, show us elaborate weapons for destroying other animals. We have unmistakable proof that throughout all past time there has been a perpetual preying of the superior on the inferior,—a ceaseless devouring of the weak by the strong. How is this to be explained? How happens it that animals were so designed as to render this bloodshed necessary? How happens it that in almost every species the number of

[1] *Optimism and Pessimism*, by Prof. Frohshammer, *Contemp. Rev.*, Aug. 1871.

individuals annually born is such that the majority die of starvation or by violence before arriving at maturity? Whoever contends that each kind of animal was specially designed, must assert either that there was a deliberate intention on the part of the Creator to produce these results, or that there was an inability to prevent them. Which alternative does he prefer? To cast an imputation on the Divine character, or assert a limitation of the Divine power?"[1]

Theologians have scarcely aimed at more than showing that the Creator has a right to take away the life He had bestowed, and that there are certain alleviations of the case: it was reserved for Evolution to prove that death is a necessity, and a necessary prelude to higher life, and so "to justify the ways of God to man." But for death the first forms of life would have been the only forms; but for death man could not have been evolved, and therefore man has no reason to complain of death. Let us look at the dilemma presented to us by Mr Spencer—"Whoso contends that each kind of animal was specially designed, asserts either a deliberate intention on the part of the Creator to produce these results, or an inability to prevent them." Surely whoever believes that the present order of things is God's work at all is driven to this alternative. We therefore accept it, and contend that the nature of things, the conditions of all work, limit the Creator to work by method, to use appropriate means, to wait for results, and to take some incidental evil with the good. This seems a limitation of His power; but omniscience means the power to do all things that are possible, not to make contradictions agree; and if this view seems to limit the power, it

[1] *Prin. of Biol.*, i. 341.

makes the wisdom more manifest, and frees the character from imputation.

It has been remarked that Natural Selection acts by killing, not by creating: "Natural Selection endows the woodpecker with its instrument—'a striking instance of adaptation'—*i.e.*, it does not give *one* woodpecker its instrument; it has nothing to do with that; it only kills off another woodpecker who has not got it. Natural Selection forms the flying squirrel with its parachute, *i.e.*, it makes away with another squirrel who has not got a parachute, and is at a disadvantage in the locality. Natural Selection has 'reduced the wing' of some species of beetles in Madeira. That means that those species which *had* reduced or shortened wings were naturally selected or survived, whereas others with full wings, by reason of this very completeness of them, perished, because they flew, and flying, they flew over the sea, and flying over the sea, got carried away by winds, and could not get back again to land."[1] All this is true. A frosty night "selects" the hardy plants in a plantation from among the tender ones as effectually as if the intelligence of a gardener had been operative in cutting the weaker organisms down; and whether you say that the strong are selected to live, or the weak selected to die, makes no difference. But this is not a method of trial and error, as Professor Huxley calls it; nor is it fatal to teleology, as he appears to think. He says,—For the notion that every organism has been created as it is, and launched straight at a purpose, Mr Darwin substitutes the conception of something which may fairly be termed a method of trial and error. Organisms vary incessantly; of these variations the few meet

[1] *Quarterly Review*, July 1869.

with surrounding conditions which suit them and thrive; the many are unsuited and become extinguished. According to teleology, each organism is like a rifle bullet fired straight at a mark; according to Darwin, organisms are like grape-shot, of which one hits something, and the rest fall wide.[1] Professor Huxley may be right in saying that teleology, *as commonly understood*, has received its death-blow at Mr Darwin's hands; but we remember his other word—"there is a wider teleology"—and we desire to arrive at that. If we may no longer say that cats exist *in order* to catch mice, but have survived because they proved the fittest to catch them, we are not obliged to hand over everything to the haphazard of grape-shot. The "variations of the feline stock which died out from want of power to resist opposing influences," did not come into life by mistake, nor pass out of it through "error." We have seen that death is the necessary stepping-stone to higher life; without the *multitude* of creatures there would not be that nice balancing of the organic world, which is more wonderful than that of the planets—the organic orbit must have its aphelion and its perihelion, and when the antagonist forces are living forces the temporary superiority of one means so much death in the other. But it is the weak which are weeded out; the irregularities, monstrosities, and abortions which are carried off—those who would have found life least enjoyable, and would have left descendants to whom it would have been a burden. Did the diseased and feeble habitually survive and propagate, the vigour of the species would be diminished; whereas the death of the worst and multiplication of the best, results in the maintenance of a

[1] *Lay Sermons*, p. 302.

constitution in harmony with surrounding conditions, and eventually in an improved type of life. The very species that suffers most in the loss of individuals is often most improved through the stringency of the selection; for all following generations are more healthy and vigorous, better able to obtain their food regularly and to avoid their numerous enemies. There is more life in the world because there is death, more enjoyment because there is some suffering; the greater prevalence of death (though, of course, of life also) is with small species, which are of lower type and less sensitive to pain; with the young, who are not yet fully bound up in life's relations, and with the aged and the diseased, to whom death is a happy release. Granting only that death would be necessary because an animal machine cannot wear without wearing out, there is wisdom in the arrangement which uses the flesh of one creature as the food of another, instead of leaving all to die of disease and pollute the air by their decomposition.

And it may be remarked before leaving the subject, that although this action of Natural Selection, in weeding out the weak and those ill-adapted to the conditions of life, explains the fact that only the vigorous and well-adapted have survived, it is no sufficient account of the "adaptations" of nature, and is no more the ultimate power which brought strong and weak alike into existence than the winds and waves of the Bay of Biscay, which have "selected" the grains of sand from amidst the gravel, and heaped them by themselves over a great area, are the powers to be credited with the origin of matter.[1]

Growth of Habit and Instinct.—In a larger Essay,

[1] See *Lay Sermons*, p. 316.

Habit would have a chapter to itself and Instinct another; and then it might be necessary to write a third chapter to show their mutual relation. Habit is acquired by practice, and expresses a facility in bodily or mental operations, or a propensity to them. We apply the term to the dexterity of the workman, the rapidity of the accountant, the quick fingering of a piano, or to Dr Johnson's action in touching every post he passed in his walks. Instinct is inherited, and is the capability of performing complex acts without instruction or experience, and without a knowledge of the purpose for which they are performed. We use the word of the action of the cuckoo in laying her eggs in other birds' nests, of chickens concealing themselves at the danger-chuckle of the mother-hen, and of the comb-making power of the hive bee.

Habit is allied to the use and disuse of organs, previously spoken of. Not a single domestic animal can be named which has not in some country drooping ears; and the view suggested by some authors that the drooping is due to the disuse of the muscles of the ear, from the animals not being much alarmed by danger, seems probable. On the other hand, the increased use of an organ through the repetitionary acts of habit, strengthens it, and this change being physiological, tends to be inherited, so that the offspring may start where the parent left off, with a facility for performing certain actions; and if disposed to use the power it feels itself to possess, will gain increased facility. Moreover, in the formation of habit, the mental powers are concerned as well as the bodily organ. Dugald Stewart remarks that "a man who has been accustomed to write with his right hand can write better with his left hand than another who never practised the art at all; but he cannot write so well with his left hand as with his right: the effects of practice, therefore, it should seem, are produced partly on the mind and partly on the body."[1] Both the bodily and the mental action tend to become automatic—the movements of the fingers, which at first required effort and attention, and the thought which was once consciously directed to their guidance, may both go on unconsciously while the mind is occupied with something else.[2] Habit becomes second nature. The mental part of habit—or, perhaps more strictly, the organic change produced by the repeated mental action—tends to be inherited, like the more obviously bodily part. In fact, the habit itself may become hereditary—the entire facility for performing certain actions, and the entire tendency to perform them. Mr Lewes had a puppy taken from its mother at six weeks old, who, although never taught "to beg" (an accomplishment his mother had been taught), spontaneously took to begging for everything he wanted when about seven or eight months old. He would beg for food, beg to be let out of the room, and one day was found opposite a rabbit-hutch begging for rabbits. This case reminds us of others connected with dogs. Dogs are trained to "point" and to "retrieve;" and although they may possess naturally some slight disposition to do these things (there must be a foundation for the trainer to build upon), there is little doubt that the breeds have been produced by education and selection. Now it cannot be disputed that young pointers will sometimes point, and even back other

[1] *Philosophy of the Human Mind.* Chap. on Attention.

[2] See Dr W. B. Carpenter's Art. on the Physiology of the Will, in the *Contemp. Review*, May 1871.

dogs the very first time that they are taken out. Retrieving, also, is certainly in some degree inherited by retrievers, and a tendency to run *round* instead of *at* a flock of sheep by shepherd-dogs. But these inherited habits or tendencies in retrievers and pointers are called instincts; and so we are led to notice the close connection, if not the identity, between instincts and inherited habits. As in repeating a well-known song, so in instincts—one action follows another by a sort of rhythm. If a person be interrupted in a song, or in repeating anything by rote, he is generally forced to go back to recover the habitual train of thought; so P. Huber found it was with a caterpillar, which makes a very complicated hammock. If he took an individual which had completed its hammock up to, say, the sixth stage of construction, and put it into a hammock completed up only to the third stage, the caterpillar simply re-performed the fourth, fifth, and sixth stages of construction. If, however, a caterpillar were taken out of a hammock made up, for instance, to the third stage, and were put into one finished up to the sixth stage, so that much of its work was already done for it, far from feeling the benefit of this, it was much embarrassed, and in order to complete its hammock, seemed forced to start from the third stage, where it had left off, and thus tried to complete the already finished work.[1]

If this be a true account of the origin of instinct, then we see that instincts, like simple peculiarities of bodily structure, taking their start from outward conditions—that is, in the case of instinct, from some occasional action which an animal is prompted to repeat—are per-

[1] Darwin's *Origin of Species*: chap. on Instinct.

fected by Natural Selection, which continually preserves the favourable variations.

Then, also, all that we have before said about the wisdom seen in the lines in which variation has been guided, applies here with a force proportioned to the utility and beauty of the results; and how remarkable the results are, as, *e.g.*, in the case of the hive bee! "He must be a dull man," says Mr Darwin,[1] "who can examine the exquisite structure of a comb, so beautifully adapted to its end, without enthusiastic admiration. We hear from mathematicians that bees have practically solved a recondite problem, and have made their cells of the proper shape to hold the greatest possible amount of honey, with the least possible consumption of precious wax in their construction. It has been remarked that a skilful workman, with fitting tools and measures, would find it very difficult to make cells of wax of the true form, though this is perfectly effected by a crowd of bees working in a dark hive."

If the tendency to a beneficial habit died with the individual who first exhibited it—if the law of heredity did not co-operate with the law of variation—the growth of instinct would be impossible, and the bees and ants would be in the position of their rude progenitors. The preservation of each new favourable variation of instinct is to these insects what the preservation of the best thoughts and discoveries of men, preserved in literature or taught in school and workshop, is to the human race; and the insects have this additional advantage, that Natural Selection, like a Romanist Council of the Index, rigorously but unerringly destroys what is not good.

