ORGANIC EVOLUTION CONSIDERED

BY

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TO

Allen R. Benton,

MY FAITHFUL FRIEND AND MY FORMER TEACHER,

This Volume

Is Lovingly Dedicated.

PREFACE.

HAVING been for many years a teacher of various branches of natural science, it has been my duty to discuss the subject of organic evolution. This volume contains some of the objections which I have from time to time presented against the acceptance of that theory, together with several chapters on other subjects.

A. FAIRHURST.

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ORGANIC EVOLUTION CONSIDERED.

I.

INTRODUCTION.

IN THE following pages I have endeavored to give a general statement of the claims of Evolution as applied to the origin of organic forms, and then to offer those objections which, it seems to me, go far toward invalidating these claims.

I have not given in detail all of the arguments which have been presented in support of the theory of organic evolution, for this would be a superfluous work in view of the fact that this has been most fully and ably done by Darwin and other writers.

My endeavor has been to urge more in detail some of the objections to the theory than has been done by others.

The evolutionist may be a Theist, an Atheist, an Agnostic, a Pantheist, or a Materialist. To my mind it is not a matter of indifference as to which of these he is.

I look upon the theory of evolution as being of no importance except as it involves the well-being of man.

My object in what I have written is to promote the belief in Theism and in the existence of a spiritual nature in man which Theism alone can explain.

It is a fact, I believe, that the propagation of the theory of Evolution has decreased the belief in Theism. While this may be true, the fact should not be lost sight of that a belief in the former is consistent with a belief in the latter.

If it can be shown that the theory of Evolution is not true, then Theism will, to most minds, be the necessary alternative. To my own mind, Theism is not an alternative to Evolution at all, for I believe that whether the latter has taken place or not, Theism is the only explanation of the present order of things.

Starting with the present distribution of matter and energy in the universe, and accepting the theory of the indestructibility of matter and the conservation and correlation of energy, the belief in the continuity of natural processes necessarily follows, so far as these processes can be explained in terms of Matter and Force, but I do not believe that all phenomena can be explained in the above terms.

I believe that Matter, Force and Mind are manifestations of the Creator, but I do not think that either of these can be explained in terms of the other two. It is the prerogative of Mind to interfere with the course of events in Nature.

The presence of Mind in Nature is the primary fact of human knowledge. To construct a Teleology which excludes Mind as a permanent factor from Nature is to annihilate the one thing of the existence of which we are most certain.

If Matter and Force are a part of Nature, so is Mind, and we have no reason to believe that the latter is less enduring than the former.

To assume the continuity of natural causes through the infinite past, at the same time eliminating Mind as a factor of Evolution, and regarding it simply as a transient phase of a small part of Nature, is not justified by the facts. I believe that if the truth of the theory of Evolution can ever be established, it can be done only on the basis of Theism.

The amount of evidence necessary to convince one of the theory depends on the data with which we begin. If Matter and Force are the only data, then the acceptance of the theory of Evolution in its widest scope necessarily follows.

If we add to the above a belief in the existence of a Supreme Intelligence, then the strength of the evidence must be greatly increased, and it must harmonize with our conceptions of God.

It is true, I believe, that the theory of Evolution has contributed to Atheism, and especially to Agnosticism. It has been common with evolutionists to deny that Nature furnishes evidence of the existence of an Intelligent Creator.

Some of them seem to delight in affirming the lack of design in Nature, as if there could be some special merit in a universe in which there is no manifestation of intelligence.

As for myself, I prefer to believe in and to seek the highest possible form of existence of which my mind can conceive.

Unless the existence of the human mind can be explained in terms of matter and force—a thing that it is impossible to do—then its existence points with certainty to a Divine Mind in the universe.

The logic that blots God out of existence blots out also the human mind.

Mind exists, and God exists as its necessary Author.

II.

MATTER.

Matter occupies space, resists being put in motion, and is unable to part with its motion except by communicating it to other matter.

About seventy simple substances are known to the chemist. A simple substance, or element, is one that cannot be separated into two or more different kinds of matter; for example, gold, silver, mercury, iron and sulphur are elements. Elements are divided into metals and non-metallic substances, most of them being classed among the former.

At ordinary temperatures elements exist as gases, liquids or solids. Four, namely, hydrogen, oxygen, nitrogen, and chlorine, are gases, while bromme and mercury are the only liquid elements, all the others being solids under ordinary conditions. It is probable that fluorine also is a gas.

Any substance may be a solid, a liquid, or a gas, depending on the temperature and pressure to which it is subjected.

All ordinary gases, both simple and compound, have been liquefied, and some of them solidified, by abstracting their heat and applying pressure.

Air has been reduced to solid lumps by the reduction of the temperature alone. Oxygen has been liquefied, but it has not yet been solidified.

The lowest temperature yet obtained is minus 225^0 C. Olzewski obtained this extremely low temperature by evaporating solid nitrogen in a vacuum.

The absolute zero, or the point at which no heat is supposed to exist in matter, is minus 273 °C, so that a temperature has been reached only 48 °C above the absolute zero.

It has been found that gases can not be liquefied and solidified by the application of any amount of pressure, however great, unless at the same time their temperature be reduced below *the critical point.* Pressure is, therefore, only a secondary factor in liquefying gases.

I have stated that there are about seventy elements known to the chemist, and that an element cannot be separated into two or more kinds of matter.

There is some evidence to indicate that the elements are compounds. The fact that the so-called elements generally give many lines in the spectrum, instead of giving a single line, would seem to indicate that an element is not composed of homogeneous material, and the fact that the chemical action of an element varies under different circumstances in remarkable ways, as, for example, carbon in the hydrocarbon compounds has been regarded as evidence that elements are really compounds.

On the other hand, it has been claimed that all elements have probably been derived from one original form of matter, which Professor Crookes calls *protyle.* From this original stuff, "fire-mist," the elements, as we know them, have been evolved in succession, by cooling; the smallest atoms, such as those of hydrogen, having been first formed.

The numerical relations between the atomic weights as arranged by Mendeléeff, may be regarded as evidence of the common origin of elements.

For all practical purposes, however, the chemist recognizes the seventy elements as such, and this from the fact that he is unable to separate them into simpler forms.

If we grind a piece of sulphur in a mortar, we break it into smaller and smaller pieces, each of which is sulphur. If we could put it into the mortars of the gods, which, it is said, "grind slow but exceeding small," would there be any practical limit to the smallness of the pieces? Is there a limit in the division of matter beyond which nature cannot go? The chemist images that there is a limit, and he calls the ultimate piece of matter which nature does not divide an atom. No eye has ever seen an atom, no microscope can ever render it visible. The mote that dances in the sunbeam is composed of millions of atoms. The spectroscope enables us to detect the $^1/_{180,000,000}$ of a grain of sodium, and this small speck of sodium must contain millions of atoms in order to color the flame sufficiently to render the sodium visible.

A grain of musk, it is said, will scent a room for years without losing an appreciable amount of its weight, and yet during this time the air in the room has changed many times, and the molecules of musk have been disseminated through the vast volume so that the sense of smell could detect their presence. What an enormous volume of air a little of the musk from the skunk will vitiate, and yet this is only possible by the almost infinite smallness of the molecules.

Nobert has drawn 4,000 lines on the breadth of one millimetre, which is more than 200,000 lines to the inch. A film of silver has been obtained $^1/_{167,000}$ of an inch in thickness, and films of platinum and gold have been obtained $^1/_{125,000}$ of an inch in thickness, and yet it is probable that this thickness contains many atoms.

The thickness of the soap-bubble at the dark part just before it breaks, is $^1/_{50}$ of the length of the sodium wave of light, which would be something more than $^1/_{100,000}$ of a centimetre in thickness. But the molecules of this thin film are very complex, so that in the thickness of the film quite a number of atoms must exist.

Sir William Thomson says "that in any ordinary liquid, transparent solid, or seemingly opaque solid, the mean distance between the centres of contiguous molecules is less than the $^1/_{5,000,000}$ and greater than the $^1/_{1,000,000,000}$ of a centimetre."*

"To form some conception of the degree of coarse-grainedness indicated by this conclusion, imagine a globe of water or glass, as large as a football, to be magnified up to the size of the earth, each constituent molecule being magnified in the same proportion. The magnified structure would be more coarse-grained than a heap of small shot, but probably less coarse-grained than a heap of footballs."

It is said that the smallest object visible under the microscope is $^1/_{4,000}$ of a millimetre, which is about $^1/_{100,000}$ of an inch, and yet such an object contains millions of molecules. It has been claimed that an organic being of that size would contain perhaps one million molecules of organic matter in addition to the water which constitutes most of its bulk.

Crookes, taking the estimate that 1 c. c. of air contains 1,000,000,000,000,000,000,000 molecules, says that to fill a globe 13.5 centimetres in diameter, which has been exhausted to the one-millionth of an atmosphere, would require, if the molecules entered at the rate of 100,000,000 in a second, 408,501,731 years. At the above rate it would require about 2,500,000 years to fill a globe one inch in diameter. If we estimate the number of molecules at 19,000,000,000,000,000,000 in a cubic centimetre, as has been done by some, then

*Popular Lectures and Addresses, Sir W. Thomson, p. 217.

the above times would be reduced to about 7,700,000 and 47,500 years respectively.

Assuming a specific number of molecules per cubic centimetre of any gas, and accepting the hypothesis of Avogadro that equal volumes of all gases under like conditions of temperature and pressure contain equal numbers of molecules, it becomes easy to calculate the number of molecules of simple substances that constitute any solid or liquid that can be readily converted into the form of gases.

For example, a cubic centimetre of nitric acid, the formula of which is $H\ NO_3$, specific gravity 1.517, is composed of about 272 cubic centimetres of nitrogen, 273 of hydrogen, and 809 c. c. of oxygen, the volume of the three gases together is 1354 c. c. When these three gases unite to form nitric acid the 1354 c. c., shrink to 1 c. c. Assuming 19,000,000,000,000,000,000 molecules in 1 c. c. of the gas, there would be in 1354 c. c. 25,726,000,000,000,000,000,000 molecules, which enter into the 1 c. c. of nitric acid. The cube root of the above number is about 29,500,000, so that according to this estimate if the molecules of nitric acid fill the entire space in the 1 c. c., so that there are no vacant spaces between the molecules, then a molecule of the above gases is, on the average, about $^1/_{29,500,000}$ of a centimetre in diameter, which is about $^1/_{73,750,000}$, of an inch.

One cubic centimetre of water is composed of 1258 c. c. of hydrogen and 629 c. c. of oxygen—in all, 1887 cubic centimetres. Estimating, as in the case of nitric acid, 19 quintillions of molecules in each cubic centimetre of gas at O^0 C and the pressure of one atmosphere, there would be 35,853,000,000,000,000,000,000 molecules of the two gases in 1 c. c. of water, which would allow an average diameter of about $^1/_{33,000,000}$

of a centimetre, or about $^1/_{82,500,000}$ of an inch, if water is not porous.

In a similar way for solids—taking ammonium nitrate, $N\ H_4\ N\ O_3$, for example, one cubic centimetre of which contains 2,083 cubic centimetres of its three constituent gases, the number of molecules in 1 c. c. of the solid would be 39,577,000,000,000,000,000,000, and the average diameter of the molecule, if the solid is not porous, would be $^1/_{34,000,000}$ of a centimetre in diameter, or about $^1/_{85,000,000}$ of an inch.

Taking another solid, ammonium bicarbonate, $N\ H_4\ H\ C\ O_3$, we estimate the size of the molecules of its elements to be about $^1/_{34,500,000}$ of a centimetre, or about $^1/_{86,250,000}$ of an inch. In this estimate the substances were taken in the simple form and the carbon was assumed to occupy the same space that it would occupy if it had the specific gravity of the diamond.

Instead of the above method, we may regard the $N\ H_4\ H\ C\ O_3$ as being composed of the two gases $N\ H_3$ and $C\ O_2$ and of water, $H_2\ O$. The average size of the molecules of these three compounds is about $^1/_{29,500,000}$ centimetre, or $^1/_{72,500,000}$ of an inch.

The above estimates of the sizes of molecules, as already stated, are made upon the assumption that solids and liquids are not porous, or that there are no vacant spaces between the molecules.

That there are such spaces, however, is evident from the fact that both solids and liquids can be compressed into smaller volumes than they occupy at O^0 C, and from the fact that they contain heat, which forces the molecules apart.

I think, however, that the vacant spaces between the molecules of a solid are small compared to the space occupied by the molecules themselves.

It seems probable that at the absolute zero, namely,

—273.7° C, if this represents the temperature at which all heat is absent, there is no molecular motion in matter, and that the molecules, if they are cubes of equal size, would fill the whole space so that there would be no pores. The small amount of expansion which solids and liquids undergo, due to a change of temperature, shows that if they could be reduced to the absolute zero, they would occupy nearly as much space as they occupy at 0° C. For example, a cubic centimetre of steel on being cooled from 0° C to —273° C would lose about $^1/_{100}$ of its volume if it followed the law of expansion and contraction which has been established for higher temperatures. Glass would lose $^1/_{125}$ and zinc $^1/_{40}$ of its volume.

From this it would seem that the molecules of solids at ordinary temperatures are probably very close together, and, for the most part, in contact with each other.

Lord Kelvin estimates from the kinetic theory of gases that in glass or water "there are probably something like 600 molecules to the wave-length" of violet light, "and almost certainly *not fewer* than 200, or 300, or 400."*

Taking 600 as the number of molecules of water in a wave-length of violet light, which is about $^1/_{2,500}$ of a millimetre in length, the size of the molecule of water would be about $^1/_{15,000,000}$ of a centimetre, or $^1/_{37,500,000}$ of an inch in diameter,—or, more accurately, this would be the average distance between the centers of adjacent molecules.

The thickness of the film of the soap bubble at the dark part, just before it breaks, is said to be $^1/_{50}$ the length of the sodium wave of light, which is equal to $^1/_{847,000}$ of a centimetre, or about $^1/_{2,118,000}$ of an inch. This represents the thinnest portion of matter that has

*Popular Lectures and Addresses, by Sir W. Thomson, p. 193.

been measured. It is evident that the diameter of the molecules of water and soap cannot exceed the thickness of the film. Regarding the molecule of soap as made up of fifty atoms,—for example, sodium palmitate, the formula of which is $C_{15}\,H_{31}\,C\,O_2\,Na$, exactly fifty atoms; then, if the black film of soap bubble contains only one layer of molecules of soap together with sufficient water to make the thickness fifty atoms, the size of the atoms, or, rather, the average distance from center to center of atoms, would be $^1/_{42,350,000}$ of a centimetre. Of course, it is impossible to tell the number of atoms or molecules contained in the thinnest part of a soap bubble. The only definite conclusion is that the diameter of the molecules in the particular case cannot exceed the thickness of the film, and that the diameter of the atoms must be considerably less than the thinnest part of the film.

Thus far I have spoken of simple substances and of the size of atoms and molecules. It is evident that, if there are but seventy simple substances known, most things with which we are acquainted must be compounds.

A compound is produced by the union of two or more simple substances. For example, thoroughly mix 32 parts by weight of sulphur with 56 of iron filings, and ignite the mixture with a burning match. The whole mass, even in the absence of air, will soon glow with heat and light. The weight of the resulting mass is equal to that of the sulphur plus that of the iron.

The heat and light were produced by the chemical action of the sulphur and iron on each other. The atoms of the two substances rushed together with such enormous velocity that intense heat and light were generated by the concussion, as is done when the motion of a cannon ball is arrested by a steel-clad vessel. An atom of sulphur and an atom of iron throughout the mass—atom for atom—crash together and hold each other in their grasp.

The result of the chemical action is a new substance that looks like neither sulphur nor iron. Before the burning match was placed in the mixture the sulphur and iron could be readily separated by mechanical means—the iron could be removed with a magnet, or the sulphur could be dissolved out with bisulphide of carbon. The compound formed looks like neither sulphur nor iron, and its mechanical and chemical properties are different from those of the two elements that compose it.

The whole of the two elements used is present in the compound, known by the name, sulphide of iron, and by various chemical means they may be separated from each other and obtained again in the simple form.

The smallest amount of this compound that can exist is represented by one atom of sulphur combined with one atom of iron, which is expressed by the formula $Fe\,S$. This smallest conceivable amount of a compound is called by the chemist a molecule. A single molecule may contain from two up to hundreds of atoms. The molecule is the unit of the compound on which its qualities as a distinct substance depend.

We are unable to tell in advance from the properties of the elements what will be the properties of the compounds produced by their union. How totally we would be unable to predict that by putting a spark to a mixture of two volumes of hydrogen and one volume of oxygen they would unite with a tremendous explosion to form a volume of water more than eighteen hundred times less than that of the two gases; or that by decomposing common salt we would find it composed of a soft metal and a very poisonous gas; or that by uniting sulphur and carbon, two solids, we would obtain a very volatile liquid of an extremely unpleasant odor; or, again, that by the union of one volume each of nitrogen and chlorine together with four volumes of hydrogen—all three of them gases—we would obtain a white solid, known as chloride of ammonium.

Examples might be multiplied indefinitely, but these few are sufficient to show how widely different are the properties of compounds from the properties of their constituent elements.

All material things with which we are acquainted, the thousands of different objects upon the earth, are built of a few primary building materials.

As infinite varieties of houses may be built of stone, and brick, and mortar, so countless varieties of compounds may be built of atoms of a few different kinds. The same atom may be made to do many different kinds of service. It is indeed an amazing fact that the primary building materials of the earth and of the other worlds which have revealed thier composition, at least partly, through the spectroscope, are but a few kinds of atoms, and that these atoms are inconceivably small.

And yet each atom is subject to definite and invariable laws. The laws of the material universe are the laws of atoms. Atoms are the law-abiding citizens of the universe; they do their work with absolute precision. The fundamental laws of chemistry are mathematically exact.

For example, take the law of "definite proportions," that in every chemical compound the kinds and relative quantities of the constituent elements are fixed and invariable. One correct analysis of pure water determines the composition of all water in existence. The chemist cannot believe that the composition of water can vary by a single atom of either of its elements. He feels certain that the rule is infallible that each molecule of water must contain two atoms of hydrogen and one atom of oxygen, and that it can have no other composition. The same principle holds good of every other compound.

Again, it often occurs that the same elements unite in different proportions to form different compounds, and, in these cases, they unite according to the law of "multiple proportions," namely, that when two elements, A and B, unite in more than one proportion, if we take quantities of the compounds which contain the same amount of A, the quantities of B will bear a very simple relation to each other. For example, take the compounds of nitrogen and oxygen represented by the following five formulas, N_2O, N_2O_2, N_2O_3, N_2O_4 and N_2O_5. It will be noticed that while each compound has two atoms of nitrogen in its molecule, the amounts of oxygen are simple multiples of the quantity in the first compound.

The formula for water is H_2O, but there is another compound of oxygen and hydrogen, H_2O_2, known as hydrogen dioxide, which is a very active oxydizing agent.

Chemists have determined with great exactness the relative weights of atoms. I shall not describe the methods by which this has been done. Hydrogen being the lightest known substance, its atomic weight is taken as unity. The atomic weights of the seventy elements range from 1 to 239, the latter being the atomic weight of uranium.

It is a remarkable fact that when elements combine with each other, their amounts are represented by their atomic weights or by some multiple of these weights. Oxygen, for example, unites with every element except fluorine, and with most elements in more than one proportion, and yet the amount of oxygen in any compound is always its atomic weight, 16, or some multiple of this weight. This renders it possible for the chemist to represent every compound by means of a formula which contains a definite number of atoms. A formula, such as that of water, H_2O, shows the kinds of elements, hydrogen and oxygen; the number of atoms of each element in the molecule, two of hydrogen and one of oxygen; and the relative weights of the two elements. The two atoms of hydrogen weigh 2 and the one atom of oxygen weighs 16. The weight of the molecule, H_2O, is equal to the sum of the weights of its atoms—2 plus 16 equal 18. We know therefore, by examining the formula that $^2/_{18}$ of the weight of water is H and $^{16}/_{18}$ O.

When we consider the countless number of compounds that may be formed by the union of the seventy elements, ranging from the molecule of only two atoms up to the most complex molecules, which contain a half dozen or a dozen elements and hundreds of atoms, and find that in every compound the law of combination according to atomic weights is observed, the fact is marvelous. Who numbers the atoms that they may combine? Who wheels them into line by twos, by tens or by hundreds and binds them together? The power of the Infinite is upon them, for they are infinitely perfect in their workings. The hand that upholds and guides the earth and planets and the countless worlds that revolve through infinite space, guides the atoms of which all these worlds are made.

What a wide and marvelous range of functions has been bestowed upon certain elements! Carbon is a remarkable example which shows the almost unlimited possibilities of an element in helping to build structures of the most wonderful and diverse kinds. In its uncombined crystalline condition, it constitutes the diamond, the hardest of all known substances. In a second form it is known as graphite, or black lead, and in other forms as charcoal and lampblack. This hardest of all elements helps to form a countless number of compounds, some of which are gases, other liquids, and still others are solids. It is a necessary constituent of every plant and animal. It is found in the gas, carbon dioxide, which is a necessary food of plants. The same gas unites with many bases to form the many mineral carbonates that exist in nature. It is a part of a vast number of organic compounds which are of the highest importance to man and in the economy of life. Among these compounds are starch, cellulose, the various sugars, the many organic acids, the alkaloids, such as those in quinine, morphine and strychnine, the alcohols, the different fats and oils, and the numerous essential oils, and the long lists of hydrocarbons. These are but a few of the great number of compounds which carbon helps to form. So important is this element that the great branch of organic chemistry is often called the chemistry of the compounds of carbon.

In many compounds carbon is combined with hydrogen alone, in many more with hydrogen and oxygen, and in a large number it is united with hydrogen, oxygen and nitrogen.

It is indeed marvelous that these four elements, which constitute the great bulk of the organic world, can, by uniting in different ways, produce the vast number of compounds that constitute the great science of organic chemistry.

Carbon and hydrogen alone unite to form several long series of homologous compounds, and it is a most remarkable fact, that in the compounds of one series the elements exist in the same relative amounts. For example, the following six formulas of this series show that there are twice as many atoms of hydrogen as of oxygen in each compound. $C_2 H_4$, $C_3 H_6$, $C_4 H_8$, $C_5 H_{10}$, $C_6 H_{12}$, $C_7 H_{14}$. The analysis of any one of these compounds shows that there is by weight six parts of carbon and one of hydrogen, and from this it might seem that one formula would serve for each of the six compounds, and yet the chemist is certain from the specific gravities of the vapors of these compounds that the above are the correct formulas.

But more remarkable than the above is the fact that sometimes different compounds must be represented by the same formulas. For example, several different compounds have the formula $C_5 H_{10}$, and others the formula $C_2 H_4 Cl_2$. In these cases of isomerism the molecular weights of the substances are the same, and we can only account for the difference in the properties of the compounds by assuming that the atoms are combined in them in different ways. We can easily imagine that the fifteen atoms in the formula $C_5 H_{10}$ might be differently grouped with each other so as to form compounds of different qualities, on the same principle that fifteen blocks of two different kinds might be arranged in different ways.

I may here state that there is no distinction between Organic and Inorganic Chemistry. It was formerly thought that organic compounds could not be produced artificially from the elements or from inorganic substances, but that they could be built up by living organisms only, or produced from matter organized by plants and animals. Chemists have, however, especially in recent years, succeeded in manufacturing from the elementary substances themselves, or from inorganic compounds, a good many carbon compounds which are obtained from organic matter, or which are produced by plants and animals. And yet it is true that the processes of manufacture, as carried on artificially on the one hand, or by the living being on the other, are probably widely different from each other. It is probable that the life force of the living being is something more than the properties of the inorganic elements, and that it proceeds according to methods that cannot be followed in the laboratory. This seems the more probable when we remember that but few carbon compounds that exist in living beings have been artificially produced, and that we know almost nothing of the methods by which organic beings produce the great multitude of very complex organic compounds. It is beyond the truth for the chemist to claim that, in manufacturing a few carbon compounds in the laboratory, he is imitating the processes carried on in the living world. It is evident that the living organism uses methods which are unknown to the chemist, and which it is not probable can ever be imitated.

I need not say that no organized form of matter has ever been produced artificially. The chemist, I presume, does not even dream that he will ever be able to manufacture from the elements albumen like the white of an egg, nor a nerve fibre, nor cell, nor a grain of corn.

While the power of the chemist in manufacturing carbon compounds must certainly be regarded as one of the great triumphs of science, yet it must be admitted that it amounts to but little when compared to the work of living plants and animals.

I make the above remarks because there are those who seem to imagine that the chemist in the laboratory may imitate the great multitude of wonderful and unknown processes which are carried on in the living world, and that the laboratory, by the use of inorganic materials, may supersede the organic world in the manufacture of carbon compounds.

A fundamental doctrine in chemistry is that matter cannot be destroyed. The chemist relies on this as a well-established fact. We know of no method by which to destroy a single atom of matter. The chemist may separate substances from each other, or he may cause them to unite by bringing them together under certain conditions; he may change substances from the solid to the liquid and from the liquid to the gaseous condition; he may render matter invisible, or the reverse, but he cannot destroy it.

The indestructibility of matter is shown not only by experiment, but also by the fact that the mind of man is totally unable to conceive that something may become nothing.

III.

FORCE.

In this chapter I will consider briefly some of the forces of nature. Force may be defined as that which can put matter in motion.

Among the forces of nature may be mentioned light, heat, electricity, magnetism, chemical affinity, cohesion, adhesion, and gravitation.

Forces act upon bodies in two ways—they cause bodies to approach or to recede from each other; to attract or to repel.

As examples of the former, chemical affinity binds atoms together to form molecules; cohesion causes like atoms or molecules to cling together to form masses of matter; gravitation causes each atom in the universe to attract every other atom in the universe; and magnetism causes the magnet to attract iron or steel.

Heat, which causes bodies to expand, thereby separating more widely their molecules, generally acts as a repellant force. The like poles of magnets, bodies electrified alike, and currents of electricity in unlike directions repel each other.

Some forces act only at insensible distances. Chemical affinity, adhesion, and cohesion are examples. Gravitation acts at all distances. No limit can imagined at which two bodies cease to attract each other.

Our knowledge of force is derived from its effects on matter. Matter in motion shows force at work.

The lifted weight and the bent spring represent forces ready to do work.

It is assumed that energy is indestructible. The quantity of energy in the universe is constant. When one form of energy disappears it has become one or more other forms of energy.

Coal is burnt under a boiler. Chemical affinity causes the atoms of oxygen of the air and the atoms of the fuel to rush together with such enormous velocity as to generate a large quantity of heat. This heat increases the motion of the molecules of water until they are forced wide apart in the form of steam, and the expanding steam gives mechanical motion to the engine. The engine runs a dynamo, thereby converting some of its energy into electricity and magnetism, and the electricity is conveyed to a distant motor and is converted into magnetism and mechanical energy to run a car. Some of the electricity is converted back into heat, and some into light; or, again, it may be made to separate the atoms which united to generate the original heat.

Thus chemical force, mechanical force, electricity, magnetism, light, and heat are seen to be in succession manifestations of the same energy. I need hardly say that the correlation of the different forms of energy is one of the greatest discoveries of modern science. All forms of energy seem to be essentially one. Each may be converted into any of the others. And so the problem of energy is simplified; and yet it should be remembered that the highest powers of the human mind have been and are being taxed in endeavoring to explain the methods by which the forces of nature produce their results. Some of the problems involved are so subtle that it seems hardly possible that they can ever be solved.

How shall we explain magnetism, electricity, light, heat, and gravity? This question involves many difficulties, some of which are probably unanswerable.

Sound is known to be the vibration of air or other material media, and the pitch depends on the frequency of the vibrations. The lowest audible note is produced by 20 to 30 vibrations per second, and it is said that some ears can appreciate sounds made by 50,000 vibrations per second. The length of waves produced by 16 vibrations per second is about 70 feet, and the wave length due to 50,000 vibrations is about $^3/_7$ of an inch. The production of waves of sound requires an elastic medium. The medium, air for example, propagates sound by a series of longitudinal vibrations of the molecules of air, resulting in a series of condensations followed by rarefactions. Sound is one form of mechanical energy which is transmitted by means of waves through elastic material media,—at the rate of about 1,100 feet per second through air, at the ordinary temperature, but more rapidly than this through liquids and solids.

How can we explain the transmission of other forms of energy? of heat and light and gravitation through interstellar space? the motion of heat and electricity through material media? the attraction of magnets, and the drawing of atom to atom in chemical action?

It should be remembered that all matter is porous—that between the molecules of all gases, liquids and solids are spaces which are not occupied by any known form of matter. If these intermolecular spaces are an absolute vacuum, then we are left to account for the transmission of energy through a vacuum.

If we heat one end of an iron rod, the heat slowly creeps along until the whole rod becomes hot. In this case we may assume that the molecules of the end first heated are thrown into more rapid vibration, and that by concussion they communicate their energy to the neighboring atoms. The rate of transmission of heat in this way would be, at most, a few feet per hour. But radiant energy, such as the light and heat of the sun, flash through space at the rate of 186,000 miles per second. Electricity travels through a conducting wire thousands of miles in a second, and it is even claimed that it sometimes travels with the velocity of light. As to the velocity of gravitation and other forms of attractive energy, we are entirely ignorant.

We now inquire, Can energy manifest itself through an absolute vacuum?

Our knowledge of energy is that it is connected with matter, and manifests itself in and through matter, and not independently of it.

Shall we, therefore, assume that all space is full of matter, and that the energy of sun and stars is conveyed through infinite space by means of some kind of universal medium?

The theory now accepted by all physicists is that there is a medium, ether, not composed of ordinary matter, which fills all space except that occupied by the atoms of ordinary kinds of matter. It permeates all gases and liquids and solids, occupying the spaces between their molecules.

The belief in the existence of such a medium has been forced upon physicists for reasons so weighty that all have been led to accept it.

