NATURAL SCIENCE AND RELIGION

TWO LECTURES, DELIVERED TO THE THEOLOGICAL SCHOOL OF YALE COLLEGE

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LECTURE I.

SCIENTIFIC BELIEFS.

I AM invited to address you upon the relations of science to religion, -in reference, as I suppose, to those claims of natural science which have been thought to be antagonistic to supernatural religion, and to those assumptions connected with the Christian faith which scientific men in our day are disposed to question or to reject. While listening weekly-I hope with edification -to the sermons which it is my privilege and duty to hear, it has now and then occurred to me that it might be well if an occasional discourse could be addressed from the pews to the pulpit. But, until your invitation reached me, I had no idea that I should ever be called upon to put this passing thought into practice. I am sufficiently convinced already that the members of a profession know their own calling better than anyone else can know it; and in respect to the debatable land which lies along the borders of theology and natural science, and which as been harried by many a raid from both ides, I am not confident that I can be helpful in composing strifes or in the fixing of boundaries; nor that you will agree with me that some of the encounters were inevitable, and some of he alarm groundless. Indeed upon much that may have to say, I expect rather the charitable judgment than the full assent of those whose approbation I could most wish to win. But I take it for granted that you do not wish to hear an echo from the pulpit nor from the

development of the earth and of the solar system, which came in with geology and modern astronomy. I remember the time when it was a mooted question whether geology and orthodox Christianity were compatible; and I suppose that when, in these quarters, the balance inclined to the affirmative, it was owing quite as much to Professor Silliman's transparent Christian character as to his scientific ability. One need not be an old man to know that Laplace was accounted an atheist because he developed the nebular hypothesis, and because of his remark that he had no need to postulate a Creator for the mathematical discussion of a physical theorem; for a venerable and most religious astronomer, still living, who adopted this hypothesis in his "Exposition of certain Harmonies of the Solar System," published only five years ago, thought it needful to add an appendix, asking the question, "Is the nebular hypothesis, in any form, essentially atheistical in its character? " He answered it in the negative, but with the salvo, that "this hypothesis, having to do with a strictly azoic period, enforces no connection with' the development theory' of the beginning or of the progress of life." The great antiquity of the habitable world, and of existing races was the next question. It gave some anxiety fifty years ago; but is now, I suppose, generally acquiesced in, -in the sense that existing species of plants and animals have been in existence for many thousands of years; and, as to their associate, man, all agree that the length of his occupation is not at all measured by the generations of the biblical chronology, and are awaiting the result of an open discussion as to whether the earliest known traces of his presence are in quaternary or in the latest tertiary deposits. As connected with this class of questions, many of us remember the time when schemes for reconciling Genesis with Geology had an importance in the churches, and among thoughtful people, which few if any would now assign to them; when it was thought necessary -for only necessity could justify it -to bring the details of the two into agreement by extraneous suppositions and forced constructions of language, such as would now offend our critical and sometimes our moral sense. The change of view which we have witnessed amounts to this. Our predecessors implicitly held that Holy Scripture must somehow

derivative origin of species mainly rest upon researches independently made, without speculative bias, being the general contributions to biological science in this century; the results of which have been accepted as far as made out without apprehension or other than scientific controversy. Upon no one of these particular points has there been a completer change of view than upon the distinctness of the animal and vegetable kingdoms. The former conviction that these two kingdoms were wholly different in structure, in function, and in kind of life, was not seriously disturbed by the difficulties which the naturalist encountered when he undertook to define them. It was always understood that plants and animals, though completely contrasted in their higher representatives, approached each other very closely in their lower and simpler forms. But they were believed not to blend. It was implicitly supposed that every living thing was distinctively plant or animal; that there were real and profound differences between the two, if only they could be seized; and that increased powers of investigation- microscopical and chemical- might be expected to discover them. This expectation has not been fulfilled. It is true that the ambiguities of a hundred years ago are settled now. The zoophytes are all remanded to their proper places, though the animal kingdom at first claimed more than belonged to it. But other, more recondite and insurmountable, difficulties arose in their place. The best, I am disposed to say the settled, opinion now is, that there are multitudinous forms which are not sufficiently differentiated to be distinctively either plant or animal, while, as respects ordinary plants and animals, the difficulty of laying down a definition has become far greater than ever before. In short, the animal and vegetable lines, diverging widely above, join below in a loop. Naturalists may help classification, but do not alter these facts; when they sever this loop arbitrarily at what they deem the lowest point, or when they cut away the whole loop, and form of it a separate kingdom -the Protista of Haeckel. The only objection to the latter is (that the definition of this tertium quid from plant on the one hand and animal on the other is equally impracticable. One difficulty is removed only to have two in its place. The fact is, that a new article has recently been added to the scientific creed, -the

moral and spiritual; and that the knowledge of God's character and will which has descended from the fountain- head in the earlier ages has come down to us, through annalists and prophets and psalmists, in a mingled stream, more or less tinged or rendered turbid by the earthly channels through which it has worn its way. The stream brings down precious gold, and so may be called a golden stream; but the water -the vehicle of transportation -is not gold. Moreover the analogy of our inquiry into design in Nature may teach us that we may be unable always accurately to sift out the gold from the earthy sediment. But, however we may differ in regard to the earlier stages of religious development, we shall agree in this, that revelation culminated, and for us most essentially consists, in the advent of a Divine Person, who, being made man, manifested the Divine Nature in union with the human; and that this manifestation constitutes Christianity. Having accepted the doctrine of the incarnation, itself the crowning miracle, attendant miracles are not obstacles to belief. Their primary use must have been for those who witnessed them; and we may allow that the record of a miracle cannot have the convincing force of the miracle itself. But the very reasons on which scientific men reject miracles for the carrying on of Nature may operate in favor of miracles to attest an incoming of the super- natural for moral ends. At least they have nothing to declare against them. If now you ask me, What are the essential contents of that Christianity which is in my view a compatible with my evolutionary conceptions as with former scientific beliefs, it may suffice to answer that they are briefly summed up in the early creeds of the Christian Church, reasonably interpreted. The creeds to be taken into account are only two,- one commonly called the Apostles', the other the Nicene. The latter and larger is remarkable for its complete avoidance of conflict with physical science. The language in which its users "look for the resurrection of the dead" bears -and doubtless at its adoption had in the minds of at least some of the council- a worthier interpretation than that naturally suggested by the short western creed, namely, the crude notion of the revivification of the human body, against which St. Paul earnestly protested. Moreover, as brethren uniting in a common worship, we

called a living being. A formless, apparently diffluent and structureless mass is seen to exhibit the essential phenomena of life, -to move, to feed, to grow, to multiply. We have spoken of beings so low in the scale that the individuals throughout their whole existence are not sufficiently specialized to be distinctively plant or animal: yet these are definite in form and fixed in phase, are individual beings, though we may not determine to which kingdom they belong. But there is life in simpler shape,