[1] Darwin's *Origin of Species*: chap. on Instinct.

Our prospect widens. If instinct is formed in this way we cannot stop at instinct. Even in animals very low in the scale of nature a little dose (as Pierre Huber expresses it) of judgment or reason often comes into play. How godlike a power is man's reason, and how wondrous must have been its evolution! Man, again, is a social animal; and if the moral sense or conscience has been developed from the social instincts, as suggested by Sir Benjamin Brodie[1] and maintained by Mr Darwin,[2] what wisdom must have been at work here! Morality leads on to religion,—belief in a Creator, faith in God, love to God! Surely the Creator has looked forward from the beginning to the evolution of a race made in His image, able to understand something of His work, to see a part of absolute truth, to appreciate in a degree absolute goodness, to sympathise with Him in what He approves, and to aim to realise it in themselves and in their fellow-men!

[1] *Psychological Inquiries*, first part, p. 199.
[2] *Descent of Man.*

CHAPTER VII.

THE BENEFICENCE OF THE ALMIGHTY SEEN IN EVOLUTION.

BENEFICENCE is so combined with wisdom in the works of the Almighty that it was difficult to avoid the frequent mention of the one attribute in treating of the other. As, however, it must have suggested itself to the reader's mind as well as the writer's, the same ground will not be gone over, to any great extent, in the present chapter.

§ 1. *Difficulties Removed.*

All who have sought in nature some evidence of the character of God have been perplexed by the seeming conflict of the indications: there is so much that looks like beneficence and so much that might be maleficence that the Dualism of ancient Pagan theologies is understood though not assented to.

> "We trusted God was love indeed,
> And love creation's final law;
> Though nature, red in tooth and claw
> With ravin, shrieks against the creed."

Existence of Carnivorous Animals.—Professor Huxley, who says that cats were not created in order to catch mice, consistently says in another place that the human eye was not constructed in order that man might see. It is clear that these two things must go together, and he who contends that Design is exhibited in the human eye, must see it also in the claws and teeth and digestive canal of the tiger—so admirably suited for catching, and tearing, and assimilating to itself the flesh of other creatures. Yet it grates against one's feeling to read a passage like the following:—"Why then has nature deliberately sacrificed a certain amount of force, by putting a triangular muscle into the leg of the tiger, to do the work which she does so effectually in my leg by a straight rope of muscle? The answer is this—I am a man and not a tiger; I am not intended, as a tiger is, to hide in a jungle, to jump from the jungle at a troop of horsemen going by, to take one of them and carry him off, spite of the rest, and eat him. That is not the purpose for which the Creator brought me here; but if I were brought here for such a purpose, I am sure I should have a triangular muscle in my leg."[1] On the one hand, we cannot escape from the admission Mr Spencer would force from us, that if organisms were severally constructed with a view to their respective ends, then the character of the constructor is indicated both by the ends themselves, and the perfection or imperfection with which the organisms are fitted to them;[2] on the other hand, our own better nature revolts from the deliberate infliction of pain. The whole difficulty has arisen from metaphysical views of creation and of Deity—from the supposition that, by an Infinite Being, results could be attained without processes, and ideal perfection without temporary incidental evil. The moment we learn from Evolution that struggle and

[1] See Professor Haughton's "Lectures on Least Action," *Brit. Med. Jour.*, May and June, 1871.

[2] *Principles of Biology*, i. 340.

death were absolutely necessary in order to render possible the advancement of the forms of life, and the eventual birth and perfecting of man, the existence of carnivorous animals ceases to appear a satire on the Beneficence of the Creator. In the lower animals there appears to be something approaching a complete enjoyment of life while it lasts; and when the end does arrive it is in most cases unforeseen, and the suffering which attends it is in general of only momentary duration. To the objection that the Creator could have fitted all animals to live on a vegetable diet, we may oppose first of all the answer of Dr Andrew Combe,—Had there been no beasts of prey, the world would soon have been overrun with herbivorous creatures to such an extent that their numbers would speedily have become excessive in reference to the possible supply of food, and there would have been infinitely more suffering from starvation and disease than what actually arises out of the existing relation of different classes to each other. On the present plan there is ample food and enjoyment for all.[1] And further, we can see, as Dr Combe perhaps could not see in 1845, that vegetable feeders, with abundant food, would not have struggled as animals struggle now, and the higher forms of life would not have been possible.

Existence of Parasites and of Diseases.—The existence of parasites, though less is said about it, is a greater difficulty than the existence of carnivores: for here it is the inferior which destroy the superior, and the suffering seems to bring no compensating benefit. There are two kinds of tapeworm which flourish in the human intestines, producing great constitutional disturbances, sometimes ending in insanity; and from the germs of

[1] Combe's *Physiology of Digestion* (Edinburgh, 1845), c. vi.

one of these, when carried into other parts of the body, arise certain partially-developed forms which cause disorganization more or less extensive in the brain, the lungs, the liver, the heart, the eye, &c.; often ending fatally after long-continued suffering. Altogether, the parasites of the human body, internal and external, animal and vegetal, number two or three dozen species; besides which almost every known animal has its peculiar species, generally more than one, and sometimes as many as man, or even more. Can we say that parasites were purposely endowed with constitutions fitting them to live by absorbing the juices of the human body; that they were designedly furnished with appliances, often of a formidable kind, enabling them to root themselves in and upon the body; and that they were made prolific in an almost incredible degree in order that their germs might have a sufficient number of chances of finding their way into the human organism? "Shall we say that man, 'the head and crown of things,' was provided as a habitat for these parasites? Or shall we say that these degraded creatures, incapable of thought or enjoyment, were created that they might cause unhappiness to man? One or other of these alternatives must be chosen by those who contend that every kind of organism was separately devised by the Creator. Which do they prefer? With the conception of two antagonistic powers, which severally work good and evil in the world, the facts are congruous enough. But with the conception of a supreme beneficence, this gratuitous infliction of misery on man, in common with all other terrestrial creatures capable of feeling, is absolutely incompatible."[1]

[1] Spencer: *Principles of Biology*, i. 344. Büchner: *Force and Matter*, p. 95.

On the hypothesis of Special Creation this is a tremendous difficulty, and if the theory of Evolution did not clear it up it would leave us in no worse position than before. Mr Spencer endeavours to explain it by the principle of "incidental evil," which, in the nature of things, is connected with a process like that of evolution—evil which is but "a deduction from the average benefits," and is "ever being self-eliminated," the tendency being "to produce a type of superior organisms less liable to the invasions of the inferior." Thus, "though there may arise the question, Why could they not have been avoided? there does not arise the question, Why were they deliberately inflicted? Whatever may be thought of them, it is clear that they do not imply gratuitous malevolence." This seems hardly enough for us, on the view maintained in this Essay; for in so far as the bodies of these creatures exhibit what we must call mechanism, we must hold them to have been designed. We confess to some difficulty. Dr Bree says, "We cannot answer these questions;"[1] but unless they admit of an answer they seem to leave room for the denial of Design in any and every part of the animal or vegetal creation. Our first suggestion is, that since incidental evils are correlated with the process to which they are incidental, they do not carry with them any denial of design in that process; but, on the contrary, so far as they are fitted for any purpose, or seem to exhibit any design themselves, they prove design in the process of which they are the incidents; much as the complex character of the refuse from chemical works indicates complexity in the processes which gave rise to it, or as the regularity of blurred letters on a fragment of

[1] *Fallacies of Darwinism*, p. 68.

dirty paper speaks of the printing machinery through which it has accidentally passed. A second suggestion is, that parasites, in so far as they affect chiefly individuals of uncleanly habits or careless feeding, and kill those whose organs are weakest, are engaged in a useful work, on the principle of Natural Selection, and may have been as much designed for that purpose as the general struggle for existence is designed. A third suggestion I find in Mr J. J. Murphy's work—viz., that parasites are descended from species which were not parasitic, and have become self-adapted to new habitats, so that we have in their existence only a particular case of the question why pain and disease are permitted at all.[1] If either of these suggestions should prove accordant with fact, it will probably supply at the same time a solution to the class of difficulties referred to by Mr Darwin in the following passage:—Finally, it may not be a logical deduction, but to my imagination it is far more satisfactory to look at such instincts as the young cuckoo ejecting its foster-brothers, ants making slaves, the larvæ of ichneumonidæ feeding within the live bodies of caterpillars—not as specially endowed or created instincts, but as small consequences of one general law, leading to the advancement of all organic beings, namely, multiply, vary, let the strongest live and the weakest die.[2]

Diseases other than parasitic seem to admit of an easier explanation. That certain substances should be so related to the blood that they will "poison" it if introduced, may be as inevitable as that pointed weapons should be fitted to pierce the skin, or that plane surfaces should admit of contact throughout their extent

[1] *Habit and Intelligence*, chap. xxvii. [2] *Origin of Species:* Instinct.

while a cube and a sphere can only touch at one point. There is some truth in Professor Huxley's strong statement that plague, pestilence, and famine are admitted by all but fools to be the natural result of causes for the most part fully within human control, and not the unavoidable tortures inflicted by wrathful Omnipotence upon His helpless handiwork.[1] No doubt there are diseases which no human prudence can at present guard against, and no human skill can cure; and if one has lost a wife through cancer, or a son through consumption, he may find it difficult for the moment to believe in the Divine beneficence; but the morbid growth of cancer may be as inevitable under some circumstances as the accumulation of slag at a foundry, or the flooding of a low country after heavy rains. Dr Carpenter leans to a belief that cancer results from a poison in the blood;[2] and Mr Murphy suggests that it may be a portion of the organism which has got away from the control of the general life, and leads a life of its own, parasitic on the rest [3]—in either of which cases we have only the difficulty which we have just endeavoured to remove. When we have traced back all diseases to their causes, we may be able to divert their currents from touching us—as people dig a hole in the hardening side of a lava stream to turn away the flow which threatened the destruction of their village. In the meantime we suffer through our ignorance: but Natural Selection may do as much good by preserving only those who are wise in soul, as by caring for those who are strong in body; and it is certain that since man's mind became at all highly developed, it is mental variations which are most selected.

[1] *Lay Sermons*, p. 283. [2] *Human Physiology*, p. 371.
[2] *Habit and Intelligence*, chap. xxvii.