First, it is impossible to conceive the action of energy through an absolute vacuum. Newton felt the difficulty of trying to explain the action of gravity through a vacuum, and wrote as follows on the subject:

"That gravity should be innate, inherent, and essential to matter, so that one body may act on another at a distance through a *vacuum*, without the mediation of anything else, by and through which their action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly according to certain laws; but whether this agent be material or immaterial, I have left to the consideration of my readers."*

Again he writes in his queries: "Qu. 21. Is not this medium much rarer in the denser Bodies of the Sun, Stars, Planets, and Comets, than in the empty celestial Spaces between them? And in passing from them to great distances, doth it not grow denser and denser perpetually, and thereby cause the gravity of those great Bodies towards one another, and of their parts towards the bodies; every body endeavoring to go from the denser parts of the Medium towards the rarer? For if the Medium be rarer within the Sun's Body than at its surface, and rarer there than at the hundredth parth of an Inch from its Body, and rarer there than at the Orb of *Saturn*, I see no reason why the increase of density should stop anywhere, and not rather be continued through all distances from the Sun to *Saturn* and beyond. And though the increase of density may at great distances be exceeding slow, yet if the elastic force of the medium be exceeding great, it may suffice to impel Bodies from the denser parts of the Medium towards the rarer, with all that power which we call Gravity. And that the elastic force of the Medium is exceeding great, may be gathered from the swiftness of its vibrations," etc.†

*On Light, by Stokes, p. 16.
†Modern Views of Electricity, by Lodge, p. 406.

"Qu. 22. May not Planets and Comets, and all gross Bodies, perform their motions more freely, and with less resistance in this Aetherial Medium than in Fluid, which fills all Space adequately without leaving any Pores, and by consequence is much denser than quicksilver and gold? And may not its resistance be so small as to be inconsiderable? For instance, if this Aether (for so I call it,) should be supposed 700,000 times more elastic than our Air, and about 700,000 times more rare, its resistance would be above 600,000,000 times less than that of Water. And so small a resistance would scarce make a sensible alteration in the Motions of the Planets in ten thousand years," etc.*

I quote the above to show that Newton regarded a medium as necessary in order to explain the action of gravity.

I may here remark that of all the forces of nature, gravity is least understood as to its method of action. No theory has been offered that meets the difficulties involved.

The belief in the existence of ether, a universal medium, has grown out of facts connected with light. It is now admitted by the scientific world, that light consists of the vibrations of ether that can be recognized by the eye. While the vibrations of matter which produce audible sounds are limited to about 50,000 per second, the vibrations of ether which produce red light are 370 trillions, and violet light 739 trillions per second; and beyond the violet are invisible rays that vibrate at a still higher rate, while below the red are rays of heat which have a slower rate of vibration than the rays of light.

In the solar spectrum, produced by the passage of the sun's rays through a prism, we find heat, light

*Modern Views of Electricity, by Lodge, p. 406.

consisting of all the colors of the rainbow, and invisible rays beyond the violet, all arranged in definite order according to their rates of vibration.

As in music the different notes depend on different rates of vibration of air, so the different colors are due to the different rates of the vibrations of ether.

We know from experience that many notes may be sounded at once and all be audible to the ear. The air as a medium responds readily at the same time to many different rates of vibration, so that the ear can distinguish them as separate notes.

So ether responds to the many rates of vibration which are necessary to produce the heat and light and actinic rays that reach us from the sun. We sometimes speak of the seven colors of the rainbow, but this is simply a convenience, for the number is indefinitely great. They shade so gradually one into another in the rainbow that it is impossible for the eye to draw definite lines between them. This vast number of colors, together with the multitude of rates of vibrations that represent the different degrees of heat and of actinic rays, show that the motions of the ether, as represented in the rays of the sun, are inconceivably complex.

And when in addition to this we remember the fact that hundreds of thousands of stars have been seen, and that in order to see them the ether must respond at one and the same time to separate vibrations from all of these bodies scattered through infinite space, the methods of vibration become infinitely complex.

Instead of waves like those of sound, varying from half an inch to 70 feet in length, we find from forty thousand to sixty thousand waves in the length of one inch. How infinitely delicate must be the organ of sight that it may appreciate such extremely small disturbances of a medium so subtle and attenuated that all the science and ingenuity of man have failed to reveal its existence as matter! And yet scientists feel sure that ether reaches from the earth to the most distant star from which light has ever reached us. Marvelous indeed is the fact that there are visible stars so distant from us that it requires thousands of years for their light, traveling at the rate of 186,000 miles per second, to reach the earth! And yet the waves of light are flashed across infinite space, and travel on and on for ages without being lost, through an ether that is being perpetually agitated in every conceivable direction and manner by the ceaseless vibrations of countless worlds.

We look upon the telegraph and telephone as being wonderful means of communication—which they truly are—but light and heat flow with ceaseless activity from world to world with no visible means of transit through infinite space. The existence of life on the earth is rendered possible by the fact that the sun's light and heat are poured through ninety-two millions of miles of space that must be, so far as ordinary matter is concerned, an almost absolute vacuum.

It may be asked, why assume the existence of a universal medium? In answer to this it may be said that, from the transmission of sound through air and other media, and the transmission of heat and electricity through conductors, it might seem that a medium is necessary in order to convey energy through space. And yet it may be said that the qualities which are assigned to ether are so different from those of ordinary matter that analogy fails. But still the human mind is left helpless in the presence of the question as to how energy can pass through an absolute vacuum. It therefore assumes the existence of a medium.

In addition to this, the various facts connected with light,—refraction, diffraction, polarization, colors shown by films,—can only be fully explained by the undulatory theory which necessarily involves a medium. Besides, this theory easily explains the different colors of light, the differences in the qualities of heat, and the ultra violet invisible rays.

In order to explain the polarization of light, it is necessary to assume that the ether vibrates transversely to the line of radiation, instead of longitudinally, as in the case of sound.

What, then, must be the properties of a medium which can transmit radiant energy at the rate of 186,000 miles per second by means of transverse vibrations?

Among the various authors who have expressed their views as to the nature of ether, no one stands higher than Lord Kelvin. He expresses his views in the following language:

"What we know of the luminiferous ether is that it has the rigidity of a solid and gradually yields. Whether or not it is brittle and cracks, we cannot yet tell, but I believe the discoveries in electricity and the motions of comets and the marvelous spurts of light from them, tend to show cracks in the luminiferous ether—show a correspondence between the electric flash and the aurora borealis and cracks in the luminiferous ether. Do not take this as an assertion, it is hardly more than a vague scientific dream; but you may regard the existence of the luminiferous ether as a reality of science; that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity—a rigidity so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned, with the wave-lengths I have mentioned. The fundamental question as to whether or not luminiferous ether has gravity has not been answered. We have no knowledge that the luminiferous ether is attracted by gravity; it is sometimes called imponderable because some people vainly imagine that it has no weight. I call it matter with the same kind of rigidity that this elastic jelly has."*

"The luminiferous ether is an elastic solid for which the nearest analogy I can give you is this jelly which you see."†

"Now what is the luminiferous ether? It is matter prodigiously less dense than air—millions and millions and millions of times less dense than air. We can form some sort of idea of its limitations. We believe it is a real thing, with great rigidity in comparison with its density; it may be made to vibrate 400 million, million times per second; and yet be of such density as not to produce the slightest resistance to any body going through it."‡

He has also assigned to it a density which makes one cubic centimeter weigh .000,000,000,000,000,000,936 grain. "This density, although about the same as that of the atmosphere at the height of 340 kilometers, is yet enormously great as compared with that which air would assume in interstellar space. The rigidity of the ether, according to the same authority, is approximately one thousand-millionth of that of steel; so that masses of ordinary matter can pass through it readily."§

Lodge speaks of it as "a perfectly continuous, subtle, incompressible substance pervading all space and penetrating between the molecules of all ordinary matter which are imbedded in it and connected with one another by its means. And we must regard it as the one universal medium by which all actions be-

* Popular Lectures and Addresses, by Sir W. Thomson, pp, 328, 329.
† Ibid, p. 327. ‡ Ibid, 347. § Barker's Physics, p. 366.

tween bodies are carried on. This, then, is its function—to act as the transmitter of motion and energy."*

"As far as we know, it appears to be a perfectly homogeneous, incompressible, continuous body, incapable of being resolved into simpler elements or atoms; it is, in fact, continuous, not molecular.

"Gravitation is explainable by differences of pressure in the medium, caused by some action between it and matter not yet understood. Cohesion is explainable also, probably in the same way.

"Light consists of undulations or waves in the medium; while electricity is turning out, quite possibly, to be an aspect of a part of the very medium itself."†

"One continuous substance filling all space; which can vibrate as light; which can be sheared into positive and negative electricity; which in whirls constitutes matter, and which transmits by continuity, and not by impact, every action and reaction of which matter is capable. This is the modern view of the Ether and its functions."‡

"The vibrations of light are not such as can be transmitted by a set of disconnected molecules; if by molecules at all, it must be by molecules connected into a solid; *i. e.*, by a body with rigidity. Rigidity means active resistance to shearing stress, *i. e.*, to alteration in shape; it is also called *elasticity of figure;* it is by the possession of rigidity that a solid differs from a fluid. For a body to transmit vibrations at all, it must possess inertia; transverse vibrations can only be transmitted by a body with rigidity. All matter possesses inertia, but fluids only possess volume elasticity, and accordingly can only transmit longitudinal vibrations. Light consists of transverse

* Modern Views of Electricity, by Oliver J. Lodge, p. 339.

† Ibid, 338. ‡ Ibid, p. 358.

vibrations; air and water have no rigidity, yet they are transparent, *i. e.*, transmit transverse vibrations; hence it must be the ether inside them which really conveys the motion, and the ether must have properties which, if it were ordinary matter, we would style *inertia* or *rigidity*. No highly rarefied air will serve the purpose; the ether must be a distinct body. Air may *exist*, indeed, in planetary space, even to infinity, but if so, it is of almost infinitesimal density compared with the ether there."*

"So at a height of only 4,000 miles above the surface, the atmospheric density is a number with 127 ciphers after the decimal point before the significant figures begin." The density of ether, as calculated by Sir William Thomson, is represented by a decimal "with only 17 ciphers before the significant figures. In interplanetary space, therefore, all the air that exists is utterly negligible; the density of the ether there, though small, is enormous by comparison."

It is known that ordinary forms of matter are not necessary for the transmission of light, for it passes readily through the most perfect vacuum.

It also passes through the diamond—the hardest known solid, but with less velocity than through the vacuum. If ether serves as a medium for light in a vacuum, it is probable that it also serves as a medium in the diamond. There is nothing to justify the conclusion that the molecules of a transparent solid serve as a medium for radiant energy. The high rate of speed at which light traverses such bodies excludes the belief that solids act as conductors of light as they do of heat.

The following are some of the conclusions with regard to ether:

* Modern Views of Electricity, by Oliver J. Lodge, p. 340.

It occupies all space except that occupied by atoms of matter.

It must be capable of transmitting light at the rate of about 186,000 miles per second.

It must offer almost no resistance to the motions of the heavenly bodies, for we know that the earth has been moving through it for millions of years without having its motion destroyed—it is now moving at the rate of about 19 miles per second.

It must be non-condensible by gravity, for if it could be thus condensed, as can our atmosphere and all other gases, it would be too rare in interstellar space to transmit radiant energy by transverse vibrations. This makes it necessary to assume that it is a continuous substance, *i. e.*, that there are no vacant spaces between the atoms of ether, unless it should be assumed that it is a substance which is free from gravity. With freedom from the effects of gravity we might imagine ether to be uniformly distributed through all space, and composed of molecules that are not in contact, *i. e.*, that ether is porous.

However this may be, ether must possess great rigidity compared with its density in order that it may transmit transverse vibrations.

It must be capable of receiving and transmitting the vibrations of the atoms and molecules of ordinary matter. The different kinds of heat and light represent different rates of vibration of atoms and molecules. Radiant energy displays the activity of atoms and molecules,—in dealing with it we have to do with the properties of elements.

The spectroscope reveals the fact that in studying light we gain a knowledge of the qualities of the atoms of matter. Light might be called the music of vibrating atoms. White light is the perfect harmony of all the vibrations of light.

Ether must not only receive vibrations from atoms, but it must impart them to other matter. The earth is dependent on the mechanical work done by the radiant energy of the sun.

The fact that it requires force to move ether and that ether in motion can impart motion to matter, indicates that ether possesses inertia.

It is evident that if ether is composed of atoms they must be vastly smaller than the atoms of ordinary kinds of matter, since it permeates the hardest solids.

Thus we have in ether a hypothetical substance which has never been detected as matter,—which, in fact, must be extremely different in its properties from any known form of matter. All modern physicists have assumed the existence of ether as a necessary medium for the transmission of radiant energy, and also of other forms of energy.

Science is driven to assume the existence of a universal medium, and, without the aid of analogy, in order to perfect her theories. She regards the existence of ether as certain—as a matter no longer to be called in question.

And so we may rest in the conclusion that nearly all space is filled with an infinitely subtle substance which possesses marvelous properties, which are, for the most part, extremely different from those of ordinary matter. If ether is a continuous substance, then no part of space is an absolute vacuum—the atoms of matter and of ether completely fill all space.

With space thus filled we are relieved of the necessity of assuming that force is transmitted through a vacuum.

With ether as a universal medium can we explain the action of the various forces? Can gravity, magnetism, electricity and chemical affinity be thus explained? Do motions of ether account for the action of each of these forces?

When we speak of ether as a medium for the transmission of force, we exclude the idea that ether itself is energy. Force is, by definition, that which can put matter in motion, and in defining matter we would be obliged to include ether. The existence of ether gives us no conception of force itself, but it simply serves to explain the transmission of certain forms of energy.

As to gravity, we can yet form no adequate conception. What sort of motions and distributions of an almost infinitely thin, non-resistant material like ether, will explain gravitation? The mind can form no adequate conception as to how the motion of ether will account for this force. It would seem that ether, which offers no perceptible resistance to the motions of the planets, is entirely inadequate as a medium to explain the action of gravity. That one body may put another in motion implies inertia and resistance in both. We know that a body falling towards the earth soon acquires a great velocity. What adequate reason have we for believing that moving ether is pushing the falling body? or that the pressure of ether is greater on one side of the falling body than on the other?

It is true that Newton and others have felt it necessary to assume the existence of ether in order to explain gravity, and yet, with ether as a medium, the human mind has made no progress in formulating an adequate theory of gravity.

If we consider chemical affinity which binds atom to atom to form molecules, the method of action is as uncertain as that of gravity. Indeed, Sir W. Thomson seeks to explain capillary attraction by the law of gravitation. He says, "Until we see how gravity itself is to be explained as Newton and Faraday thought it must be explained, by some continuous action of intervening or surrounding matter, may we not be temporarily satisfied to explain capillary attraction merely as Newtonian attraction intensified in virtue of intensely dense molecules movable among one another, of which the aggregate constitutes a mass of liquid or solid."*

Again he says, "Hence, unless we find heterogeneousness and the Newtonian law of attraction incapable of explaining cohesion and capillary attraction, we are not forced to seek the explanation in a deviation from Newton's law of gravitational force."†

May we regard the attractions of molecules and atoms as due to the force of gravity acting at insensible distances? When a mixture of one volume of oxygen with two volumes of hydrogen explodes to form water, is it due to the fall of these atoms against each other, produced by gravitation?

If we answer in the affirmative, the answer is simply an unknown quantity.

If we seek to explain how ether acts as a medium in chemical affinity, we fail to do so.

It may be that electric currents are ether in motion through certain media, and that magnetism is due to ether moving in vortices.

Magnetism acts readily through a vacuum and through solids, liquids, and gases. Neither the total absence of matter nor the presence of the densest solids interferes with its action. It may be that the motions of ether will explain the facts of magnetism. In fact, we are compelled to choose between ether and an absolute vacuum in explaining the action of all attractive forces. Shall we accept the theory that a

* Popular Lectures and Addresses, pp. 9, 10. † Ibid, p. 4.

substance can exist all around and in us which we cannot detect with any of our senses, or shall we believe that energy can pass through a vacuum? We know that matter may exist in such conditions that it does not appeal to our senses. When the atmosphere in which we live is perfectly quiet it excites no one of our senses, and we are unconscious of its existence. If this is true of matter so dense as our air, it can easily be imagined that a substance might exist so attenuated as to escape our senses. We cannot weigh ether, because we cannot exhaust it from a vessel, owing to the fact that it passes readily through the densest solids; nor can we, for the same reason, condense it.

It may be said, however, that ether in motion as light, heat and electricity, appeals to the senses.

We must, in fact, believe in the existence of ether unless we choose to fall back upon the corpuscular theory of radiant energy—a theory which totally fails to explain many of the phenomena of light.

We conclude, therefore, that all space in the universe is filled with matter and ether, every atom of which is in constant agitation; that each can receive motion from, and impart motion to, the other, and that by means of ether as a medium, the radiant energy of the universe may be distributed through space with the velocity of light. According to this view all physical energy is held by matter and ether.

Matter is continually imparting its radiant energy to ether. Must not the time finally come when all the energy of matter which can be radiated will be imparted to ether and dissipated through infinite space? The quantity of matter in the universe is finite, and consequently the quantity of energy in this matter is finite. It cannot, therefore, require infinite time in which to part with its radiant energy. Owing to the radiation of energy it would seem that sun and stars and all material things must finally become dark and cold.

Even if we claim that the concussion of falling bodies generates the light and heat of the universe, yet it is evident that with infinite time a finite number of finite quantities of matter must do their work and part with their energy.

Looking backward we might ask, If sun and stars have existed through an infinite past, how is it possible for them to be in their present highly heated condition? We know that they are material bodies, and that, like other bodies of matter, they must part with their heat and light. It is evident, therefore, that they cannot have had their present high temperatures through an infinite past. The present high temperature of the sun has, according to any physical theory, been maintained but a few millions of years at most. The vast sums of energy in matter have in some way been stored up there within finite time, and the finite future will serve to dissipate this energy through infinite space.

It may be claimed that past time is infinite, that matter has existed during the infinite past, and that, consequently, the fact that much of it is so highly heated is evidence that worlds may be kept glowing with light and heat through an infinite future. In answer to this we may say that we know of no physical means by which a finite quantity of matter, surrounded by an infinite quantity of ether, could be kept hot through infinite time—and this for the reason that the light and heat of this matter would be radiated into infinite space, with no known method by which they could again be concentrated in matter.

The present concentration of energy in matter, as we see it in the sun and stars, has taken place within the finite past,for the evident reason that they cannot have radiated light and heat through infinite time and still be highly heated. The present energy of the heavenly bodies has been stored in them within a finite past, and must be dissipated within a finite future. The present condition of the universe is temporal. There must, therefore, be a power unseen and eternal, unconditioned, that has established the visible universe in its present condition. The universe as it now is cannot be explained according to known physical laws. We must assume something more than matter and ether in motion—we must at least predicate a cause of motion.

IV.

METHOD OF CREATION.

THERE exist on the earth at present from a million to a million and a half species of animals and vegetables,* and it is commonly believed that the number of extinct forms is many times greater than the living. These organic beings are divided into kingdoms, sub-kingdoms, classes, orders, genera, species and varieties.

It is taught by evolution, that beginning with protoplasm, derived by spontaneous generation from inorganic matter, the process of evolution, acting through secondary agencies alone, has, from this primordial protoplasm by ordinary generation and by processes strictly natural, but in no case supernatural, derived the countless multitude of animal and vegetable species that have appeared upon the earth. The primordial protoplasm was the parent from which all organic beings have descended.

Spontaneous generation being strictly a natural process, a process so rare, according to some authors, that we need not expect it to be repeated, the existence of all organic species, including man, was suspended on the production of life by strictly natural processes which are still in operation, but which are persistently refusing to produce a similar result.

If there is an intelligent Creator, it would seem that he carried rashness to the verge of destruction when

*The Interpretation of Nature, by N. S. Shaler, p 149.

he suspended the possible existence of life upon secondary agencies which have acted for at least a hundred million years* upon the earth, but which in all that time have been able to produce and propagate the primordial protoplasm only once. It was indeed fortunate that the one and only possible card of fortune in the lottery of infinite impossibilities was drawn so early in the geological history of the earth, so that there would be an abundance of time while the sun retained its light and heat to evolve the countless species of living beings, the highest of which culminated in man. It is a significant fact in the existence of living beings that they appeared so early in the history of the earth.

From the dead, unconscious matter that we tread beneath our feet, we may, according to the theory of evolution, ascend by secondary agencies alone, by virtue of "the laws impressed on matter by the Creator," as Darwin has expressed it, through spontaneous generation, on and on, through an infinite number of organic forms till we reach the mind of man, which is the pinnacle of evolution.

I need not say that Darwin in "The Origin of Species," has given to the world most of the facts and arguments that have been urged for and against the theory of organic evolution. Perhaps no other scientific book has ever done so much in so short a time to turn human thought aside into a new channel.

Before proceeding to consider the facts which bear upon the theory of the evolution of organic forms, I will present the possible Theistic theories according to which new organic forms may have been brought into existence.

First, the Creator may have created each species by

*The Interpretation of Nature, by N. S. Shaler, p, 122.

means of secondary agencies alone, by the process of evolution.

Second, he may have created each species from inorganic matter by means of a special fiat.

Third, he may have created certain types of living beings from inorganic matter by special fiats, and from these types he may have evolved, by secondary agencies, all other forms.

The existence of secondary causes implies a primary cause. The unity in nature shows that the primary cause is one and not many.

The method of creation is nothing except as it bears on our interpretation of the nature of the creative power. Theism stands in no danger from creation by secondary causes, for they are consistent with the existence of an intelligent Creator. Evolution may be atheistic, but it is not necessarily so. Either of the above methods of creation may be Theistic.

Evolution, if true, is only the immediate explanation, but the vital question is, What is the nature of the final Cause as indicated by the secondary causes?

Evolution, in the belief of the Theistic evolutionist, is due to secondary agencies working according to established law through all ages, under the guidance of the Divine Mind. The action of natural causes has been continuous, and it is believed by evolutionists generally that they are sufficient to account for the present condition of things in the universe.

On the other hand, it is evident that a failure in the sufficiency of secondary causes to produce a known result, renders it necessary that the Primary Cause should come to their aid.

Each new form that is created involves to a certain extent a change in the method of creation. It may not demand new agencies, but it requires at least a change in the method by which the agencies work.

When we speak of secondary causes, we imply the existence of a Primary Cause from which they have sprung. If matter and the forces of nature are secondary causes, then their existence is due to the Primary Cause, and their creation required special acts of that cause. Darwin speaks of "the laws impressed on matter by the Creator." The impression of these laws on matter must have required special fiats of the Creator. Spencer attributes all known phenomena to the Unknown and Unknowable Power.

It seems to me that at least several fiats were necessary in creation, namely, the creation of matter, the creation of the forces of nature, the creation of the first living being, the creation of the senses, the creation of instincts, and the creation of the mind of man. These are exceptional kinds of work, which demanded, I think, the exercise of exceptional kinds of power, or they demanded exceptional methods of the action of secondary agencies, which could be brought about only by the acts of the Primary Cause.

It is conceivable that the Creator's method may be similar to that of man in dealing with nature. Man accomplishes an endless number of purposes by making use of existing matter and forces.

A special act of the Creator does not involve the abandonment of the use of secondary agencies, but it may be a special use of these agencies, so that they accomplish work which they would not otherwise perform. The mind of man is a controlling agency in the affairs of the earth. Mind perpetually interferes with the workings of nature, directing her forces into new channels, and thus producing results which are as wonderful as miracles. It is the prerogative of mind to rule over all else—to subdue, combine, direct and fulfill the endless purposes of intelligence.

The Creator has made the universe. Its laws are his laws. Its present condition is due to him. We may say that he created nature and left it to its own workings, or, on the other hand, that the workings of nature are due to his immediate presence and the perpetual exercise of his power.

That the Creator would make the universe and then separate himself from it, as if he had no interest in it, seems to my mind wholly improbable. "In him we live and move and have our being," expresses, I believe, a scientific truth. He is a universal presence and power in and through nature at all times. All power is his power, and all the workings of nature are due to him.

"For of him, and through him, and unto him are all things." "For your Father knoweth what things ye have need of, before ye ask him."

"Are not two sparrows sold for a farthing? and not one of them shall fall on the ground without your Father; but the very hairs of your head are all numbered."

"The glory of the Lord shall endure forever: the Lord shall rejoice in his works. He looketh on the earth and it trembleth: he toucheth the hills and they smoke."

"The Lord reigneth; let the earth rejoice." "His lightnings enlightened the world: the earth saw, and trembled. The hills melted like wax at the presence of the Lord, at the presence of the Lord of the whole earth."

The Bible represents the Creator as a present, living, intelligent God, who is interested in his works, and who is ever working in and through nature. The forces of nature are the power of God, and the results produced by these forces are due to his will.

We are not to look on the Universe as a complex machine which the Creator has made and set to work, and from which he has withdrawn himself and which he views as a spectator, but we are to regard its operations as being due to his omnipresence and to the perpetual exercise of his power, and believe that all things are done with absolute wisdom.

Whatever may be our theory as to the nature of the first Cause, we must believe that the Universe, as it exists, is the best possible.

If the Creator is destitute of intelligence, then it is evident that the Universe, as it is, was the only thing possible. If, on the other hand, the Creator is a God of intelligence, wisdom, mercy and love, it is evident that in creating the Universe he manifested to the fullest possible extent the nature of his attributes.

We have no reason to believe that nature might have been better, that it is imperfect, and that things are out of joint. It is impossible, from our limited view of things, that we should be able to show a lack of wisdom in the works of the Creator of an infinite Universe.

Our capacities, and time, and opportunities for knowing are all extremely limited, and these things would suggest that we are not prepared to pronounce adverse judgments against the attributes of an infinite Intelligence working through eternity.

The fact that the work of creation has advanced from inorganic matter to the mind of man, would of itself, in a general way, seem to indicate the wisdom and beneficence of the Creator.

The vital question at issue with regard to the creation of living beings is as to the nature of the Creator. At bottom the question as to the method of creation is only a dispute between Theism and Atheism. If the existence of all things can be explained in terms of matter and force, then Atheism triumphs. If the existence of a Supreme Spirit must be assumed in order to account for the present condition of things, then Theism is established.

Whether the Creator created living beings suddenly or slowly, whether he made them directly from inorganic matter or created some from others by the process of evolution, whether he created by fiat or by the use of secondary agencies, is of importance only as it helps us to understand the nature of the Creator himself.

It is certain that the bodies of all animals and plants consist of a few simple kinds of ordinary matter. It is certain that the plant gets its food from soil, water and air, and that its tissues are converted into the tissues of animals. The plant is not the less noble that its cells are made of inorganic matter, nor the animal the less elevated because its body is constructed of the materials furnished by plants, nor is man less spiritual because he subsists on animals and plants and minerals.

If the plant can grow into an animal, if the worm can be developed into a fish, the fish into a reptile, the reptile into a mammal, and the mammal into a man, then the fact of such origins does not degrade the higher forms into the lower, but it shows the greatness of the Power that has created them.

But we would be blind, if, having concluded that the above was the method of creation, we should also affirm that soil, plant, worm, fish, reptile, mammal and man are essentially alike. The attempt to prove this is a mistake which has been made by some evolutionists.

It is this effort especially that the Theist resists, for he regards it as Atheism. He denies that man is only matter and force. He denies that all the members of the series, although constructed of the same material elements, are essentially alike. He denies that man can be explained in terms of the mammal, and so on back till all are explained in terms of a common soil and sunshine.

He believes that as we ascend the scale, whether by evolution or otherwise, something more than dynamics must be appealed to in order to account for the marvelous progress.

If we knew that man was made directly from inorganic matter, then there could be no question as to the existence of an intelligent Creator. The miracle is evidence of supernatural power.

A miracle producing a small change is as strong proof as one producing a great change, but in the former case there is more room to question the fact as to its being a miracle. For example, the creation of a single living cell—an amoeba—directly from inorganic matter might possibly be regarded as a case of spontaneous generation, while the creation of a man in a similar way would be an undoubted miracle. On account of the doubts thus arising as to the cause of small changes, which constitute the method of evolution, the Theist is slow to accept this as a substitute for the older belief. My own conviction is that, whatever the method, it is Divine. Equal results require equal causes, whether produced suddenly or prolonged through the ages.

V.

SPONTANEOUS GENERATION.

THAT living beings have had a beginning on the earth all scientists admit. As to when they began it would be useless to inquire, but it was, without doubt, at a time vastly remote.

The authentic geological record of plants and animals extends backward, perhaps, fifty million years, and it cannot be claimed that the oldest known fossils represent the first organisms that were created.

We do not know from the geological record whether the plant and the animal appeared simultaneously, or whether the plant preceded the animal.

It is believed by some geologists that the oldest known fossil is the Eozoon canadense, and that this is the skeleton of a very low, but not of the lowest, form of animal life. The weight of opinion of the latest authorities is, I think, that Eozoon is not a fossil. If it represents an animal it is evident that plants must have existed, as food, at the same time, for it is well known that no animal can live exclusively on inorganic food. The presence of graphite in the rocks in which Eozoon is found can be explained by supposing that it was obtained from organic matter.

I make these remarks to show that we cannot look to the geological record to reveal the beginning of life.

The only known method of producing a plant or animal is by means of one or more parent organisms.

As long as there is no necessary break in this method it must be exclusively accepted.

But the break in the chain of ordinary method when we come to the first living organism is abrupt—it is a great gulf reaching from the dead to the living. There is no greater chasm in nature than that between dead matter and a living being, unless it is that between mind on the one hand and matter and force on the other.

It is a gulf which science cannot bridge. We have not even the aid of analogy when we try to explain the origin of the first living being. The parents, according to the theory of abiogenesis, are inorganic matter and the forces of nature, and these are not analogous to a living parent.