"If shape it might be called that shape has none, Distinguishable in member, joint, or limb,"

there is vital activity in that which has not attained even the semblance of individuality. Little lumps of protoplasm are these, with out- line in a state of perpetual change, divisible into two or three or more, or two or three combining into one mass, either way without hindering or altering their manifestations. This living matter -of which Bathybius, if there be a Bathybius, or if it be any thing more than protoplasm of sponges, is one example -is said to have nothing more than molecular structure. It would be safer to say that the microscope has as yet revealed no organic structure. The natural history of protoplasm has recently been well expounded by Professor Allman, late President of the British Association, a most judicious naturalist, of conservative tendency; and his address, which you have read or should read, saves me from further de: tails, and enables me to proceed to other evidences of the substantial oneness of the two kingdoms of organic nature. Cellulose makes up the bulk of a vegetable, and was thought to be its true element. But it is now known to be not even peculiar to it: it enters largely into the fabric of certain animals, not of the very lo\vest grade. Starch was equally regarded as a purely and characteristically vegetable production; and its presence, in ambiguous cases, has been taken as a test. But it follows the example of cellulose. Being a prepared material from which cellulose in the plant is made by a molecular change, we are not now surprised to learn that starch-grains of animal origin have been found. We cannot conceive any thing more characteristic of a

superadded to all lower psychical faculties, is thereby per saltum immeasurably exalted. This, and only this, brings with it language and all that comes from that wonderful instrument; it carries the germs of all invention and all improvement, all that man does and may do in his rule over Nature and his power of ideally soaring above it. So we may well deem this a special gift, the gift beyond recall, in which all hope is enshrined. None of us have any scientific or philosophical explanation to offer as to how it carried to be added to what we share with the brutes that perish; but it puts man into another world than theirs, both here, and -with the aid of some evolutionary ideas, we may add-here- after. Let us consider. It must be that the Eternal can alone impart the gift of eternal life. But He alone originates life. Now what of that life which reaches so near to ours, yet misses it so completely? The perplexity this question raises was as great as it is now before evolution has ever heard of; it has been turned into something much more trying than perplexity by the assurance with which monistic evolutionists press their answer to the question; but a better line of evolutionary doctrine may do something toward disposing of it. It will not do to say that thought carries the implication of immortality. For our humble companions have the elements of that, or of simple ratiocination, and the power of reproducing conceptions in memory, and -what is even more to the present purpose -in dreams. Once admit this to imply immortality and you will be obliged to make soul coextensive with life, as some have done, thereby well-nigh crushing the whole doctrine of immortality with the load laid upon it. At least this is poising' the ponderous pyramid on its apex, and the apex on a logical fallacy. For the entire conception that the highest brute animals may be endowed with an immortal principle is a reflection from the conception of such a principle in ourselves; and so the farther down you carry it, the wider and more egregious the circle you are reasoning in. Still, with all life goes duality. There is the matter, and there is the life, and we cannot get one out of the other, unless you define matter as something which works to ends. As all agree that reflective thought cannot be translated into terms of extension (matter and motion), nor the converse, so as truly it cannot be translated into terms of sensation and perception,

direction, vegetables are making reprisals on the other. The rule is, that vegetables create organic matter, and animals consume it, producing none. But, while some animals produce some organic matter, some plants even among those of the highest grade feed wholly upon other plants, or even upon animals or their products. Like animals, some are herbivorous and some are carnivorous. That certain plants live parasitically upon other plants or upon animals, has long been too familiar to be remarkable. But that plants of the highest grade could capture or in some way take possession of small animals, extract and feed upon their juices, and appropriate these, as nourishment, is essentially a recent wonder and a recently ascertained fact. Yet some of the facts which point to this conclusion are old enough; and the conclusion would probably have been reached years ago, except for the preconception that plants and animals were too distinct for interchange of functions. Now that we know they are not, and that the living structure in the two is fundamentally identical, what were formerly regarded as freaks of Nature are no longer mere wonderments, but parts of a system, and. capable of being correlated with the rest by investigation. And investigation soon ascertained that this carnivorous attachment to the vegetable organism in Diona'a and Drosera was an organ for digesting as well as capturing animal food. Juices are t imbibed by it directly, as in animals from the stomach; and nourishing solid parts are rendered soluble and assimilate by imbuing them with peptones or digestive ferments, analogous in composition and in action to the gastric juice of the higher animals. Perhaps nothing in Nature can be more wonderful than all this; and nothing is more characteristic of the change which has come over scientific mind in our day than the manner in which such a discovery is received. The leading facts were well known a hundred years ago, and more. But, until recently, these phenomena were regarded as altogether anomalous; and such anomalies appear to have troubled no-body, except the framers of definitions. "Lusus natura" was a convenient phrase, and stood in the place of explanation, -as if the play of Nature was something apart from her work. No one seems to have had any difficulty in believing that a few particular plants were endowed