The Existence of Pain.—Admitting that liability to disease and injury was inevitable, it may still be asked, Why they should be accompanied by pain? Cancer, stone, and every other dreadful complaint might be submitted to, but for the excruciating agony. Let us look at this. Pain *per se* is an evil; but allowing for that conditional necessity in nature which renders it impossible to effect all imaginable unmixed good at a bound, it can easily be shown that the suppression of the sense of pain would imply the extinction of the highest forms of life. We have seen that the higher animals, such as man, have the most highly differentiated organization, and can least afford to have a part of the body cut off, or any organ severely injured. It is trite to say that in the e very animals the nervous system is the most highly developed, and the capacity for pain the greatest. It may be a newer thought that, since this capacity increases from lowly organisms up to man, it must have been developed by Natural Selection; and that taking this fact in connexion with Mr Darwin's well-proved rule that Natural Selection never produces in a being anything injurious to itself, but acts solely by and for the good of each, we are supplied with a *proof* that pain is a beneficent thing. Darwin, in passing, expresses his agreement with Paley, that no organ is formed for the purpose of causing pain, or for doing an injury to its possessor;[1] but the higher animals are so sensitive to pain that one almost expects to find in the *Origin of Species* a chapter on the uses of this sensitiveness in the struggle for life, and on its development by the aid of Natural Selection. It is quite evident that an animal body, in its very nature, admits of being injured and disorganized

[1] *Origin of Species*, chapter vi.

by extremes of heat and cold, by blows, by falls, by the thrust of weapons, &c., and that the animals which were best warned against these dangers by a sensitive skin, so as to be able to withdraw the body before mischief was done, would benefit so far in the struggle for life. Of two animals in which the differentiation of organs was carried equally far, and in which the same necessity existed for keeping all the limbs sound and whole, under circumstances of equal danger one would be selected to live by its greater sensitiveness of skin—by its capacity, that is, to suffer pain. Is it Sir Charles Bell who tells us of the man who, having lost sensation in one hand, lifted the cover of a pan out of the fire and had the skin of his palm and fingers completely destroyed? It is related in the Life of Drew the metaphysician, that when he and his shipwrecked comrades were brought ashore, nearly dead through exposure and cold, the neighbours unwisely placed their feet very close to the fire, and the sense of pain being absent, they remained in this position till severely injured, so that the scars never disappeared. Confining our view to this physical aspect of the matter, the history of the evolution of life on the globe only confirms the statement made long ago by Dr Rogêt,—"Sensibility to pain must enter as a necessary constituent among the animal functions; for had this property been omitted, the animal system would have been but of short duration, exposed as it must necessarily be to perpetual casualties of every kind." The sensitive nerves "act the part of sentinels, placed at the outposts to give signals of alarm on the approach of danger."[1] There is a higher aspect in which the sense of pain may be viewed, as spurring man

[1] *Bridgewater Treatise:* chapter on Sensation.

to effort and enterprise, and leading to inventions, to the advancement of civilization, and the development of the intellectual faculties; but we should be trenching on a part of the subject which it may be better to reserve. It is also obvious to remark, that while liability to injury is incidental to all living structures, and sensitiveness to pain is beneficently correlated with this liability in the higher organisms, pleasure, for which there seems less absolute need, is made to stream in at all the five gateways of the senses.

§ 2. *Direct Marks of Beneficence.*

Beneficence in Heredity.—The laws of inheritance, as remarked before, have the appearance of being capricious in their action; but this is only because, like the laws which govern the weather, they are too complicated to be yet understood. Still, one or two things may be noted. When we reflect that in animals low in the scale the sexes are not differentiated, we are carried back in thought to a period in the history of Evolution when there was no distinction of male and female in any species. When we look round upon human society, the foundation of which is *the family*, and when we reflect upon all that preachers and poets have said and sung of the love of wife and mother, and the purifying influence of affection, we see that the differentiation of the sexes is a principal element in human happiness. And *this* condition of things has been evolved out of *that*, by laws of inheritance at present unknown to us, but whose beneficent character must be judged from their fruits! So far as we know, there was no absolute need of life at all: so far as we know, life might have been made to stop at the lower stages, before the sexes became different, or Evolution might have brought the higher animals upon the stage with this law of a-sexuality still in force.

Another beneficent peculiarity in the working of the laws of inheritance is remarked upon by Mr Darwin himself: "It is indeed fortunate that the law of the equal transmission of characters to both sexes has commonly prevailed throughout the whole class of mammals; otherwise it is probable that man would have become as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen."[1] Properly to appreciate this we must bear in mind the great difference between the sexes in some creatures—in most instances to the disadvantage of the female—the apparent ease with which heredity restricts its favours to one sex when it pleases (or, as we might put it, the difficulty it seems to find in transmitting them to both); the fact that the law of unequal transmission is partly followed in man's case, *e.g.*, in regard to the size of the body, the possession of a beard, &c.; and lastly, the tremendous weight it would be on humanity if woman were no better than a domestic animal. In birds, the brightest plumage, the most conspicuous ornaments, and the sweetest gift of song, belong to the males: it is in the males that we find all sorts of crests, wattles, horns, air-sacs, plumes, and lengthened feathers springing from all parts of the body; while the females are generally of dull colour and tame appearance. Among insects the female glowworm is destitute of wings and grovels as a worm, while her husband enjoys the freedom of the air: and this is the case also with many moths. But while man is superior to woman in size and strength, in energy,

[1] *Descent of Man*, ii. 328.

perseverance, courage, and in mental power, the difference is not great enough to prevent intellectual sympathy; and woman has the advantage in tenderness, unselfishness, rapid perception, and some other qualities —so that the endowments of the two are complementary, and each has a power of borrowing good from the other.

Beneficence in Variability.—Andrew Wagner, as quoted by Haeckel, considered that domestic animals and plants were created variable for the special benefit of mankind. Of course we now know that all living things are variable; and Mr Darwin is probably right in thinking that the greater variability in our domestic productions is simply due to the artificial conditions under which they have been raised. Dogs are not made variable in order that man may produce a variety which shall pin down the bull for his brutal sport, nor is the organization of pigeons rendered plastic to enable us to produce a breed which shall tumble in the air. But for all this there remains the fact, that some animals are capable of domestication and some are not; that side by side with man there have been planted on the earth creatures suited to his service and capable of affection for him. And if these were not created as they are, but have been evolved from lower forms, *pari passu* with man's evolution from lower forms, there is something like design and beneficence in this separate education and eventual contact of two beings who, when they meet, are as fitted to work in union as the troops who arrive on a battlefield and the marshal who has come by a different route. Professor Owen has pointed out in public lectures the existence of fossil animals which show an increasing approximation to the forms of the horse and the ox,—an approximation, says the Duke of Argyll, related in time, as it seems to be in purpose with the coming need of them for the service of man.[1] If the Evolution theory is true, the former existence of these animals was to be inferred, as a matter of necessity, from the existence of the domestic animals to-day; but if we discover purpose in the present relation of these creatures to man, the intention must be carried back along the entire line, just because of the inevitable link-to-link character of it. Mr Wallace contends for the guidance of a higher intelligence to make man what he is in brain and faculty, in hand, and skin, and voice. Was it a new thought with this Intelligence when, some millenniums ago, He saw in the interior of Africa the ape-like progenitor of man—who had come on his way thus far without guidance—that the creature was capable of higher things, if the laws of variation, multiplication, and survival were taken under control? That a creature taken in hand at such a stage could be transformed, through the guidance of the variations into certain channels, appears clear to us from the analogy of man's action; but the Higher Intelligence may be supposed to foresee what He will do, and it is reasonable to credit Him with preparing the ground for Himself by guiding the ape-like creature through its previous stages of Evolution as well as through those which are to follow. If this much be allowed there should not be any difficulty in allowing that variation was guided along useful lines to give man the horse for his carrier, the dog for his companion, the sheep and the ox for his food.

In this there would be no want of beneficence to the animals themselves; for though we slaughter cattle and

[1] *Reign of Law.* See also Huxley on the pedigree of the horse, in Address to Geol. Soc., 1870.

sheep by thousands, an equal number would be somehow disposed of in a state of nature. The domestic horse is better cared for than any wild animal, and the dog is positively happy in man's society. Towards man there would be the exercise of great beneficence; for we may so far agree with Dr Kidd as to believe that the absence of these animals would be almost incompatible with the continuance of the human race.[1]

A similar argument might be drawn out for the guidance of the variations which have given man the cereals for his food; but repetition is wearisome.

Beneficence in Correlation.—If there be any truth in our previous argument relating to the correlation of man's improving brain with some part of his frame on which Natural Selection had a strong hold, the fact is as great a proof of Beneficence as of Wisdom. We know not how many useful structures may have been assisted through their early stages by the working of this "law:" and that it should work in this way for beneficent purposes is quite consistent with what we know of nature's processes; for what is the correlation of the kangaroo's pouch to the young kangaroo, or of the human infant to its mother, but the burdening of one structure with another which it is able to carry?

As an instance of the beneficent working which we suppose possible, let us look at the powers of the human voice and the human ear—the wonderful range, flexibility, and sweetness of the sounds producible by the larynx, and the extreme delicacy of the auditory organ which appreciates them. The apparatus of the ear is very complicated, and includes a key-board arrangement of filaments, concerned in giving the sensation of

[1] *Bridgewater Treatise*, chap. ix.

particular tones: the human throat is a complicated instrument of muscle, cartilage, ligament, and bone, so delicate that a little cold destroys its powers. Now, even among birds, where the faculty of song may have been increased by sexual selection, the power of appreciating song can hardly have been evolved by the same means without the aid of correlation; and among savages, as Mr Wallace remarks, singing is a more or less monotonous howling; the females seldom sing at all, and are certainly not selected as wives because of their fine voices.[1] Neither will any other form of Natural Selection account for these powers in man, unless the aid of correlation be called in: for Natural Selection preserves only what is immediately useful; and Mr Darwin remarks that neither the enjoyment nor the capacity of producing musical notes are faculties of the least direct use to man in reference to his ordinary habits of life, and must therefore be ranked among the most mysterious with which he is endowed.[2] How, then, are we to account for the evolution and preservation among savages of successive generations, of the extreme delicacy and refinement in the organs of voice and hearing necessary to serve as the foundation for the powers of a Jenny Lind, and for the ears that can appreciate Handel and Mendelssohn (to say nothing of the mental appreciation without which the perfection of the organs would be useless)? In this case it would not appear to be the ear which has preserved the larynx, nor the larynx which has protected the ear, nor any third organ which has fought the battle for either; but the organ being complex in itself, one power of it has been correlated with another—a useful part with a part not yet useful—like

[1] *Natural Selection*, p. 350. [2] *Descent of Man*, ii. 333.

an independent society supporting its own weak members. Delicacy of hearing would serve the savage in guarding against the approach of enemies, and with this has been correlated perception of the intensity and quality of sounds. Strength of voice and accuracy of articulation would be useful in ordinary intercourse, and with these have been correlated melodiousness and those differences in voices which make harmony possible. The business of life could have gone on without music—it is only when man becomes civilized that he takes pleasure in it—and yet, on the theory of Evolution, the foundation of his powers in this respect is to be sought in the far-off ages of which we have no historical record, and in the living forms which were not yet worthy to be called human. Such long anticipation and patient quiet working is only what we might expect, if we believe in an Almighty Being, to whom the process of evolution is to be ultimately ascribed; yet still it is only as we *look at them* that our admiration is called forth: and the patient working might have been with a view to simple utility, whereas it appears that the delight of man is an end also.