Some evolutionists speak lightly of the "special-act" theory of creation. The beginning of life on the earth involved a special act of some kind. Whether the Creator worked directly or indirectly, the act of creation was no less special. If the first living being was brought into existence by the Creator through the exercise of secondary agencies, it required a special directing of these agencies to produce the result, and this is all that the Theist needs to mean by the word miracle. We are driven to assume a special act of the Creator by the break in the method of producing new organic beings by ordinary generation, and by the failure of the theory of spontaneous generation. I will now proceed to briefly examine this theory.

Let us get clearly before us the nature of the problem to be solved. Every living being, whether plant or animal, must have as constituent parts of its body at least four elements, namely, carbon, hydrogen, oxygen and nitrogen. These four elements, either free or in combination, or both, exist abundantly in all parts of the earth. The forms of plant food which the plant commonly uses, are carbon dioxide, represented by the formula CO_2; water, the formula of which is H_2O, and ammonia, with the formula NH_3, and a nitrate, with the formula KNO_3.

The plant obtains its carbon from carbon dioxide, which it takes from the air; its hydrogen and oxygen mostly from water, which it obtains from the soil, and its nitrogen from some compound of ammonia or some nitrate, both of which it gets in solution in water from the soil.

It will be noticed that the formulas of these plant foods are simple; that is, the molecule of each kind has but few atoms, as shown by the formula. The plant alone, and not the animal, has the power to take these comparatively simple inorganic compounds and, by the aid of heat, light and the other usual physical conditions, convert them into the exceedingly complex tissues that compose its body. The most essential of these tissues, the one that is necessarily present in every organic being, is protoplasm. This is the substance in which life manifests itself especially. It is composed of the four elements named above, and it is exceedingly complex in its structure, each molecule of protoplasm containing hundreds of atoms. One of the formulas given for protoplasm is $C_{72} H_{112} N_{18} S O_{22}$.

In order to prove that spontaneous generation has taken place, it would be necessary to show that a living being, composed of the exceedingly complex substance, protoplasm, capable of propagating its kind by the ordinary method of generation, can be produced from the above four elements and their compounds, by the action of the forces of nature. It will be noticed that this is not simply a question of chemical composition, but also of life and of ability to propagate its kind. Dead protoplasm may have the same chemical composition that living protoplasm has, and even living protoplasm may be wholly unable to produce other protoplasm.

Did nature in her laboratory, through the secondary agencies of matter and force alone, create the first living organism, with the wonderful power of propagating its kind?

If she has done this we are absolutely ignorant of the fact. There is no case of analogy from which we can conclude that she thus creates living beings from dead matter. Besides this, the facts, so far as known, point in the other direction. It should be remembered that spontaneous generation is a necessary part of the theory of evolution as held by most evolutionists.

If natural forces acting on matter in the usual way ever created living beings, I know of no reason why this process should not have continued through all time since the first living being appeared. It is not commonly claimed that spontaneous generation is taking place at present. A few years ago the scientific world was much agitated over the subject. Dr. Bastion thought that, beyond doubt, he had shown that spontaneous generation takes place from organic infusions. Then followed Tyndall with almost a thousand experiments, in which he proved to the satisfaction of the scientific world that spontaneous generation does not take place from organic infusions; that, so far as experiments show anything, it is that a living organism must have had a parent organism.

It will be noticed that in these experiments he and others used water which already contained organic matter. The protoplasm necessary to form the body of the new living organism was ready made and at hand. If living beings could not come into existence from this highly organized matter, which can serve as animal food and of which their bodies are made, what hope can there be that they can originate from very simple forms of inorganic matter? If spontaneous generation has taken place, it is still a legitimate problem for the laboratory to solve. If it has taken place in nature, then I can see no reason why it may not be repeated time after time.

It is admitted by some scientists that it is not now taking place, and it is assumed by them that it is an occurrence so extraordinary that we ought not to expect it to be repeated. But why extraordinary? Spontaneous generation, as believed in by most evolutionists, is simply a matter of chemistry, and certainly no chemical action can be regarded as being so extraordinary that it may not be repeated.

We have good reason to believe that life began millions of years ago under physical conditions that substantially exist in many parts of the world to-day, and that have existed from the first dawn of life.

The earth is one vast laboratory in which every moment are taking place countless millions of experiments. The materials for the construction of organic beings are everywhere present, and the same forces are ceaselessly doing their work, as they have been from the first. To conclude that under the numerous and widespread conditions favorable to the existence of life, which have so long existed and which still exist in the earth, spontaneous generation, a chemical problem, could have been produced but once, or only a few times, is beyond belief.

In view of the presence of such conditions, extending through the many millions of years since life began, nature ought to have successfully repeated the experiment resulting in spontaneous generation a great many times. And yet all the known evidence is against the belief that nature can create a living organism from dead matter.

If, therefore, we cannot look to spontaneous generation, which represents only secondary causes, we must look beyond to the First Cause as the Creator of life.

I am aware that there are those who question the legitimacy of this conclusion. There are those who claim that matter and the forces of nature are the only cause, and they, of course, must believe that spontaneous generation has taken place.

The functions performed by the living organism, however simple it may be, are so different from any thing in the inorganic world that *a priori* we would not expect the former to spring from the latter by spontaneous generation. The functions of the organism, including the prehension, digestion, circulation, and assimilation of food, the reproduction of other organisms like itself, and then decay and death, followed by the return of the body to comparatively simple inorganic forms of matter, constitute a cycle of changes for which we find no analogy in the inorganic world.

It is true that the chemist has manufactured certain organic compounds from their inorganic elements, but in no case has he been able to produce from inorganic matter an organic compound that is an essential part of the tissues of a living being, and, least of all, has he been able to manufacture protoplasm, which is the absolutely essential substance in every living thing. And even if he could build up protoplasm by starting with the elements, a thing which is beyond all hope, still the manufactured protoplasm would be destitute of life, and the question as to the origin of life would remain unanswered.

Dead protoplasm can neither grow nor propagate. Every living organism has an individuality and structure, and it performs functions which are beyond the power of the chemist to produce.

Nor is there any physical science which can throw light upon this subject. Chemistry, Anatomy, Physiology, Biology and all the microscopes serve only mechanical purposes—they cannot reveal the origin of life. We will wait in vain for science to speak with authority in this matter. The known facts of science are, I believe, opposed to the theory of spontaneous generation.

It is evident that with this state of facts there can be no conflict between science and religion with regard to the origin of life. Science admits that she knows nothing on the subject, but at the same time many evolutionists deem it necessary to defend the theory of abiogenesis as being necessary to complete that 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."

The creation of the first living being was an exceptional kind of work which required the exercise of an exceptional kind of power. If, as Mr. Darwin says, life was breathed by the Creator into the first forms, this constitutes a break in the sufficiency of natural causes alone to produce life. If a special fiat was necessary at this point, why may it not have been at others?

The insufficiency of natural causes makes it necessary to assume the exercise of some power that can control nature, and thus produce results that would not otherwise have been produced. The creation of a living being from inorganic matter by the Creator was, so far as I can see, no more an interference with the processes of nature than is my voluntary act in writing these words. In each case the result is due to a power that does not exist in the inanimate world.

VI.

NATURAL SELECTION.

THE theory of "Natural Selection" has been most elaborately argued *pro* and *con*, by Mr. Darwin, in "The Origin of Species," and on this theory he, for the most part, relies to explain the evolution of organic forms.

The general facts concerning it are the following: The earth can produce but a limited supply of food for living beings. Every species of plants and of animals multiplies its kind in a geometrical ratio, so that if all the young of any species of organism could live to the average age of those of its kind that arrive at the age of maturity, the earth would in a few generations be filled by the individuals of that species. As a matter of fact this is not the case, for the earth is occupied by hundreds of thousands of organic forms.

The whole possible number of organisms that can live on the earth at one time, is limited by the possible quantity of food at their disposal. Taking the birth-rate of organisms and the quantity of food at their disposal, it is evident that most of them must perish before arriving at the age of maturity, for lack of food, if for no other reason.

In many cases the number of animals living is much less than the food will support, there being frequently a superabundance of food that goes to waste.

It is, therefore, evident that nature has some means of destroying most organic beings that are produced before they arrive at the age of maturity.

The supply of food being insufficient to support all of the organic beings that are produced, a struggle to obtain that food is perpetually going on, in which the great majority, being necessarily unsuccessful, perish. Everywhere in the organic world is perpetual competition, warfare, a "struggle for existence," in which, other things being equal, the weaker perish.

A second fact in the theory of natural selection is that the offspring closely resemble the parents.

A third fact is that the offspring are never exactly like the parents. The variation from the parent form may be in shape, size, color, and, in fact, in an endless number of respects.

It is claimed by Darwin that the variation at any one time is, as a rule, extremely small; so small, in fact, that it would not be noticeable.

Again, it is claimed that if any variation is useful to the individual possessing it, if it enables it the better to compete with its kind and with other organisms for food, or if it gives it an advantage in escaping from its enemies, or an advantage in any other respect over others of its species, then it will survive, while those less favored will perish.

It is further claimed that the useful variation will be propagated, so that the offspring of the individual which possesses the favorable variation will stand a better chance of surviving than those that have not favorably varied. In this way, therefore, Nature is continually selecting the forms that are best able to compete with other organisms for existence. To express this process Mr. Darwin has used the expression "Natural Selection," and Herbert Spencer the expression "Survival of the Fittest."

It is further claimed by Darwin, and by evolutionists generally, that, given a sufficient length of time and slowly varying conditions, such as exist upon the earth, there is no practical limit to the amount of variation of organic forms that may slowly take place, and that natural selection is, for the most part, sufficient to account for the preservation of favorable variations, thus accumulating them in certain directions. It is not, however, commonly held that natural selection alone will account for the evolution of all organic forms.

Darwin says that "Natural selection acts solely through the preservation of variations in some way advantageous, which consequently endure." Again he says, "It may metaphorically be said that natural selection is daily and hourly scrutinizing, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in process, until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were."

Again he says, "I believe that animals are descended from at most only four or five progenitors, and plants from an equal or lesser number.

"Analogy would lead me one step further, namely, to the belief that all animals and plants are descended from some one prototype. But analogy may be a deceitful guide."

In these quotations are clearly set forth the general claims of the theory of natural selection.

It is true that in the organic world there exist the two tendencies above named, the tendency of the offspring to closely resemble the parent, and the tendency to vary somewhat from the parent. The essence of the theory of organic evolution is involved in the relative strength of these tendencies. They may be compared to the centripetal and the centrifagul forces.

Is there an orbit of variation for each species beyond which the tendency to variation cannot carry the form? Is the tendency to resemble the parent a centripetal force that can forever hold the amount of variation within a definite orbit? or, on the other hand, does the centrifugal force carry the new forms off in tangents so that there is no return to the ancestral form?

It is evident that if the theory of natural selection is true, it is not a complete theory of organic evolution. It accounts only for preserving certain forms instead of others. Darwin says, "Natural selection acts solely through the preservation of variations in some way advantageous, which consequently endure."

Again, he says, "I have called this principle by which each slight variation, if useful, is preserved, by the term Natural Selection, in order to mark its relation to man's power of selection."

Natural Selection attempts, therefore, to account for the preservation of certain variations, and not for their production. As to the causes and the amount of variation, no satisfactory theory has been given. Darwin, after assigning various reasons why he thinks variations may take place, says, "Our ignorance of the laws of variation is profound. Not in one case out of a hundred can we pretend to assign any reason why this or that part has varied." And so it happens that we are left in almost total darkness as to the cause of the most important factor in organic evolution. A complete theory of evolution by secondary agencies alone demands an explanation of the causes of variation.

It may be that the causes of variation are purely secondary, or it may be that variations are produced by secondary agencies under the direct control of the Creator, or they may be produced by special fiats. It is evident that with these alternatives the evolutionist has no right to urge the theory of secondary causes alone, and this is especially true if, by secondary causes, is meant causes that may work independently of the direct control of the Creator, for the use of the expression, secondary causes, implies the existence of a Primary Cause, and known facts do not justify us in assuming that any part of the Universe can run itself if severed from the Primary Cause. That every event must have an efficient cause there can be no doubt, but there may be grave doubts as to whether a cause is to be regarded as secondary or primary.

The following closing paragraph of "The Origin of Species" contains a general summary of Darwin's theory. "It is interesting to comtemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each, and dependent on each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance, which is almost implied by reproduction; Variability from the indirect and direct action of the conditions of life, and from use and disuse; a Ratio of Increase so high as to lead to a struggle for life, and as a consequence to Natural

Selection, entailing Divergence of Character and the Extinction of less improved forms. Thus from the war of Nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows. 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, while 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."

From this passage it is seen that Darwin did not accept the theory of spontaneous generation. He speaks of "life with its several powers, having been originally breathed by the Creator into a few forms, or into one." This first form was the egg from which all subsequent organic beings have been hatched by incubation through the long ages. This primordial protoplasm, which, according to most evolutionists, was produced by spontaneous generation, was, it seems to me, endowed with miraculous power, as shown by its ability to vary without limitation in countless directions, to produce the most complex physical results and all the varied and wonderful phenomena of life, together with the human mind with all of its marvelous powers.

If the Creator could breathe life into "a few forms or into one," as Darwin thinks he did, without violating the law of his own being, and in accordance with the laws which he has established, it seems evident that he might at other times breathe life into other forms in accordance with his laws. I see no necessity for a logic that would compel the Creator to confine the number of his creative fiats to a few, or to one, nor which would limit the fiats to one time.

With most evolutionists the backbone of their theory is the assumption that secondary agencies alone have produced all organic forms.

Darwin says, "To my mind it accords better with what we know of the laws impressed on matter by the Creator, that the production and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and the death of the individual." The "secondary causes," as I understand him, are "the laws impressed on matter." If this is true, then it would seem that the Creator might have retired after creating matter, or, at most, after creating the first organism, and have let the work go on without his further special care.

Again, Darwin says that the facts, so far as he can judge, do not "afford any evidence of the existence of an innate tendency toward perfectibility or progressive development." * Again, he says, "I believe in no law of necessary development."

As for myself, I believe that mind was the goal of creation which the Creator had in view. No other theory gives a sufficient explanation of creation. Without mind as the crowning work I would say that creation would have been a failure.

Does Mr. Darwin accept the theory that mind was the intended goal of creation? And, if so, would he say that the "secondary causes," "the laws impressed on matter by the Creator," had the necessary tendency, beyond the possibility of failure, to evolve man endowed with mind? I think that he does not accept this view.

If the theory of evolution is true, the unbroken chain of organic beings reaching from man back to the first living being, extends, I presume, over at least

* Origin of Species, p. 102, 5th Ed.

a hundred million years. If we imagine the primordial protoplasm to have been turned over to the management of purely secondary causes, to the "laws impressed on matter," to run the amuck of adverse circumstances during all that time, without the direct supervision of the Creator, it seems to me that there were millions of chances to one that this direct chain would have been broken, and thus have destroyed the possibility of the evolution of man.

It was possible, according to the theory, for man to be evolved in one line only, and that line was composed of an infinite number of forms in succession, the extinction of any one of which, without leaving progeny, would have prevented the evolution of man.

That blind chance, without the intervention of an Intelligent Creator, could have preserved the infinite ancestral line, does not seem probable.

This evolution, according to Mr. Darwin, by virtue of "the laws impressed on matter by the Creator," proceeded upward from protoplasm to man, in spite of the fact that there does not seem to be "any evidence of the existence of an innate tendency toward perfectibility or progressive development."

The evolution of man assumes the preservation in every instance of the most highly developed forms in each of the countless generations that compose the chain of evolution, unless it may be assumed that ultimate forms higher than man might have been evolved from beings that have perished.

Natural selection does not, however, necessarily preserve the most highly developed forms. It only preserves those forms that are best adapted to compete in the struggle for existence under the given circumstances. The fact of a more highly organized body, or even of greater intelligence, does not necessarily insure preservation.

The forms that have been most successful in the struggle for existence through the long geological ages, such as the lingula and certain protozoa, are simple in their structure, while the most complex beings, and those in which the brain is most highly developed, such as the highest species of vertebrates, have had but a brief existence. There is nothing in the laws of nature to insure beyond doubt, at all times, the preservation of the higher forms instead of the lower, for the latter may be better adapted to compete for existence under the particular circumstances.

"Survival of the fittest" does not necessarily mean survival of the highest. This is shown to be true by the very recent disappearance of man's immediate ancestors, if he was produced by evolution.

Between man and the anthropomorphous apes, which are regarded as being substantially like the remote ancestors of man, there existed the immediate progenitors of man, all of which have perished; yet they must have been vastly more intelligent than the apes which have survived.

Without dwelling further upon this, I will say that the fact that man was created, either by a fiat or by evolution, can only be explained by assuming the existence of an Intelligent Creator.

The theory of evolution would imply a no less wonderful Intelligence than that of fiat, involving as it does long ages and an infinite number of vicissitudes and varying circumstances.

Mr. Darwin seems to imply an Intelligent Creator when he says: "The birth 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."*

* Descent of Man, Vol. 2, p. 378.

The figure of a tree has been a favorite one by which to represent the evolution of organic forms. Beginning with primordial protoplasm as a seed, we follow its growth. The main trunk of the tree, representing the direct line of man's ascent, is made up of the countless forms that have intervened between man and the first organism, the different races of men being represented by an equal number of small twigs at the top. As the primordial form multiplied, it branched by favorable variations, the new forms thus produced constituting branches of the tree of evolution. Long before the authentic geological record began, the tree of life divided into two great divisions,—that of animals and that of plants, and when the authentic record began we find animals, widely different in structure, representing all the subkingdoms and most of the classes of invertebrates. And so the tree continued to grow and branch through the ages, the individual twigs representing species and varieties.

If this tree were planted in the earth so that the part under the earth would represent extinct forms, and the part above the ground represent living forms, it is evident that most of the tree would be buried, for the reason that the living species are few compared to the extinct. It is also evident that the branches and twigs above ground, that represent living forms, would, for the most part, stand isolated, and that, to find their points of union, we must look beneath the surface among extinct forms. If we knew the entire record of life we could begin with any species and trace it back, without a break, to the primordial form.

Having stated the general outline of the theory of natural selection, I will present some of the arguments which have been offered for and against the theory.

Darwin gives special attention to the subject of variation under domestication. It is well known that new varieties of plants and animals are produced under domestication, and that they are separated and preserved as distinct varieties by the agency of man.

He dwells at length on the many varieties of domestic pigeons, and attempts to show that their common ancestor was the rock pigeon. These varieties, he claims, are as different in structure from each other as are all well-marked species.

The varieties of pigeons all cross readily with each other, producing fertile offspring, and there is a frequent tendency in these crosses to revert to the form of the original stock. This is the clearest case that he presents among the domestic animals of the recent origin of well-marked varieties.

He claims that these varieties are incipient species, and that species are only well marked varieties. If we grant that varieties can be produced, where can we set the limits of variability?

He concludes that we cannot set a limit, and that, consequently, by the law of natural selection principally, all organic forms have been evolved from a simple form.

With regard to the fertility of hybrids he says, "Now it is difficult, perhaps impossible, to bring forward one case of the hybrid offspring of two animals clearly distinct being themselves perfectly fertile."

It is well known that as a rule distinct species will not cross, and that if they do cross the offspring are not fertile.

On the other hand, it is true that all varieties of a species readily cross, producing fertile offspring.

This has commonly been regarded as a well-defined distinction between varieties and species.

If the varieties of pigeons which are so different from each other did not freely cross, and if the mongrel offspring were not fertile, his argument as to the production of new species under domestication would be complete.

The fact is, we do not know of the origin of any two species of animals that do not cross and whose offspring are not fertile; in other words, we do not know of the origin of species, but only of varieties. The origin of species that will not cross and produce fertile offspring is assumed from the origin of varieties that do cross and produce fertile offspring.

This leaves the evolutionist to account for one of the most difficult things in connection with his theory, namely, how did varieties of animals of the same species become cross-sterile? Let us consider this difficulty.

It is claimed by evolutionists that varieties are incipient species; that closely related existing species were once only varieties of the same species. These closely related species which, it is claimed, have had a common origin, now often live side by side, occupying the same or contiguous territories.

It is a well known fact that by crossing varieties the offspring are rendered more vigorous and fertile, while by crossing species the offspring are either sterile or become so in a few generations and die out. How can varieties that are perfectly cross-fertile become species that are cross-sterile?

Suppose that a species A, in a state of nature, produces a variety B, the known facts lead us to believe that A and B would cross with each other, and that B would be lost as a variety. It is admitted by evolutionists that if the closely related varieties of domestic animals were permitted to freely mingle, in a state of nature, they would, in a few generations, produce a common form. There is nothing like the agency of man, in nature, to prevent varieties from mingling.

The only method by which A and B could remain separated while located side by side, would be for them to be rendered cross-sterile in some way. If B were born cross-fertile with A, there is no conceivable method probable, by which, if the reproductive organs of both are perfect, which is necessarily implied in this case, they could ever become cross-sterile. This leads to the most important question, whether B may, by birth, be cross-sterile with its parent A, while the individuals composing B are fertile with each other and also those of A with each other.

It is admitted by evolutionists that cross-sterility between A and B cannot be accounted for by the theory of natural selection, for it could be of no conceivable advantage.

Dr. Romanes cuts the Gordian knot by assuming that B is, by birth, cross-sterile with A, and at the same time he assumes, and must assume, that the sexual organs of both A and B are perfect, so that each can propagate its kind.

According to this assumption there must be produced in the same locality, and at the same time, enough individuals of B, cross-sterile with A but fertile with each other, to propagate B, and, besides, there must be some favorable variation of these individuals that will enable them to survive.

Besides this, cross-sterility of A with B must be repeated every time a new species B originates, in order to isolate it from the parent form, which, considering the hundreds of thousands of known species of living organisms, together with the common assumption that all known forms, both living and fossil, as Darwin claims, are as nothing compared to the number of unknown extinct species, would make it necessary to repeat cross-sterility by birth between parent A and offspring B an infinite number of times.

When we remember that the universal rule seems to be that parent and offspring are cross-fertile, and not cross-sterile, as the theory of evolution absolutely demands, there is no sufficient reason for making the extreme assumption of cross-sterility by birth. All known facts are against this extreme assumption. When we consider that no case of cross-sterility is known between A and B, when the sexual organs of both are perfect, and that the theory of evolution demands an infinite number of such cases, so that they could hardly be regarded as exceptions to the fact of cross-fertility, and when we remember that the infinite number of species of animals which have survived to propagate their kind represent only a small fraction of those that were born cross-sterile with the parent form, because only those survived that were born not only cross-sterile, but also with some favorable variation that would the better enable them to compete for existence—remembering these things, it would seem that the theory of evolution is pushed to the verge of despair in adopting the theory of cross-sterility by birth between parent and offspring. And yet this assumption, which has of late been urged by Dr. Romanes especially, and adopted by others, is regarded as the most plausible way out of the difficulty.

The formation of permanent varieties in a state of nature is infinitely more difficult than under domestication, because in the latter case man separates the forms that he wants to propagate, and keeps them apart from the parent stock, whereas, in the former case the variation is lost by mingling with the common stock.

Mr. Darwin says that very "rarely single variations, whether slight or strongly marked, could be perpetuated."

He says: "If, for instance, a bird of some kind could procure its food more easily by having its beak curved, and if one were born with its beak strongly curved, and which consequently flourished, nevertheless, there would be a very poor chance of this one individual perpetuating its kind to the exclusion of the common form; but there can hardly be a doubt, judging by what we see taking place under domestication, that this result would follow from the preservation during many generations of a large number of individuals with more or less curved beaks, and from the destruction of a still larger number with the straightest beaks."*

Here he admits that even a favorable variation in a single individual is not at all likely to be propagated, but he attempts to bridge the difficulty by assuming that the same favorable variation may take place at the same time in a large number of individuals, so that the favorable variation, in spite of mingling with all other variations, can be propagated.

I think that this assumption is destitute of the support of facts. The fact is that variations take place in all conceivable directions, and, as Darwin repeatedly urges, they are generally very slight. Variations in one direction are, on an average, probably equal to those in another, and, consequently, when all the variations are mingled, as they are in a state of nature, the form of the species remains substantially constant.

Besides, this theory, if true, would account for

* Origin of Species, 5th Edition, p. 94.

only one species at a time in the same locality, for it assumes that the individuals with the favorable variation survive at the expense of the parent form; nor does it account for cross-sterility between closely-related species.

The later evolutionists, feeling the insufficiency of Darwin's assumption, have bridged the difficulty by introducing a still greater one—that of cross-sterility by birth.

Darwin says that he cannot agree "that migration and isolation are necessary for the formation of new species."*

Again: "Although isolation is of great importance in the production of new species, on the whole I am inclined to believe that largeness of area is still more important, especially for the production of species which shall prove capable of enduring for a long period and spreading widely."†

Suppose, according to this, that we find two species that have been evolved from a common stock occupying contiguous territories and mingling with each other on the common border. How can we account for the evolution of these two species in these localities? It is evident that the difficulties that arise from the merging of new forms and of producing cross-sterility remain in full force. These difficulties are always present in a state of nature, whether the territory is large or small, for the new species and its parent must occupy the same territory. The great difficulty in all cases is to isolate new forms from the parent form so that they will not be lost by mingling. Nature has no method, so far as facts show, of doing this.

Again, Darwin says, that "isolation is of great

* Origin of Species, 5th Edition, p. 105. † Ibid. p. 106.

importance in the production of new species."* It is evident, however, that if a species be divided into two parts by barriers, this cannot decrease the difficulties already mentioned—this cannot prevent the merging of variations, nor produce cross-sterility between parent and offspring. The same difficulties that arise in forming a new species from a whole species, apply with equal force to the formation of a new species from a part of a species. The dividing of a species by barriers cannot therefore account for the formation of a new species.

When we consider that many hundreds of thousands of species have existed, we cannot for a moment suppose that sufficient barriers could have isolated them, or even any considerable per cent of them, while being formed.

Besides, closely related species occupy the same territory, which could not generally be the case if they had been isolated from each other by barriers while being formed, for if such barriers had existed they would have kept the species permanently isolated.

Besides, if the supposed barriers were sufficient to isolate the parts of a species, they would be sufficient to prevent the species from separating into parts—for the barriers are, by supposition, impassable.

Mr. Darwin, however, as already stated, denies that "migration and isolation are necessary for the formation of new species." When we consider the large numbers and relative positions of species, it seems necessary to assume that closely related species have generally been formed without being insolated by barriers.

With regard to the difficulty of preserving variations in nature, Le Conte says: "But how can the process of progressive divergence begin, when slight

* Origin of Species, p. 106.

varieties are even more fertile by cross-breeding than by close breeding? Is it not evident that, with every generation, the slight varieties would cross-breed with one another and with the parent stock, and thus all varietal differences be funded into a common stock, and the type would be preserved unchanged? This, as already pointed out, has always been the chief difficulty in the way of imagining how varieties can grow into species; and the difficulty is only increased by our discussion of the law of cross-breeding. Now just here Dr. Romanes's most important and prolific idea comes to our help, and, as it seems to us, completely solves the difficulty." *

Thus, in the face of the fact that slight variations render animals more fertile by cross-breeding, it is assumed that new varieties are born cross-sterile with the parent form and cross-fertile with their own kind.

I know of no assumption among scientific men that seems more extreme and unwarranted than this—none more in opposition to the facts at present known.

Le Conte says further: "But suppose among these divergent variations there arise, from time to time, some which affect the reproductive organs in such wise that the variety, though perfectly fertile with its own kind, is infertile, or imperfectly fertile, with other varieties, and especially with the parent stock."†

Here we find several things that must happen in a single generation.

First, a number of individuals must be born and exist at the same time, which possess the same variation.

Second, this variation must, if it can be preserved, be of such a kind that it will give the individuals pos-

* Evolution and Creation, p. 226. † Ibid, p. 227.

sessing it an advantage over the parent stock in the struggle for existence.

Third, the individuals possessing the favorable variation must be cross-sterile with the parent stock, otherwise the variation will be "funded into a common stock, and the type preserved unchanged.'

Fourth, the individuals with the favorable variation must be fertile with each other.

Fifth, these individuals with the same favorable variation must find each other so that they can propagate their kind, a thing that would hardly take place if they were few, as they probably would be, and were scattered over a wide territory.

All of these things are assumed in face of the fact that variation increases instead of decreasing fertility. Besides, as already shown, it becomes necessary to assume that the remarkable fact of cross-sterility of parent and offspring has occurred an infinite number of times in order to produce all species.

This idea must therefore be regarded as most "prolific" in order to meet the demands of the theory of evolution.

It is assumed by Darwin and by evolutionists generally, that the formation of a species takes places very slowly, by innumerable slight variations. If this view is accepted, together with that of Romanes, then cross-sterility between parent and offspring must be the overwhelming rule instead of the exception, in order to keep the very slight variations from being lost by mingling with the parent form. We know, however, that it is not the rule, nor is it even known, so far as I am informed, that there are exceptional cases among animals where a variety in nature is cross-sterile with the parent, but fertile with those of its own kind.

With regard to cross-sterility, Darwin says: "After mature reflection it seems to me that this could not have been effected through natural selection, for it could have been of no direct advantage to an individual animal to breed badly with another individual of a different variety, and thus to leave few offspring; consequently such individuals could not have been preserved or selected."*

Again, he says: "That the sterility of first crosses, and indirectly of hybrids, is simply incidental on unknown differences in the reproductive systems of the parent species."†

Mr. Spencer has written a series of articles entitled "The Inadequacy of Natural Selection." As to artificial and natural selection he says: "They are analogous only within certain narrow limits, and in the great majority of cases, natural selection is utterly incapable of doing that which artificial selection does."‡

He quotes from Mr. Darwin: "Any particular variation would soon be lost by crossing, reversion and the accidental destruction of the varying individuals, unless carefully preserved by man,"§

Mr. Spencer claims that "the inheritance of acquired characters" is a necessary supplement to natural selection. Referring to his "Principles of Biology," he says: "It was contended that the relative powers of co-operative parts cannot be adjusted solely by survival of the fittest, and especially where the parts are numerous and the co-operation complex."