these unknown causes to be natural or supernatural? As to the first question, you are aware, from my whole line of thought and argument, that I know no natural process for the transformation of a brute mammal into a man. But I am equally at a loss as respects the processes through which any one species, anyone variety, gives birth to another. Yet I do not presume to limit Nature by my small knowledge of its laws and powers. I know that a part of these still occult processes are in the every-day course of Nature; I am persuaded th1tt it is so through the animal kingdom generally; I cannot deny it as respects the " highest members of that kingdom. I allow, however, that the superlative importance of comparatively small corporeal differences in this consummate case may justify anyone in regarding it as exceptional. In most respects, man is an exceptional creature. If, however, I decline to regard man's origin as exceptional in the sense of directly supernatural, you will understand that it is because, under my thoroughly theistic conception of Nature, and my belief in mediate creation, I am at a loss to know what I should mean by the exception. I do not allow myself to believe that immediate creation would make man's origin more divine. And I do not approve either the divinity or the science of those who are' prompt to invoke the supernatural to cover our ignorance of natural causes, and equally so to discard its aid whenever natural causes are found sufficient. It is probable that the idea of mediate creation would be more readily received, except for a prevalent misconception upon a point or genealogy. When the naturalist is asked, what and whence the origin of man, he can only answer in the words of Quatrefages and Virchow, " We do not know at all." We have traces of his existence up to and even anterior to the latest marked climatic change in our temperate zone: but he was then perfected man; and no t vestige of an earlier form is known. The believer in direct or special creation is entitled to the advantage which this negative evidence gives. A totally unknown ancestry has the characteristics of nobility. The evolutionist can give one satisfactory assurance. As the wolf in the fable was captious in his complaint that the lamb below had muddied the brook he was drinking from, so those are mistaken who suppose that the simian race can have defiled the stream along

scientific answer must be yes, so far as we know. Thus far, spontaneous generation, or abiogenesis, -the incoming of life apart from that which is living, -is not supported by any unequivocal evidence, though not a little may be said in its favor. However it may be in the future, here scientific belief stands mainly where it did forty-five years ago, only on a better-tried and firmer footing. It remains to mention two supposed distinctions between vegetables and animals which were until recently prominent, but which are no longer criteria, even as between the higher forms of the two. The first is the faculty of automatic movement, or -to take up the question only on the highest plane -the faculty of making movements in reference to ends. This is affirmed of animals, and is an undoubted faculty of all of them, but was long denied to plants, perhaps from a notion that such movements argued consciousness. But consciousness, in any legitimate sense of the term, pertains only to the higher animals. To show the breaking down of the distinction, it would suffice to contrast the rooted fixity and vegetative growth of very many lower animals with the free loco-motion of most ,microscopic aquatic plants and of the genus of those not microscopic; but plants of the highest organization furnish obvious "examples better suited to our purpose. Is there not an independent movement, in response to an external impression, and in reference to an end, when the two sides of the trap of Dionaea suddenly enclose an alighted fly, cross their fringe of marginal bristles over the only avenue of escape, remain quiescent in this position long enough to give a small fly full opportunity to crawl out, soon open if this hap- pens, but after due interval shut down firmly upon one of greater size which cannot get out, then pour out digestive juices, and in due time re-absorb the whole? So, when the free end of a twining stem, or the whole length of a tendril, outreaches horizontally and makes circular sweeps, and secures thereby a support, to which it clings by coiling; when a tendril, having fixed its tip to a distant support, shortens itself by coiling, so bringing the next tendril nearer the support; when a free revolving tendril avoids winding up itself uselessly around the stem it belongs to, and ill the only practicable way, namely, by changing from the horizontal to the vertical position until it passes

effect is, and has ever been, preceded by natural causes, then it would be in terms inconsistent with supernatural interference and with supernatural origination of the system. But science does not give us nor find any such principle. All scientific beliefs are in themselves as true and as fully proved if supernatural interference be possible as they are if such interference be impossible. A law does no more than state that under certain circumstances (positive and negative) certain phenomena will occur. If on some occasions these circumstances, owing to supernatural interference, do not occur, the fact that the phenomena do not follow proves nothing as to the truth or falsehood of the law." If such interference violates the law of the uniformity of Nature, the human will, and all wills, and all direction of material forces to ends, are every day violating it. It is also urged that giving particular direction in a special act would be an addition to the plenum of force in the universe, and therefore a contradiction to the recently acquired scientific principle of the conservation of energy. The answer may be this. It is not at all certain that all direction given to force expends force; it is certain that, under collocations, a minute : use of force (as pulling a hair-trigger or jostling a valve) may bring about immense results; and, finally, increments of force by Divine action in time, of the kind in question, if such there be, could never in the least be known to science. The only remaining supposition that I now think of is the crude one that thought and will are functions of the body, secretions as it were of the organ through which they are manifested, " psychical modes of motion." Then, as has well been said, they must be correlated with physical modes of motion, at least in conception; but it is conceded by all sensible I thinkers that thought cannot be translated into extension, nor extension into thought. Now, since the only conceivable source of physical force is supernatural power, still more must this be the only conceivable source of thought. There is an old objection which threatens to undermine the ground on which we infer Divine will from the analogy of human; namely, that our wills, being a part of the course of Nature and amenable to its laws, their movements, though seemingly free, are as fixed as physical sequences upon this insoluble problem we have nothing practical

the ocean from which it was lifted, perhaps upon a mountain summit, where as snow or glacier-ice it may long remain poised and comparatively stationary. But sooner or later it falls into the rivulet and the river, and in its fall and flow it expends its endowment of energy, and does work, -turns wheels and spins or forges, if man so directs, -and, when it has reached stable equilibrium at the level of the ocean, it will have expended just the energy which was imparted to it in the raising. So the energy with which the sun endowed vegetable matter when it was raised to the organic state may be given up as heat when this matter is restored to its original condition by burning, or falls slowly back to the same condition in the process of natural decay; or the heat, like the falling water, may do mechanical work. But also the organic material may be consumed in the plant itself. For the plant, like the animal, is a consumer. The only difference is that, whereas the animal is always and only a consumer and decomposer, the plant creates or composes likewise, and it produces vastly more than it consumes or decomposes. It decomposes only when it does mechanical work. But all its processes, all movements; all transformations, are work done at the expense of organized material and accumulated energy. Even the act of storing up solar force in the green herbage, or rather the changes connected with it, can only be done at a certain cost, though the cost is small in comparison with the gain. But every transference of material from one place or one state to another is done only by the decomposition and loss of some portion of it, -one part suffering that another may be changed and saved. When the germ feeds upon the maternal store in the seed, a considerable part is consumed in order to make the rest available; and the loss is made manifest, just M in the breathing of an animal or in the combustion of fuel, by the evolution of carbonic acid and of heat. The same thing in its measure occurs in the upbuilding of the fabric, the carrying of material high into the air, -into a tree-top, for instance; and in all the processes of flowering, and in storing up in the seed the richest products as an outfit for a new generation. Where visible movements take place, the quicker action is at equivalent cost. The sensitive tendril, which will coil promptly after the first brushing