Sexual Selection: Colour and Ornament.—Beauty of form, symmetry of outline, richness of colour, delicacy of tint, variety of pattern—the living world is full of these; and man delights in them. It used to be thought sufficient to point to the bird's plumage, the butterfly's wing, and the colours of flowers, in proof that the Creator delighted in beauty, and desired to gladden the eyes of man: but the Evolutionists have checked us in this. There was a time, we learn, when flowers were not beautiful in colour, but those which showed a tendency that way were more easily discovered by insects, and selected to be fertilized; there was a time when birds were not handsome, but the females being possessed of taste selected the males in whom spots and stripes of colour were occurring; the majority of birds, again, have no colour, reptiles are ugly, and much of the beauty that does exist in nature is buried beneath the waters, or hidden deep in the forests.

Mr Darwin thinks that moths and butterflies have sufficient mental capacity to admire bright colours—bees and butterflies may be watched flying from flower to flower, disregarding all other parts of the plant—they certainly discover flowers by colour, and it is proved that plants which are fertilized exclusively by the wind never have a conspicuously coloured corolla. The humming-bird sphinx may often be seen to swoop down from a distance on a bunch of flowers in the midst of green foliage; and in the south of France, as Mr Darwin was assured by a friend, these moths repeatedly visited flowers painted on the walls of a room. Of course there is honey in flowers, for unless a bait co-existed with the colour, the insect would not be attracted; but this correlation of sweetness and colour being once established in some slight degree, the plants presenting most of the desired food, and showing most clearly where it lies, would have their fertilization and multiplication furthered—their beauty would be *useful* in the struggle for existence; and where beauty is not useful it is not given, for Natural Selection never wastes its energies on sentiment. To butterflies and birds it would be an advantage to be of dull colour, and many of them are protected from their enemies by this very means; so that Natural Selection, in the narrower sense of the word, would scrupulously weed out all brilliant colours, top-knots, fine plumage, &c., as threatening the safety of the species: but here *sexual* selection comes in—the colours are arranged as if for display, their possessors take pains to exhibit them before the female, and the female chooses the most brilliant suitors. The beauty, after all, is useful to its possessor; and Mr Darwin stated in the *Origin of Species*, that it would be absolutely fatal to his theory if it could be shown that structures were created for beauty in the eyes of man, or for mere variety.[1] The Creator has not uniformly abolished deformity from the world, as a man possessing high taste and unlimited wealth would banish ungraceful and disagreeable forms and colours from his domains: if the horse and deer are graceful, the elephant, hippopotamus, and camel are the reverse; monkeys and apes are not beautiful; many insects and reptiles are positively ugly; and not more than half the plants in the world have bright-coloured or beautiful flowers.[2]

If these are truths they must be received, and in the long run truth will prove of more value than delusion. But let us look at the cases. With regard to flowers, we may admit the theory at once, and admire the means by which about half the plants of the world have been rendered beautiful, when it appears that the wind could have been made to fertilize them without any such enticement. We do but see here the method of creation —and we knew before that there had been *some* method adopted; we are but thrown back on the circumstances or "conditions" which cause the colours the insects are so quick to detect; we read beneficent design in the final outcome of beauty, and trace it back along all the lines

[1] *Origin of Species*, p. 219.
[2] Wallace: *Natural Selection*, p. 284.

which have led up to it; and, finally, we admire the correlation of sweet secretion with gay colour or pleasant odour.

With regard to the colours of birds and butterflies the case is different, for here the element of conscious choice comes in. Let it be the case, as Hunter said it was, that the female requires to be courted; let it be the fact, as Darwin and Wallace affirm (and they have a host of naturalists at their back), that male birds assiduously display their plumage, perform strange antics, and pour forth their song in presence of the female; and grant that choice is exercised generation after generation, the repeated selection resulting in the great beauty of the males. Let us suppose that in the course of several thousands of generations we have one thousand variations of the right sort combined into one harmonious whole, like a thousand small pieces of mosaic artistically arranged into a pattern or picture. The process, indeed, is comparable to that by which some mosaic pictures of great excellence have been worked, with millions of tiny pieces, successive artists wearing out their lives upon them, each still leaving the picture for another to finish. The artists, however, leave us a picture at last, because there has been a design from the first; and each man could fit his work on to that of his predecessor, because he had the same original sketch to work by. But the female bird has no prevision of the final result, no hand in putting a new piece to the mosaic (she only stamps it to remain when "variation" has introduced it), and yet the eventual forms of beauty, as, for instance, in the peacock's tail, seem to imply the action of mind *somewhere.* If the female bird *could* see the end from the beginning, and consciously work towards it, this would be quite as wonderful as the Creator designing the result, and working for it; and, on the other hand, as Mr Wallace remarks, successive generations of female birds choosing any little variety of colour that occurred among their suitors, would necessarily lead to a speckled or piebald and unstable result, not to the beautiful definite colours and markings we see.[1] Admitting that the exquisite colours, patterns, and ornaments require the agency of the bird's mind for their evolution, can we suppose that the plumage and the mind together, and all the beauty in nature, have come about without the agency of a greater Mind? Mr Wallace's view is, that "some law of necessary development of colour in certain parts of the body and in certain hues is first required; and then, perhaps, in the case of birds, the females might choose the successive improvements as they occurred; though, unless other variations were altogether prevented, it seems just as likely that they would mar the effect the law of development of colour was tending to produce." There can be no objection to this "law" of development—this *cause* working uniformly; and should this cause be traced down to a deeper cause, it matters not (we have met the case before)—however deep the succession of cause underlying cause, we have on the surface marks of mind, and at the bottom mind itself, or else the pattern showing itself through all the sheets has no type underneath to impress it.

Perhaps even the want of beauty in some forms, and its lavish scattering where man cannot see it, may admit of explanation. It must be admitted at once that beauty was not intended for man's admiration alone; for the shells and corals of the old Silurian sea were

[1] *Academy*, March 1871.

elaborate and richly carved, the marine mollusca of to-day are rich in ornament, and the graceful patterns of the Diatomaceæ, which no graver's tool could imitate, are invisible except with the microscope. It is equally certain, however, that all beauty is not the result of sexual selection; Mr Darwin himself allowing that in the lower divisions of the animal kingdom sexual selection seems to have done nothing—could do nothing [1]—while here we find the gorgeous tints of the sea-anemone, the lustrous sheen of the sea-slug, and all the exquisite carving of sea-shells. Mr Wallace points out that even among insects it is only in butterflies that any difference in beauty occurs in the sexes; and that in caterpillars, which of course do not mate together, we have almost all the classes of coloration found in perfect insects—protective and conspicuous tints; spots, streaks, bands, and patterns; beautiful fleshy tubercles or tentacles; beautifully coloured hairs arranged in tufts, brushes, starry clusters or long pencils; horns on the head or tail, either single or double, pointed or clubbed, &c.

To these two facts, viz., that beauty is not all for man's sake, and is not all produced by sexual selection, let us add a third, which is, that beauty is not always useful, and therefore not always produced by Natural Selection working directly in any form, but is apparently correlated with what is useful. Mr Darwin says "The most probable view in regard to the splendid tints of many of the lowest animals seems to be that their colours are the direct result either of the chemical nature or the minute structure of their tissues, independently of any benefit thus derived. Hardly any colour is finer than that of arterial blood; but there is no reason to

[1] *Descent of Man*, ii. 396.

suppose that the colour of the blood is in itself any advantage; and though it adds to the beauty of the maiden's cheek, no one will pretend that it has been acquired for this purpose. So again with many animals, especially the lower ones, the bile is richly coloured; thus the extreme beauty of the Eolidæ (naked sea-slugs) is chiefly due, as I am informed by Mr Hancock, to the biliary glands seen through the translucent integuments, this beauty being probably of no service to these animals. The tints of the decaying leaves in an American forest are described by every one as gorgeous; yet no one supposes that these tints are of the least advantage to the trees. Bearing in mind how many substances closely analogous to natural organic compounds have been recently formed by chemists, and which exhibit the most splendid colours, it would have been a strange fact if substances similarly coloured had not often originated, independently of any useful end being thus gained, in the complex laboratory of living organisms."[1] Exactly so: decaying leaves must have *some* colour—*i.e.*, they must bear some relation to the vibrations of the ether, and therefore to the eyes which are attuned to certain sets of vibrations—their tints may be a necessity of their molecular condition at the moment; and so may be the tints of the flower which the insect selects to fertilise, and the colours of a bird's feathers which happen to please the female or happen to be always covered from view and so can please nobody. But then, as the chemist can introduce a new element changing the molecular state of a dye, and with it the colour, so this inevitable correlation in nature need not shut the door to all choice.

[1] *Descent of Man*, ii. 323.

Next, let it be allowed to us that beauty is not a mere matter of fancy, but that its standard is immutable—as mathematical truth is immutable—so that it must bear the same appearance to all intelligences of a sufficiently high order. It is no argument against this that men's tastes differ or that savages distort the features and call the distortion beauty; for the same savages prefer hideous howling to the grandeur of an oratorio, and would probably confound all ellipses with circles. Grant that true beauty is something independent of caprice and fashion, and some light is thrown on the question we are discussing. First we get some explanation of the "remarkable circumstance" noted by Mr Spencer, "that these [sexual] characteristics which have originated by furthering the production of the best offspring, while they are naturally those which render the organisms possessing them attractive to one another, directly or indirectly, should also be those which are so generally attractive to us—those without which the fields and woods would lose half their charm."[1] Mr Darwin says, "The mental powers of birds, if reason be excluded, do not fundamentally differ from ours;"—"birds have fine powers of discrimination, and in some few instances it can be shown that they have a taste for the beautiful;"—"assuredly the same colours and the same sounds are admired by us and by many of the lower animals;"—"there is no abstract improbability in the Lepidoptera, which probably stand nearly or quite as high in the scale as these insects [ants and beetles], having sufficient mental capacity to admire bright colours." This seems reasonable: as birds and butterflies and all creatures with eyes related to the external

[1] *Principles of Biology*, ii. 253.

ether, see things in much the same way, so, in so far as they possess mental powers and refinement of taste, they admire the same forms and colours as beautiful—beauty being as much a fixed thing, independent of fancy, as light is a fixed thing, independent of the eyeball.

Further, it would seem to follow that as geometrical truth is the same to the Divine mind and to ours, and all truth is known to Him; so beauty is the same to His mind and to ours, and all beauty is pleasing to Him. This, taken in connection with the truth that Evolution is but the method of creation, would account for all the beauty that seems purposely created—it *is* purposely evolved; it would account for all such as is hidden in the ocean, or under exterior coating, or in microscopic species—it may spring from necessary correlation where the thing correlated with it was the thing aimed at (unless even here it is for the Creator's own pleasure); while the fact that many forms exist which are not beautiful would be explicable on the same principle of necessary correlation—the good attained, considering the process by which it has been attained, not admitting of beauty going with it.

The Duke of Argyll shows by some beautiful instances that utility and beauty are often found in combination, where the mere utility would have answered every practical purpose. This is the principle which guides man's action—not to fill his little world with ornament, but after providing for practical use to adorn what is useful, or shape it into a thing of beauty. When the savage carves the handle of his war-club to give his hand a firmer hold, any shapeless scratches would suffice; but he works it into an elaborate pattern, to satisfy his sense of beauty and love of ornament.