After arguing this proposition at length, he says: "Close contemplation of the facts impresses me more strongly than ever with the two alternatives—

* Origin of Species, p. 247. † Ibid, pp. 248-9.

‡ Popular Science Monthly for April, May and June, 1893.

§ Animals and Plants under Domestication, Vol. II., p. 292.

either there has been inheritance of acquired characters, or there has been no evolution."

Also, "For the inheritance of acquired characters, which it is now the fashion of the biological world to deny, was by Mr. Darwin fully recognized and often insisted on." . . . "The neo-Darwinists, however, do not admit this cause at all."

In concluding he says: "See then how the cause stands. Natural selection, or survival of the fittest, is almost exclusively operative throughout the vegetable world, and throughout the lower animal world, characterized by relative passivity. But with the ascent to higher types of animals, its effects are in increasing degrees involved with those produced by inheritance of acquired characters, until, in animals of complex structures, inheritance of acquired characters becomes an important, if not the chief, cause of evolution."

He admits that known facts which show that acquired characters are inherited are few, but he thinks that they are "as large a number as can be expected, considering the difficulty of observing them and the absence of search."

From the above, we see that the biological world is against Mr. Spencer's view; that he would abandon the theory of evolution unless acquired characters had been inherited, but that facts in support of this theory are meager.

I think that his argument shows the insufficiency of the theory of natural selection, but the truth of his own theory remains to be established. We shall see further on that natural selection has been supplemented by the theories of sexual selection and of the correlation of growth

If Mr. Spencer's theory as to the inheritance of acquired characters is true, still I do not see how this can result in the formation of new species in a state of nature. Whatever might be the acquired characters of individuals, they would be lost by mingling, and the difficulties which I have presented of evolving new species remain in full force.

Biologists in the above instance, as well as in others, differ in theory as to fundamental principles of evolution.

He who imagines that the theory of organic evolution has been proved to the point of demonstration, has but to read the contentions of evolutionists themselves with regard to the most important things involved in the theory, in order to satisfy his mind that there is great diversity of opinion.

GEOLOGICAL AGES AND PERIODS.

To be read upward by beginning at Archæan on this page and ending at Recent on next page. Classes and Orders of Animals survive by the dying out of old and the introduction of new Species.

35,000 feet thick (Maximum.)	Carboniferous Age, or Age of Coal Plants.	PERMIAN. CARBONIFEROUS OR COAL-MEASURES. SUBCARBONIFEROUS.	First known Reptiles. Trilobites disappear. Orthocerous Cephalopods nearly extinct. Fishes with vertebrated tails almost extinct. Cephalopods of many kinds. First Amphibians:—Labyrinthodonts. Fishes were all Sharks and Ganoids. Lepidodendrids, Sigillarids, Calamites, Ferns and Conifers abound. Spiders, Myriapods, Scorpions. Numerous Insects:—May-flies, Locusts, Cockroaches, Beetles. (Some of the insects were gigantic in size.) First land Snails. Crinoids culminated. Sea-urchins.
20,000 feet thick (Maximum.)	Devonian Age, or Age of Fishes.	CATSKILL. CHEMUNG. HAMILTON. CORNIFEROUS.	Ferns, Lycopods, Sigillarids, Calamites and Conifers. Eurypterids of large size. Limnoids; Shrimps. Orthopterous and Neuropterous Insects. Myriapods. Large number of Corals. Fishes:—Placoderms, Dipnoans, Ganoids, Chimæroids, Sharks. Goniatites. Brachiopods probably culminated in the Devonian.
42,000 feet thick (Maximum.)	Silurian Age — Upper.	ORISKANY. LOWER HELDERBURG. SALINA. NIAGARA.	Echinoids. Insects:—Orthopters and Hemipters. Scorpions; Brachiopods and Cephalopods abundant through Silurian. Trilobites abounded through the Silurian.
	Silurian Age — Lower.	TRENTON. CANADIAN.	Fishes:—Ganoids, Placoderms, and probably Sharks. Insects; Eurypterids. Trilobites culminated in the Lower Silurian.
		PRIMORDIAL.	Sea-weed, the only plants found. Cephaloposds; Trilobites; Crinoids; Star-fishes; Worms; Brachiopods; Lamellibranchs; Gastropods; Sponges; Corals; Hydrozoans; Pteropods.
		ARCHÆAN.	Eozoon. (Probably not a fossil.)

Cenozoic, 35,000 feet, (Maximum Thickness.)	Quatern ary, or Age of Man.	RECENT. CHAMPLAIN. GLACIAL.	Man made his first appearance at some time during the Quaternary. It may have been in the Glacial period. Brute mammals culminated in the Champlain. Herbivores prevailed in North America; Carnivores and monkeys in Europe; Edentates, in South America; and Marsupials, in Australia.
	Tertiary, or Age of Mammals.	PLIOCENE.	Elephants, Mastodons, Various Monkeys. Species of ox, cat, bear, hyena, fox, porcupine, beaver, hare, mouse, and machairodus. Horses with one toe in front and one behind.
		MIOCENE.	Tapir-like and Rhinoceros-like and Camel-liks mammals. The first true Carnivores. Bats, Squirrels, Opossums, Mastodons, Rhinoceroses. Whales of various kinds. Horses of different genera.
		EOCENE.	Mammals of many kinds: Quadrumana (monkeys or lemurs, some with only 32 teeth). Herbivorous, Carnivorous and Rodent Species. Whales:—Zeuglodon. First horses (four toes in front and three behind). Many Tapir-like animals. Bats, Insectivores, Creodonts. Dinocerata of Elephantine dimensions.
59,000 feet, Maximum Thickness.	Mesozoic, or Age of Reptiles.	CRETACEOUS	Small marsupial and, probably, monotreme mammals. Birds with teeth and also toothless birds. .Reptiles stiil numerous. First snakes also. Teleosts (bony fishes). Angiosperms of many kinds appear. (Highest plants.)
		JURASSIC.	Mammals:—numerous small marsupials. First Birds:—they had long vertebrated tails. Reptiles and Amphibians culminated in the Mesozoic. Fishes were Ganoids and Selachians. Cephalopods culminated in Mesozoic.
		TRIASSIC.	First Mammals:—marsupials, very small. Reptiles:—Dinosaurs, Crocodilians, Stegosaurs, Testudinates, Pterosaurs, Ichthyosaurs, Plesiosaurs, and Lacertians in the mesozoic. Labyrinthodonts still abound in Triassic. Great increase of Lamellibranchs during Mesozoic. But few Brachiopods. Cycads the prevailing plants in Triassic and Jurassic.

VII.

PALEONTOLOGY.

The length of time which has elapsed since the first known life began upon the earth is to be counted by millions of years, but whether we are to regard it as fifty or a hundred million there is no general agreement. As to when life began, or what were its first forms, no one claims to know.

The Archæan rocks of Canada, which extend from the region of the great lakes to the northeast and the northwest, and which constitute the backbone of the continent, are regarded as the oldest known sedimentary rocks. Their maximum thickness is estimated at from forty to fifty thousand feet.

In this metamorphic Archæan rock is found *Eozoon* canadense, which, if it is a fossil, represents by far the oldest known living being.

It is thought by some to be a low form of compound protozoan, but the latest authorities have decided against its organic origin.*

Lyell, quoting from Sir Wm. Logan, says: "Its antiquity is such that the distance of time which separated it from the upper Cambrian period, or that of the Potsdam sandstone, may be equal to the time which elapsed between the Postdam sandstone and the nummulitic limestones of the Tertiary period. The Laurentian and Huronian rocks united are about 50,000 feet in thickness."

Eozoon is found in the lower Laurentian.

* Text Book of Geology. Geikie, p. 695.

When it is remembered that the Potsdam, or Primordial, is the first period in which undoubted fossil remains are found, it will be seen that the time which elapsed from the appearance of *Eozoon* to that of the fossils in the Potsdam is nearly equal to the time from the Potsdam to the present.

Dana gives the time ratios for the Paleozoic, Mesozoic and Cenozoic as 12: 3: 1.

According to Logan's estimate, which Lyell seems to accept, the length of time between *Eozoon* and Potsdam was equal to the Paleozoic and Mesozoic combined, which, according to Dana, include fifteen of the sixteen parts of time between the beginning of the Potsdam and the present.

Here, then, we find an enormous stretch of time which may perhaps amount to 50,000,000 years between the dawn of the *Eozoon* and the Potsdam, in which no fossil has been found.

If *Eozoon* was a protozoan, as is claimed by some, and if the various fossils that are found in the Potsdam were evolved from *Eozoon* and other Archæan forms, then it seems strange beyond belief that not one of the vast number of intermediate forms that must have existed has been found.

We are told that the *Eozoon* had a calcareous skeleton, which is the kind of material most common in the hard parts of marine forms.

It may, of course, be claimed that the fossils of the Archæan have all been obliterated except *Eozoon*. Le Conte says: "It is impossible to say that animals of low form did not exist; yet the absence of any reliable trace in rocks not more metamorphic than some of the next era, which are crowded with fossils of many kinds, seems to indicate a paucity, if not an entire absence, at this time, of such animals."*

* Elements of Geology, p 287.

Metamorphism cannot, therefore, satisfactorily account for the absence of fossils between *Eozoon* and the various fossils of the Potsdam period.

In order to bridge this vast interval of time between *Eozoon* and the fossils of the Potsdam, a lost interval is assumed, in which organic beings were numerous on the earth, but of which we have no fossil remains.

This assumed lost interval, as already stated, was probably equal to the whole of geological time from the Primordial to the present.

Here, then, at the threshold, as a necessary part of the theory of evolution, we are asked to believe that the first half of the history of life is lost, and that during this almost infinite period evolution was steadily going on until it resulted in the various organic forms that are found in the Primordial.

I know of no facts to justify this boundless assumption. Besides, we shall find that this is only one of an endless number of similar assumptions that must be made in order to render possible a complete theory of evolution.

With regard to the animals of the Primordial, Le Conte says: "If we could have walked along that beach when it was washed by the primordial seas, what would we have found cast ashore? *We would have found the representatives of all the great types of animals, except the vertebrata.* The Protozoa were then represented by *sponges* and Rhizopods; the Radiates by *Hydrozoa* (graptolites) and Cystidean *Crinoids;* the mollusks by *Brachiopods*, *Gasteropods* (Pleurotomaria), *Pteropods*, and even *Cephalopods* (orthoceras); and the Articulates by *Crustaceans* (trilobites, etc.,) and Worms. Plants are represented by *Fucoids.* These widely-distinct classes are already clearly differentiated and somewhat highly organized. Nor is the fauna a meagre one in number of species. In the United States and Canada alone about 200 species are already known, of which nearly 100 are *trilobites.*"*

Again he says: "At the end of the Archæan times —when the Archæan volume closed—we find only the lowest protozoan life. But with the opening of the next era, apparently with the first pages of the next volume, we find already the great types of structure except the vertebrata. And these not the lowest of each type, as might have been expected, but already trilobites among Articulata, and Cephalopods among Mollusca—*animals which can hardly be regarded as lower than the middle of the animal scale.*"

As an explanation of this remarkable condition of things, of this sudden appearance in the geological record of so many and such highly organized forms of animals, we are told that "We must remember that between the Archæan and Paleozoic there is a *lost interval* of enormous duration," and that during this interval the above named numerous forms were evolved from simple Archæan forms; that this lost interval was long enough to evolve trilobites and cephalopods "*which can hardly be regarded as lower than the middle of the animal scale,*" from the protozoa of the Archæan.

Here are two great classes of animals, complex in structure,—the trilobite possessing well-developed compound eyes, and the cephalopod having simple eyes, that closely approach in complexity the eyes of man. The cephalopods are probably the most highly organized of the invertebrates. They possess two eyes, a beak much like that of a parrot reversed in position, two or four gills—the ancient ones had four gills,—a distinct alimentary canal, with a well

* Elements of Geology, p. 297. * Ibid, p. 298.

defined stomach, and with both oval and anal openings, one systemic heart to drive the blood through the body, and two branchial hearts to force the blood to the gills, a system of closed blood vessels which allow part of the blood to make a complete circuit in closed blood vessels—the only invertebrate of which this is true,—a highly developed nervous system with the cerebral ganglion partly enclosed in a cartilaginous skeleton, a liver, an ovary, and tentacles on the head for the prehension of food. The sexes of cephalopods are in different individuals.

The rocks of the world are absolutely silent as to the origin of these highly organized animals, for their fossil remains have not been found earlier than the Primordial. It is certain that if the Primordial animals were evolved, they had numerous ancestors of many forms—varying from *Eozoon* on the one hand to Orthoceras, Trilobite, worm, crinoids, and all the classes of mollusks on the other.

That the record of this enormous period, during which the animal kingdom made at least one-half of its total progress, could have been entirely lost, while its ancient progenitor, the *Eozoon*, composed of similar materials, was preserved, seems impossible. Evolution says, however, that all of these highly organized and widely different forms were evolved, and so she interpolates a record to supply the necessary unknown, equal in length of time to the whole geological record since the Primordial. By this wholesale method of manufacturing evidence, geology is made to support a theory.

We do not know that *Eozoon* is a fossil. Whitney and Wadsworth, Roemer and Zittel and Gregory decide against its organic origin.* Romanes, an extreme evolutionist, says "that it is probably not a

* Geikie's Text Book of Geology, p. 695.

fossil."* We have no positive knowledge, therefore, that life existed prior to the Primordial. The sedimentary rocks older than the Primordial were formerly, and are still called, by some naturalists, Azoic, meaning that there was no life when they were formed, and, for aught we know, this may have been the fact. The oldest animals of the Primordial must, if at all, have been evolved from forms that are lost. The Lingula seems to be the oldest known fossil, and it appeared in the early part of the period.

Dana says: "Among Mollusks there were only Brachiopods for the greater part of the Primordial period; but in the later division appear some species of Lamellibranchs, Pteropods, Gasteropods, and Cephalopods."†

If this is true, are we to assume that in this period these highest classes of mollusks were evolved from the Brachiopods? I presume that no evolutionist would claim that this was possible. The only possible explanation of their existence in the Primordial is to assume their existence previous to the period.

It is a most remarkable fact that in the first geological period in which undoubted fossils occur all the sub-kingdoms except that of the vertebrates are well represented, and that there is no evidence from fossils that one sub-kingdom, or even that different classes of the same sub-kingdom were evolved from each other. The great gulfs that separate the animal kingdom into sub-kingdoms and classes existed then, and have continued till the present time.

As to species, also, it is well known that when a new species appears among fossils it comes as a well-defined species, and that it cannot be connected by transitional forms with any previously existing species. As we pass through the geological record from

* D. and after D., p. 163. † Text Book of Geology, p. 207.

period to period or from stratum to stratum, species suddenly appear and disappear, apparently without ancestors and without descendants.

According to the theory of evolution, and especially of natural selection, if we start with any organism and trace its history backward, we would find that through an endless number of generations it had been very slightly changing, so that any individual is always a transitional form between its immediate ancestors and its own offspring.

If, according to this, we had all of man's ancestors in line, they would extend by almost imperceptible differences of form from Protozoan to Man. About 5,500 species of mollusks have been found in the Silurian age, in which all the classes of mollusks are largely represented. The shells of mollusks being composed of carbonate of lime are extremely durable, and, as fossils, they compose a large part of most limestones. This being true, one would expect, if the theory of evolution is true, to find vast numbers of transitional forms connecting earlier and later species in the various periods where fossils are well preserved. This, however, is not true. Species, when they first appear, stand sharply defined.

Darwin expresses his disappointment at the absence of transitional forms as follows: "But I do not pretend that I should ever have suspected how poor was the record in the best preserved geological sections, had not the absence of innumerable transitional links between the species which lived at the commencement and close of each formation pressed so hardly on my theory." *

Taking the mollusks of the Silurian, it is evident that the transitional forms representing slight successive changes must have almost infinitely outnumbered

* Origin of Species, p. 286.

the 5,500 species that are known, and that, being composed of the same kind of materials, their remains ought not only to exist, but to be found. The conditions favorable to the preservation of a species are equally favorable to the preservation of transitional forms. That the absence of these forms should be, not simply exceptional, but quite universal, is a matter of great surprise and of much moment.

LeConte says: "In fact, if we only had all the extinct forms, the organic kingdom, taken as a whole and throughout all time, ought to consist not of species at all, but simply of individual forms, shading insensibly into each other, like the colors of the spectrum, and our classification ought to be a mere matter of convenience, having no counterpart in nature. But this is not the fact. On the contrary, the law of distribution in time is apparently similar in this respect to the law of distribution in space already given. As in the case of *contiguous* geographical faunas, the change is apparently by *substitution* of one species *for* another, and not by transmutation of one species *into* another. So also in *successive* geological faunas, the change seems rather by substitution than by transmutation." * Notwithstanding the fact that the record seems to show "substitution" and not "transformation," evolutionists assume that the latter has taken place. In order to meet this difficulty they claim that nearly all of the geographical record has been lost. Darwin says that "the number both of specimens and of species, preserved in our museums, is absolutely as nothing compared with the number of generations which must have passed away even during a single formation." †

It is assumed that the almost infinite number of intermediate forms which connected the great number

* Evolution, p. 233. † Origin of Species, p. 318.

of known species, and which were inhabiting the same regions, were lost, while, for the most part, only well-defined species were preserved.

LeConte says: "We think the fragmentariness of the geological record has been overstated. While it is true that there are many and wide gaps in the record; while it is true, also, that even where the record is continuous many forms may not have been preserved, yet there are some cases, especially in the Tertiary fresh-water deposits, where the record is not only continuous for hundreds of feet in thickness, but the abundance of life was very great, and the conditions necessary for preservation exceptionally good. In such cases the number of fossil species found on each horizon seems to be as great as in existing faunas over equal space. The record in these cases seems to be continuous and without break, and crowded with fossil forms; and yet, although the species change greatly, and perhaps many times, in passing from the lowest to the highest strata, we do not usually, it must be acknowledged, find the gradual transitions we would naturally expect, if the change were effected by gradual transitions. The incompleteness of the record, therefore, although a true and important cause, is not the whole cause." * He further speaks of the absence of connecting links as "the greatest of all objections" against the theory of evolution.

If the above case of the Fresh-water Tertiary exists with rocks hundreds of feet in thickness, with abundance of life, and exceptionally good circumstances for preserving fossils, with abundance of well-defined species, but with the usual absence of intermediate forms, then may it not be that a large part of the geological record is destitute of the numerous breaks

* Evolution, p. 234.

that have been assumed in order to explain the absence of intermediate forms?

If the theory of evolution is true, then in these Tertiary rocks where the record is "continuous for hundreds of feet," the slow transition of the many species was taking place, and the countless multitudes of connecting links must have left their remains in these rocks, so that we might well expect that their remains would be found mingled with those of the species that they connect. It is not surprising that Mr. Darwin should acknowledge that the absence of these connecting links presses hardly on his theory.

The natural conclusion drawn from their absence, under the circumstances, is that the connecting links did not exist. It should be borne in mind that connecting forms assumed to be lost are probably thousands of times as numerous as the known species, so that the theory of evolution not only assumes that the first half of the whole record—namely, that prior to the Primordial—is wholly lost, but at every step in every age and in every class of animals we must grant that probably 999 out of every 1,000 forms are hopelessly lost.

The evolutionist not only assumes that the 999 are lost, but that if they could be found they would go to prove the truth of his theory.

As to whether forms constitute species or varieties is, in this connection, not a matter of importance—this is simply a question of names.

The real question is, Do the transitional forms exist? If they do, then evolution is true; if not, then the theory fails.

That they have not been found all admit. The only question that remains is, Can their absence be satisfactorily explained if they once existed? I think not.

I admit that there are many animals whose remains are not likely to be preserved, so that there might be a great deficiency of fossils of such animals.

But when we consider animals which have hard and durable parts, such as the mollusks, there is no reason for assuming that in a given stratum, all intermediate forms between species should have been so uniformly destroyed.

Some evolutionists, it would seem, would abandon paleontology in considering their theory. Romanes says: "With so fragmentary a record as this to study, I do not think it too much to say that no conclusions can be fairly based upon it, merely from the absence of testimony. If we speak of it as a history of the succession of life upon the planet, we must allow, on the one hand, that it is a history which merits the name of a 'chapter of accidents;' and, on the other hand, that during the whole course of its compilation pages were being destroyed as fast as others were being formed, while even of those that remain it is only a word, a line, or at most a short paragraph here and there, that we are permitted to see." *

In answer to this I may say that we do not know it to be a fact that the destruction of the record has been so great as is here affirmed. As already stated, Le Conte, who is an evolutionist, claims it to be otherwise. This extreme fragmentariness of the record is assumed as a matter of necessity in order to make it harmonize with the theory.

Suppose that there were 100 species of mollusks within a given area at the same time. It is evident that we must account for their origin either inside or outside of the area where they are found. If there are some hundreds of feet of continuous rocks full of the remains of mollusks under the 100 species, then

* D. and after D., p 159.

the transitional forms in large numbers ought, as ev lutionists admit, to have been expected there.

The overwhelming testimony of the fossils is th transitional forms are absent,—and this, where t] fossils are abundant and well-preserved.

It must, therefore, be assumed that the 100 speci originated elsewhere, and that they migrated into t region where they are found.

This theory of origin elsewhere than where speci are actually found, if applied as strictly as evolutio ists are accustomed to apply it, will transfer the orig of species to some other world.

We are told repeatedly, when we look at the gre number of species imbedded in a formation, that th have not originated there, but elsewhere, and th they are immigrants. So much is this explanati repeated that it is made to account for the presen of every species in every stratum known in the eart until there is no place left for species to originate.

It should be remembered that, according to evol tion, every individual of every species is a transition form, and that, consequently, the origin of species taking place continually wherever organisms a found, and that, therefore, we ought to expect abun ant evidence of these transitions, especially in su formations as the fresh-water Tertiary to which l Conte refers.

I am not urging simply, in a general way, the a sence of intermediate fossil forms against the theo of evolution, but urging it in special cases where fo sils are abundant and well-preserved and the reco seemingly continuous.

Le Conte attempts to account for the absence transitional forms by supposing "*that the steps evolution are not always uniform.*" *

* Evolution, etc., p. 239.

He refers to change of climate, migrations and loss of geological record as accounting for "those sweeping changes, not only of species, but even of genera, families, and orders which characterize the passage from one great era to another."

"But this does not explain the apparent discontinuity between *consecutive* species in the same locality in continuous, comformable strata, or the rarity of transitional forms when one species takes the place of another in an apparently continuous record. In such continuous deposits the successive faunas do indeed graduate insensibly into one another, but apparently as in contiguous geographical regions, by substitution, not by transmutation."

From this it is evident that in some cases he regards the record as being comparatively complete, and not extremely fragmentary, and it is admitted that in this record the transitional forms between species are absent. The reason why they are not found is, according to him, that, for the most part, they never existed, owing to the fact that the formation of species takes place very rapidly, in which case few connecting links are required.

His idea is that heredity resists change of form until circumstances either compel it to give way, resulting in the evolution of new species better adapted to the environment than the old, or, on the other hand, in the destruction of the species if they do not change sufficiently.

This paroxysmal theory of the origin of species is opposed to Darwin's idea of slow and imperceptible changes.

The absence of intermediate forms between species has led Le Conte to advance this theory. Instead of requiring many generations to form a new species, as is taught by most evolutionists, perhaps one or two, or, at most, a very few generations will produce a distinct species. This is supplemented by the theory that the new species is born cross-sterile with the parent species. These things being true, the absence of connecting links is accounted for.

The only difficulty about this is that it is founded on two assumptions, both of which are destitute of the support of facts. If sexually isolated species have been thus generally produced, it is opposed to the commonly accepted theory of evolutionists, who hold Darwin's view of very slight changes.

It seems, however, that Le Conte does not accept his own theory that species have been suddenly formed with but few connecting links, except in cases like the hundreds of feet of continuous rock in the fresh-water Tertiary, where he stands in pressing need of such a theory to account for species which seem to come as if "by substitution of one species *for* another, and not by transmutation of one species *into* another," for he also tells us* that Planorbis has been evolved by slight changes which have been traced out to the "subtilest gradations," but that the changes in its evolution seem to have sometimes been "somewhat paroxysmal."

Without dwelling longer on this, it is evident that evolutionists must, with Le Conte, deny the existence of many intermediate forms between species, or, admitting that many transitional forms have existed, they must give some plausible theory explaining their quite universal absence among fossils. Unless this is done the theory fails. Their absence is a matter of vital importance.

It should be remembered that the geological record contains nearly the whole of the tree of life, so that if it "merits the name of a chapter of accidents,"

* Evolution, p. 238.

and if "no conclusions can be fairly based upon it, merely from the absence of testimony," why should the evolutionist attempt to use this fragmentary record in support of his theory?

If, as Darwin claims, the known forms are absolutely as nothing in number compared to the unknown, if we know but one species in a thousand that has existed, how can we with safety determine from the one known species what the thousand unknown species were? Evolution presumes to do this, for it asserts that the unknown were intermediate forms between known species. It demands, in the first place, that the absence of these forms shall not go to negative its claims, and then it proceeds to supply the nearly entire and enormous absent record and make it conform to its own necessities.

Darwin says that in our present condition of knowledge "it seems to me to be about as rash to dogmatize on the succession of organic forms throughout the world, as it would be for a naturalist to land for five minutes on some one barren point in Australia, and then to discuss the number and range of its productions."*

This means that from our extremely fragmentary knowledge of extinct species it is impossible for us to determine the order of their geological succession,—the great majority of the species being, it is claimed, entirely unknown to us.

Evolution, however, does take very definite grounds with regard to the kinds of species and to their order of succession. It asserts that nearly all species of animals that have existed are unknown to us, that all the infinite number of lost species were either connecting links between known species, or that they were genetically related to them.

* Origin of Species, p. 285.

Of course it does not attempt to do this from tl geological evidence alone, but if Darwin's stateme: with regard to extinct forms is true, then if we ac to our knowledge of extinct species our knowledge those that are living, still the total amount of o knowledge of species must be almost nothing cor pared with our ignorance of the facts in relation them.

If this is true, is it not beyond our province- attempt to frame a theory to account for the orig and relations of known species, and also of an infini number of assumed unknown forms? Evolution h abandoned paleontology largely as an unfruitful fiel and yet paleontology contains nearly the whole recor both as to time and as to the number of species.

Is not the effort of evolution much like attemptii to construct a definite history of all ancient natio from our knowledge of modern history combined wi a few fragments that have come to us from ancie times?

This must be so if the record is so extremely fra mentary as Darwin and Romanes would have us b lieve. The latter says: "Probably not one per ce of the species of animals which have inhabited tl earth has left a single individual as a fossil, where to record its past existence."*

Of the total number of species that have been pı served as fossils, I presume that, according to l method of estimating, it would be safe to say th not more than one in a hundred has yet been d covered, so that we have a knowledge of one on hundredth of one per cent—or, we are acquaint with only one species in ten thousand of the toi number that have existed.

If anything like this is true, it would seem to be

* Darwin and After Darwin, p. 423

waste of time to try to tell what the nine thousand nine hundred and ninety-nine were from the form of one which is like neither of them. And even when we add to this our knowledge of living species it will constitute a very fragmentary history of the animal kingdom from its beginning to the present time.

With a record so extremely fragmentary it seems marvelous that the evolutionist persists in writing a definite history of the whole animal kingdom by sandwiching between the few known species an infinite number of assumed unknown forms, that he may complete his imaginary tree of life.

VIII.

PALEONTOLOGY.

In the present chapter I shall attempt to shc that the great progress in structure which evoluti assumes to have taken place in deriving man fro primordial protoplasm is not consistent with the tot lack of progress in many of the forms in the anim kingdom.

The great instability of organic forms implied the evolution of man is, I think, entirely inconsiste with the known stability or comparative stability of large part of the animal kingdom.

First, as to species, which are supposed to be ve unstable, it is well known that many of them a long-lived. Dawson says* that he has examin more than two hundred species of Post-pliocene m lusks, and that they are identical with living species that even the varieties are the same now that th were then.

Again he says that "Pictet catalogues ninet eight species of mammals which inhabited Europe the Post-glacial period. Of these, fifty-seven st exist unchanged, and the remainder have disappeare Not one of them can be shown to have been modifi into a new form, though some of them have be obliged, by changes of temperature and other con tions, to remove into distant and now widely sep rated regions. Further, it would seem that all t existing European mammals extended back in ge

* Story of the Earth and Man, p. 359.

logical time at least so far as man, so that since the Post-glacial period no new species have been introduced in any way." *

Gray, in speaking of DeCandolle's conclusion as to the length of time that the living species of oaks have existed, says: "He accepts and, by various considerations drawn from the geographical distribution of European Cupulifera, fortifies the conclusion—long ago arrived at by Edward Forbes—that the present species, and even some of their varieties, date back to about the close of the Tertiary epoch, since which time they have been subject to frequent and great changes of habitation, but without appreciable change of specific form or character; that is, without profounder changes than those within which a species at the present time is known to vary." †

In Huxley's address before the Geological Society for 1870, he says, speaking of the dredgings: "These investigations have demonstrated the existence, at great depths in the ocean, of living animals in some cases identical with, in other cases very similar to, those which are found fossilized in the white chalk: The Globigerinae, Cyatholiths, Coccospheres, Discoliths in the one are absolutely identical with those in the other; there are identical or closely analogous species of Sponges, Echinoderms and Brachiopods. Off the coast of Portugal there now lives a species of Beryx, which, doubtless, leaves its bones and scales here and there in the Atlantic ooze, as its predecessor left its spoils in the mud of the sea of the Cretaceous epoch."