its most reasonable interpretation in theism, but one which theism only can account for. That, it seems to me, you have. An excellent judge, a gifted adept in physical science and exact reasoning, the late Clerk-Maxwell, is reported to have said, not long before he left the world, that he had scrutinized all the agnostic hypotheses he knew of, and found that they one and all needed a God to make them workable. When you ask for more than this, namely, for that which will compel belief in a personal Divine Being, you ask for that which He has not been pleased to provide. Experience proves that the opposite hypothesis is possible. Some rest in it, but few I think on scientific grounds. The affirmative hypothesis gives us a workable conception of how" the world of forms and means" is related to "the world of worths and ends." The negative hypothesis gives no mental or ethical satisfaction whatever. Like the theory of the immediate creation of forms, it explains nothing. You inquire, whither are we to look for independent evidence of mind and will "concerned in natural events happening within the range; of the solar system." Certainly not to the court of pure physical science. For that has ruled this case out of its jurisdiction by assuming a fixed dependence of consequent upon antecedent throughout its domain. There are plenty of phenomena to which it cannot assign known causal antecedents; but it supplies their place at once, either by assuming that there is a physical antecedent still unguessed, or by inventing one in an hypothesis. It deals in effects and callses, and knows nothing of ends. It has no verdict to render against our case, for it does not entertain it, and has no jurisdiction under which to try it. But its wiser judges do not insist that theirs is the only court in the realm. We have not to go beyond Nature for a jurisdiction, which may be likened to that of Equity, since it enforces specific performance, and which adds to causes and effects the consideration of ends. Biology takes cognizance of the former, like physics, of which it is on one side a part, but also of ends; and here ends (which mean intention) become a legitimate scientific study. The natural history of ends becomes consistent and reasonably intelligible under the light of evolution. As the forms and kinds rise gradually out of that which was well-nigh form- less into a consumate form, so do biological ends rise and

regard began about forty years ago; and the doctrine of the individual life of cells is recent. Unfortunately the rather inappropriate name cell came into use before the structure was rightly understood, and may be misleading. It was given, naturally enough, to the walls circumscribing cavities in ordinary plant-tissue, before it was understood that the walls were not made and then filled, -before it was known that the contents are the living thing, and the wall an encasement or shell. The substance of our recent knowledge is, -that a plant is an aggregate of organic units, mostly of very small size; that these are to the herb or tree what the bricks and stones of this chapel are to the edifice. Only they" are living stones, fitly framed together" in organic growth, and their walls answer to the cement. Animals do not differ materially, except that the mortar is mostly of the same nature as the bricks, and there is a greater or at length complete fusion or confluence of the cells. The component material, the protoplasm, is essentially the same, as has already been stated. But each aggregate, each ordinary plant or animal, begins as one cell, which is then the simple individual. This is growth and propagation divides itself into two, these two into four, these into sixteen, and so on, thus building up the structure, -a whole, of which the individual cells are component parts. The simplest plant begins in the same way with an initial cell, but this, instead of multiplying with cohesion into a structure, multiplies with separation into progeny. Other simple plants go on without separation to form a row of similar cells, which may casually fall apart into individuals or may remain connected; but in either case each has its own life, and does what the others do, so that the separation or the continued connection is a matter of indifference. But when, higher in the scale, structures are built up, what were individuals become parts or organs, or the thousandth or millionth part of an organ; then the life of the cells is their own no less, but their individuality blends in the common life of the aggregate. By increasing complexity of organization, with increasing subordination of parts and specialization of office, the highest plants and animals are composed. In them each unit or cell has its own life and its own nutrition, while also contributing to the

whereby. Now, to adopt the apt words of Francis Newman, "after stripping off all that goes beyond the mark of sober and cautious thought, there remain in this world fitnesses innumerable on I the largest and the smallest scale, in. which alike common sense and uncommon sense see I design, and the only mode of evading this belief is by carrying out the cumbrous Epicurean argument to a length of which Epicurus could not dream. We cannot prove, we are told, that the eye was intended to see, or the hand to grasp, or the fingers to work delicately. Of course we cannot. But what is the alternative? To believe that it came about by blind chance. No science has any calculus or apparatus to decide between the two theories. Common sense, not science, has to decide, and the most accomplished physical student has in the decision no a vantage whatever over a simple thoughtful man." Arrangements innumerable, extending through all nature, subserving all ends, of course involve innumerable contingencies. The theist is not expected to have any definite idea of the respective limits of these. He can. only guess at the limits of intention and contingency in the actions of his nearest neighbor. The non-theist gains nothing by eliminating instances, unless he can eliminate all design from the system. Until he does this, he gains nothing by showing that particular fitnesses come to pass little by little, and under natural causes. He cannot point to a time where there were no fitnesses, apparent or latent, and if he argues that all fitnesses were germinal in the nebulous matter of our solar system, he does not harm our case. The throwing of design ever so far back in time does not harm it, nor deprive it of its ever- present and ever-efficient character.. For, as has been acutely said, "If design has once operated in rerum natura (as in the production of a first life-germ), how can it stop operating and undesigned formation succeed it? It can-not, and 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, but the climax and consummation of the whole." I am not going to re-argue an old thesis of my own that Darwinism does not weaken the substantial ground of the argument, as between theism and non-theism, for design in Nature. I think it brought in no new difficulty, though it