When mere ornaments are used in architecture they are commonly the traditional representation of parts which had their origin in essential structure. Similarly the forms of many fish which are beautiful are also forms founded on the lines of least resistance; and some of the most beautiful lines on the surface of shells are simply the lines of their annual growth, following definite curves as their "law." "Even in those cases where concealment is the main object in view, ornament is never forgotten, but lies, as it were, underneath, carried into effect under the conditions and limitations imposed by the higher law and the more special purpose. Thus the feathers of the ptarmigan, though confined by the law of assimilative colouring to a mixture of black and white or grey, have those simple colours disposed in crescent-bars and mottlings of beautiful form, even as the lichens which they imitate spread in radiating lines and semi-circular ripples over the weather-beaten stones. It is the same with all other birds whose colour is the colour of their homes. For the purpose of concealment, that colouring would be equally effective if it were laid on without order or regularity of form. But this is never done. The required tints are always disposed in patterns, each varying with the genus and the species; varying for the mere sake of variation, and for the beauty which belongs to ornament. And where this purpose is not under the restraint of any other purpose controlling it, and keeping it down, as it were, within comparatively narrow limits, how gorgeous are the results attained! What shall we say of flowers, those banners of the vegetable world, which march in such various and splendid triumph before the coming of its fruits? What shall we say of the humming birds—whose feathers are made to return the light which falls upon them as if rekindled from intenser fires, and coloured with more than all the colours of all the gems?"[1] Professor Haughton, in a different department of study, comes to the same conclusion:—"I may therefore be asked, How comes it, if the principle of least action be true, that nature ever employs muscles involving a necessary loss of force? I answer, because nature has other problems in view than mere economy of force in a single muscle. She has to consider, if she economise force simply, without regard to other circumstances, such as beauty of form, and surface of least resistance, whether she might not lose rather than gain, taking into consideration all the conditions. I have always maintained that beauty of form, symmetry of outline, was one of the pre-existing conditions in the mind of the Contriver of the Universe, as well as economy of force. We find, therefore, that nature never uses a triangular or quadrilateral muscle, except under great necessity." [2]

Our view, then, in brief is this,—that the laws of beauty are as immutable as the laws of mathematics or of matter and motion, and that beings of sufficient intelligence must perceive beauty and agree in their estimate of it, as they perceive the properties of numbers or of circles and agree about them; that consequently all beauty incidental to the Creator's work is perceived and appreciated by Him, and there is reason to think He purposely brings about more than would naturally arise; that much of this is displayed before the eyes of man for the delight of man; besides which, and most important of all, whatever proportion of this beauty may

[1] *Reign of Law*, p. 201. [2] *Lectures on Least Action.*

spring out of the unalterable nature of things, there is beneficent purpose in giving man the eye to see it and the faculty to appreciate it.

The Struggle for Existence: Friends in the Struggle.—The absolute necessity of the struggle for life having been proved, the Divine character is freed from imputation; but it may be possible, in addition, to show some indications of positive beneficence. The terms used in these discussions—Battle, Struggle, Survival—though perfectly justified by the facts, direct attention too exclusively to the conflict between enemies: but in every warfare the soldier may have his friends, the army may have its allies, and it is quite as fair to direct attention to these.

In the first place, every creature is armed against its foes, by weapons; or defended by armour, by speed of foot, by odours, by habits, by means of concealment. No human mother takes the same care in clothing her children as nature takes in giving fur and wool and feathers, a white coat or a black coat, a thick coat or a thin one, according to the exigencies of climate. She gives a conspicuous butterfly an unpleasant odour, a gaudy caterpillar a disagreeable taste; she protects the beetle by hard wing-cases, and the tortoise by an adamantine shield. The flower is fertilized by the aid of insects or the wind; every plant has its indirect helpers in the birds that scatter abroad its seed and the animals that manure it with their dung. Many creatures are social and herd together; some of the higher species place sentinels while they feed or while they sleep; *all* species find food to eat, with opportunity of rest and enjoyment, and on the average are probably as happy as is man, taking into account the measure of their capacities. We know that these adaptations have been brought about by Natural Selection, but we contend that Evolution is but the method of creation, and that it is as proper to look on the repose as on the struggle when judging of the relation of all things to the Creator.

The possession of organs of sense and their location in suitable parts of the body, might seem at first to be as much in favour of the aggressor as of the weaker animal; but this is not always the case. The giraffe possesses a natural watch-tower, not to be found in its enemies; eye-lids are exclusively protective, favouring their possessor when sight is threatened; taste is a guide in the choice of food, but does not aid a beast of prey to find a victim, &c. &c.

Protective Resemblances.—The *Kallima inachis,* or common Indian butterfly, and its Malayan ally *Kallima paralekta,* when reposing on a twig, have exactly the perspective effect of a shrivelled leaf—size, colour, form, markings, and habits all combine to produce a disguise which may be said to be absolutely perfect; and the protection which it affords is sufficiently indicated by the abundance of the individuals that possess it. Such instances could be multiplied. The British moth called *Sesia bombiliformis* very closely resembles the male of the large and common humble bee, *Bombus hortorum,* and thence gets its name; the *Sphecia craboniforme* is coloured like a hornet, and is much more like it when alive than when in the cabinet—and these resemblances to the stinging hymenoptera make the birds more cautious, and so protect the moths. *Such* instances could be multiplied. Until recently, these resemblances were looked upon as accidental, or as instances of curious analogy which the Creator had thought fit to produce, but which we could never hope to understand. We now know that they benefit their possessor, and that they are perfected by Natural Selection, though the external "conditions" which give origin to the variations are not yet understood. Mr T. W. Wood states that the chrysalides of butterflies possess a most astonishing means of eluding observation, their shells being photographically sensitive for a short time after the caterpillars' skins have been shed, so that each individual assumes the colour most prevalent in its immediate vicinity. At a meeting of the Entomological Society he exhibited a great number of chrysalides of the two common species of white butterflies, taken from the stone-coloured sides of a house: against one of the sides a grape-vine was trained, and here the chrysalides of both species were green, being affected by the light shining through the leaves, while on the bare side of the house not a single green specimen could be found; and a glance at them conveyed an accurate idea of the colour of the surface to which they were attached. Mr Wood has noticed that the chrysalis of the small tortoise shell (*Vanessa urticæ*), is golden only when found amongst nettles; for when on walls, palings, tree-banks, &c., it invariably partakes of their colours and general appearance of surface. The same remark may be made of the large tortoise shell (*Vanessa polychloris*), which, when found amongst leaves, is of the colour of a withered elm leaf, with a few silver spots, though when found on walls, &c., the whole colouring is different and the spots are absent. Some experiments made by rearing caterpillars and placing them in coloured boxes exposed to sunlight, showed results in accordance with these facts.[1]

[1] *The Student*, September 1868.

It seems probable, then, that the chemistry of nature, going beyond the results attained by man, accomplishes photography in colours; and although this does not explain imitative *forms*, it reminds us that all effects admit in their nature of being explained.

With a right view of creation, we find no difficulty in this; satisfied that the lines of causation centre in the chambers of the Eternal, we do not expect to shorten the distance by cutting the lines; and possessing no evidence of the existence of other *human* minds excepting in results which have their physical causes, we do not consider Divine Intelligence excluded because we find out how "mimicry" is accomplished. We admire the wondrous chemistry which accomplishes such magical effects, and in the protection afforded we see something to set against the existence of enemies. Observe the principle on which this assimilative colouring is distributed. It seems not to be given to animals whose habits do not expose them to special danger, nor to any which are endowed with other more effective means of escape. This is what the Duke of Argyll calls "the higher law of purpose which governs the lesser law, whatever it may be, by which assimilative colouring is produced." Birds whose habitat is the open plain or treeless moor, where the hawk has uninterrupted range for his sight and free scope for his great powers of wing, and who cannot retreat to any covert when taken at a disadvantage—these are almost the only birds which have their plumage assimilated to the general tinting and mottling of the ground on which they lie and feed. Observe, again, the apparent ease with which protection is given. In the leaf-like mantis there is no departure from the type of insects of the same order; but the whole effect is produced by a little elongation here, a little swelling there, a little dwarfing of one part, a little development of another. The most striking part of the whole imitation—that of the "nervation" of the leaf—is produced by a modification, not very violent, of a structure which belongs to all flying insects! It may occur to some minds that many other insects, birds, &c., might be benefited by the same kind of resemblance to inanimate objects, or mimicry of creatures not liable to attack; but there is a reason against this. The imitators must be few, or they will soon be found out; the measure of their increase is the measure of their danger. If the imitating butterflies, for instance, were to the imitated as two to one, the birds would soon find out that two butterflies in three were eatable, and although the third was nauseous, they would venture when they were hungry.

Growth of Instincts.—The savage instinct of the queen bee urges her to destroy the young queens, her daughters, as soon as born, or to perish herself in the combat. The instinct of the worker bees leads them to slaughter all the drones, their brothers, after the queen is fertilized. Maternal and sisterly hatred are not admirable, but fortunately they are rare, and even in the instances cited they serve so good a purpose that Mr Darwin is probably right in saying we ought to admire their action—it is undoubtedly for the good of the community that useless drones and supernumerary queens should die, and love or hatred is all the same to the inexorable principle of Natural Selection.[1] Very well. Then can it be without beneficent arrangement that in the generality of cases love and not hatred works for the good of

[1] *Origin of Species*, chapter vi.

the community, almost every animal loving its young, and the little ones delighting to play together? The most unsocial brute will protect its own offspring, and happiness is never better exhibited than by young animals, such as puppies, kittens, and lambs, when playing together like our own children.

Instinct is, first of all, for the good of the individual possessing it—is to it a possession of accumulated wealth stored by many generations of ancestors, and which, in place of becoming squandered, is increased by daily use and handed down to generations following. When social instincts arise, the community is enriched without the individual being robbed, for the wealth of all is enjoyed by each in his measure (receiving back from the common fund), besides which there is a present pleasure to the individual in the very exercise of instinct which is enriching the tribe. Were it not for the springing up of social instincts man himself would never have become civilized, moral and religious, but each individual would have been a brute, and worse than an isolated Ishmaelite amongst brutes.

If we looked at every instinct separately, we should find it to be for the good of its possessor, or of the species to which he belongs. The instinct which leads the hive bee to make hexagonal cells is an instinct which leads to the greatest economy of wax; so that, in times of plenty, the community is saved unnecessary trouble, and in times of scarcity is preserved, where others would not survive. The nest-building instinct among birds, the nut-burying instinct of squirrels, the hare-hunting instinct of a dog, are all for the advantage of both the individual and the species; and even the acquired instincts of domestic animals, such as that of the shepherd dog, which leads it to drive and run round a flock instead of worrying them, is for the good of the dog in being for the good of his master, and evidently gives delight to the animal itself. It is not necessary to fill a chapter with instances, since these are sufficiently well known to all readers, but only to point out how Evolution makes the beneficence of instinct the more conspicuous by showing that instead of being bestowed by instantaneous fiat, it could only be given through long persistent working and great patience.