Darwin says: "It is not an insuperable difficulty that Foraminifera have not, as insisted on by Dr. Carpenter, progressed in organization since even the Laurentian epoch." ‡

* Story of the Earth and Man, p. 357.

† Darwiniana, p. 185. ‡ Origin of Species, p. 313.

Again he says: "It is no great difficulty that fresh-water shells, as Prof. Phillips has urged, have remained almost unaltered from the time when they first appeared to the present day, for these shells will have been subjected to less severe competition than the mollusks inhabiting the more extensive area of the sea with its innumerable inhabitants." * From this explanation it would seem that we ought to expect great advance in organization in marine mollusks, but he says "that certain Brachiopods have been but slightly modified from an extremely remote geological epoch." † These salt-water Brachiopods have existed a vastly greater length of time than the fresh-water mollusks, and yet, with all the competition and change of conditions that the ocean can furnish, they have made hardly any perceptible change in structure.

Again Darwin says: "The problem whether organization on the whole has advanced is in many ways excessively intricate. The geological record, at all times imperfect, does not extend far enough back, as I believe, to show with unmistakable clearness that within the known history of the world organization has largely advanced." ‡

This indeed sounds strange from one who teaches that all organic beings, including man, were derived from, at most, only three or four forms, and, judging from analogy, probably from one original form of organism. If he cannot, from the known geological record, which probably extends over 50,000,000 years, assert that "organization has largely advanced," what infinite time beyond the Primordial period would be necessary in order to make a large advance?

In accordance with Darwin's idea, let us notice the

* Origin of Species, p. 314. † Ibid, p. 313. ‡ Ibid, p. 314.

history of some of the animals that are found in the geological record.

From the fact that the Trilobites, so highly organized, appeared in the Primordial, it would seem that they were specially adapted to make progress. They lived through Paleozoic Time, which, according to Dana, represents twelve of the sixteen parts of all geological time, beginning with the Primordial; or, calling the whole geological time 48 millions of years, the Trilobites lived 36 millions of years, or three-fourths of all geological time. From their great persistence in time it would seem that they had a remarkably good opportunity to make wonderful progress in structure. During that time there were thousands of species, yet they made no progress. We do not know that in all those millions of years a single higher form was evolved from any one of the great multitude of species of Trilobites. As Darwin says of the goose, so I say of the Trilobite; it "had a singularly inflexible organization."

The remarkable thing about this, however, is that previous to the Primordial, while it was becoming a Trilobite it must have had a singularly flexible organization, otherwise it could not have obtained its complex structure; but when it reached the Primordial it became very conservative.

It is strange beyond belief that an animal which was making such wonderful strides on the road of evolution, outstripping every competitor except the Orthoceras, should suddenly lose all power to progress in structure and still live on with little change through most of geological time.

The lingula, a brachiopod, has existed through all geological time—from the Primordial to the present—and has made no progress in organization. Living lingula are nearly identical in form with those of the Primordial. As in the case of the Trilobite, if the Lingula was evolved from some lower form, why did it become fixed when it reached the Primordial and remain forever incapable of either change or progress? It certainly cannot be due to uniformity of external conditions—climate and competitors—for they have changed many times. The existence of such long-lived forms as Trilobites, Lingula and the species enumerated, shows inherent incapacity in inorganic beings for undergoing great changes in a state of nature.

According to the theory of evolution, the summons must have come to Lingula many times to either change its structure or perish—for changing environment is a demand for change of structure; but in spite of all this it still lives and bears witness to the permanence of organic forms.

If we look at the great class of Brachiopods which have, perhaps, done more to form the limestones than all other animals together, which have existed in all geological ages, we find that while there were many genera and a vast number of species, the representatives of the class which are now living are no higher in structure nor do they differ much from those that lived in the earliest geological times.

Evolution, however, means infinitely more than the derivation of one species of brachiopod from another—it means the derivation of man by descent from some animal that lived in the Primordial. If man is to be thus derived, we must find there some form of life that is extremely and persistently progressive.

If we examine the Lamellibranchs, the other great class of bivalve mollusks, we find that from the Primordial down to the present time they have undergone very little change, nor can we say that they have advanced materially in organization. If there has been any upward tendency in their evolution through all the ages, it is hardly possible to measure it.

And so the living Gasteropods can claim but little superiority in structure over those of the Primordial.

The same is true of Cephalopods, which are, perhaps, the highest of the invertebrates. The Orthocerata existed throughout the Palaeozoic—three-fourths of all geological time—and made no material change in structure. The Pearly Nautilus of to-day is closely like the Nautilus of the Mesozoic, and even the Dibranchs now living are not much higher in structure than the earliest known orthoceras.

It is indeed most remarkable that if the Primordial animals of these various classes were evolved from lower forms, thus showing great capacity for improvement in divergent lines, they should uniformly, from their earliest known appearance through all subsequent ages, have made little change in structure, and little or no marked progress in organization. The progress of all these animals prior to the Primordial is, I think, inconsistent with the almost total lack of progress since that period, and this lack of progress is inconsistent with the claim that man has been evolved from some Primordial animal.

I am not here concerned with the origin of species, but with those great changes in structure which the theory of evolution demands in order to derive the highest from the lowest forms.

Already, in the Primordial, animals had made one-half their total progress in structure, according to Le Conte, but they had widely diverged in structure, so that they represented all the sub-kingdoms except the Vertebrata, and, if the theory of evolution is true, vertebrates must have been there.

The divergence which has taken place between the sub-kingdoms of invertebrates since the Primordial is, I think, small compared to that which had previously taken place.

Taking the earliest representatives of the animal kingdom and following them in their history, we find a persistent tendency towards stability of form, and little tendency to progress in organization.

This incapacity to change, so marked among the invertebrates of the Primordial, would lead us to believe that an animal so different in structure and so highly organized as a vertebrate could not have been evolved from any invertebrate line. The more we look at this class of facts the greater the difficulty becomes.

Insects and scorpions have been found in the Silurian. They stand among the highest of even living articulates, and they are the oldest known air-breathing animals.

We seek in vain for the progenitors of these highly organized articulates or for some conceivable method by which their wings and special breathing apparatus could have been evolved.

We do not know that these first insects and scorpions have made any material progress through all the ages. As in the case of the Primordial animals, so it is in this instance a remarkable fact that while they must have progressed rapidly in order to become insects and scorpions as early as the Silurian, yet from that age to this they have made no advance in structure.

In the Devonian, May-flies have been found. In the Carboniferous, several orders of insects are represented; the Neuroptera by Dragon-flies; the Orthoptera by Locusts, Cockroaches, etc., and the Coleoptera by Beetles. Spiders, Centipedes, and Scorpions also existed. These various groups of articulates seem to have been as highly-organized and as well-defined then as at present.

The sub-kingdom of Radiata shows also a great lack of progress. The Crinoids and Star-fishes of the Silurian were as highly-organized as are the living species of these classes, while the Sea-urchins of to-day are not superior to the oldest known fossil forms.

The coral-forming Polyps which have persisted through nearly all geological time still exist in large numbers, but with little change and no progress towards a more complex structure.

That which is most noticeable in all the classes of all the sub-kingdoms of invertebrates through the long ages is the small amount of change in structure and the lack of progress. Professor Huxley in delivering the anniversary address to the Geological Society for 1870, quotes the following from an address before the same society in 1862:

"If we confine ourselves to positively ascertained facts, the total amount of change in the forms of animal and vegetable life since the existence of such forms is recorded is small. When compared with the lapse of time since the first appearance of these forms, the amount of change is wonderfully small. Moreover, in each great group of the animal and vegetable kingdoms, there are certain forms which I termed Persistent Types, which have remained, with but very little apparent change, from their first appearance to the present time.

"In answer to the question, 'What then does an impartial survey of the positively ascertained truths of paleontology testify in relation to the common doctrines of progressive modification, which suppose that modification to have taken place by necessary progress from more to less embryonic forms, from more to less generalized types, within the limits of the period represented by the fossiliferous rocks?' I reply, 'It negatives these doctrines; for it either shows us no evidence of such modifications, or demonstrates such modification as has occurred to have been very slight; and as to the nature of that modification, it yields no evidence whatsoever that the earlier members of any long-continued group were more generalized in structure than the latter ones.

"The significance of persistent types and of the small amount of change which has taken place even in those forms which can be shown to have been modified, becomes greater and greater in my eyes, the longer I occupy myself with the biology of the past.

"Consider how long a time has elapsed since the Miocene epoch. Yet, at that time there is reason to believe that every important group in every important order of the Mammalia was represented. Even the comparatively scanty Eocene fauna yields examples of the orders Cheiroptera, Insectivora, Rodentia and Perissodactyla; of Artiodactyla under both the Ruminant and the Porcine modifications; of Carnivora, Cetacea and Marsupialia.

"Or, if we go back to the older half of the Mesozoic epoch, how truly surprising it is to find every order of the Reptilia, except the Ophidia, represented; while some groups, such as the Ornithoscelida and the Pterosauria, more specialized than any which now exist, abounded."

He then speaks of the Labyrinthodonts which extend "from the bottom of the Carboniferous series to the top of the Trias, if not into the Lias." And continues, "Since that time eight or ten distinct genera of Labyrinthodonts have been discovered in the Carboniferous rocks of England, Scotland and Ireland, not to mention the American forms described by Principal Dawson and Professor Cope. So that at the present time, the Labyrinthodont Fauna of the Carboniferous rocks is more extensive and diversified than that of the Trias, while its chief types, so far as osteology enables us to judge, are quite as highly organized. Thus it is certain that a comparatively highly-organized vertebrate type, such as that of the Labyrinthodonts, is capable of persisting, with no considerable change, through the period represented by the vast deposits which constitute the Carboniferous, the Permian and the Triassic formations.

"The very remarkable results which have been brought to light by the sounding and dredging operations, which have been carried on with such remarkable success by the expeditions sent out by our own, the American, and the Swedish Governments, under the supervision of able naturalists, have a bearing in the same direction. These investigations have demonstrated the existence, at great depths in the ocean, of living animals, in some cases identical with, in others very similar to, those which are found fossilized in the white chalk.

"The Globigerina, Cyatholiths, Coccospheres, Discoliths in the one are absolutely identical with those in the other; there are identical or closely analogous species of Sponges, Echinoderms and Brachiopods. Off the coast of Portugal there now lives a species of Beryx, which, doubtless, leaves its bones and scales here and there in the Atlantic ooze, as its predecessor left its spoils in the mud of the sea of the Cretaceous epoch.

"Many years ago, I ventured to speak of the Atlantic mud as 'modern chalk,' and I know of no fact inconsistent with the view which Professor Wyville Thompson has advocated, that the modern chalk is not only the lineal descendant of the ancient chalk, but that it remains in the possession of the ancestral estate; and that from the Cretaceous period (if not much earlier) to the present day, the deep sea has covered a large part of what is now the area of the Atlantic. But if *Globigerina* and Terebratula caput-serpentis, and Beryx, not to mention other forms of animals and plants, thus bridge over the interval between the present and the Mesozoic periods, is it possible that the majority of other living things underwent a 'sea-change into something new and strange' all at once?

"Thus far I have endeavored to expand and to enforce by fresh arguments, but not to modify in any important respect, the ideas submitted to you on a former occasion. But when I come to the propositions touching progressive modification, it appears to me, with the help of the new light which has broken from various quarters, that there is much ground for softening the somewhat Brutus-like severity with which, in 1862, I dealt with a doctrine for the truth of which I should have been glad enough to be able to find a good foundation. So far indeed as the *Invertebrata* and the lower *Vertebrata* are concerned, the facts and conclusions which are to be drawn from them appear to remain what they were. For anything that, as yet, appears to the contrary, the earliest known Marsupials may have been as highly organized as their living congeners; the Permian lizards show no signs of inferiority to those of the present day; the Labyrinthodonts cannot be placed below the living Salamander and Triton; the Devonian Ganoids are closely related to Polypterus and to Lepidosiren."*

I have quoted at length Professor Huxley's revised and reaffirmed opinion as to the known geological

* Cyclopedia of Science, p. 172.

facts and their bearing upon the question of evolution. His language is very emphatic in asserting that the known facts of paleontology "negative the common doctrines of progressive modification, which suppose that modification to have taken place by necessary progress from more to less embryonic forms, from more to less generalized types, within the limits of the period represented by the fossiliferous rocks." "It either shows us no evidence of such modifications, or demonstrates such modification as has occurred to have been very slight." "And it yields no evidence whatsoever that the earlier members of any long-continued group were more generalized in structure than the latter ones."

The above opinion is reaffirmed with regard to the Invertebrata and the lower Vertebrata, but is somewhat modified as to the higher Vertebrata.

The long endurance of species, the persistence of types, the absence of generalized structures from which groups could have branched, are all opposed to the theory of evolution. If, throughout all time since the Primordial, invertebrates have made little or no progress, how was it possible for the Primordial types to be evolved from some extremely simple form of life? Why should the various classes of the sub-kingdoms of invertebrates which had marched steadily upward by evolution till they reached the various complex structures of the Primordial, at that point suddenly become incapable of making further progress, so that they have remained comparatively unchanged?

If Labyrinthodonts, "a comparatively highly organized type," could persist through the Carboniferous, Permian and Triassic, with no considerable change; if "Permian lizards show no signs of inferiority to those of the present day;" if Devonian Ganoids were as highly developed as, and "are closely related to Polypterus and Lepidosisen;" if "the earliest known Marsupials may have been as highly organized as their living congeners;" if, in fact, these several kinds of highly organized vertebrates—Fishes, Amphibians and Reptiles—could exist through such long periods of time without making much change or progress, then, indeed, it would seem hopeless to look to any of these as the ancestors of mammals, and, finally, of man.

Here, then, to begin with, we have a large volume of evidence from Paleontology with regard to the Invertebrates and the lower Vertebrates up to and including Marsupials which negatives the idea of evolution. This leaves only the question as to the origin of the higher Vertebrates to be considered from the known facts derived from their fossil remains.

With regard to them Prof. Huxley says in the same address: "But when we turn to the higher Vertebrata, the results of recent investigations, however we may sift and criticise them, seem to me to leave a clear balance in favor of the doctrine of evolution of living forms one from another. Nevertheless, in discussing this question, it is very necessary to discriminate carefully between the different kinds of evidence from fossil remains which are brought forward in favor of evolution.

"Every fossil which takes an intermediate place between forms of life already known, may be said, so far as it is intermediate, to be in favor of evolution, inasmuch as it shows a possible road by which evolution may have taken place. But the mere discovery of such a form does not, in itself, prove that evolution took place by and through it, nor does it constitute more than presumptive evidence in favor of evolution in general. Suppose A, B, C to be three forms, while B is intermediate in structure between A and C. Then the doctrine of evolution offers four possible alternatives. A may have become C by way of B: or C may have become A by way of B: or A and C may be independent modifications of B: or A, B and C may be independent modifications of some unknown D."

It is evident also that in order to favor the theory of evolution fossils must show the proper chronological arrangement, and that they must be located geographically in such a way that it would be possible to evolve the one from the other.

I will briefly consider the geological evidence as to the evolution of vertebrates.

The earliest known vertebrates were the fishes of the Trenton period of the lower Silurian. Dana says of them: "Remains of Fishes, the earliest known Vertebrates, occur in the rocks of the Trenton period. . . . The fossils are abundant near Cañon City, Col. Most of them are plates and scales of Ganoids, the largest about half an inch across. Of these *plates*, . . . two are referred to Placoderms, the group which comprises the oldest Fishes previously known, those of the Upper Silurian and early Devonian. The scales have the markings of a typical Ganoid, much like those of the genus Holoptychius, a form not found hitherto in beds earlier than the Middle Devonian. Besides these, there are remains of what are supposed to be the ossified sheaths of a notochord of a species of the Shark tribe related to the Chimaera. The beds affording these remains of Fishes contain many other fossils that are referred to the Lower Trenton, and are overlaid by others carrying Upper Trenton fossils." *

Geikie says: "The first traces of vertebrate life

* Dana's Manual of Geology, Fourth Edition, 1895, pp. 509-10.

make their appearance in the Silurian system. They consist of the remains of fishes, the most determinable of which are the plates of placoderms (Pteraspis, Cephalaspis, Auchenaspis, Scaphaspis). The bone-bed of the Ludlow rocks has also yielded certain curved spines which have been referred to a Cestracious, and some shagreen-like plates which have been supposed to be scales of placoid fishes (Sphagodus, Thelodus), and bodies like jaws with teeth which were called Plectrodus, but which are now known to be lateral shield-spines of a cephalaspidean fish (Eukeraspis)." *

Recent discoveries have, therefore, carried the geological history of fishes from the upper part of the Upper Silurian into the Lower Silurian. The evidence seems to justify the conclusion that in the lower part of the Trenton each of the three orders of Paleozoic Fishes was well represented. This oldest known evidence shows that Fishes had become so widely different in structure that they can be classed in the three great orders which include most of the fishes of all geological time.

This being true, if they were evolved, it is evident that they must have had a long history which extends back through the Primordial into the Archæan. It will be remembered that the oldest known fossils of any kind are in the Primordial. Already the known history of Fishes extends back almost to that period. Instead of their becoming more alike as we trace them back in time, their earliest known remains prove them to have been widely different in structure. This fact renders more difficult the belief that they could have been evolved, while it renders quite certain the fact that if they were evolved they must have begun as fishes at some remote period in the Archæn.

* Text-Book of Geology, Third Edition, p. 744.

The general principle is self-evident that the higher the forms, the greater their divergence in structure, and the earlier the period at which they were introduced, the more difficult it becomes to account for their evolution.

So far as known fossils are concerned, they furnish no evidence to show that Fishes were evolved from invertebrates. The oldest remains are those of highly organized fishes which differed from each other widely in structure. These Fishes could not have been evolved from any of the known invertebrates which existed in the Primordial. The time was too short for the production of the enormous advance in structure involved in the evolution of these fishes.

If we rely on known fossils as evidence, we would be obliged to conclude that highly organized fishes were suddenly introduced. The break in the supposed chain of evolution between the invertebrates and the highly organized vertebrates of the Lower Silurian is one of the greatest in the whole geological record. As already stated, the discovery which carries the history of Fishes back to the lower Trenton, does not narrow the gap between the two great and widely divergent divisions of the animal kingdom. The vast gulf between these structures must, I think, remain unbridged except by the imagination.

The following quotations from Le Conte and Huxley, which were written when the oldest known fossil remains of fishes were in the Upper Silurian, are still applicable since the discovery of their remains in the Trenton.

Le Conte says: "But it is impossible to overlook the comparative suddenness of the appearance of a new class—fishes—and a new department—vertebrates—of the animal kingdom. Observe that at the horizon of appearance in the uppermost Silurian there is no apparent break in the strata, and therefore no evidence of lost record, and yet the advance is immense. It is impossible to account for this unless we admit paroxysms of more rapid movement of evolution—unless we admit that when conditions are favorable and the time is ripe for a particular change, it takes place with exceptional rapidity, perhaps in a few generations." *

Huxley says, in the address already quoted from: "The *Amphibia* and *Pisces* tell the same story. There is not a single class of vertebrated animals which, when it first appears, is represented by analogues of the lowest known members of the same class. Therefore, if there is any truth in the doctrine of evolution, every class must be vastly older than the first record of its appearance upon the surface of the globe. But if considerations of this kind compel us to place the origin of vertebrated animals at a period sufficiently distant from the Upper Silurian, in which the first Elasmobranchs and Ganoids occur, to allow of the evolution of such fishes from a vertebrate as simple as the Amphioxus, I can only repeat that it is appalling to speculate upon the extent to which that origin must have preceded the epoch of the first recorded appearance of vertebrated life."

From the above it is evident that Le Conte believes in paroxysmal evolution in which great advances in structure take place in a short time, while Huxley believes in slow changes which carry the history of fishes and other classes of vertebrates back to a period immensely remote from the oldest known fossils of those classes.

The former assumes that in the case of the early fishes the record is comparatively complete, while the latter claims that most of it is lost. I have no doubt

* Elements of Geology, p. 345.

that, if fishes were evolved, their history as vertebrates began far back in the Archæan. The entire record of fossils in the Archæan, if they ever existed there, has been obliterated, so that there can be no hope that fossils will be discovered which will reveal the earliest forms of vertebrates.

Evolution must assume either that the first vertebrates were evolved from invertebrates of the Primordial period, of which there is no evidence given by fossils, or that there is an immensely long but lost record in the Archæan.

If this were the only assumption of the kind necessary in the history of the vertebrates it might be justifiable, but a similar assumption becomes necessary for every class and order of vertebrates, and for every class and order of the entire animal kingdom.

I quote again from Huxley's address with regard to the geological record of vertebrates. It will be noticed that his remarks apply to parts of the geological record where fossils are abundant, and in which the beginnings of new forms ought to have been preserved.

He says: "The same moral is inculcated by the study of every other order of Tertiary monodelphons Mammalia. Each of these orders is represented in the Miocene Epoch; the Eocene formation, as I have already said, contains *Cheiroptera*, *Insectivora*, *Rodentia*, *Ungulata*, *Carnivora* and *Cetacea*. But the Cheiroptera are extreme modifications of the *Insectivora*, just as the Cetacea are extreme modifications of the Carnivorous type; and therefore it is to my mind incredible that monodelphons *Insectivora* and *Carnivora* should not have been abundantly developed along with Ungulata in the Mesozoic epoch. But if this be the case, how much further back must we go to find the common stock of the monodelphous *Mam-*

malia! As to the Didelphia, if we may trust the evidence which seems to be afforded by their very scanty remains, a Hypsiprymnoid form existed at the epoch of the Trias, contemporaneously with a carnivorous form. At the epoch of the Trias, therefore, the Marsupialia must have already existed long enough to have become differentiated into carnivorous and herbivorous forms. But the *Monotremata* are lower forms than the Didelphia, which last are intercalary between the *Ornithodelphia* and the *Monodelphia*. To what point of the Paleozoic epoch, then, must we, upon any rational estimate, relegate the origin of the *Monotremata?*"

If the theory of evolution is true, then I have no doubt that this argument is correct. Each order of animals, when it first appears in the fossil form, is highly developed, and therefore it must have been preceded by a long ancestral line of animals leading up to the fossil forms.

The Eocene contains six of the orders of monodelphous mammals. If these highly differentiated orders were evolved from a common stock it is evident that when they reached the Eocene they had already had a long history as monodelphous mammals. Prior to their history as *Monodelphia* they must have existed for a long period as *Didelphia* and before that as *Monotremata.* But we know that there were a good many species of mammals in the Jurassic, most of which are thought to have been insectivorous marsupials, with probably some rodents. In the Triassic several species of mammals have been found.

The existence, therefore, of so many kinds of mammals in the Eocene, Jurassic, and especially Triassic, shows beyond doubt that if mammals were evolved they must have begun as mammals at some point in the Paleozoic, and, as Huxley suggests, at a remote period in the same.

Again, the existence of Jurassic birds and their probable existence in the Triassic, as shown by fossil foot-prints, would necessitate their origin in the Paleozoic, and this would push the origin of reptiles much farther back in the Paleozoic than known fossils indicate.

Professor Huxley says: "It is almost appalling to reflect how far back in Paleozoic times we must go before we can hope to arrive at that common stock from which the Crocodilia, Lacertilia, Ornithoscelida and Plesiosauria, which had attained so great a development in the Triassic epoch, must have been derived."

Thus it is assumed by evolutionists at all points that the fossil forms which have been found are always far more highly developed than the first forms of the order or class to which they belong, and that in each case there is a long lost record favorable to their theory.

According to their theory all of the five classes of vertebrates must have abounded in at least the latter part of the Paleozoic—Mammals of various kinds; Birds, of the reptilian type; numerous kinds of Reptiles, some of which were transitional between birds and reptiles; besides, many Amphibians and Fishes.

Instead, however, of finding all of these classes in the Paleozoic, only Fishes and Amphibians were abundant, while true Reptiles were few, and no fossil Birds or Mammals have been discovered. Making all due allowance for perishability of remains, it would seem evident that if Fishes and Labyrinthodonts could be preserved in abundance, we ought to find some remains of Mammals and Birds, together with numerous fossils of true Reptiles. This is not a case of lost record in the sense that no rocks were being formed or that they were being made in places that we have never discovered. The rocks that ought to contain remains of these highest classes are present and contain abundance of the fossils of the lower vertebrates. I regard their absence, under the circumstances, as strong evidence that Mammals and Birds did not exist in the Paleozoic and that Reptiles were comparatively few.

The fact that evolution must assume that the history of the origin of every class and order has been lost, that the same has occurred in the case of nearly all species,—the fact that a record through practically infinite time must, if the theory is true, have existed, but that nearly all of it has been lost, leaves, so far as paleontology is concerned, but a narrow foundation on which to build the theory. As Professor Huxley admits, the known facts of paleontology with regard to Invertebrates and the lower Vertebrates negative the idea of evolution by progressive development, "within the limits of the period represented by the fossiliferous rocks."

IX.

PALEONTOLOGY.

I WILL now consider the theory of evolution with regard to vertebrates.

Having written of the "ideal primitive vertebrate" as imagined by Haeckel, Professor Romanes says: "Now I should not have presented this ideal representative of a primitive vertebrate, for I have very little faith in the 'scientific use of the imagination' where it aspires to discharge the functions of a creator in the manufacture of archetypal forms—I say I should not have presented this ideal representative of a primitive vertebrate, were it not that the ideal is actually realized in a still existing animal. For there still survives what must be an immensely archaic form of vertebrate, whose anatomy is almost identical with that of the imaginary type which has just been described. I allude, of course, to Amphioxus, which is by far the most primitive or generalized type of vertebrated animal hitherto discovered. Indeed we may say that this remarkable creature is almost as nearly allied to a worm as it is to a fish. For it has no specialized head, and therefore no skull, brain or jaws; it is destitute alike of limbs, of a centralized heart, of a developed liver, kidneys, and in short of most of the organs which belong to the other Vertebrata. It presents, however, a rudimentary backbone, in the form of what is called a notochord. Now a primitive dorsal axis of this kind occurs at a very early period of embryonic life in all vertebrated animals; but with the exception of *Amphioxus*, in all other existing *Vertebrata* this structure is not its destined to become the permanent or bony vertebı column. On the contrary, it gives way to, or is ı placed by this permanent bony structure at a la stage of development. Consequently, it is very sι gestive that so distinctly embryonic a structure this temporary cartilaginous axis of all the otl known Vertebrata should be found actually persisti to the present day as the permanent axis of *Amp oxus*. In particular, we must notice that the wall the neck is always perforated by what in Amphiox are the gill-openings, and that the blood-vessels they proceed from the heart are always distributed the form of what are called gill-arches, adapted convey the blood round or through the gills for t purpose of aeration. In all existing fish and otl gill-breathing Vertebrata this arrangement is pern nent. It is likewise met with in a peculiar kind worm, called *Balanoglossus*—a creature so pecul indeed, that it has been constituted by Gegenbau *class* by itself. We can see by the wood-cuts, that presents a series of gill-slits, like the homologo parts of the fishes with which it is compared, *i.* fishes of a comparatively low type of organizati which dates from a time before the development external gills. Now, as I have already said, these g slits are supported internally by the gill-arches, the blood-vessels which convey the blood to oxygenated in the branchial apparatus; and t whole arrangement is developed from the anter part of the intestine, as is likewise the respirat mechanism of all the gill-breathing Vertebra That so close a parallel to this peculiar mechani should be met with in a worm, is a strong additio piece of evidence pointing to the derivation of t Vertebrata from the Vermes." *

* Darwin and after Darwin, p. 144.

I have thus quoted at length in order that we may have a clear understanding of the claims of evolution as to the origin of the first vertebrates.

It will be noticed that *Amphioxus* is destitute of nearly every organ that belongs to the vertebrates. The only claim that it has to a position among vertebrates is that it has a spinal cord and a noto-chord.

Romanes says that it corresponds very closely to Haeckel's ideal primitive vertebrate and that it is "an immensely archaic" form of vertebrate.

According to this I infer that *Amphioxus* is either an actual link in the chain of evolution of the higher vertebrates and of man, or that it is a form which does not differ materially from an ancestor of man. Highly organized fishes are found in the Lower Silurian. If *Amphioxus* or something closely like it was their ancestor, then *Amphioxus* must have originated as early as the Primordial, if not earlier. Thus we find that this "immensely archaic form of vertebrate," has existed without making any progress, through all geological time, comprehending, as some claim, from 50,000,000 to 100,000,000 years. It has survived through all the varying circumstances to which any organism living in the water could be subjected in this infinite time, and still it has not made any perceptible progress. Its long survival without change is evidence of the inherent inability of *Amphioxus* to undergo change, and of the inability of environment to produce change, and also the lack of necessity for becoming more highly organized or for making any change in order to accommodate itself to varying conditions of environment.

It would seem that this immutable form is an exceedingly poor stock from which to try to evolve man.

In like manner the worm, Balanoglossus, possessing the gill-slits, if it was the progenitor, or if it is closely related to the progenitor of the vertebrates, which implied by the use which Romanes makes of it, th it is a still older form than *Amphioxus*, and it h survived without progress through all the geologic ages, and its present existence gives rise to the abov named difficulties.

In view of the existence of these "immense archaic" forms through practically infinite time, wi little or no change, it would be difficult to imagine worse attempt to find the primitive vertebrate fro which man has been evolved.

Of course, we may be told that some of the mo enterprising offspring of *Amphioxus* managed to pu their way upward, producing finally the highest ver brates and man, while the parent form endured u changed. But the answer is that a parent form whi has undergone no change through all geological ti is not capable of producing offspring that can ma unlimited progress, ending in man.

The same kind of difficulty is met with everywhe in the amimal kingdom, and especially among t vertebrates.

If we take Lampreys, which are probably the lo est of living fishes, in order to find their first anc tors, that closely resemble them as they now are, would be compelled to go back to a period much l yond the oldest known fossil fishes in the Siluri From that time to the present they have lived wi out progress.