wonderful. The further the investigation is carried under the modern microscope, the more complex and recondite does their structure and behavior appear to be. They seemed to be simple because they are small; but much of the simplicity vanishes upon intimate acquaintance. Wherefore, in view of recent discoveries of this sort, it is premature to conclude that the "little lumps of protoplasm" described by Haeckel are really destitute of organic structure. It is an illusion to fancy that the mystery of life is less in an amoeba or a blood-corpuscle than in a man. From individuals in themselves, let us pass to questions relating to their succession and kinds. Plants and animals, each propagating their kind, produce lines of individuals, sustaining to each other the relation of parent and progeny. These lines are the species of the naturalist. Have the species come down from the beginning of life, unaltered or altered; or have there been successive creations? Taking first the vegetable and animal kingdoms as a whole, it has long been well understood that ages upon ages have passed since the earth was stocked with living beings of numerous sorts. Kind after kind has appeared, flourished, and disappeared; and, in the long succession, species of progressively higher rank have come into existence, the forms more and more approximating those which now exist. There is good reason to believe that at more than one epoch the earth has been as fully stocked with species as it is now, and in equal diversity, except as to the highest types. What relation have these beings of the earlier and of the succeeding times sustained to each other and to the present inhabitants of the earth? Half a century ago; when I began to read scientific books and journals, the commonly received doctrine was, that the earth had been completely depopulated and repopulated over and over, each time with a distinct population; and that the species which now, along with man, occupy the present surface of the earth, belong to an ultimate and independent creation, having an Ideal but no genealogical connection with those that preceded. This view, as a rounded whole and in all its essential elements, has very recently disappeared from science. It died a royal death with Agassiz, who maintained it with all his great ability, as long as it was tenable. I am not aware that it now has any scientific upholder. It is certain

facts suggest and inferentially warrant the conclusion that the course of natural history has been along an unbroken line; that - account for it or not- the origination of the kinds of plants and animals comes to stand on the same footing as the rest of Nature. As this is the complete outcome of Darwinian evolution, it has to be met and considered. The inquiry, what attitude should we,- Christian theists, present to this form of scientific belief, should not be a difficult one to answer in my opinion, we should not denounce it as atheistical, or as practical atheism, or as absurd. Although, from the nature of the case, this conception can never be demonstrated, it can be believed, and is coming to be largely believed; and it falls in very well with doctrine said to have been taught by philosophers and saints, by Leibnitz and, Malebranche, Thomas Aquinas, and Augustine. So it may possibly even share in the commendation bestowed by the Pope, in a recent sensible if not infallible allocution, upon the teaching of "the Angelic Doctor," and make a part of that genuine philosophy which t the Pope declares to stand in no real opposition to religious truth. Seriously it would be rash and wrong for us to declare that this conception is opposed to theism. Our idea of Nature is that of an ordered and fixed system of forms and means working to ultimate ends. If this is our idea of inorganic nature, shall we abandon or depreciate it when we pass from mere things to organisms, to creatures which are themselves both means and ends? Surely it would be suicidal to do so. We may, and indeed we do, question gravely whether all this work is committed to Nature; but we all agree that much is so done, far more than was formerly thought possible; we cannot pretend to draw the line between what may-be and what may not be so done, or what is and what is not so done; and so it is not for us to object to the further extension of the principle on sufficient evidence. I trust it is not necessary to press this consideration, though it is needful to present it, in order to warn Christian theists from the folly of playing into their adversary's hand, as is too often done. But I am aware that we have not yet reached the root of the difficulty. We are convinced theists. We bring our theism to the interpretation of Nature, and Nature responds like an echo to our thought. Not always unequivocally: broken, confused, and even

and stable; capable of variation, indeed, but only within circumscribed limits. Wherever it was difficult or impracticable to discriminate them, the difficulty was presumed to be, not in the things themselves, but in the imperfection of the naturalist's knowledge or acumen. There was the evidence of a good number of cases to show that species had not perceptibly altered in four or five thousand years, and of some having lasted for a vastly longer time. Hence it was an article of scientific faith that species on the whole were fixed now, and that probably they have come down essentially unaltered from the beginning,- a beginning which was wholly beyond the ken and scope of science, which is concerned with questions about how things go on, and has nothing to say as to how they absolutely began. The naturalists of that day might suppose -certainly many of them did suppose -that existing species may have come into being by other than direct supernatural origination, and, indeed, the foremost of them were well aware that the "' question 'of origin would have to be reargued c at no distant day. But, so far, the various speculative attempts at explaining the mystery of the s: incoming of species had not been encouraging, and eminent naturalists deprecated all general theories of the sort, as at the best a waste of time. So the fixity and inscrutability of species -though silently doubted by some, and controverted by a few was still the postulate of natural history; and more than one laborious naturalist has been known to declare that, if this fixity was not complete, natural history was not worth pursuing as a science. There is now a different attitude toward this class of questions. First, the absoluteness of species is no longer taken for granted. That species have a stability, that every form reproduces after its kind, is obvious; but it is equally obvious that the similarity of its individuals is not complete. It had been assumed that the differences brought about by variation are always comparatively small, unessential, and limited. This is now partly doubted, and partly explained away. In the first place, much of the popular idea of the distinctness of all species rests on a fallacy, which is obvious enough when once pointed out. In systematic works, every plant and animal must be referred to some species, every species is described by such and such marks, and in the