Variety in Nature.—Compare all the millions of faces of men and women, and no two will be found alike; but if it follows from this that a perfect beauty must be a prodigy, we are not without some compensation. The great anatomist Bichat long ago said that if every one were cast in the same mould there would be no such thing as beauty. If all our women were to become as beautiful as the Venus de Medici, we should for a time be charmed; but we should soon wish for variety; and as soon as we had obtained variety we should wish to see certain characters that pleased us a little exaggerated beyond the then existing common standard.

It would appear that birds and all creatures who possess sufficient mental power to discriminate are as fond of variety as ourselves, for it is to sexual selection that Mr Darwin traces the marvellous variety in the colours and ornaments of the males. It would even appear, he says, that mere novelty, or change for the sake of change, has sometimes acted like a charm on female birds, in the same manner as changes of fashion with us.[1] "Among the humming-birds different parts of the plumage have been selected in different genera as the

[1] *Descent of Man*, ii. 230.

principal subject of ornament. In some it is the feathers of the crown worked into different forms of crest; in some it is the feathers of the throat, forming gorgets and beards of many shapes and hues; in some it is a special development of neck plumes, elongated into frills and tippets of extraordinary form and beauty. In a great number of genera the feathers of the tail are the special subjects of decoration, and this on every variety of plan and principle of ornament. In some the two central feathers are most elongated, the others decreasing in length on either side, so as to give the whole the wedge form. In others the converse plan is pursued, the two lateral feathers being most developed, so that the whole is forked after the manner of the common swallow. In others, again, they are radiated, or pointed and sharpened like thorns. In some genera there is an extraordinary development of one or two feathers into plumes of enormous length, with flat or spatulose terminations. Mere ornament and variety of form, and these for their own sake, is the only principle or rule with reference to which Creative Power seems to have worked in these wonderful and beautiful birds."[1]

But sexual selection will not explain all the variety of the world any more than all its beauty. The flinty shells of those microscopic organisms the Diatomaceæ are some striated, some fluted, punctured, or dotted in patterns of perfect and often complex beauty. In the same drop of moisture there may be some dozen or twenty forms, each with its own distinctive pattern, all as constant as they are distinctive, yet having all apparently the same habits, and without any perceptible difference of function. Orchids are flowers as varied

[1] *Reign of Law*, p. 244.

and fantastic as they are beautiful, showing curious resemblances to bees, butterflies, spiders, &c., possessing strange springs and traps and pitfalls, none of which seem absolutely necessary for the fertilization of the flowers, since though actually of use as they exist, yet other flowers exist without them. In trees the distributions of the branches are different for each individual; in minerals the chemical combinations are most varied; the contours of hills, the windings of rivers, the coast-line of continents and islands, are different in every case—in everything there seems to be a disposition to indefinite variation in all conceivable directions. The inexhaustible variety of nature in all her domains is a fact that stares us in the face, and must remain a fact though the cause be ascertained, and must be attributed to the intention of the Creator unless we are to refrain from attributing to Him anything whatever: but the philosophy which denies that we can know anything of the Deity will not be looked for in an Essay the object of which is to illustrate His attributes of Wisdom and Beneficence.

The tendency to variation in all living things is the great fact on which Mr Darwin builds his theory of Natural Selection, and without the variety the continuous evolution of species would have been as impossible as the theory. It may be true that this variation in living forms is traceable to changes in the environment—we can see that the principle of heredity, in endeavouring to give the child the form of each of its two parents, must necessarily take a line somewhere between them; the new individual, subjected to a different play of outward forces, necessarily responds by variation; the smaller cycles of outward conditions, being but episodes in the grand march of change, there can be no return of variations to their starting point; and so on—but every explanation of this kind is but a step backward towards that original nebulosity out of which all is believed to have come, in which nebulosity it existed potentially, like the leaves folded up in a bud; and there is still demanded all the conscious intelligence which would be required for its production by immediate fiat, if that were possible.

Among the inhabitants of the world, as soon as we get a certain mental capacity we find a love of variety —in birds it is a probable fact, in man it is undoubted —it seems as necessary an accompaniment of any high order of mind as is the love of beauty and the clear perception of outward fact. How came these minds to possess it? and what ground is there for denying that they were intended to possess it? and what ground for denying it of the Divine mind? None but the excessive fear of Anthropomorphism, which denies that there is in man any shadowing forth of God, and might on the same ground deny that truth is truth, and virtue is virtue.

CHAPTER VIII.

MORAL ASPECTS OF EVOLUTION.

ALTHOUGH the Theory of Evolution rests on a basis of fact, and is to be accepted or rejected according to the evidence, there can be no doubt that prejudice has influenced many minds against it, and that the prejudice arises mainly from the moral aspects of the doctrine. It may be well, therefore, to see what reassuring hints we can gather from evolutionist writers, and what we can add of ourselves, on this part of the subject.

§ 1. *The Ascent of Man.*

"Man, the outcome of creation's past,
Is flower of all earth's life."[1]

As Bacon spoke of the living generation of men, his contemporaries, as the true ancients, so may we speak of the process of man's evolution as an ascent to a higher form and to the possession of nobler endowments. According to Mr Spencer, the forces within an organism balance the forces without—they are acted upon but they react; and they become of more consequence the higher the organism in the scale of life. It follows that as soon as there came into existence a being possessing mental and moral attributes like those of man, the internal powers would count for more as conditioning

[1] *A Tale of Eternity*, by Gerald Massey.

the course of events, and the being would begin to control circumstances instead of being almost completely at their mercy. As soon as the intellectual and moral qualities began to be of more importance than bodily powers in the struggle for life, Natural Selection would operate chiefly on these, and the advance of man would be rapid. Where a beast would suffer in a period of scarcity, man's intelligent foresight would have made some provision; and where a lower animal would starve, through some little sickness preventing it from capturing food, man would receive help from his fellows and tide over the difficulty. When outward conditions changed, and it became necessary to a beast to possess greater strength and swiftness, or grow longer claws and teeth to catch its prey, man would construct traps and pit-falls, make sharper spears, and combine in hunting parties. With his rafts and canoes he would catch fish or cross over to neighbouring fertile islands; observing the course of nature, he would plant seeds and shoots for himself; by the discovery of fire he would reduce hard and stringy roots to a digestible condition, and render poisonous roots or herbs innocuous. In colder winters he would not be killed off because no thick fur grew on his back, for he would borrow the hides of animals, and build for himself a warmer shelter. The individuals of greatest ingenuity and fertility of mind would be best able to preserve themselves and offspring, and would become of most value to the tribe. Natural Selection having transferred its action to the mind, man would no longer be as one of the brutes, but would have become a being apart—" a being in some degree superior to nature, inasmuch as he knew how to control and regulate her action, and could keep himself in harmony with her. Here, then, we see the true grandeur and dignity of man."[1]

Even in the savage state man is the most dominant animal that has ever appeared on the earth. He has spread more widely than any other highly organized form; and all others have yielded before him. He manifestly owes this immense superiority to his intellectual faculties, his social habits, which lead him to aid and defend his fellows, and to his corporeal structure. The supreme importance of these characters has been proved by the final arbitrament of the battle for life.[2] The tribes which possessed them in the highest degree would have the advantage in the struggle, and would eventually be selected to survive. Inclement seasons and sterile soils would only develop a hardier, more provident, and more social race; and the warlike struggles between tribe and tribe would leave the best endowed the masters of the field. This would be Natural Selection.

As civilization advanced the rule would remain the same—the advantage would be with the intellectually endowed; for however obscure the problem, we can at least see that a nation which produced during a lengthened period the greatest number of highly intellectual, energetic, brave, patriotic, and benevolent men, would generally prevail over less favoured nations. And this would be Natural Selection.

"In regard to the moral qualities, some elimination of the worst dispositions is always in progress, even in the most civilised nations. Malefactors are executed or imprisoned for long periods, so that they cannot freely transmit their bad qualities. Melancholic and insane persons are confined or commit suicide. Violent

[1] Wallace: *Nat. Sel.*, 325.

[2] *Descent of Man*, i. 136.

and quarrelsome men often come to a bloody end. Restless men, who will not follow any steady occupation, emigrate to newly-settled countries, where they prove useful pioneers. Intemperance is so highly destructive that the expectation of life of the intemperate, at the age, for instance, of thirty, is less than fourteen years, whilst for English rural labourers at the same age it is over forty years. Profligate women bear few children, and profligate men rarely marry; while both suffer from disease."[1] This again is Natural Selection.

Had man not been subjected to Natural Selection, assuredly he would never have attained to the rank of manhood; and although the severity of the struggle for existence, resulting from a rapid rate of increase, leads in barbarous countries to infanticide and other evils, and in civilized nations to abject poverty, celibacy, and the late marriages of the prudent, we can see that in the long run such evils tend to be left behind. The standard of morality rises higher and higher continually. At first, murder, robbery, and treachery are only infamous within the limits of the tribe, and beyond these limits may be innocent or even praiseworthy; no pity is felt for the sufferings of enemies, of slaves, or even of women; intemperance and licentiousness are not counted as vices, because they seem only to concern the individual and his family: but civilization leaves all this behind. Man gradually advances in intellectual power, and is enabled to trace the more remote consequences of his actions; he acquires sufficient knowledge to reject baneful customs and superstitions; he regards more not only the welfare but the happiness of his fellow-men; and his sympathies become more tender and more widely dif-

[1] *Descent of Man*, i. 172.

fused, so as to extend to the men of all races, to the imbecile, the maimed, and other useless members of society, and finally to the lower animals.

It is considered creditable in a man that he should have advanced beyond his father in education and refinement; it is matter of boasting to a nation that it has cleared itself of the semi-barbarism of the middle ages. If the nation has done more, and risen out of savagery; if the individual has climbed up from the apes and still lower forms, the reasons for congratulation are surely not lessened.

§ 2. *The Future of the Human Race.*

"The perfect statue now rough-cast in clay."[1]

Man may be excused for feeling some pride at having risen to the very summit of the organic scale; and the fact of this great advance from a lowly origin constitutes in itself a prophecy of a still higher destiny in the distant future. Our forefathers declared that they were descended from demi-gods; but the more hopeful view of science is, that leaving the past below us, we are daily rising to a more divine height.

In the first place, it seems probable that the human race has before it a long career, in comparison with which the past historical period is as nothing. It is a fact that the distribution of the organic world in time is very similar to its distribution in space; and thus the wide-spread sway which man has attained in the earth is an indication that his rule will be of long continuance. The knowledge and ingenuity which enable him to plant his foot in all latitudes, to meet the cold with warmer clothing, to increase his food supply by cultivating the

[1] *A Tale of Eternity.*

ground, and tide over famine by previous accumulation of stores, will enable him to adapt himself to slow climatic and geographical changes, and outlive many species and genera of the lower animals. Every advance in scientific knowledge, in mechanical skill, in means of communication and commercial interchange, will tend in the same direction; and it may be confidently anticipated that man's increasing power to meet changed conditions—we may almost say to create the conditions suitable to himself—will carry him and those he chooses to protect through many geological periods to come.