It will be remembered that the oldest known fos fishes were more highly organized than living La preys, and consequently the latter must be referred a stock of a more ancient date.

The Cecilians, the lowest form of living Amphi ans, present a similar difficulty. In general appeara they are much like worms, and if the theory of evo tion is true, they must have branched off from the Amphibian stock early in its history and in all of their long history they have made no progress. And so I might continue through every class and order of vertebrates.

Reptiles of any living order are as simple in structure as were the oldest known reptiles of that order, and, consequently, if birds and mammals were offshoots of the reptilian stock, they are a most remarkable exception to the rule that reptiles have kept right on from the first without making progress in structure.

The Ornithorhinchus, now living, is an older form than the marsupials, and consequently we must seek the first of its kind far back in the Paleozoic. It can not differ much in structure from the monotremata which preceded the marsupials. It might be called an "immensely archaic" form of mammal, and yet it survives, while some one of its kind, more fortunate than the living species, shot upward in the line of progressive organization and finally resulted in man.

One of the first great changes which the monotreme made was to become a marsupial. The pouch of the latter would have been useless until sufficiently developed to contain the young, and, as usual with rudimentary organs, we are unable to account for its evolution at all.

The oldest known mammals were in the Triassic. They were small insectivorous marsupials. The lower jaw-bone of one from the Triassic of North Carolina is about one inch long. But few remains of mammals have been found in the Triassac, and they are teeth and fragments of jaw-bones.

In the Jurassic of both Europe and America the teeth and jaws of a good many species of insectivorous marsupials of the size of rats and mice have been discovered. From these remains it is evident that marsupials of many kinds must have abounded in the Jurassic.

It is also evident that the progenitors of these Triassic marsupials must have begun as mammals, perhaps as monotremes, at some period in the Paleozoic. As to how the transitions could have taken place from reptile to monotreme, from monotreme to marsupial, and from marsupial to placental mammal, we will not at present inquire.

The oldest known mammals are not the lowest in structure, and, from their long history antecedent to their oldest remains thus far known, we may expect to find their remains in Paleozoic rocks, if they have been evolved from lower forms.

From the abundance of the remains of marsupial mammals in the Jurassic and the numerous kinds of placental mammals in the Eocene, we would expect that, in the Cretaceous, which intervenes between the Jurassic and the Eocene, would be found the remains of many marsupial and placental mammals, together with transitional forms between them. It is, however, a remarkable fact that nearly the whole of the enormous deposits of the Cretaceous, amounting to 38,000 feet in thickness,* are, so far as had been discovered up to 1894, destitute of the remains of mammals. Not a single placental mammal has been found in the Cretaceous. Up to 1894 only one specimen of a mammal had been found in the foreign Cretaceous, and that was in the Wealden, the lowest part of the Cretaceous period. The other remains of mammals in the Cretaceous have been found in the upper part, while none have been discovered in the deposits of great thickness intervening between the remains in the lower and upper parts.

* Manual of Geology, Dana, pp. 818 and 828.

Geikie says of these remains: "Though mammalian remains had long been known to occur in the Triassic and Jurassic formations, none had been obtained from Cretaceous rocks, and this absence was all the more remarkable from the great abundance and perfect preservation of the reptilian forms in these rocks. But the blank has now been filled by the remarkable discovery in the Upper Cretaceous rocks of Dakota and Wyoming of a large series of jaws, teeth, and different parts of the skeletons of small mammals belonging to many individuals, and including not a few genera and species. They are found associated with remains of deinosaurs, crocodiles, turtles, ganoid fishes, and invertebrate fossils, indicating brackish or fresh water conditions. The mammalian forms show close affinities to the Triassic and Jurassic types. There are several distinct genera of small marsupials, others seem to be allied to the monotremes, but there are no carnivores, rodents, or ungulates." * (He then enumerates the names of the sixteen genera as proposed for them by Marsh.) "More recently the discovery of a single small tooth in the Wealden series of Hastings is the first trace of mammalian life yet found in the Cretaceous formations of Europe."

Dana says of the Cretaceous mammals: "The mammals of the Cretaceous thus far discovered are probably all marsupial or monotreme, like those of the Jurassic period. The remains are mainly teeth, with a few broken jaws and limbs." †

"The Monotremes and Marsupials from the Cretaceous formation show little progress in Mammals beyond the condition in the Jurassic period—nothing, up to the present time, that bears the decided character of a placental mammal." ‡

* Text-Book of Geology, p. 935.
† Manual of Geology, p. 852. ‡ Ibid, p. 871.

The above is a remarkable state of facts if the numerous kinds of large and highly-organized placental mammals which are found in the Eocene, immediately succeeding the Cretaceous, were evolved from Cretaceous marsupials.

During the immense time of the Cretaceous, while 38,000 feet of rocks were being deposited, the marsupials and monotremes of the Jurassic did not become placental mammals, and, we may add to this the 6,000 feet of Jurassic and 15,000 feet of Triassic, —making the whole Mesozoic 59,000 feet thick—and during this enormous time small marsupials remained such, so that at the close of the Cretaceous, so far as fossils show, both large marsupials and placental mammals were absent.

If, as Geikie says, "the great abundance and perfect preservation of the reptilian forms in these rocks" would cause us to expect the remains of mammals in them, then we ought to expect the remains of large and small placental mammals and of the transitional forms between them and the marsupials. This, at least, is one of the very special cases where, if evolution has taken place, we have the right to believe that the record would have been preserved, and its absence may be strongly urged against the truth of that theory.

We have but to consider the Eocene mammals and contrast them with the small marsupials of the uppermost Cretaceous in order that we may see the force of the above statement. As to the Tertiary marsupials, Dana says:

"The Marsupials, as in earlier time, were small species, related to the Opossums, and their remains are known from the Early Eocene onward." *

"No immediate precursors of the Tertiary non-

* Manual of Geology, p. 902.

marsupial or placental Mammals, linking them to the Marsupial, have yet been found in any part of the world, notwithstanding the occurrence in many regions over America, as well as the other continents, of a gradual passage from the Cretaceous formation into the Tertiary. They are naturally supposed to have existed in the later Cretaceous over the dry land of eastern and western America; but still it is strange that they did not find resorts somewhere on the border of the Cretaceous seas along with the Marsupials." *

It is evident that Dana is disappointed at the absence of the remains of placental mammals from the later Cretaceous, where marsupials are abundant. I know of no plausible theory by which the evolutionist can account for this important fact of imperfect record.

"Another strange fact is that although the Marsupials of earlier time had become variously specialized, their placental successors should have had unspecialized or prototype characters." †

This fact, of course, goes to negative the theory that the Eocene mammals were evolved from Cretaceous marsupials. Continuing with regard to the difficulties in the way of evolution, Dana says:

"Diversity of Eocene Mammals. Another remarkable fact is that so great a diversity of Mammals, diversity in structure as well as size, should have appeared before the Eocene period had passed. The prototypic plant-eaters and flesh-eaters of the earliest part, supposed to be plantigrade in feet, were followed, even in the Wasatch division of the lower Eocene, by species of large, short-footed Ungulates, the Coryphodonts, and in the later Eocene huge Dinocerata, the latter supplied with horns for attack

* Manual of Geology, p. 928. † Ibid, p. 928.

and defense. In the Eocene also, the Tapir-like species advanced far toward the modern genera, Tapirus and Rhinoceros. There also appeared various species with paired toes, in the line of the Hogs, Hippopotamus, Camel, so that the type of Artyodactyls, and the types of several of its principal subdivisions, were established. There were also some prominent Eocene types of Rodents and Insectivores. Further, the Quadrumana of the Early Eocene, having the typical number of teeth, 44, were followed in the later Eocene by others, in which the number of teeth was reduced to 32, the final limit in the Quadrumana, and that characterizing Man.

"Moreover, there were several successions of Mammalian faunas in this first period of the North American Tertiary, and the species in each of them probably outnumbered those of Recent North America. The kinds found fossil may have been a fourth of all then existing in the region, and probably not more." *

"Before the close of the Eocene there were whales in the seas—the Zeuglodons," some of which were seventy feet long.

We are asked by evolutionists to believe that all of these remarkable forms of mammals, highly developed and differentiated from each other—including forms resembling Tapirs, Rhinoceroses, Hogs, Camels, Hippopotamuses, Rodents, Insectivores, Whales 70 feet long, and Quadrumana having only 32 teeth, were evolved from the small Cretaceous Marsupials, either during the Cretaceous or the Eocene period, and yet no remains of a single placental mammal have been discovered among the numerous small Marsupials, of the Upper Cretaceous. Starting with those small Marsupials which were land animals,

* Manual of Geology, p. 928.

how can we account for the Zeuglodon, a whale 70 feet long?

It is claimed by evolutionists that some carnivorous land animal was forced to take to the water, and that from this the Zeuglodon was evolved.

If it is claimed that the above placental Mammals were evolved in the Cretaceous, then it becomes necessary for the evolutionist to account for the absence of their remains in a continuous record where other vertebrate fossils abound. Dana, in the language above quoted, shows his surprise at their absence "notwithstanding the occurrence in many regions over America, as well as the other continents, of a gradual passage from the Cretaceous formation into the Tertiary."

Le Conte, speaking of Eocene mammals, says "there is at a certain horizon a rapid and most extraordinary change in the life-system. This it seems impossible to explain on the theory of evolution, unless we admit *periods of rapid evolution.*"* "True placental mammals not only appear suddenly and in great numbers, but of nearly all orders. In the oldest Eocene beds, (Wahsatch beds of the Green River and San Juan basins) Cope finds eighty-seven species of vertebrates, two-thirds of which are mammals. In the Fort Bridger beds of the Green River basin (Middle Eocene), Marsh finds 150 species of vertebrates, of which the larger number are mammals, some Herbivora, some Carnivora, and some Lemurine monkeys."†

In the Eocene of the Paris basin in France, fifty species of mammals have been found, forty of which are Tapir-like.

At the time Le Conte wrote the above, no marsupials had been discovered in the Cretaceous. Their

* Elements of Geology, p. 497. † Ibid, p. 517.

subsequent discovery, together with the absence of the remains of placental mammals, renders his language more forcible. Relying on the continuity of the record, he thinks it necessary to "admit *periods* of *rapid evolution*."

Without dwelling on this longer, I will say that the absence of the remains of placental mammals from the upper Cretaceous, under the circumstances, I regard as being a very strong, if not insuperable, objection to the theory of evolution. Besides this, there are the other great difficulties enumerated by Dana.

The history of the marsupials does not warrant the assumption that placental mammals can be evolved from them. When Australia was discovered, two monotremes, many marsupials, but no true mammals, except bats, were found there. These marsupials, according to the theory of evolution, were isolated before true mammals were evolved. They have, therefore, had in Australia an opportunity extending over millions of years to show their capacity for becoming placental mammals, but not one of them, so far as we know, has ever advanced beyond the marsupial condition. Beginning with the present, we have an unbroken line of marsupials back into the Triassic, and possibly into the Paleozoic, through nearly a hundred thousand feet of stratified rock, and they still remain marsupials, not having advanced much in structure from the time of their oldest fossil remains.

It is said to be a law of England that "once an Englishman, always an Englishman," and so it seems to be a law of Nature, hoary with age, that once a marsupial, always a marsupial.

The remains of the Zeuglodon, a whale 70 feet long, have been found only in the Jackson beds, which are the uppermost division of the Eocene. This is a remarkable fact when we remember that the older divisions of the Eocene are well represented along the Gulf-border region, as is also the Cretaceous. Le Conte says: "No intermediate links have yet been found connecting this with other orders of mammals, or with the great reptiles. And yet from their large size and marine habits, they are more likely than land mammals to have been found if they existed in the earlier Eocene or Cretaceous times."*

That the remains of whales are likely to be preserved, is shown by the abundance of their remains in the Miocene. Dana says: "The Miocene of the Atlantic border has afforded remains of many Cetaceans. Among them are various Dolphins, several species of Whales of the genus Squalodon, related in teeth to the Zeuglodon, the largest about 30 feet long. Others having the teeth excessive in number, or multiplicate, and provided with only one root; others having similar teeth, but only in the upper jaw, as in the genus *Physeter*, or that including the Sperm Whale; others with teeth in neither jaw, as the Baleen, or Whalebone Whales, but having several hundred plates of the so-called whale-bone growing vertically downward from above."†

It is no adequate answer to this to say that in the Cretaceous and other periods there are rock deposits that are quite destitute of fossils of any kind. The force of the objection in this and similar cases is that the remains of the Zeuglodon and other Eocene mammals are absent from rocks abounding in vertebrate fossils, in which, if they lived while these rocks were being deposited, their remains would be preserved.

It is claimed that the fossil remains of certain

* Elements of Geology, p. 523. † Manual of Geology, p. 912.

mammals show that they were evolved. The geological history of the horse is to the evolutionist a source of perennial delight. It has indeed become a veritable hobby-horse, which he delights to ride and to which he points with pride as an unanswerable argument.

The Eocene horse, which was about as large as a fox, had four toes in front and three behind; the Miocene horse had three toes and a splint in front, and three behind; the Pliocene horse gradually lost the two toes at the side, until they were represented by splints, leaving only the middle toe, as in the horse of to-day. Why did he lose these toes? If the modern evolutionist had been geologically contemporaneous with the horse we would say that the latter had lost his toes by being hardly ridden up and down the slopes of the Rocky Mountains.

It may be a question as to whether the horse has been evolved, as claimed. Le Conte says: "About thirty-five or forty species of this family, ranging from the earliest Eocene to the Quaternary, are known in the United States."* This number of known species would, according to the assumptions of evolutionists as to the proportion of lost forms, indicate the existence of hundreds, if not thousands, of species within the above period. If this is true, how do we know that the Miocene horse of three toes did not exist in the Eocene, and that the Pliocene horse of only one toe did not exist in both Miocene and Eocene? For the purposes of evolution the known record is presumed to be quite sufficient, and this, in spite of the fact that, according to the claims of that theory, most of the record is unknown.

But, granting that the horse did gradually lose three of his toes and that his teeth underwent a cer-

* Elements of Geology, p. 832.

tain amount of change, what conclusions can be legitimately drawn from these facts? From the early Eocene to the present from thirty-five to forty thousand feet of sedimentary rocks have been deposited. In this immense time the horse has lost two or three toes, has increased in size, and his teeth and bones have undergone no fundamental changes.

Are we to conclude from this that the great Zeuglodon, a whale 70 feet long, was evolved during the Cretaceous, in which its remains are not found, from the small marsupials of that period—or that the Quadrumana, the highest order of mammals next to man, and the numerous large and highly-developed and differentiated mammals of the Eocene were evolved from the same small marsupials, of which there is no evidence from fossils whatever? or, going backward in time, shall we from the case of the horse conclude that the first mammals were evolved from reptiles, and that the first fishes were evolved from worms? It is possible that the horse might, in his long history, have undergone the changes claimed, which are not very great comparatively—not fundamental, and that from this we might not legitimately conclude that an invertebrate has become a vertebrate, or that a reptile has become a mammal.

In my opinion it is not true that every change of structure is to be regarded as a proof of the general theory of evolution. It may be granted that certain changes have taken place in organic forms by way of evolution without thereby admitting that all the great and fundamental differences between organic beings have thus been produced.

I have in another chapter endeavored to show the impossibility of satisfactorily accounting for the evolution of various classes and orders of animals.

Looking at the known geological facts, there exist through all geological time wide gulfs between groups of organic beings which are not bridged by intermediate forms. And very remarkable it is that the gulfs between the great groups of animals are, in most cases, quite as wide in the beginning as they are in the end. It is a quite universal rule that species, orders, and classes appear suddenly, as if by substitution, and not by evolution.

X.

EMBRYOLOGY.

EVOLUTIONISTS rely much of late upon embryology in trying to establish the truth of their theory. Embryology treats of the structure and the development of the animal in the egg.

All animals are divided into two divisions with regard to their method of reproduction; namely, the Protozoa and the Metazoa. The Protozoa do not produce true eggs, while the Metazoa produce eggs.

The Protozoa are the simplest of all animals, consisting generally of a minute speck of protoplasm, ranging in size from less than $^1/_{1000}$ of an inch to more than an inch in diameter. They reproduce by the division of an individual into two organisms. The nucleus, which is the center of physiological action, first divides, forming two nuclei, and each of these serves as a center for the new individual. A protozoan is commonly regarded as being a nucleated cell.

The Metazoa reproduce by means of eggs which must be fertilized by spermatazoa. A metazoan is always composed of more than one, and generally of many cells. The cells that compose the body are of more than one kind, each tissue of the body being composed of cells peculiar to itself, and adapted to perform a special kind of work.

The Metazoa may also propagate by budding. Dr. Romanes claims that the asexual reproduction by budding among the Metazoa "is ultimately due to their propagation by sexual methods," so that without the sexual method propagation would, in a short time, cease.

He states the differences between the methods of reproduction among the Protozoa and Metazoa as follows: "In nearly all cases where a Protozoan multiplies itself by fission, the process begins by a simple division of the nucleus. But when a Metazoan is developed from a germ-cell, although the process likewise begins by a division of the nucleus, this division is not a simple or direct one; on the contrary, it is inaugurated by a series of processes going on within the nucleus, which are so enormously complex, and withal so beautifully ordered, that to my mind they constitute the most wonderful—if not also the most suggestive—which have ever been revealed by microscopical research. It is needless to say that I refer to the phenomena of karyokinesis." *

Again he says: "Lastly, the only other distinction of a physiologically significant kind between a single cell when it occurs as a Protozoan and when it does so as the unfertilized egg of a Metozoan is, that in the latter case the nucleus discharges from its own substance two minute protoplasmic masses (polar bodies) which are then eliminated from the cell altogether. This process . . . appears to be of invariable occurrence in the case of all egg cells, while nothing resembling it has ever been observed in any of the Protozoa." †

The Metazoan generally reproduces by means of eggs which must be fertilized by spermatazoa, and when they reproduce by budding this is ultimately due, according to Romanes, to the sexual method. The ovum and the spermatazoa may both be produced by the same or by different individuals. The

* Darwin and After Darwin, p. 129. † Ibid, p. 114.

ova in all the higher animals are produced by the female and the spermatazoa by the male.

Before fertilization the ovum discharges the polar bodies, and it is claimed by some that the spermatazoan also discharges similar bodies.

In order to fertilize the ovum the spermatazoan must find its way into the ovum, penetrating its cell-substance, where it sets up the process of development. Fertilization having taken place, next follows the "enormously complex" process of karyokinesis.

Thus I have stated in outline the differences between the methods of reproduction by the Protozoa and the Metazoa. I will enumerate them:

First. The Protozoa produce no eggs, while the Metazoa produce eggs.

Second. The Protozoa produce no spermatazoa, but the Metazoa produce them.

Third. The ovum of Metazoa discharges polar bodies.

Fourth. The spermatazoa probably discharge polar bodies.

Fifth. After fertilization, there takes place in the nucleus of the ovum the "immensely complex" process of karyokinesis, while the division of the nucleus in the Protozoan is simple.

Sixth. All Metazoa pass through the gastrula stage of development, which stage is represented by a double-walled cavity composed of two layers of cells.

Seventh. A Protozoan is composed of only one kind of cells, while a Metazoan is composed of more than one kind, and generally of many kinds.

It is evident that the evolutionist must bridge the chasm between the Protozoa and the Metazoa. Little has been done in this direction.

Romanes says that there is "a suggestive foreshadowing of sexual propagation among the unicellular organisms." As an example of this he gives the case of "conjugation," in which two or more Protozoa unite together, become encysted with each other, forming one body, which finally breaks up, and thus releases spores that produce organisms like those that united. But he does not claim that this is at all similar to the very complex method of reproduction among the Metazoa. He says, "Nevertheless that there are great distinctions between true sexual propagation and this foreshadowing of it I do not deny."

I am not able to understand in what the foreshadowing consists. The cells of Protozoa which unite are essentially different from the ovum and the spermatazoa that unite; the method of union is different in the two cases, and the processes and results of development after union are totally different. It is true that in both cases there is some sort of mechanical union, but further than this I see no similarity. The evidence necessary to show that Metazoa may be evolved from Protozoa is, I think it will be admitted, entirely insufficient.

As heretofore urged, the evolutionist must furnish sufficient evidence to show that spontaneous generation has taken place from inorganic matter. Here the evidence totally fails. "As to the origin of life," says Romanes, "science is not in a position to furnish so much as any suggestion on the subject."

Having shown that spontaneous generation can take place from inorganic matter, resulting, as we may presume, in non-nucleated, undifferentiated protoplasm, he must show that such protoplasm can become nucleated cells or organisms capable of propagating their kind. Of this there is no evidence.

Having shown how Protozoa may be evolved, he must then prove that Metazoa may be evolved from them. From the lowest Metazoa he must show how the highest Metazoa might have been evolved, including the enormous ascent from sponge to man. In this it would be necessary to show the evolution of the vertebrate from the invertebrate animal.

At this point we would naturally look to embryology to bridge the chasm. Dr. Romanes, however, who more than almost any other writer has called to his aid embryology in trying to establish the truth of the theory of evolution, does not attempt to use it in trying to show the evolution of the vertebrate from the invertebrate. He claims that the lowest vertebrate, the Amphioxus, is related in structure to Balanoglossus, a living species of worms, and that the two probably had a common ancestor.

It is well known, however, that there are radical differences between the embryos of vertebrates and invertebrates. Worms and other articulates in embryo lie doubled backwards around the yolk, while all vertebrates are doubled in the opposite direction.

According to the theory that the embryonic condition is a recapitulation of the stages of organic evolution, this fundamental fact of invertebrate embryology ought to have been preserved by the vertebrate, and it ought, at least, to pass through a stage of development bent backwards around the yolk. Evolution gives no account of this reversal of position by the vertebrates.

Again, among the vertebrates are found three modifications of development. Fishes and Amphibians have no amnion nor allantois; Reptiles and birds have both, while the Mammals alone have a placenta. Evolution gives no account of these fundamental differences.

It is true that the embryology of the vertebrates shows that at an early stage of development the embryos of all vertebrates closely resemble each other in form, and that as development proceeds they become more and more unlike in form until birth. This resemblance is the stronghold of the evolutionist.

It is claimed that the egg-cells, or germ-yolks, of all eggs are alike in structure. The germ-yolk is that part of the egg that is developed into the animal. Its usual size is from $^1/_{100}$ to $^1/_{200}$ of an inch in diameter. The greater part of the egg, in many cases, is food for the growing embryo.

Inside of a few weeks, or, at most, of a few months, beginning with vertebrate eggs that are said to be essentially alike in structure, we see developed Fish, Amphibian, Reptile, Bird and Mammal.

If all eggs are essentially alike in structure, how can one become a fish and another a dog? No egg ever makes a mistake and develops into an animal of another class. It is evident that while all eggs, from that of the sponge to that of man, may seem to be alike in structure, they are really as far apart in their essential nature as are the fully developed sponge and the full-grown man. The essential factor of possibility in the life of any organism is bound up in the egg.

The resemblance of embryos, it is claimed by evolutionists, denotes genetic affinity.

Taking the embryos of man and fish, his argument is as follows. The embryos of man and fish at a certain stage of development are closely alike in appearance; therefore, the adult man and the full-grown fish had a common ancestral origin.

This conclusion is, I think, not warranted by the premises. Suppose that we embody the same facts in the following proposition:—the fully developed man and fish differ enormously from each other in many essential respects; therefore, the embryos of the man and of the fish, although they look much alike, are essentially different; and, therefore, neither embryos nor adults could have had a common ancestor. This, I think, is the correct conclusion from these facts.

The conclusion which the evolutionist draws is based upon a mere seeming and very transient resemblance, while the fact that the two embryos are essentially unlike is shown by the vast distance apart at which they arrive by development.

If, therefore, the theory of evolution is true. embryology cannot serve to establish its truth.

Romanes regards it as "the most important of the lines of evidence" to establish the theory.

I have already given what evolutionists regard as the chief law of embryology in relation to evolution, namely, that the embryo of the individual is a recapitulation of the process of evolution of the class to which it belongs.

If we try to apply this rule to the evolution of man, we will find it extremely defective. His ancestral line might, according to the theory of evolution, have been something like the following:—undifferentiated protoplasm, differentiated protoplasm in the form of plant cells, Protozoa, Mollusks, Worms, Amphioxus, Fish, Amphibian, Reptile, Ornithorhinchus, Marsupial, Placental Mammal, Lemur, Monkey, Anthropomorphous Ape, and Man.

Taking this ancestral line and comparing it to the embryo of man, we would be obliged to strike out all of the line up to Fish, also Amphibian, Ornithorhinchus, or Monotreme, and Marsupial.

Why should the whole first half of the history of evolution be not even hinted at in the epitome? and why should the Monotreme and the Marsupial be totally forgotten? while the remembrance of all the others is so jumbled together that we cannot tell whether or not the historian would remember any one of them in any definite way. I regard the so-called epitome as being mostly imaginary.

It is true that the embryos of vertebrates look much more alike than do the adults, and that the eggs are still nearer alike in appearance than are the embryos, but I insist again that in fact the embryos are no nearer together in essential structure than the adults. If we draw lines from adults to embryos, and on to eggs, these lines will not be convergent, but parallel. It seems evident that the egg which can be developed into a man is just as different in nature from the egg of a fish as the man is from the fish. The eggs are essentially unlike. We cannot say that their present resemblance points to a time when they were not only alike in appearance, but also alike in essence. This is the claim of evolution.

Taking fish and man, we find eggs, embryos, and adults essentially unlike, and, consequently, from embryology it cannot be asserted that they were ever identical. To assert former similarity in essential character in the face of the widest present essential differences all along the line is not justifiable.

The evolutionist seeks to break down enormous essential differences by appealing to certain transient resemblances. He would have us believe that the egg-cells of all animals are not only alike in appearance, but that there was a time when they were identical.

The essential qualities of eggs are beyond the power of the microscope to reveal. We know beyond doubt that eggs and embryos which look closely alike are almost infinitely different in their powers of development. The thing to be accounted for by evolution is the unseen difference between eggs. Present resemblances between eggs are much less significant than the present invisible differences.

The claim that the history of the embryo is an epitome of the history of the ancestral line, is an assumption, for the evident reason that we do not know what the ancestral line was. We must know what the history itself is before we can assert that this or that is an epitome of that history.

If we assume evolution as a fact, then we may assert the existence of the epitome, but if we deny that evolution has taken place, then we deny the possibility of an epitome. To assert the existence of the epitome is to assume the fact of evolution, and consequently the supposed epitome cannot be proof of the fact of evolution which it assumes.

Embryology, instead of confirming the truth of evolution, stands waiting at the door of evolution for its own confirmation.

We are told that the embryos of all vertebrates at a certain stage have gill-arches. My answer to this is that the embryo man with gill-arches is just as different from the embryo fish with gill-arches as is the full-grown man from the full-grown fish. Embryo man with gill-arches is still man, and if we can read the lesson within it, we will find that this embryo man points upward to adult man with all of his marvelous powers of mind, and not downward to something infinitely below him. The human embryo is produced by human beings only, and whatever may be its microscopic appearance, it is at every stage of its development strictly human. It does not at any time point to the fish as its ancestor, but at every step points to man, as is shown by the final results of development.

Embryology, as applied to evolution, fails, in that it deals only with the surface of things. It accepts microscopic resemblances as an explanation of the essence of things, while it takes no notice of the essential, well-known, but unseen differences.

Le Conte, in speaking of the six aortic arches in adult lizards, says: "Now there is no conceivable use in having so many aortic arches. We know this, because there is but one in birds and mammals, and the circulation is as effective, nay, much more effective in these than in reptiles. If the thing were done out of hand, unconditioned by the previous structure in fishes, to have made six was surely but a bungling piece of work."*

From this it would seem that the lizard has not made the progress that it should have made under the circumstances, for one gill-arch would serve its purpose better than the six which it possesses. Yet the extra five gill-arches have been preserved millions of years, just as if they had been best for the lizard. How did it happen, according to the theory of natural selection, that the five have been preserved so long, not only in the embryo, but also in the adult lizard? If they might have been disposed of to the great advantage of the lizard, why has it retained them? The fact that they have been retained is evidence that they have been useful. If anything better could have been done for the lizard to make its circulation more perfect for an animal of its kind, then natural selection ought to have made the improvement in the vast time it has been at work. If the evolutionist claims that the lizard's circulation would be improved by dropping five of the six aortic arches, then he cannot account for their preservation.

Le Conte tells us that if the lizard was not evolved, but created by fiat, then the six gill-arches were surely "but a bungling piece of work." This seems

* Evolution, etc,, p. 134.

to mean that he knows better how a lizard ought to be constructed than the Power that made it. Since, however, lizards have lived for millions of years with their present structure, I think that I may doubt the correctness of his assertion.

Evolutionists assume that the Creator would be relieved of responsibility if he worked by the process of evolution instead of by fiat. It seems to me, however, that a "bungling piece of work" by fiat would also be a "bungling piece" by evolution. The attributes of the Creator are as much at stake by the one method as by the other.

Darwin says: "The points of structure in which the embryos of widely different animals within the same class resemble each other, often have no direct relation to their conditions of existence. We cannot, for instance, suppose that in the embryos of the Vertebrata the peculiar loophole courses of the arteries near the branchial slits are related to similar conditions in the young mammal which is nourished in the womb of its mother, in the egg of a bird which is hatched in a nest, and in the spawn of a frog under water."*

This language seems to imply that the gill-arches and slits in the embryos of vertebrates do not serve a useful purpose. If this is true, it is impossible that these parts should have survived for millions of years by natural selection.

Embryos are subject to this law, and by it parts that are not functional ought, after the lapse of a long time at least, to disappear.