reason (or unreason) be said that there is no use for God, that there may have been a God at times! So it cuts away the ground from under the Christian evolution which the writer quoted from allows, as well as from that which he deprecates. And it equally dispenses with use for God in Nature for the several thousand years which have passed since creation under the biblical view was finished, and the Creator rested from all the work which he had made." There is no more validity in the argument in the one case than in the others. A word or two upon the subject of creative acts occurring in time may not be out of place. These, when spoken of in the present connection, do not usually refer to the making of a new form of plant or animal instanter out of the dust of the ground. However it might have I been when there was only one act of creation to think of, the enormous crudeness of such a conception when applied to a long succession of animals would now be seriously felt by every one. It is a phrase most used by those who accept the" idea of the evolution of one species from another, but who feel the utter incompetence of known natural causes to account for it. In the absence of such causes, they, being theists, naturally (and I cannot say unphilosophically) assign the simpler and seemingly easier part of evolution to recondite natural causes which they are unable to specify, the more difficult or inscrutable to a diviner and more direct or supernatural act, which they liken to creation. I suppose they do not feel the necessity, as they have not the ability, to draw any definite line between what they think mere Nature may accomplish, and what they believe she cannot. Probably what they have in mind is mediate creation and not miracle. Perhaps they are convinced that if they could behold the birth of a species, they would see nothing more miraculous than in the birth of an individual. They mean that the springs of Nature are somehow touched by a new form or instance of force directed to some new end. Yet so they must be in a degree in the origination of a new race or variety. This whole conception of mediate creation is logically carried out to its extreme by my philosophical colleague, Professor Bowen, when he concludes that " not only every new species but that each individual living organism, originated in a special act of creation." So the difference

they" are shadows, not 'substantial things," but I believe that they have only a relative fixity and permanence. You will ask if lack of capacity to interbreed .is not a criterion of species. I must answer, No. As a matter of course individuals of widely diverse species cannot interbreed; those of related species not uncommonly do; but it is said that when they do interbreed the hybrid progeny is sterile. Commonly it is so, sometimes not. The rule is not sufficiently true to serve as a test, either in the vegetable or in the animal kingdom. The only practical use of the test is for the discrimination of the higher grade of varieties from species. Now in fact some varieties of the same species will hardly interbreed at all; while some species interbreed most freely, and produce fully fertile offspring. So the supposed criterion fails in the only cases in which it could be of service. All that can be said is, that whereas known varieties tend to interbreed with unimpaired and sometimes with increased fertility, distinct species of near re- semblance tend not to interbreed at all; and between the two extremes there are all inter- mediate conditions. Here, as throughout organic nature, the extremes are far apart; the, interval is filled with gradations. What then is the substantial difference between varieties and species? Just here is the turning-point between the former vie"" and the present. The former doctrine was that varieties come about in the course of nature, but species not; that varieties became what they are, but that species were originally made what they are. I suppose that, even before the day of Darwin- ism, most working naturalists were reaching the conviction that this distinction was untenable; that the same rule was applicable to both; and therefore that either varieties did not come in the course of nature, or that species did. Perfectly apprehending the alternative and its consequences, Agassiz took the ground that varieties as well as species were primordial, or rather that the more marked forms called varieties by most naturalists were species, and. therefore original creations. Rightly to understand his view, it must be taken along with his conception of species, as consisting from the very first of a multitude of individuals. Other naturalists were looking to the opposite alternative, and were coming to the conclusion that species as well as varieties were natural developments. In botany,

arrested. Variation provides that upon which natural selection operates; the operation of natural selection makes room for further variation, gives opportunity for variability to change its fashions and display its novelties; and so the two go on, hand in hand. But, although thus conjoined, there is always this difference between the two, that natural selection works externally, with known natural agencies, and in the light of common day; variation works internally, in darkness, and its agencies and ways are recondite and past finding out. Or, when we find out something, -as we may hope to do, -we only resolve a before unexplained phenomenon into two factors, one of them a now ascertained natural process, the other a something which still eludes our search. But we suppose it to be natural, although as yet unknown. Surely we are not to suppose that natural agencies cease just where we fail to make t them out. To Proceed: what Darwinism maintains is that variation, which is the origination of small differences, and species-production, which represents somewhat larger differences, and genus- production, which represents still greater differences, are parts of a series and differ only in degree, and therefore have common natural causes whatever these may be; and that natural selection gives a clear conception of a way in which continually or occasionally arising small differences may be added up into large sums in the course of time. This is a legitimate and on the whole a good working hypothesis. The questionable point is whether the sum of the differences can be obtained from the individually small variations by simple addition. I very much doubt it. I doubt especially if simple addition is capable of congruously adding up such different denominations. That is, while I see how variations of a given organ or structure can be led on to great modification, I cannot conceive how non-existent organs come thus to be, how wholly new parts are initiated, how any thing can be led on which is not there to be taken hold o£ Nor am I at all helped in this respect by being shown that the new organs are developed little by little. The doubt is not whether the organs and forms were actually evolved in the course of Nature. I agree with Darwin that they probably were, and if so then doubtless under natural selection. And I cannot help thinking that Darwin would agree with me that the principle of natural

had advanced. Similarly would white races, to the exclusion of dark, be developed and prevail in cooler regions. Now, this simple principle, -extended from races to species; from the present to geological ages; from man and domesticated animals to all animals and plants; from struggle with disease to struggle for food, for room, and against the diverse hardships which at times beset all living things, and which are intensified by the Malthusian law of the pressure of population on subsistence, -population tending to multiply in geometrical progression, while food can increase only in a much lower ratio, and room may not be increasable at all, so that out of multitudinous progeny only the few fittest to the special circumstances in each generation can possibly survive and propagate, -this is Darwinism; that is, Darwinism pure and simple, free from all speculative accretions. Here, it may be remarked that natural selection by itself is not an hypothesis, nor even a theory. It is a truth, -a catena of facts and direct inferences from facts. As has been happily said, it is a truth of the same kind as that which we enunciate in saying that round stones will roll down a hill further than flat ones. There is no doubt that natural selection operates; the open question is, what do its operations amount to. The hypothesis based on this principle is, that the struggle for life and survival of only the fittest among individuals, all disposed to vary and no two exactly alike, will account for the diversification of the species and forms of vegetable and animal life, -will even account for the rise, in the course of countless ages, from simpler and lower to higher and more specialized living beings. We need not here enter into any further explanation of this now familiar but not always well-understood hypothesis; nor need I here pronounce any judgment of my own upon it. No doubt it may account for much which has not received other scientific explanation; and Mr. Darwin is not the man to claim that it will account for every thing. But before we can judge at all of its capabilities, we need clearly to understand what is contained in the hypothesis; for what can be got out of it, in the way of explanation, depends upon what has gone into it. So certain discriminations should here be attended to. Natural selection we understand to be a sort of personification or generalized expression for the processes and the results of the