No great change in the bodily organization of man is to be looked for, such as would transmute him into a new species, because it is chiefly the mental "variations" which are "selected" now and made to accumulate in particular directions. Man has already experienced far greater changes in the conditions of his environment than any other highly organized animal could have survived unchanged, and has met them by mental adaptations. His mental activity will, however, cause his brain to increase in size and complexity, and his skull to undergo corresponding changes of form; while the face, as the medium of expressing the most refined emotions, will sympathize in these changes. On the whole, Mr Wallace thinks that man's external form may remain unchanged, except in the development of that perfect beauty which results from a healthy and well-organized body, refined and ennobled by the highest intellectual faculties and sympathetic emotions.[1] It may be questionable whether he can retain this opinion after reading the facts adduced by Mr Darwin in the *Descent of Man*. It is shown, for instance, that the

[1] *Natural Selection*, p. 329.

proportions of the body may vary with the occupation. The United States Commission ascertained that the legs of the sailors employed in the late war were longer than those of the soldiers, and their arms shorter. It is familiar to every one that watchmakers and engravers are liable to become short-sighted; while sailors, and especially savages, are generally long-sighted. It is asserted that the hands of English labourers are at birth larger than those of the gentry, and there appears to be a correlation between the extremities of the body and the jaws, which makes them increase or decrease in size together. It appears as if the wisdom-teeth were tending to become rudimentary in the more civilized races of man, the posterior portion of the jaw being shortened, probably through having less to do than among savages in the way of chewing hard and uncooked food. These may suffice as instances, and they are enough to suggest caution in our speculations.

Man's battle with the lower animals, already nearly over except where he chooses to enter the jungle or to track a brute for sport, may be expected to end in the extermination of wild beasts, excepting that a few may be kept in menageries and gardens for the sake of instruction. The pressure of population must ultimately lead to the peopling of the entire globe, and then the tiger, hyena, and serpent will as surely disappear for ever as the wolf is gone from England. There will be no jungle or wilderness unreclaimed, no desert that is not constantly traversed, no cave or den that is not well known to man. "We may anticipate the time," says Mr Wallace—perhaps with a little exaggeration,— "when man's selection shall have supplanted Natural Selection, and when the ocean will be the only domain in which that power can be exerted which for countless cycles of ages ruled supreme over all the earth."[1]

The struggle for existence will continue between man and man—for if it ceased man would cease to advance —and one result will be a continual improvement in mechanical skill and the applications of science, in intelligence and self-control. "Every industrial improvement is at once the product of a higher form of humanity, and demands that higher form of humanity to carry it into practice. The application of science to the arts, is the bringing to bear of greater intelligence for satisfying our wants; and implies continued progress of that intelligence. To get more produce from the acre, the farmer must study chemistry, must adopt new mechanical appliances, and must, by the multiplication of processes, cultivate both his own powers and the powers of his labourers. To meet the requirements of the market, the manufacturer is perpetually improving his old machines and inventing new ones; and by the premium of high wages incites artizans to acquire greater skill. The daily-widening ramifications of commerce entail on the merchant a need for more knowledge and more complex calculations; while the lessening profits of the shipowner force him to build more scientifically, to get captains of higher intelligence, and better crews. In all cases pressure of population is the original cause. Were it not for the competition this entails, more thought and energy would not daily be spent on the business of life; and growth of mental power would not take place. Difficulty in getting a living is alike the incentive to a higher education of children and to a more intense and long-continued appli-

[1] *Natural Selection*, p. 326.

cation in adults. In the mother it induces foresight, economy, and skilful house-keeping; in the father, laborious days and constant self-denial. Nothing but necessity could make men submit to this discipline; and nothing but this discipline could produce a continued progression."[1]

As men will have to hold their places and rear their families under the intensifying competition of social life, a larger body of emotion will be necessary as well as an increase of intellectual energy. But the brain will have become larger, and the greater power will be exercised with less of effort, having become more instinctive, spontaneous, and pleasurable. As, even when relieved from the pressure of necessity, large-brained Europeans voluntarily enter on enterprises and activities which the savage could not keep up even to satisfy urgent wants; so their still larger-brained descendants will, in a still higher degree, find their gratifications in careers entailing still greater mental expenditures.

The tendency will be that the good man shall survive and leave offspring, while the wicked disappears from the earth. We may expect that virtuous habits and tendencies will grow stronger, becoming perhaps fixed by inheritance like instincts, and the lower impulses of our nature will be more easily conquered. In the end, pressure of population and its accompanying evils will disappear,[2] and will leave a state of things requiring from each individual no more than a normal and pleasurable activity. "Changes numerical, social and organic, must,

[1] *Principles of Biology*, ii. 499.

[2] This is inferred from the fact that increasing evolution is necessarily correlated with a decline in fertility, so that families will be smaller.—*Principles of Biology*, ii. 506.

by their mutual influences, work unceasingly towards a state of harmony—a state in which each of the factors is just equal to its work. And this highest conceivable result must be wrought out by that same universal process, which the simplest inorganic action illustrates."[1]

It may occur to some minds, that while it is satisfactory to believe that the race will eventually subdue the earth and accomplish its own happiness, nature seems to be "careless of the single life"—in this struggle we are marched on to the field, strike our blow and receive our fatal wound, but are not permitted to share the joy of victory. To satisfy our longing, it seems to be necessary that each individual should continue to develop after death—that while the race is progressing here, we, who may have left the world, should be progressing in a career of our own. Looking along the line of human history, our own existence seems to be but a point; but if we could believe it is a line which crosses the other at right angles, touching it indeed only in one point, but having a continuation of its own and eventuating in eternity, we could be satisfied. Well, there is nothing in the doctrine of Evolution incompatible with such a belief; only, the evolutionist philosopher, pursuing his investigations along the former line simply, may not profess to know anything of the latter. Yet evolution in the latter line may be a fact, and the analogy of evolution in the former may be said to make it more probable, while the demand of the spirit for its own advancement *pari passu* with the advancement of the race, becomes almost a reason for believing in it. The future of the individual may then

[1] *Principles of Biology*, ii. 508.

be conceived of as beginning with the present and growing out of it, as the earthly future of the race has the present state of mankind as its base to spring from.

> "Such use may lie in blood and breath;
> Which else were fruitless of their due,
> Had man to learn himself anew
> Beyond the second birth of death."

§ 3. *The Trustworthiness of Conscience.*

> "The unwritten law divine,
> Immutable, eternal, not like those of yesterday,
> But made ere Time began."[1]

He who believes in the advancement of man from some lowly-organized form, will naturally ask how does this bear on the authority of conscience, on the belief in God, and the immortality of the soul? If the moral sense has been evolved from the social instincts (first gained through Natural Selection), if belief in God is not instinctive in man (or if, being so, the instinct has been evolved), if the hope of immortality is a late growth—in short, if we are descended from creatures who cannot be supposed to have had a conscience, an immortal soul, or an idea of God—how far can we trust our own instincts and aspirations in these respects? When did our progenitors begin to be immortal; where could you draw the line in the graduated ascent; or do we delude ourselves in supposing that we possess undying spirits?

The first thing to observe is, that the theory of Evolution has not presented us with any difficulty which did not exist before; for parallel questions may be asked regarding the manner of evolution of every human child

[1] Sophoc., *Antig.*

from its parents. The babe is developed from an ovule about the 125th of an inch in diameter, which differs in no respect from the ovule of other animals, and goes through a series of changes analogous to those which Evolution ascribes to the race. It is only in the later stages of development that the young human being presents marked differences from the young ape; while the latter departs as much from the dog in its developments as the man does. If the new being sees the light before the seventh month it will not live, and it is difficult to say at what period or stage before that it becomes worthy to be called a child. Much more difficult is it to determine at what stage before or after birth it becomes an immortal soul, attains to the possession of a conscience, and the idea of God. The fact of the evolution of the child is incontestible, and these difficulties connected with it existed before Mr Darwin investigated or Mr Spencer philosophised; and yet few persons have felt any anxiety about them. It is certain that there is no greater cause for anxiety because of parallel difficulties in the gradual evolution of the race: and Mr Darwin is justified in calling upon those who denounce his views as irreligious, to show why it is more irreligious to explain the origin of man as a species, by descent from some lower form, through the laws of variation and Natural Selection, than to explain the birth of the individual through the laws of ordinary reproduction. The birth both of the species and of the individual are equally parts of that grand sequence of events which our minds refuse to accept as the result of blind chance. The understanding, he says, revolts at *such* a conclusion!

The belief in God, Mr Darwin thinks, is not innate or instinctive, nor the belief in immortality; the moral sense or conscience[1] is born with us, but did not exist in our far-off ancestors—for it is an instinct, and the growth of instincts is accounted for by the theory of Evolution. "The imperious word *ought* seems merely to imply the consciousness of the existence of a persistent instinct, either innate or partly acquired, serving him as a guide, though liable to be disobeyed. We hardly use the word *ought* in a metaphorical sense, when we say that hounds ought to hunt, pointers to point, and retrievers to retrieve their game."[2] What reason have we for believing that a faculty which originates in this way is trustworthy? Let attention be given to the following analogical argument:—When the human eye perceives difference of colour in objects, there *is* corresponding difference in the reflecting surfaces, although, as a matter of fact, the human eye has been evolved from an inferior eye, and the first rudiment of an eye that appeared on the theatre of the living world was not worthy to be called an eye at all. The vibrations of the ether have an existence external to the eye, and independent of the eye; and, being of a certain nature, they have certain relations with other objects; and when such an organ as the eye comes to exist, the relation between the retina and the ethereal vibrations is such that sensations of colour arise—the ether existed, the eye is attuned to it, and takes cognizance of it. Similarly, when the human understanding perceives the properties of numbers and of triangles, these perceptions are to be

[1] "The moral sense *or* conscience" is a common expression. Mr Darwin, however, makes a just distinction: the moral sense tells us what we ought to do, and conscience reproves us if we disobey it.—*Descent of Man*, i. 93.

[2] *Ibid.*, i. 92.

relied on, although the mental powers of man have been attained by gradual evolution, and their first glimmerings in some lowly-organized form were not worthy to be called mental; for mathematical truths are necessary and eternal, independent of any mind whatsoever; but when a mind of sufficient calibre comes to be evolved, the truths cannot but be seen to be what they are. Still again, when the moral sense of man perceives a difference between right and wrong, the intimation is to be trusted, although the moral sense has been evolved from social instincts, and those instincts evolved by Natural Selection; for right and wrong are immutable, not depending on the will or act of any being, but springing out of relations, and when a nature like man's is evolved it necessarily becomes conscious of moral distinctions. Right and wrong are first, and the moral sense is afterwards, and is attuned to them, as the retina is attuned to the previously-existing ethereal vibrations. The conscience may sometimes approve a wrong act; but so may the intellect of a mathematician miscalculate, the reasoning faculty of a logician mislead him, and the eye be occasionally deceived, or be colour-blind.