Gill-arches and slits have, however, survived in all classes of vertebrates through the immense geological periods since the classes were introduced. The uniform survival of these parts in embryos for such

* Origin of Species, p. 395.

great lengths of time is, of itself, I think, sufficient evidence to prove that they are functional. If they are of use in the embryos of the higher vertebrates, then their existence cannot be regarded as a vestige of the process of evolution—they cannot be looked on as rudimentary organs. If these parts are functional in embryonic fishes, as we presume they are from their inheritance by fishes through most of the geological ages, then I see no reason why they may not be functional in the other classes of vertebrates. In all these classes the embryo exists in an egg and is surrounded by a fluid or by soft material—the most striking difference to which they are subjected being that of temperature.

XI.

SPECIAL OBJECTIONS TO THE THEORY OF EVOLUTION.

I WILL now consider some of the special difficulties that are opposed to the theory of evolution.

If the doctrine of evolution is correct, then every part of every organism has been produced by the process. If any part of an organic being exists, the evolution of which is opposed to known facts, or which is not supported by sufficient facts, then the theory fails.

With regard to the difficulties that beset the theory, Darwin says: "Some of them are so serious that to this day I can hardly reflect on them without being staggered; but to the best of my judgment, the greater number are only apparent, and those that are real are not, I think, fatal to my theory." *

Again he says: "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down. But I can find no such case." †

Also: "In many cases it is most difficult to conjecture by what transitions many organs have arrived at their present state." ‡

It is easy to imagine that by the necessary additions and subtractions any organism can be evolved from any other organism. By the purely imaginative method an elephant may be evolved from a cell of yeast. If it is simply a matter of imagination as to

* Origin of Species, p. 167. † Ibid, p. 181. ‡ Ibid, p. 190.

evolving this or that organ, then it may be granted that evolution is true.

If, on the other hand, we may demand some plausible method before accepting the theory, then the matter assumes a different aspect.

When Darwin says that he can find no case of a complex organ which could not possibly have been formed by numerous slight changes, it would be presumed that he had a tolerably clear mental picture, based upon known facts, of the evolution of the various complex organs.

When, however, he says that "in many cases it is most difficult to conjecture by what transitions many organs have arrived at their present state," the poverty of the evidence is at once revealed. If we cannot even "conjecture" "what transitions" have taken place, may not the existence of the transitions themselves be a matter of doubt? If imagination, conforming to known facts, fails to reveal routes by which evolution may probably have traveled, why should we accept evolution as a fact?

I am aware that some evolutionists declare that the theory has been fully established by induction, and that, accepting the theory as a fact, they have little trouble in disposing of what they rather lightly refer to as special objections.

The so-called special objections, however, are just as legitimate as any other kind, and the truth of the theory must not be assumed in order to dispose of them.

The evolution of various complex organs in the animal kingdom presents difficulties which I regard as inexplicable by the theory of evolution, unless it be granted that the imagination may legitimately supply most of the facts.

When we are told that all the complex organs of animals have been evolved but that the evolutionist is under no logical obligation to furnish plausible routes of evolution, I think that we may rightly object.

One of the most difficult organs to account for is the electric organ of the skates. In these fishes it has been shown to be a true electric battery, but the discharges from this battery, even in the adults, are so feeble that they are of no practical use so far as has been ascertained. It is well known that the electric eel and the torpedo use their batteries for stunning other animals.

It is evident that, according to the theory of natural selection, these batteries could not have been preserved through their long functionless and useless stages, for that theory assumes that they were preserved because they were useful.

Darwin says: "The electric organs of fishes offer another case of special difficulty; for it is impossible to conceive by what steps these wondrous organs have been produced." *

Romanes, having tried to account for the existence of the electric organs in the rays, says: "In view of all these considerations taken together, I freely confess that the difficulty presented by this case appears to me of a magnitude and importance altogether unequaled by that of any other single case — or any series of cases—which has hitherto been encountered by the theory of natural selection. So that if there were many other cases of the like kind to be met with in nature, I should myself at once allow that the theory of natural selection would have to be discarded." †

Some of the electric organs of fishes are in the heads and others in the tails, so that they could not have had a common origin, and they must, therefore,

* Origin of Species, p. 184. † Darwin and After Darwin, p. 373.

have been produced independently of each other. Even if it be granted that they are not homologous in structure, this does not at all relieve the difficulty of accounting for them.

If, as Darwin says, "it is impossible to conceive by what steps these wondrous organs have been produced," the difficulty is only multiplied by the fact that they have had several, instead of one origin. It is impossible to account for the existence of any one of the electric organs of fishes by natural selection or by any other plausible theory of evolution.

It is admitted that wings as organs of flight have been independently evolved in at least four different lines—namely, in insects, pterodactyls, birds and bats.

That an organ so highly specialized as any one of these wings could be evolved seems improbable; while the evolution of the four different kinds, independently of each other, only increases the improbability.

Romanes admits that if homologous organs were independently evolved the theory of natural selection would be destroyed.

The difficulty, to my mind, is to account for the evolution of any known kind of wing. In each case there exists the insuperable difficulty of preserving the organ through the rudimentary stages. The wing of an insect in the first generation of its evolution would be almost imperceptible and entirely useless for any purpose whatever, and so it would continue to be for a great number of generations. It is evident, therefore, that they could not have been preserved through their long rudimentary stage on the ground that they were useful, nor do we know of any theory that will account for their evolution. To say that they were evolved is easy, but to account for their evolution seems impossible.

As to the evolution of the wings of birds, we are in the dark. It is claimed that birds were evolved, not from Pterodactyls, but from reptiles that had no wings. The oldest known fossil birds were covered with feathers, and the wings were sufficient for flight. No birds with rudimentary wings have been found connecting the bird with any older form.

Among living birds we find all grades of wings. The apteryx has rudimentary wings that are of no use; the ostrich has wings by far too small for flight; the penguin has small wings that are used as fins; the logger-headed duck has barely sufficient power of flight to skim along the surface of the water.

It might seem that these are examples of the evolution of wings, but evolutionists themselves claim that these various wings which are useless for flight have been rendered so by disuse.

The opposite of this, however, which evolution implies, is not true. If we take the wings of the apteryx, which are the merest rudiments, and are of no use whatever, we can conceive of no probable method by which they could ever become useful wings for swimming, for flight, or for any other purpose.

An organ may possibly become smaller and smaller, and finally pass out of existence by disuse, but until an organ is of sufficient size to be used it cannot be developed by use. The inability of limbs of any kind to survive the thousands of generations involved in the rudimentary period, I regard as fatal to the theory of evolution.

We are told, however, that an organ may at one time serve one purpose and at another time another purpose. The wings of the penguin are given as an illustration.

So far as the wings of birds which cannot fly are concerned, they, by admission, illustrate a retrograde movement, and consequently do not show the method of evolving wings that are useful for flight. The penguin uses its wings as fins and, doubtless, has been so using them for many generations, and yet we do not know that this use is increasing their size and preparing them to become birds of flight. Their wings have been in constant use, and yet, according to the theory of evolution, they have decreased in size till they are useless as organs of flight and comparatively useless for any purpose.

We have no evidence to show that the wing of the bird has been evolved from the fore leg of the reptile. The oldest known fossil bird's wings were widely different from the legs of reptiles. There is no clew whatever to the evolution of feathers, which all birds have possessed, and which no known reptiles have possessed.

We cannot regard feathers, therefore, as something transient and of little importance. To say that feathers are homologous to the scales of reptiles is no explanation of their origin. We have no reason to believe that the scales of reptiles can, or ever have become feathers. The structure of a feather is extremely unlike that of a scale. If we try to imagine the steps by which the scales on a lizard's fore legs could be developed into the great complex feathers necessary for flight, we utterly fail to make the transitions, and yet evolution assumes that feathers had some such origin.

Evolutionists assume that by disuse the legs of most snakes have entirely disappeared, while in the Python, rudimentary bones, marking the position of one pair of legs, remain. Some lizards have no legs, others have a rudimentary pair, others four small and comparatively functionless legs, while most have four well developed legs. It is claimed that lizards have lost their legs by disuse.

If well developed wings and legs can, after many successive generations, become less and less useful, and finally become rudimentary or entirely disappear, it would not seem possible that an entirely functionless and merely rudimentary limb could endure through countless generations of uselessness and then become useful.

It is no answer to this to say that an organ may serve different purposes at different stages of its evolution, for there is in every case a long rudimentary period during which appendages and most organs can be of no use whatever.

The first limbs, it is presumed, were fins; from which were evolved paddles, and from these were evolved the first amphibian legs, and then the legs of reptiles, wings of pterodactyls, birds and bats. We find here a marvelous series of transitions. As to the origin of fins we have no evidence whatever. They are said to be homologous to the limbs of the higher vertebrates, but I regard the homology as far-fetched. The word homology will, I believe, have to answer for a multitude of sins. To call all the above named appendages homologous, would be to some persons a satisfactory method of accounting for their origin,—so much so, that the use of the word puts an end to all controversy.

Paleontology furnishes no evidence to show the evolution of the first known legs from fins. The oldest known vertebrates that possessed true legs with separate toes were the Labyrinthodonts of the Subcarboniferous period, which had four toes on the hind foot and five on the fore foot. There are no fossils which show the evolution of the legs and feet of these animals from the fins of fishes. The difference between the legs of these amphibians and the fins of any older fishes, and, in fact, of any known fishes, is enormous. To claim that they were evolved from the fins of the fishes is much more than known fossils justify. The fossil evidence indicates that the Labyrinthodonts came suddenly and with highly developed legs and feet, extremely unlike, in structure, the fins of fishes.

Huxley says: "The limbs of Fishes have an endoskeleton which only imperfectly corresponds with that of the higher Vertebrates. For while homologues of the cartilaginous, and even of the bony, constituents of the pectoral and pelvic arches of the latter are traceable in Fishes, the cartilaginous, or ossified, basal and radial supports of the fins themselves cannot be identified, unless in the most general way, with the limb-bones, or cartilages, of the other Vertebrata." *

Thus it is admitted by Huxley, who is a leading authority in comparative anatomy, that there is a great difference between the structure of the fins of fishes and the limbs of the higher animals. Among the oldest known amphibian tracks are those of the Sauropus primævus, found in the Sub-carboniferous, near Pottsville, Pennsylvania. That the feet of this animal could have been evolved from fins is beyond my belief. We are left to assume that these highly differentiated feet, with perfect and separate toes, were evolved from the fins of the fishes of the Devonian age.

The Archegosaurus is regarded by evolutionists as one of the most primitive known forms of the amphibians. It was found in the Bavarian Coalmeasures. It had paddles for swimming, each of which contained the bones of four toes. Le Conte shows that the

* Anatomy of Vertebrates, by Huxley, p. 37, 38,

paddles of the Proteus, a living amphibian, are closely like those of the Archegosaurus. From this it is seen that this most ancient type of paddles known among amphibians has endured unchanged from the time of their introduction. If the type itself is so enduring, how can we account for its sudden evolution? Why did limbs which showed such great capacity for change suddenly cease to change and remain unchangeable through the long geological ages?

The flying reptiles, Pterodactyls, appear suddenly in the Jurassic. The bones of the little finger were enormously elongated, and the wing was formed of membrane stretched from these bones to the hind leg and tail.

Le Conte says that "These flying reptiles were certainly among the most extraordinary animals that have ever lived."* Several genera of them have been found.

Huxley says: "The sternum is broad, and, unlike that of other Reptilia, completely ossified, and bears a strong median crest on the anterior part of its ventral surface."† Also, "The brain-case is more rounded and more bird-like than in the other Reptilia, and in many other respects the skull approaches that of birds," etc. "The scapula and coracoid are wholly unlike these structures in any other Sauropsida, but are extremely similar to the same parts in birds, and indeed to the shoulder-girdle of the less reptilian Carinitæ."

More than twenty species of these reptiles, belonging to several genera, have been found in the Jurassic and Cretaceous. They appear suddenly, without any known previous history.

When we consider the greatly differentiated structure of these reptiles,—especially the coracoid bone,

* Geology, p. 446. † Anatomy of Vertebrates, p. 230.

the scapula and the wings—and remember that in the Jurassic they were already separated into several genera, it is evident that if they were evolved they had existed long before the Jurassic, and yet no trace of them has been found earlier than the Jurassic, although the rocks contain abundant fossils of other animals. We have no direct evidence showing the evolution of their wings, and we are left, as usual, to assume the fact.

It might be supposed that Pterodactyls were the ancestors of birds, but evolutionists claim that this is not the case.

It is admitted that the evolution of birds from reptiles involves great difficulties. There are two divisions of the class of birds: the struthious birds, including the ostrich, emeu, cassowary, apteryx, which have no keel on the breast bone; and the carinate birds, which have a keel.

Some think that the carinate birds might have been derived from the Pterodactyls, but that the struthious birds could not have had this origin. It is thought, however, that the latter might have been evolved from Dinosauria, which had no wings.

This would give to birds two separate origins, a thing which their general similarity of structure forbids. On the other hand, unless birds were derived from Pterodactyls, how can we account for their various peculiar points of resemblance; and if struthious birds were not derived from Dinosauria, how can we account for their special points of similarity? The above difficulty has not been satisfactorily explained. Mivart has dwelt on it at length.*

Mivart says that "Prof. Huxley seems inclined to cut the Gordian knot by considering the shoulder

* See Genesis of Species by Mivart, p. 83, et. seq.

structure of the pterodactyl as independently educed, and having relation to physiology only."

The cutting of a Gordian knot by the evolutionist is nothing remarkable, since he is obliged to repeat the operation a large number of times in order to complete his theory. I presume that Prof. Romanes intends to cut another Gordian knot when he tells us that the wings of the bird and of the pterodactyl have been independently evolved.

The wings of the bird are composed of feathers instead of membrane; only three fingers are represented, one of which is rudimentary, while the other two are united and imperfect. The oldest birds and pterodactyls found were in the Jurassic, and paleontology has furnished no evidence that the one was evolved from the other.

Passing to the Eocene, we find a large number of mammals, among which is the bat. It is claimed that it was evolved from an insectivorous mammal. Its wings are composed of membrane stretched between the bones of four greatly elongated fingers, the side of the body, hind leg and tail.

I quote from Romanes, page 347, with regard to the evolution of homologous organs: "The objection is the same as that which we have already considered in relation to the general theory of descent, namely, that similar organs or structures are to be met with in widely different branches of the tree of life. Now this would be an objection fatal to the theory of natural selection, supposing these organs or structures in the cases compared are not merely analogous but also homologous. For it would be incredible that in two totally different lines of descent one and the same structure should have been built up independently by two parallel series of variations, and that in these two lines of descent it should always and independently have ministered to the same function. On the other hand, there would be nothing against the theory of natural selection in the fact that two structures, *not* homologous, should come by independent variation in two different lines of descent to be adapted to perform the same function. For it belongs to the very essence of the theory of natural selection that a useful function should be secured by favorable variations of whatever structural material may happen to be presented by different organic types.

"Flying, for instance, is a very useful function, and it has been developed in at least four different lines of descent, namely, the insects, reptiles, birds and mammals. Now if in all, or indeed in any of these four cases, the wings had been developed on the same anatomical pattern, so as not only to present the analytical resemblance which it is necessary they should present in order to discharge their common function of flying, but likewise an homologous or structural resemblance, showing that they had been formed on the same anatomical 'plan'—if such has been the case, I say, the theory of natural selection would certainly be destroyed."

Here we have the admission that if any two of these wings were homologous it would be fatal to the theory of natural selection. The wings of the pterodactyl and bat have been independently evolved, if at all, and yet they are so nearly homologous that they bring the theory quite to the verge of destruction. The only difference is that the pterodactyl has only one finger lengthened for sustaining the membrane, while the bat has four.

Romanes and others claim that the theory of natural selection will account for any number of analogous organs. This, however, is assuming the great difficulty that lies in the way of evolving any complex organ, namely, of preserving it through its incipient and useless stages.

All the stages of the evolution of each kind of vertebrate's wings are left for the imagination to supply. There is no evidence from fossils of the existence of any of the necessary steps of evolution in the case of any wing. We have already spoken of the rudimentary and other wings of birds that are not used for flight, and of the fact that if they show anything it is the process of decrease in size by disuse. If it could be shown that the wing of an Apteryx, or even of a Penguin, could be developed into an organ of flight by use, then the argument based upon different uses at different stages of evolution would be admissible, but this has not been done.

If the evolution of any kind of wing seems impossible, much more so would be the independent evolution of three kinds of vertebrate wings. Indeed, according to evolution, we would be obliged to assume that the evolution of wings was no very difficult matter, for we find each of the winged vertebrates appearing at a comparatively early period in the history of the class to which it belongs, and, in the case of each, the first known could fly.

On the other hand, we would have expected that organs so highly developed and differentiated as wings would not have appeared till late in the history of each class. The same is true with regard to the wings of insects.

With regard to the origin and preservation of organs, Romanes says: "Even if it be granted that there are structures which in their first beginnings are not of any use at all for any purpose, it is still possible that they may owe their origin to natural selection—not indeed directly, but indirectly. This possibility arises from the occurrence in nature of a principle which has been called the Correlation of Growth."

Thus correlation of growth is brought in as a supplement to natural selection in attempting to account for organs through their long functionless period. It is evident that correlation of growth would cause the propagation of any new parts that might arise, and that a useless part would be preserved as readily as a useful one. Since variations take place in all sorts of directions, most of which could never be of any use, we would, by this law, expect to find any animal possessing a large number of parts that are useless. Such, however, is not the case. The rule is that useless parts are the rare exceptions.

To rely upon correlation of growth to explain the preservation of eyes, ears, legs, wings and other essential organs through their incipient stages is far beyond what the known facts warrant.

It is admitted by most evolutionists that natural selection alone is insufficient, and that it must be supplemented in various ways. The supplement, however, sometimes becomes the principal thing, as in the above case of correlation of growth to account for the origin and preservation of the most important organs.

Herbert Spencer, after showing "the inadequacy of natural selection," explains such difficulties, although he does not specify these organs, by referring them to "a cause which it is now the fashion among biologists to ignore or deny." "This cause is the inheritance of acquired characters." * He shows that the sense of touch, as we find it in different parts of the body, has not been developed by natural selection, and he claims that "inheritance of acquired charac-

* Popular Science Monthly, April, 1893.

ters" will explain the matter. I presume that he would claim that what are now the most important organs, were preserved simply by inheritance, through their rudimentary and useless stages.

If the doctrine of "inheritance" is true, it will explain the preservation of all kinds of organs, both useful and useless, and the characters inherited are quite as likely to be of the latter as of the former kind. The number of useless parts in the organic world ought, according to this theory, to be vastly greater than we find it to be.

Spencer does not deny the efficiency of natural selection, but offers the above as a supplement and as a necessary part of the theory of evolution.

The difficulty of accounting for the eyes of animals has been repeatedly and rightly urged against the theory of evolution. In considering this subject, Darwin says: "It is indeed indispensable, in order to arrive at a just conclusion regarding the formation of the eye, with all its marvelously perfect chapters, that the reason should conquer the imagination; but I have felt this difficulty far too keenly to be surprised at any degree of hesitation in extending the principle of natural selection to so startling a length." Again he says: "The simplest organ which can be called an eye consists of an optic nerve, surrounded by pigment-cells covered by translucent skin, but without any lens or refractory body. We may, however, according to M. Jourdain, descend even a step lower and find aggregates of pigment cells, apparently serving as an organ of vision, but without any nerve, and resting merely on sarcodic tissue. Eyes of the above simple nature are not capable of distinct vision, and serve only to distinguish light from darkness." *

Binet says: "Of all the organs of sense the eye is

* Origin of Species, p. 180.

the one which is first differentiated. It is found in the organisms belonging to the vegetable kingdom as well as in those belonging to the animal kingdom."* These so-called eyes of microscopic plants and of animals are pigment spots.

It is also claimed that around the rim of the jelly-fish are "pigment spots," "eye-specks," or "ocelli," consisting of pigment enclosed in little cavities.

The pigment spots on the ends of the rays of star-fishes are spoken of as rudimentary "eyes."

It is said that each of the five "ocular plates" of the Echinus bears an "ocellus," or rudimentary eye.

The Pecten, a bivalve mollusk, has eyes that are organs of vision, located in the edge of its mantle, and they are similar to those of the snail in structure.

The snail has two simple eyes located on the tips of its long tentacles. Each eye consists of "a globular lens, with a transparent skin (cornea) in front, and a colored membrane (choroid) and a nervous net-work (retina) behind."

The Nauplii, larvæ of Barnacles, and other forms, have a median eye; but after several moults they become pupæ with two compound eyes. Cyclops, one of the Water-fleas, has a single large eye.

Horse-shoe crabs have compound eyes and also ocelli. The Eurypteridæ, which became extinct in the Paleozoic, had a pair of ocelli and two large marginal compound eyes.

The Isopoda generally have two eyes that are collections of simple eyes, but sometimes they are compound.

Spiders have from two to eight simple eyes, which differ much in their methods of arrangement. The genus Nops has only two eyes, which are described as "large, black, glittering," and they are unique among

* The Psychic Life of Organisms, by Binet, p. 23.

the eyes of spiders. Most spiders have six or eight eyes.

Some of the Tunicata have ocelli "placed between the oral tentacles."

Scorpions have six, eight, or twelve simple eyes. Among the Myriapoda, Lithobius Melanops "has twelve large black eyes on either side of the head," while Lithobius rubriceps has fourteen small black eyes on each side.

Among the Planarida, "Pigment spots, or rudimentary eyes, from two to sixteen in number, are often present, and are always placed in the præ-oral region of the body,"

Many insects have two compound eyes, containing from a few facets up to many thousands of facets in each, and they also have three simple eyes on top of the head. The facets in the eyes of insects are six-sided, while those of crustaceons are four-sided.

Darwin says of compound eyes: "But these organs in the Articulata are so much diversified that Müller formerly made three main classes of compound eyes with seven subdivisions, besides a fourth main class of aggregated simple eyes."

The cuttle-fish has the most highly organized and perfect eye found among the invertebrates. It approaches the eyes of vertebrates in structure.

Finally, in the eyes of vertebrates we find organs of the most wonderful structure and powers.

The above are some of the many kinds of eyes and eye-spots found in living beings. To enumerate them: There are the eye-spots of microscopic plants, of certain protozoa, of the jelly-fish, of the star-fish, of the sea-urchin, of the Tunicata and the eyes of the pecten in the edge of the mantle, of the snail on stalks, the median eye of Nauplii, which disappears and is followed by two compound eyes, the single eye of Cyclops, the various kinds and numbers of simple eyes of insects, spiders, scorpions, and myriapods, the various kinds of compound eyes, the fact that both simple and compound eyes are usually found in insects, the eyes of cuttle-fishes and the eyes of vertebrates.

From the above it is evident that if eyes have been evolved they have been evolved many times independently of each other. This follows both from their differences in structure, in number, and from the various positions that they occupy in different animals.

It is evident that the eyes of the Pecten in the edge of the mantle, and of the snail on tentacles, could not have had a common origin; that the compound eyes with hexagonal facets could not have been evolved from those with four sides; that the ocelli of insects could not have originated from compound eyes; that the eye of the Cuttle-fish could not have been evolved from any known eye, and that the eyes of vertebrates have not originated from any known eyes of invertebrates.

How are we to account for the independent evolution of so many different eyes and eye-spots? The frequency of its occurrence would seem to indicate that it is a matter of no great difficulty. Romanes attempts to explain the evolution of the eye in the following language: "Take, for example, what is perhaps the most wonderful instance of refined mechanism in nature—the eye of a vertebrated animal. Comparative anatony and embryology combine to testify that this organ had its origin in modifications of the endings of the ordinary nerves of the skin. Now it is evident that from the very first any modification of a cutaneous nerve, whereby it was rendered able, in however small a degree, to be differently affected by light and by darkness, would be of benefit to the creature presenting it; for the creature would thus be able to seek the one and shun the other, according to the requirements of its life. And being thus useful from the very moment of its inception, it would afterwards be gradually improved as variations of more and more utility presented themselves, until not only would finer and finer degrees of difference between light and shade become perceptible, but even the outlines of solid bodies would begin to be appreciated. And so on, stage by stage, till from an ordinary nerve, ending in the skin, is evolved the eye of an eagle.

"Moreover, in this particular instance there is very good reason to suppose that the modification of the cutaneous nerves in question began by a progressive increase in their sensitiveness to temperature. Wherever dark pigment happened to be deposited in the skin—and we know that in all animals it is apt to be deposited in points and patches, as it were by accident, or without any prophecy as to future uses—the cutaneous nerves in its vicinity would be better able to appreciate the difference between sun and shade in respect of temperature, even though as yet there were no change at all in these cutaneous nerves tending to make them responsive to light."*

Here we learn that the eye of the vertebrate, "perhaps the most wonderful instance of refined mechanism in nature," "had its origin in modifications of the endings of the ordinary nerves of the skin."

From this we would suppose that the eyes of vertebrates would frequently be evolved, and in all sorts of positions on the body, since the pigment is "apt to be deposited in points and patches, as it were by accident." These accidental deposits of pigment would necessarily determine the positions of eyes.

* Darwin and After Darwin, p. 352.

If a deposit of pigment is the beginning of the evolution of eyes, it would seem that the entire surface of the skin of the Negro is making a desperate effort to evolve eyes, especially, since everywhere in this pigment nerve fibres have their terminations.

As to location of eyes, we find that all animals which possess a fore-and-aft structure have the eyes on the front part of the body. If the eyes of snails, cuttle-fishes, the simple and compound eyes of insects, the compound eyes of crustaceans, the single eye of Nauplii, the eyes of spiders, centipedes and myriapods, and the eyes of vertebrates have all had separate origins, it is very strange that according to the above theory they should all be located in the head. The origin of eyes from pigment "deposited in points and patches, as it were by accident," will do very well to locate eye-spots which are found in various positions on animals, but it totally fails to locate the kinds of eyes found in the head, which had separate origins. It is said that lightning never strikes twice in the same place, but the accidental pigment spots giving origin to eyes occurred many times on the heads of different animals. That they should occur in this place and nowhere else in these various animals, is indeed marvelous. If it is claimed that these various eyes located in the head were all evolved from the eyes of some one original form, we answer that, as already shown, it is manifestly impossible. According to this pigment-spot theory, eyes are not necessarily located in the best places on the body, as we find them to be, but they would be evolved in any place where they would be of use. It is evident that eyes located in almost any part of the body would be better than no eyes. Nor would their evolution be confined to any particular time in the history of a species. If Spencer's theory of "the inheritance of acquired characters" is true, then there is no reason why a species may not evolve eyes in various parts of the body and at different times.

If pigment spots are rudimentary eyes, then the star-fishes, which have these spots, have been extremely slow in evolving eyes, for they have lived through nearly the whole authentic geological time, and would, no doubt, have been benefited by better eyes, and during all this time pigment spots have, it is presumed, existed, on which spots heredity and natural selection have been at work, and yet after these fifty millions of years, they have nothing but pigment spots, which are supposed to represent eyes.

It may be claimed, however, that the eye-spots of star-fishes are of comparatively recent origin. The burden of proof is on him who claims this. But if we were to grant this to be true, it would not improve the matter, for it would only show the extreme difficulty of forming even a rudimentary eye from patches of pigment deposited "as it were by accident."

The most that is claimed for the "eye-specks" of star-fishes functionally, is that they are more sensitive to heat and light than other parts of the body, and that they can convert light into heat. It is claimed that this entitles them to be called "rudimentary eyes." I see no sufficient reason why this should be so. There is no evidence that such an organ can be or has ever been developed into an organ of sight. Calling them "eye-specks" and rudimentary eyes does not make them homologous to eyes. It is impossible to show that they are homologous to eyes. They are heat-specks instead of eye-specks. If they are sensitive to light at all, it is by converting it into heat. That they could ever become sensitive to light, as is the retina of the higher animals, is purely imaginary.

Pressing them into service as eyes, shows the distressing extremity to which the theory of evolution is pushed in trying to account for the most wonderful of all organs.

As to the eyes of vertebrates, they must have been independently evolved, for there are no eyes of invertebrates from which they could have been evolved, and there are no rudimentary eyes among vertebrates which show any possible stages of evolution. The rudimentary eyes which are found among the vertebrates have, it is claimed, been rendered such by disuse.

Darwin tells us that in considering this subject, "the reason should conquer the imagination." When, however, we are told that we "find aggregates of pigment-cells, apparently serving as an organ of vision, but without any nerve, and resting merely on sarcodic tissue," or that at the end of any nerve terminating on the surface pigment is liable to be deposited, and that this pigment spot is liable to finally be developed into the eye of the eagle, it occurs to me, after a careful consideration of the few facts that he and other evolutionists have presented upon this subject, that they have made a most liberal use of the imagination. So far as I can see there is little except imagination involved in this whole matter.

As before remarked, it is easy in imagination to begin at some point and by adding little by little build up any object whatever. It is equally easy to say that nature follows this method in all cases. But if we rest upon facts, then we must draw such conclusions as the facts warrant.

As to pigment-spots, they are not eyes; neither are they homologous or even analogous to eyes—neither like them in structure nor in function.

There is no chain of intermediate forms connecting them with eyes. They have existed through nearly all geological time without being developed into eyes, in the star-fishes, and we do not know that eyes have ever been evolved from them.

In all cases "eye-specks" occupy positions on the bodies of animals different from that of any true eyes, consequently, no known eyes could have been evolved from known "eye-specks."

I regard eye-specks, therefore, as of no value as evidence in trying to account for the evolution of true eyes. The whole tribe of eye-specks ought to be "ruled out of court."

If we consider the eyes of any class of animals, we know of no stages in their evolution. It is not claimed that the eyes of the highest members of any class are essentially different in structure from those of the lowest members of that class.

If it is difficult to account for the evolution of any known eye, vastly more difficult does it become to account for the independent evolution of the many eyes referred to above, some of which, although independently produced, seem to be quite homologous in structure.