only one known to me which can be termed a real cause in the scientific sense of the term. Other modern hypotheses assign metaphysical, vague, or verbal causes, such as development, anticipation, laws of molecular constitution, without indicating what the special constitution is, -none of which have much advantage over the "nisus formativus" of earlier science. I have no time to recapitulate what I briefly said of natural selection in a former lecture; nor to analyze the applications of the principle by Darwin, Wallace, and others to critical instances; nor to specify its limitations and apparent failures. The discussion or even the presentation of these would fill the hour, and divert me from my particular task. Instead of this, I will merely give my impression of the present state of the case as respects the points now before us. You will remember the distinction which I pointed out between the principle of natural selection, which I take to be a true one, and the Darwinian hypothesis founded on it, which I take to be to a considerable extent probable. That is, I think that the influences and actions which the term "natural selection" stands for, give a sufficient scientific explanation of the way in which smaller differences among plants and animals may rise into greater, varieties into species. Given differences -and an internal tendency to differ more, i.e., given variation as an inexhaustible factor, and natural selection should suffice for the preservation and increase of the select few as a consequence of the destruction of the intermediate many. Surely there is nothing either improbable or irreligious in the idea that lines of individuals or races, once in existence, should be subject to the conditions of Nature, and that the fittest for particular conditions should thereby be preserved. As to variation, that really occurs as a fact, though we know not how; and, if we frame explanations of the mode and get conceptions of the causes of the variation of living things, still we probably shall never be able to carry our knowledge very much further back; for in each variation lies hidden the mlJ8terlJ of a beginning. We cannot tell why offspring should be like unto parent; how then should we know why it should sometimes be different? So then Darwinism has real causes at its foundation, viz., the fact of variation and the inevitable operation of natural selection,

abstraction, which meaning every thing, can explain nothing. It is like saying that whatever happens is the cause of whatever comes to pass. We may conclude, therefore, that natural selection, in the sense of the originator of the term, and in the only congruous sense, stands for the influence of inorganic nature upon living things, along with the influence of these upon each other; and that what it purports to ac-count for is the picking out, from the multitude of incipient variations, of the few which are to survive, and which thereby acquire distinctness. There is a further assumption in the hypo- thesis which must not be overlooked; namely, that the variation of plants and animals, out of which so much comes, is indefinite or all-directioned and accidental. This, I would insist, is no fundamental part of the hypothesis of the derivation of species, and is clearly no part of the principle of natural selection. But it is an assumption which Mr. Darwin judges to be war- ranted by the facts, and in some of its elements it is unavoidable. Evidently if the innate tendency to vary upon which physical circum- stances operate is indefinite, then the variations which the circumstances elicit, and which could not otherwise amount to any thing, must be accidental in the same sense as are the circum- stances themselves. Out of this would immediately rise the question as to what can be the foundation and beginning of this long and wonderful chapter of accidents which has produced and maintained, not only for this time but through all biological periods, an ever-varying yet ever well-adapted cosmos. But the facts, so far as I can judge, do not support the assumption of every-sided and in- different variation. Variation is somehow and somewhere introduced in the transit from parent to offspring. The actual variations displayed by the progeny of a particular plant or animal may differ much in grade, and tend in more than one direction, but in fact they do not appear to tend in many directions. It is generally agreed that the variation is from within, is an internal response to external impressions. All that we can possibly know of the nature of the inherent tendency to vary must be gathered from the facts of the response. And these, I judge, are not such as to require or support the assumption of a tendency to wholly vague and all-directioned variation. Let us here correct a

perplexities to old antinomies, which can neither be reconciled nor evaded, the burden will be off our shoulders. It might suffice to show that evolution need raise no other nor greater religious or philosophical difficulties than the views which have already been accepted, and held to be not inimical to religion. But, indeed, our universal concession that Nature is, and that it is a system of fixed laws and uniformities, under which every thing we see and know in the inorganic universe, and very much in the organic world, have come to be as they are, in unbroken sequence, implicitly gives away the principle of all ordinary objection to the evolution of living as well as of life- less forms, of species as well as of individuals. It leaves the matter simply as one of fact and evidence. Indeed, mediate creation is just what the thoughtful and thorough observer of the ways of God in Nature would expect, and is what some of the most illustrious of the philosophic saints and fathers of the church have more or less believed in. In saying that the doctrine of the evolution of species has taken its place among scientific beliefs, I do not mean that it is accepted by all living naturalists; for there are some who wholly reject it. Nor that it is held with equal conviction and in the same way by all who receive it; for some teach it dogmatically, along with assumptions, both scientific and philosophical, which are to us both unwarranted and unwelcome; more accept it, with various confidence, and in a tentative way, for its purely scientific uses, and without any obvious reference to Its ultimate outcome; and some, looking to its probable prevalence, are adjusting their conditional belief in it to cherished beliefs of another order. One thing is clear, that the current is all running one way, and seems unlikely to run dry; and that evolutionary doctrines are profoundly affecting all natural science. Here you remark that your objection is not so much to the idea of mediate creation as to the form it has assumed; that the mediate production of species mall indeed be completely theistic. But that, whereas their immediate creation directly asserts Divine action, their incoming under Nature only implies it. To those who already believe in a Supreme Being the two views may religiously amount to the same thing. But, you continue, living beings were thought to afford a kind of demonstration of