Conscience is what it is. We are what we are, and what we know ourselves to be, and Evolution has only shown us how long the path is by which we have reached this height. Is any chemical compound other than it is because we know of what elements it is constituted? Does water cease to have the properties of water, and to be trustworthy as a quencher of thirst, because its constituents are oxygen and hydrogen gases, which were not at all like the liquid they have formed? The fragrances which the chemist makes to rival the odour of the rose and sweetest flowers, are as delicious as our sense perceives them to be. Does it matter that they were manufactured from the refuse of the stable ?

One thing more may be said in this place. The standard of morality is continually rising, similarly as our knowledge of mathematics is extending: man is coming to perceive more clearly what he ought to do and what he ought not to do, and is striving more to obey the imperious *ought*. But while actions must always have *some* quality, and there has ever been an *ought* and an *ought not*, the specific acts to be put under the two headings will differ with circumstances, and some things which once were right may become wrong. It may be right for the queen bee to kill her daughters, but would be wrong for Queen Victoria to kill the royal princesses. The wars between savage tribes have contributed to the advancement of the human race, through the operation of Natural Selection, and the more scientific warfare of civilized nations has sharpened the inventive faculties, and done other incidental good; but the time is come when war ought to cease. Evolution accounts for evil without aspersing the character of God—it shows that many "evils" have served a good purpose, and were not evils while they were doing so—actual evil is the lingering of a practice when the day of its usefulness is gone by, like an old law remaining on the statute-book when circumstances have completely changed. Thus the conclusion of pessimism, that the world is bad, and so cannot have had a Divine Author, is not favoured by Evolution, whose teaching comes nearer to the optimism of Leibnitz, in showing, not indeed that this is the best of all possible worlds, and must therefore have been created as it is, but that the creation (still going on) is a lengthened process, every stage of which is good in its time, and preliminary to what is better.

§ 4. *Duties suggested by Evolution.*

> "The ghosts of our own crimes long-buried will
> Live after us and haunt our children still."[1]

There is an unfounded fear in the minds of some that the acceptance of the theory of Evolution will abolish the sense of duty and the feeling of responsibility. A reviewer of Mr Darwin's *Descent of Man* says: "If our humanity be merely the natural product of the modified faculties of brutes, most earnest-minded men will be compelled to give up those motives by which they have attempted to live noble and virtuous lives, as founded on a mistake."[2] On the contrary, whatever the temporary effect, and the effect on minds only half acquainted with the theory of Evolution, we believe the legitimate and lasting effect will be to increase the sense of responsibility by showing that every act is linked with others which it drags after it, entailing consequences to our own character and constitution, and very often to the constitution and character of others. With regard to ourselves, there is not a single faculty—functional or structural, moral, intellectual, or instinctive—which is not capable of improvement. There is no act, however trivial, which may not lay the foundation of a habit; and no habit, good or bad, which does not tend to become instinctive, and to go down to succeeding generations. Special tastes, general intelli-

[1] *A Tale of Eternity.*

[2] *Edin. Rev.*, July 1871. Miss Cobbe also enters a protest (*Darwinism in Morals*).

gence, qualities such as courage, temper (bad and good), are certainly transmitted. Deteriorated mental powers, equally with genius; insanity or bodily disease, quite as much as a sound mind and a vigorous health, are known to run in families. We find ourselves part and parcel of humanity, with less of individual independence than we supposed ourselves to possess, with duties which cannot be evaded, and with laws of variation, of development, and of inheritance, ever ready to put their stamp upon our deeds. If we find in ourselves any remnant of the brute we must try to strangle it—"Let the ape and tiger die;" and since higher instincts must have a beginning, we ought to give them their initial impulse by the every-day practice of good deeds and dispositions.

With regard to marriage Mr Darwin says: "Man might by selection do something, not only for the bodily constitution and frame of his offspring, but also for their intellectual and moral qualities. Both sexes ought to refrain from marriage if in any marked degree inferior in body or mind, or if unable to avoid abject poverty for their children." On the other hand, as Mr Galton has remarked, if the prudent avoid marriage whilst the reckless marry, the inferior members of society will tend to supplant the better. There should be open competition for all men; and the most able should not be prevented by laws or customs from succeeding best, and rearing the largest number of offspring.

Respecting the education of the ignorant, there is good sense in the remarks made by Professor Allen Thomson at the British Association meeting in 1871,— If the law of the Survival of the Fittest be applicable to the mental as well as to the physical improvement of our race (and who can doubt that in some measure it must be so?) we are bound by motives of interest and duty to secure for all classes of the people that kind of education which will lead to the development of the highest and most varied mental power. And no one who has been observant of the recent progress of the useful arts, and its influence upon the moral, social, and political condition of our population, can doubt that that education must include instruction in the phenomena of external nature, including more especially the laws and conditions of life and health; and that it ought to be, at the same time, such as will adapt the mind to the ready acquisition and just comprehension of varied knowledge.

In dealing with criminals we shall regard them as unfortunate without ceasing to hold them responsible, and so shall learn to temper severity with pity and some effort to effect reformation. It is a curious fact of Evolution, that the offspring will sometimes revert to the likeness of the grand-parent, or even some very remote ancestor, instead of bearing the image of the parent; for instance, there is reason to believe that sheep, in their early domesticated condition, were brown or dingy black; and a black sheep will occasionally appear in a flock where nothing of the kind has been known for generations. In like manner with mankind; some of the worst dispositions, which occasionally, without any assignable cause, make their appearance in families, may perhaps be reversions to a savage state, from which we are not removed by very many generations. This view seems indeed recognised in the common expression, that such men are the black sheep of the family.

"Furthermore, there is common companionship of men with animals, and duties from him to them, which duties have the significant name of humanity, as though the humane man recognised his species wherever life is seen."[1] Bishop Butler argues that brutes may possibly become rational and moral agents, and arrive at immortality, "since we know not what latent powers and capacities they may be endued with."[2] Mr Darwin has surprised many by the almost human degree of taste and caprice which he attributes to birds; on which subject also Mr Wallace says, "It is evident that if colours which please us also attract them, and if the various disguises of 'protective resemblance' are equally deceptive to them as to ourselves, then both their powers of vision and their faculties of perception and emotion must be essentially of the same nature as our own—a fact of high philosophical importance in the study of our own nature, and our true relations to the lower animals." In all this, and in the grand fact that the animals stand related with us through some common ancestor, we have as strong a reason for showing kindness to brutes as could exist for any believer in metempsychosis who regarded the brute by his side as possibly his grandfather sent back to earth in a degraded form.

§ 5. *Origin of Moral Species.*

"A number of prisoners, taken during the Santal insurrection, were allowed to go free on parole, to work at a certain spot for wages. After some time cholera attacked them, and they were obliged to leave; but every man of them returned and gave up his earnings to the guard. Two hundred savages, with money in

[1] J. J. Garth Wilkinson: *The Human Body and its connection with Man*, p. 284.

[2] Butler's *Analogy*, part i. chap. i.

their girdles, walked thirty miles back to prison rather than break their word!" Mr Wallace finds it difficult to account for such virtue by the operation of Natural Selection. This is only part of a more general question. Since Natural Selection acts on a strictly utilitarian method, how comes it that great intellectual truths, high moral conceptions, and pure conscientiousness of life are arrived at by men in any age or country, and are preserved? It is not, in the first instance, useful to a man to be gifted in these ways; he lives before his age, his virtue is not appreciated, he is neglected, or perhaps "selected" to die. The world has ever persecuted its reformers, and put its prophets to death. Whatever the laws of inheritance might have done for the new virtues, they are robbed of their opportunity: there will be no family to the first possessor, or if there is they will be bound up in the same bundle and burned. Nor is it easy to see how the occurrence of an intellectual or moral prodigy now and then would materially benefit the tribe, since the individual is destroyed as soon as discovered, or as soon as he begins to reprove his generation by his conduct, his words, or his writings.

Is not the explanation this: Virtue does not wait for physical generation and the slow growth of instinct; it is propagated more quickly in another way: the labour of the spirit produces progeny in other minds. To put good men to death is like sowing dragons' teeth—the blood of the martyrs is the seed of the Church—the new opinions or the new practices spread, and multiply a thousandfold. These are well-known phenomena, of which the common explanation is, that the producers and the produced stand in the relation of parent and offspring — spiritual fathers and spiritual seed; but what would be their rendering in terms of evolution? The man in whom the higher truth or higher virtue is first found may be said to constitute a new moral "species" or "variety." The men who are nearest to him in the points in which he is distinguished are the species from which he probably has sprung, and being nearest to him would require least alteration in themselves to make them quite like him. The influence fitted to produce this alteration is the presentation of his peculiarities before them in the example of his life or sufferings, in his verbal teaching, or his written works. These, therefore, are the "conditions of the environment" which induce "variation" in a number of individuals, and convert them into the new species: it is not that offspring are generated in the parental likeness, but one species is evolved from another. Thus we have the wonderful fact that a new moral species can create the conditions which will cause others to vary into its likeness—the highest moral life agrees with the lowest physical life in possessing a protoplasmic power of multiplying itself indefinitely by contact. Not only has Natural Selection transferred its action to the mind, but the environing conditions which occasion the mental variations before they are selected have also to a large extent become mental. But this does not at all explain how the variation in the first individual originates. Whence does he get that deeper truth, that purer conception, that more virtuous impulse which lifts him above *all* his fellows? This surely is as great a marvel as the evolution of living matter from matter not living, as inexplicable as any variation in the apparent absence of the conditions proper to effect the variation. Evolutionist philosophers would probably trace even this to physical causes and show that it must have lain potential in the original cosmic vapour, and if pressed to go further would allow the existence of an Unknown Cause beyond; but probably the mass of men, for some time to come, will pass by the intermediate links, go straight to the great Fount of things, and say the new light comes by inspiration. How is it, again, when the new truth or virtue does come that it should have this marvellous power of spreading? When it brings death, or at least persecution, to him who first shows it, why should it prove fascinating to those who behold it, and to whom it may herald no better fate? It is difficult to conceive of any more satisfactory explanation than this—that truth and goodness have an immutable beauty proper to themselves, and sufficient to make them attractive when placed clearly before minds and consciences capable of perceiving the true relations of things.

It follows also—since there is no limit to this protoplasmic multiplying power possessed by moral species, since the contact may be extended by written record into other countries, and may reach down to after generations; since each new individual that catches up the new life for himself becomes a new centre from which it may spread; and since the higher moral species, like the higher physical species, tend to supplant the lower—it follows that if any age or country has ever seen, or should ever see, a perfect moral being, we may confidently read in that being the hope of the human race. Such a being many of us see in Jesus Christ; and accordingly our hope is in him, for ourselves and for humanity.

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