surface; in systematic natural history, the reason why species and genera and orders are so variously related, are here connected by transitions and there separated by wide gaps; in morphology why the same functions may be assumed by different organs, or the same kind of organ may perform here one function and there another, or again exist as a vestige, of no service at all; in anatomy and biology, the transition from one element of structure to another, the gradual specialization of organs, and the remarkable coincidence between the order of the development in the individual animal and that of the rise from low to high in the scale of being, and that of the successive appearance of the grades in time; finally in psychology, the gradations between beings endowed with rudimentary sensation and beings endowed with mind. Here, where the "touch of Nature makes the whole world kin," we reach the sensitive point. Man, while on the one side a wholly exceptional being, is on the other an object of natural history, -a part of the animal kingdom. If you agree with Quatrefages that man is a kingdom by himself, you must agree with him that this' kingdom is solely intellectual; that he is as certainly and completely an animal as he is certainly something more. We are sharers not only of animal but of vegetable life, sharers with the higher brute animals in common instincts and feelings and affections. It seems to me that there is a sort of meanness in the wish to ignore the tie. I fancy that human beings may be more humane when they realize that, as their' dependent associates live a life in which man has! a share, so they have rights which man is bound to respect. Man, in short, is a partaker of the natural as well as of the spiritual. And the evolutionist may say with the apostle: "Howbeit that was not first which is spiritual, but that which is natural, and afterward that which is spiritual." Man, "formed of the dust of the ground," endowed with "the breath of life," "became a living soul." Is there any warrant for affirming that these processes were instantaneous? As has just been intimated, the characteristic of that particular theory of evolution which is now in the ascendant is that, by taking advantage of "every creature's best" for bettering conditions, it has made strife work for good, throughout" an immensely long line of adjustments and readjustments, in a series

expect us to adopt your assumption of specific creations by miraculous intervention with the course of Nature, not once for all at a beginning, but over and over in time. We will accept intervention only when and where you can convincingly establish it, and where we are unable: to explain it away, as in the case of absolute beginning. If the naturalist starts with the presumption against him when he broaches the theory of the descent of later from preceding forms in the course of Nature, so no less does the theologian when in a world governed by law he asserts a break in the continuity of natural cause and effect. But, indeed, you are not so much concerned to know whether evolutionary theories are actually well-founded or ill-founded, as you are to know whether if true, or if received as true, they would impair the foundations of religion. And, surely, if views of Nature which are incompatible with theism and with Christianity can be established, or can be made as tenable as the contrary, it is quite time that we knew it. If, on the other hand, all real facts and necessary inferences from them can be adjusted to our grounded religious convictions, as well as other ascertained facts have been adjusted, it may relieve many to be assured of it. The best contribution that I can offer towards the settlement of these mooted questions may be the statement and explanation of my own attitude in this regard, and of the reasons which determine it. I accept substantially, as facts, or as apparently well-grounded inferences, or as fairly probable opinions, -according to their nature and degree, -the principal series of changed views which I brought before you in the preceding lecture. I have no particular predilection for any of them; and I have no particular dread of any of the consequences which legitimately flow from them, beyond the general awe and sense of total insufficiency with which a mortal man contemplates the mysteries which shut him in on every side. I claim, moreover, not merely allowance, but the right to hold these opinions along with the doctrines of natural religion and the verities of the Christian faith. There are perplexities enough to bewilder our souls whenever and wherever we look for the causes and reasons of things; but I am unable to perceive that the idea of the evolution of one species from another, and of all from an initial form of life,

LECTURE II

THE RELATIONS OF SCIENTIFIC TO RELIGIOUS BELIEF.

IN a preceding discourse I brought to your (if notice a series of changes in view and opinion which have taken place among scientific men within my own remembrance. I restricted the survey to the biological sciences (with merely a reference to the principle of the conservation of energy in its application to the organic world), and in these to the supposed facts and immediate inferences, to what may be called their natural-historical interpretation. These new views are full of interest of a kind which you cannot expect a naturalist to under- value. For they have greatly exalted his calling. In the days of Linnaeus, who died only a hundred and two years ago, and throughout a long generation of his followers, species were looked upon as" simple curiosities of Nature," to be inventoried and described; and striking phenomena in plants and animals, as something to be wondered at, but not to be explained. With the advent of Morphology, the precursor and parent of Evolution, Natural History developed from a curious pursuit, training the observing powers, to that of a true science, engaging the reason in the search for causes. According to one definition, "Science is the labor of mind applied to Nature." In this sense, modern botany and zoology have certainly become scientific. They are at least attempting great labors. But in widely extending, as they now do, the operation of natural causes in the organic world, they make close connections between biology and physics, or what used to be called, and I think deserves to be called, natural philosophy. And the connection brings in, or brings up afresh, considerations which affect the ground of natural and revealed religion. Under this aspect, they properly excite your anxious attention. I used throughout the phrase "scientific belief," as the one best suited to the occasion. The term is comprehensive

and elastic, covering many degrees of conviction or assent, from moral certainty down to probable opinion. In this respect, scientific and theological beliefs are similar; as they also are in being mainly states of mind toward that which is incapable of demonstration, - either because, as in the case of ultimate beliefs (on which all science and knowledge are based) it is impossible to go beyond them, or else Because the subject-matter is not positively known, and certainty is unattainable from the nature or the present conditions of the case. The proofs upon which both biological and theological investigations have to rely are largely probabilities, some of a higher, some of a lower order, and much that is accepted for the time is taken on trial or on prima facie evidence. Much also is or should be held under suspense of judgment, a state of mind eminently favorable to accurate investigation. As to those who can forthwith assort the contents of their minds into two compartments, one for what they believe and the other for what they disbelieve, neither their belief nor their denial can be of much account. In all subjects of inquiry, those only are to be trusted who discriminate between inevitable beliefs, established convictions, probable opinions, and hypotheses on trial. Now, our general inquiry in this lecture is, What should be the attitude, I will not say of theological students, but of thoughtful men, in respect to scientific beliefs, tendencies, and anticipations, such as we have been considering? To a certain extent it may well be a waiting attitude. The strictly scientific matters must necessarily be left mainly to the experts, whose very various and independent investigations, pursued under every diversity of bias, must in time reach reasonably satisfactory conclusions. But the naturalists claim no monopoly in the consideration of the great problems which now interest us, in which indeed most of them de- cline to take any part. Perhaps theological students and divines might be asked to wait until views and hypotheses still ardently controverted among scientific investigators are I brought nearer to a settlement. But the disposition to discount expected results, either for or against supernatural religion, has always prevailed. The theologians at least have never waited, and cannot be expected to wait; and while some of their contributions to the subject have been inconsiderate,