It is not to be wondered that in considering this subject, Darwin, as he says, "felt this difficulty far too keenly to be surprised at any degree of hesitation in extending the principle of natural selection to so startling a length."

The evolution of ears presents similar difficulties. The simplest form of ear is a sac filled with a watery liquid in which the auditory nerves are spread out, and in which are minute hard granules called otoliths.

This is the structure of the ears of invertebrates when they have organs of hearing, but most invertebrates are destitute of ears.

As to the location of ears, it is said that "In the Clam, it is found at the base of the foot; some grasshoppers have it in the fore-legs, and others in the sides of the abdomen, and in many insects it is in the wing. Lobsters and Crabs have the auditory-sacs at the base of the antennæ." * The ears of vertebrates vary much in the complexity of their structure, and are located in the sides of the head.

The above various positions of ears show that they must have been independently produced. Even among insects they are found in at least three different positions, namely, in the wings and legs and side of the abdomen.

Are the ears of invertebrates to be regarded as homologous or as simply analogous? Whether one or both, it matters little as to the difficulty involved in their evolution. It is claimed that organs at different stages of their evolution may serve different purposes. If this is true in the case of the ear, what purpose could the ear serve during the first generation of its growth? What would be the structure of this organ at that time or at the end of the thousandth generation? How could a rudimentary ear be preserved until it could perform the function of hearing?

We know of no answer to these questions. As already stated, Darwin admits that "in many cases it is most difficult even to conjecture by what transitions many organs have arrived at their present state."

The breathing apparatus of animals presents other difficulties. All animals must absorb free oxygen. Those that obtain oxygen from solution in water are

* Orton's Zoology, p. 178.

called water-breathers, and those that breathe atmospheric air are called air-breathers.

Many of the simple aquatic forms absorb oxygen through the general surface of the body; others have tubes that carry aerated water, through the walls of which tubes oxygen is absorbed.

Some marine worms have tufts of gills distributed externally along the sides of the body. Bivalve mollusks have two flat gills on each side of the body. Aquatic gasteropods sometimes have tufts of gills similar to those of worms, or comb-like ciliated gills in a cavity behind the head to which the water is admitted by a siphon.

"The cuttle-fish has flat gills covered by the mantle; but the water is drawn in by muscular contractions instead of by cilia." "The gills of lobsters and crabs are placed in cavities covered by the sides of the shell (carapace); and the water is brought in from behind by the action of a scoop-shaped process attached to one of the jaws, which constantly bales the water out at the front." *

Most fishes have several gills with comb-like fringes lying close together under a covering at each side of the head; others have pouch-like gills scattered along the side of the neck. The Amphioxus absorbs air through the mucous membrane of the pharynx.

The breathing apparatus of air-breathers is either tubes, sacs or lungs.

Insects have a system of air-tubes extending through the body, which have several external openings along the sides of the body.

In spiders the tubes are connected with air-sacs which aid in breathing. Scorpions breathe by means of four pulmonary sacs.

Snails have a cavity on the right side of the neck

* Orton's Zoology.

which serves as a lung. Amphibians have gills when young, but afterwards acquire lungs. They generally, but not always, lose the gills on arriving at maturity.

All the higher vertebrates breathe by means of lungs alone.

From this brief statement we see some of the various forms of breathing apparatus.

It is evident that these gills, air-tubes, sacs and lungs, so various in position and different in structure, represent quite a number of separate evolutions, if they were evolved at all. They cannot all have been derived from any one primary form of breathing apparatus.

Gills, tracheæ and lungs are widely apart in structure. Gills themselves, so different from each other in structure and location must have had quite a number of independent origins.

As to the origin of tracheæ we know nothing. It is evident, however, that they could not have been evolved from gills. Insects, which breathe by means of tracheæ, we know appeared as early as the Lower Silurian. We have no hint as to any possible method of evolving their breathing apparatus. The appearance of these highly organized air-breathing animals at so early a period in the geological record is not in harmony with the theory of evolution.

With regard to the evolution of lungs, it is claimed that the air-bladder of fishes is homologous to the lungs of vertebrates.

The Dipnoi, which are the highest order of fishes, in addition to gills, have a cellular air-bladder which performs the office of a lung, and it is claimed that they show the transition from fish to amphibian. If this is true, when did the Dipnoi originate? If their lungs are of recent origin, then they show the evolution of lungs independently of each other at periods vastly remote, for we know that the amphibians of the Carboniferous age had lungs, and that these must have been evolved from the lungs or air-bladders of the fishes of the preceding age.

Are we to assume that organs so highly developed as lungs have been independently evolved several times? If, on the other hand, the living Dipnoi are the descendants of the fishes of the Devonian, whose air-bladders performed the office of lungs, how can we account for the fact that the lungs of the Dipnoi are still rudimentary? Why have they not made progress in evolution in the many million years? We are told that the theory of progress in organization is consistent with the theory of lack of progress in some members of a group.

This doctrine which I have already discussed, seems to me to be wholly inadequate to explain the great and frequent discrepancies that exist in all classes of the animal kingdom.

We might continue the inquiry as to the evolution of special organs until we had exhausted the list, and in each case find that evolution of an organ through its incipient stages is inexplicable.

The organs which spiders possess for secreting material and for making a web could not have been gradually evolved. The whole apparatus involved in making the web would be useless until sufficiently developed to make a web.

The same is true of the sting of the scorpion, the stings of bees, the mandibles of spiders with the gland of poisonous fluid at the base, and the poison apparatus of serpents. All of these glands for secreting poison would be useless until they could secret a harmful fluid. Are we to assume that the perforated sting of the scorpion, including the gland of poison at its base, was evolved in a single generation? If it was evolved gradually, what was its condition at the end of the first, the tenth, or the hundredth generation? How long would it take for it to perform the office of a sting? What purpose could it serve, and how could it survive through its long rudimentary period?

If the mandibles of spiders through which the poison is forced existed before the formation of the gland that produces the poison, how could the mandibles become perforated for the passage of the poison? Were there not millions of chances to one that the poison would find an exit through some neighboring part instead of through the mandible. In all the cases of a gland of poison with a sting and mandible, how did it happen that the gland and the instrument for introducing the poison came together? Without the sting the poison is useless. The production of teeth does not insure the existence of a sac of poison at their base, as is shown by the harmless snakes.

It is evident, in the case of snakes, that the poisonous have been evolved from the harmless snakes if the doctrine of evolution is true. This being true, what were the probabilities that a gland of poison would be developed, and this in animals that do not seem to need it, as is shown by the great number of harmless snakes? What were the probabilities that the gland would be developed at the root of the fang, where alone it could be made effective, and that it would be developed at no other place in the whole body? What were the probabilities that the fangs would become so modified as to form a tube for the passage of the poison? Did the formation of a poison gland at the base of a tooth insure an exit through the tooth for the poison? It seems evident that the poison fang of snakes, if evolution is true, was produced by modifying an existing tooth of harmless snakes. I regard such a change as totally improbable. The perforated spurs of the Ornithorhinchus, with a poison gland at the base, present similar difficulties.

I have considered some of the difficulties that arise in attempting to account for the evolution of various organs—the many kinds of eyes, the ears, the various wings, legs, electric organs of fishes, stings, fangs with poison,—and I think that the theory of evolution gives no satisfactory account of their origin.

If it be said that these and the like objections are only special difficulties, I answer that animals are composed of organs, and that any theory which proposes to explain the origin of the animal kingdom must duly consider the origin of every important organ.

I am aware that there is a disposition with some to say that the theory of evolution has been shown to be true, and that they are, therefore, under no obligation to speak of the evolution of special organs, but I regard this as simply begging the question at issue.

XII.

RUDIMENTARY ORGANS.

THE subject of rudimentary organs furnishes difficulties against the theory of evolution. Have functional organs become rudimentary? Have all rudimentary organs been functional? Have organs not only become rudimentary, but have they, in some instances, disappeared entirely?

Evolution must answer the first and third of these questions in the affirmative, but to the second may possibly give a qualified answer.

As an example of rudimentary organs—all male mammals except monotremes have rudimentary teats. How did they acquire these organs? Were they originally functional in the males, and have they become rudimentary by disuse? Shall we assume that the males of the first mammals, which probably existed in the Paleozoic, had functional mammæ, and that from these all living mammals have inherited them as rudiments?

The fact that all males possess them indicates that, if they were ever functional, they became rudimentary in the original mammalian stock, for this is more reasonable than to assume that they separately became rudimentary after the mammals had become differentiated into groups. Whether we assume that they were rudimentary from the first and that they never were functional, or that, being at first functional, they afterwards became rudimentary, it is evident that as the merest rudiments they have survived through an immense period of time.

It must be claimed, however, by evolution that organs can not only become rudimentary but entirely disappear, as is claimed to have taken place in the case of the legs of most snakes.

If a mere rudiment can survive so long in the case of the mammal, why shall we assume that functional legs may totally disappear by disuse?

Evolutionists commonly assume that rudimentary organs were at one time functional, and that they have become rudimentary by disuse.

With regard to mammæ, Mr. Darwin says: "In the mammalia, for instance, the males always possess rudimentary mammæ." Again, "Rudimentary organs declare their origin and plain meaning in various ways." *

Again, "Rudimentary organs, on the other hand, are essentially useless, as teeth which never cut through the gums. As they would be of even less use, when in a still less developed condition, they cannot have been formed through variation and natural selection, which latter acts solely by the preservation of useful modifications. They relate to a former state of things, and have been partially retained by the power of inheritance." † Again, "On the view of descent with modification, the origin of rudimentary organs is simple. . . . I believe that disuse has been the main agency; that it has led in successive generations to the gradual reduction of various organs until they have become rudimentary." ‡

From the above quotations I think that Mr. Darwin claims that the mammæ of male mammals were originally functional, and have become rudimentary by disuse.

How could these organs have been evolved in the males, and if they were once functional how could

* Origin of Species, p. 405. † Ibid, p. 406. ‡ Ibid, p. 408.

they have become rudimentary? In all mammals the mother is the natural provider for the young, which, as a rule, are born in a very helpless condition, and require to be carefully and promptly supplied with milk in order that they may survive.

In what conceivable way could the milk glands have been evolved and such radical changes have taken place in the life and instincts as those involved in changing from the reptilian to the mammalian type?

It is presumed that the mammæ were gradually evolved after many generations of fruitless efforts on the part of the young. What could have induced the young to persist in nursing, in the absence of organs to furnish nourishment? Are we to presume, with Prof. Huxley, that the mammæ have been evolved from sebaceous glands? There are no facts connected with the reptiles, from which it is claimed mammals were evolved, to justify this extraordinary conclusion.

The evolution of milk-glands I regard as an impossibility, even in the females. But what shall we say of the probability of their appearing in the males? We are to assume that the young carried on the same process with regard to both sexes at the same time, and that the result was the development of functional milk-glands in both—and, what is more strange, they were in identical positions. According to this theory, these glands in the two sexes were separately evolved. If this were possible, the great difficulty of the process would show the extreme importance of the result to the species, and, this being true, it is not probable that these organs could have become universally rudimentary in males while they remained functional in females.

I regard it as quite certain that these rudimentary organs in males have not been separately evolved as functional organs, and that they did not afterwards become rudimentary by disuse.

There could have been no necessity for their being functional in both sexes, and, consequently they could not have been developed by natural selection. The female alone is, as a rule, present at the birth of the young, and it is absolutely necessary that she should have the instinct and the power to furnish food and look after their interests in their extremely helpless condition. Among all the mammals and most birds, the female alone has the instinct to care for the young.

From the above I think it evident that the mammæ of males have always been rudimentary, and that, as rudiments, they could not have been evolved by natural selection; also, that they have existed from the earliest history of mammals.

Here, then, we find rudiments that do not "relate to a former state of things," and yet which have been preserved among all mammals for millions of years. Evolutionists offer no plausible theory by which to explain the existence and preservation of these organs. If they fail to account for these organs, is it not possible that their theory may be deficient when applied to other rudimentary organs?

There are other difficulties with regard to the evolution of milk glands. The number of these glands differs greatly in different animals,—varying from two up to at least a dozen. They differ also in position. In some cases they are towards the front of the ventral part of the body; in others at the posterior part; and in others still, they are scattered along the most of the ventral surface;—the latter being true in the great majority of cases, including the low forms. From this it is safe to assume that the first mammals possessed many mammæ and brought forth many young, as is common with low forms at present.

This being true, how can we account for the total disappearance of mammæ in various places in many existing mammals, and from both sexes, so that not even a rudiment remains to tell of their former existence? If rudimentary mammæ could survive through the entire history of mammals, in the males, how was it possible for numerous mammary glands to totally disappear from both males and females—glands that were formerly functional in the females?

These two claims, I think, are entirely inconsistent with each other. If the rudiments have survived in males, as they certainly have, then the others could not have entirely disappeared—which means that they never existed. Animals, for example, such as man, which have but two mammæ, could never have had more, otherwise there would be rudimentary mammæ as evidence of the fact, since these rudimentary organs are extremely persistent.

If this is true, man could not have been evolved from a lower form of mammal, for, going down the scale, we soon reach mammals with more than two mammæ.

I think, then, that we are justified in concluding that in males the mammæ have always been rudimentary, that they have existed during the entire history of the mammals, and that mammals have not had mammæ, as evolution must assume, that have entirely disappeared.

Since writing the above I find that I have overlooked certain views of this subject which Mr. Darwin has stated in the Descent of Man. He says: "In the mammalian class the males possess in their vesiculæ prostraticæ rudiments of a uterus with the adjacent passage; they bear also rudiments of mammæ, and some male marsupials have rudiments of a marsupial sack." * These facts, according to the supposed laws of embryology, would indicate hermaphrodite or androgynous ancestors among the mammals. He says, however, that such an ancestry "seems improbable in the highest degree," for the reason that if true, then, hermaphrodite vertebrates ought still to be found, especially among fishes and amphibians. He says, "To account, however, for male mammals possessing rudiments of the accessory female organs, and for female mammals possessing rudiments of the masculine organs, we need not suppose that their early progenitors were still androgynous after they had assumed their chief mammalian characters. It is quite possible that as the one sex gradually acquired the accessory organs proper to it, some of the successive steps or modifications were transmitted to the opposite sex."

Here, then, we find rudimentary organs of various kinds, which Mr. Darwin admits were never functional, but were transmitted as rudiments from one sex to the other. There are many such differences between the sexes.

These facts are opposed to the general claim that rudimentary organs are the remains of functional organs. If this large class of rudimentary organs cannot be accounted for on the theory that they were formerly functional organs, then it is quite possible that the theory of evolutionists as to rudimentary parts may not be correct.

They rely much on rudimentary organs as an argument, but unless they can show that they have all been produced by variation and natural selection, which Mr. Darwin admits cannot be done in the case of many sexual differences, then their argument is greatly weakened.

* Vol. 1, p. 199.

I think that they have given undue weight to their theory as to the origin of rudiments in order that they might have an argument in favor of evolution.

They have claimed in a very emphatic way that their theory gives meaning to the existence of all rudimentary organs, but, from the above facts as to mammæ, etc., I think that it fails.

Such rudiments have been preserved through long ages by the unknown laws of heredity, and we know of no physical law by which to account for their origin.

The fact that the Monotremata, the lowest living mammals, have no nipples, indicates, as Mr. Darwin claims, that these appendages must have originated in a later mammalian stock. Since all other mammals have nipples, it would be necessary to assume that they originated in animals as low in structure as the marsupials. Mr. Darwin thinks that "the nipples were first developed in the females of some very early marsupial form, and were then, in accordance with a common law of inheritance, transferred in a functionally imperfect condition to the males."

He is not, however, entirely satisfied with this view, for he says: "Nevertheless, a suspicion has sometimes crossed my mind that long after the progenitors of the whole mammalian class had ceased to be androgynous, both sexes might have yielded milk, and thus nourished their young, and, in the case of the marsupials, that both sexes might have carried their young in marsupial sacks." *

It is evident that unless this last view is correct, then the nipples of males have been rudiments from their origin; and further, that if nipples can exist through long ages without ever having been functional, then other rudimentary organs may have always been such.

* Ibid, p. 20.

Attempting to find a male marsupial which nourished the young with milk does not, however, greatly relieve the subject of difficulty. How did the nipples originate in male marsupials? They did not exist in the Monotremes, the progenitors of the marsupials, and consequently they must have been evolved in the latter. They must have been evolved either independently in the two sexes, or else in one and then transmitted to the other. They must, in either case, have been the merest rudiments, so that to account for rudimentary nipples in male mammals now living, nothing is gained by assuming that they were functional in the early marsupials. If they were rudiments at first in males they might, and I have no doubt did, always remain such.

Mr. Darwin's "suspicion" that both sexes of the ancient marsupials might have yielded milk is also negatived by the fact that the male Monotremes do not at present thus nourish the young.

His assumption in this matter is, I think, made in the interests of the theory which he and other evolutionists have advanced in their effort to account for the origin of rudimentary organs.

The endeavor to explain the rudimentary sexual organs which it is claimed exist in vertebrates by referring them to some extremely ancient hermaphrodite progenitor is not supported by facts. If it was ever true, then hermaphrodite forms ought still to be found among some of the lowest vertebrates. Mr. Darwin suggests this objection himself, and yet he claims that the ancient stock of vertebrates was hermaphrodite.

That functional organs, such as the womb, could have existed in the male vertebrates and have become rudiments before these animals were differentiated into classes, and have survived as rudiments through most of geological time, is to my mind, totally incredible; and for the reason already stated, namely, that if disuse can cause an organ that is useful to decrease and become entirely useless, then it ought for the same reason to totally disappear.

We would be obliged to look for Mr. Darwin's hermaphrodite progenitor of the vertebrates somewhere in the Silurian age, and that such a progenitor, without a womb, should be the cause of existing fœtal male mammals having a rudimentary womb is not at all credible. I have no respect for such exorbitant claims made by evolution and embryology.

Mr. Darwin says that he had formerly * "attributed the not very rare cases of supernumerary mammæ in women to reversion," but owing to the fact that mammæ erraticæ occur in various situations, even on the back, he thinks that the force of his argument in favor of reversion is quite destroyed. He also admits that "it is extremely doubtful whether supernumerary digits can thus be accounted for."

The spurs of birds present further difficulties to the theory of evolution. Most birds have no spurs. When they possess them, as a rule the males alone have them well-developed, while they are rudimentary in the females. In some cases, however, both sexes possess them in a well-developed form.

The general absence of even rudimentary spurs among birds shows, either that most birds have lost them entirely, or that, not having been common to birds, they have been evolved in the few that possess them. The latter seems more probable, if they were evolved; but how could a spur be evolved in either sex? As a rudiment, it would for many generations be entirely useless for any purpose, and consequently

* Descent, Vol. 1, p. 120.

it would not be preserved by natural selection, nor in any other possible way, so far as I can see. The spurs are in the best possible position on the legs for combat. Why did they appear in the best place and nowhere else? As useless rudiments they would be quite as likely to survive in one place as in another? In a few instances they are found on the wing, in a position that renders them most effective.

That nature should locate them and preserve them as rudiments in these two places alone is not credible. As rudiments, or, even as useful appendages for combat, they ought to be found in other positions. There is no reason why spurs might not be evolved by natural selection, if they can be evolved at all, in any position where they would be of use, though not necessarily of the greatest possible use. For example, they might be of use on the front of the leg or on the external side, though of less use than where they are now located.

If spurs could not have been preserved by natural selection through their rudimentary stage, why assume that they have been evolved according to this law? If they could survive through the critical rudimentary period till they became of use, why not assume that their evolution was continued according to the same law? The fact is, however, that we know of no law according to which they could have been evolved.

Mr. Darwin says: "When the male is furnished with leg-spurs, the female almost always exhibits rudiments of them—the rudiments sometimes consisting of a mere scale, as with the species of Gallus. Hence it might be argued that the females had aboriginally been furnished with well-developed spurs, but that these had subsequently been lost either through disuse or natural selection. But if this view be admitted, it would have to be extended to innumerable other cases; and it implies that the female progenitors of the existing spur-bearing species were once encumbered with an injurious appendage." *

In this he admits that the rudimentary spurs of female birds have never been functional, and, consequently, they cannot come under that law which it is claimed gives meaning to their existence.

The greatest difficulty in this matter is to account for the evolution of functional spurs in either sex—and their being in the best positions only increases the difficulty.

Other rudimentary organs furnish difficulties which, I think, the theory of evolution fails to meet. For example, fœtal calves have rudimentary incisor teeth in the upper jaw which never cut the gums, and these, it is claimed, indicate the presence, in their stead, of functional teeth in distant ancestors.

If the ruminants at one time had upper incisors that were functional, I do not see how they could have ceased to perform their work and have disappeared. It could, so far as I can see, be no conceivable advantage to a ruminant to lose its upper incisors. With these teeth present, they could nip the grass more closely, and thus the better obtain a supply of food in time of scarcity. Besides, they might serve, as in the case of the horse, as a means of defense. The upper incisors could not have disappeared because they were useless nor because they were not used, for they were of constant service. Natural selection cannot, therefore, account for their disappearance.

These teeth must have passed into the rudimentary condition in the primitive ruminant stock before it had subdivided, for this is indicated by their general absence among living ruminants. If this is true, they

* Descent, Vol. 2, p. 155.

have survived in the most rudimentary form through a long period of time. If functional upper incisors could become useless and pass into the rudimentary condition, how has it been possible for them to survive as useless rudiments for a length of time probably equal to that occupied in passing into the rudimentary condition? If they could so greatly decrease while in constant use, why have they not, after a great lapse of time, totally disappeared by disuse? If the former is true, then the latter, I think, ought to have followed; but since it has not, it discredits a belief in the former.

The same objection holds good in many other cases. The absence of legs from snakes is another example.

It has commonly been claimed that the oldest known fossil snakes occur in the Eocene, but Dr. Romanes says that they are found in the Cretaceous. Professor Huxley says: "No ophidian possesses any trace of anterior extremities, but the Typhlopidæ, the Pythons, Boas and Tortrices, have rudiments of a pelvis, and the latter snakes even possess very short representatives of hind-limbs terminated by claws." *

It is claimed by evolutionists that the reptilian stock, from which snakes have descended, had four functional legs, all of which have entirely disappeared except the rudiments named above. True snakes are found, according to Dr. Romanes, in the Cretaceous. At that time they had lost their legs so that they had no rudiments, and yet we find rudiments surviving in some through the immense period of time that has since elapsed.

The loss of functional parts, as a rule, implies a feebleness in the force of heredity, while the persistence of useless rudiments through long periods shows

* Anat. Vert., p. 207.

a great strength in this force inconsistent with the implied weakness.

In conclusion, I may say that I know of no physical theory that accounts for the existence of all rudimentary organs. It is evident, I think, that many rudiments have never been functional.

If some of them were formerly useful, still, this fact would be useless as an argument to prove that rudiments can be developed into useful organs. There is no method by which rudimentary organs can be preserved and developed into functional organs. This objection presents itself in the case of the evolution of most organs, and I regard it as quite conclusive against the theory.

XIII.

SECONDARY SEXUAL DIFFERENCES.

It is admitted by Mr. Darwin and other evolutionists, that there are many peculiarities of structure and instinct among animals which cannot be explained on the theory of natural selection.

Among these are secondary sexual differences—that is, differences which exist aside from the sexual organs themselves.

These differences between the sexes may be in size, the males being generally, but not always, the larger; in color, the males in many cases being the more highly colored, the reverse, however, being sometimes true; in the presence of wings in one sex and their absence in the other; in the possession of peculiarly modified legs or of various peculiar appendages; in the presence or absence of voice, or of the power of song, or of other means of making sound; in the presence of certain appendages in the males alone, such as spurs, horns, or other peculiar parts; in instincts, and in many other respects.

Mr. Darwin claims that many of the differences between the sexes can be accounted for by sexual selection, that is, by the choice of the female through many generations.

The theory of sexual selection involves the assumption that the females are in some way called on to make a choice between rival males, and that they have an instinct which impels them to do so. Certain conditions would be necessary in order that this choice might be exercised.

If the males and females were equally numerous, as Mr. Darwin thinks they probably are—at least he does not think that there is any great inequality—and if they were all sexually mature at the same time, there would be no occasion for exercising choice, unless, as is sometimes the case, they are polygamous. If they are polygamous, the possession of the females is decided by the law of battle—they follow the old Jacksonian doctrine, "to the victors belong the spoils."

He thinks, however, that the males are frequently sexually mature in advance of the females, or that the males migrate first, as in the case of some birds, so that the males are thus brought into competition for the females when they arrive. The strongest females would arrive first, and the strongest males, or those that were most favorably colored, or that possessed the greatest power of song, would obtain possession of these females and would breed first, and this would give them advantage over the weaker birds that arrived at a later period.

Mr. Darwin, in "The Descent of Man," has presented many facts as to secondary sexual differences, and has with great ingenuity endeavored to account for these differences mostly by sexual selection and the law of battle.

It would be entirely beyond the scope of this work to attempt to follow him in detail. I cannot believe, however, that his theories are sufficient to account for the vast number of secondary sexual differences among animals.

I think that in most cases he presents little, if any, evidence that a choice of males is made by the females, or that the law of battle is so general as to supplement sufficiently the theory of sexual selection.

I will present a few differences between the sexes which I think no theory of evolution is sufficient to explain.

The horns of deer offer special difficulties. The males alone possess horns. If they have been evolved by natural selection alone, and have been preserved because they are useful then they ought to have been developed by the females also which live under like conditions. The fact, however, that the females have survived along with the males shows that the horns are probably of no use in preserving the species, which is the great purpose served by natural selection.

The survival of females without horns shows that males might have survived equally well without them. We cannot therefore assume that they have been preserved because of their utility.

If it is claimed that they have been preserved and evolved on account of combat between the stags themselves, I think it evident that in their rudimentary condition for many generations they would have been useless for combat. Besides, if evolved, they must for a long time have been simple horns without prongs. The fact that the horns of young deer have no prongs shows, according to the claims of embryology, that the first stags' horns were simple. If this were so, why did they not remain simple?

Mr. Darwin says: "Although the horns of stags are efficient weapons, there can, I think, be no doubt that a single point would have been much more dangerous than a branched antler; and Judge Caton, who has had large experience with deer, fully concurs in this conclusion. Nor do the branching horns, though highly important as a means of defense against rival stags, appear perfectly well adapted for this purpose, as they are liable to become interlocked. The suspicion has therefore crossed my mind that they may serve partly as ornaments, ... but I have no evidence in favor of this belief." *

In the evolution of these horns, then, there was first a long rudimentary period, during which they were useless, and during which they could not have been preserved by natural selection; and after they became useful they were for a long time without prongs and were preserved because they were useful; after this they branched and became less efficient in battle than they were as simple horns. If "a single point would have been much more dangerous than a branched antler," why did they branch? Certainly not by natural selection, and Mr. Darwin admits that he knows of no evidence in favor of sexual selection. He claims that the *spike-horn buck*, a variety of Cervus Virginianus, is displacing the prong-horned buck of the same species. The former has a horn which "consists of a single spike, more slender than the antler, and scarcely so long, projecting forward from the brow, and terminating in a very sharp point. This horn is more efficient in battle and less impediment in traveling through the woods than the prong-horns. It is known that the great branching horns of the bucks are a serious impediment in thick woods.

Besides, they are shed every year and renewed in from two to three months. The production of such large appendages is a great demand on the energy of the animal, for which there seems to be no adequate compensation in the way of utility.

The horns of many antelopes are of such shape and point so much backwards that they are useless in battle, and they cannot therefore have been produced by natural selection. I am inclined to think that this is perhaps true with regard to the horns of most ruminants.

* Descent of Man, Vol. 2, p. 243.

It is evident that useless horns, such as those of the Oryx leucoryx and other antelopes, cannot be accounted for by natural selection. It is also evident, I think, that sexual selection cannot account for their evolution. Among some antelopes the males alone have horns, and among others both sexes have them.

We find the same difficulties here as in the evolution of deers' horns—namely, the long period during which they were rudimentary and during which no kind of selection will account for their preservation, followed by a second period during which they were useful, and then a third period during which they are useless. The first and third periods cannot be accounted for. If we assume that the third period—the period of uselessness—has been produced by sexual selection, we have a theory without facts to support it. Sexual selection, in this case, was opposed to and prevailed over natural selection to the disadvantage of the species, by converting useful into useless horns. Considering the dangers to which these animals are exposed, such an assumption is not justified

I think that the protection of most deer and antelopes is, and has always been, their fleetness, and not, to any great extent, their horns—that by the latter they have sometimes been rendered more helpless. I regard their horns as, for the most part, ornaments, and I see no theory by which their evolution can be satisfactorily explained.

Mr. Darwin refers to various chameleons, the males of which have appendages on the head, of which the females are nearly or entirely destitute. The male of the Chameleon Owenii "bears on his snout and forehead three curious horns, of which the female has not a trace. These horns consist of an excrescence of bone covered with a smooth sheath, forming part of the general integument of the body, so that they are identical in structure with those of a bull, goat, or other sheath-horned ruminant." He thinks that "these almost monstrous deviations of structure serve as masculine ornaments," and that they have been developed by sexual selection.

In this instance we meet with the usual difficulties: First, the absence of evidence to show that female reptiles of this species or of any other species exercise any such choice, and second, that the exercise of choice implies the development to a considerable extent of the organ concerning which the choice is exercised.

It cannot be presumed that in the great multitude of instances in which Mr. Darwin claims that sexual selection has been efficient it has acted on the merest rudiments, and yet this assumption lies at the foundation of his theory. I regard this as a fatal objection to the theory of sexual selection.

Among birds sometimes both sexes are colored alike, but in many cases the males are more highly and in exceptional cases less highly ornamented than the females. Mr. Darwin admits that, as a rule, it cannot be useful to birds to be highly ornamented. The greatly developed and gaudy feathers, such as those of many male pheasants, render them more conspicuous to their enemies, and, consequently, their long tails and beautiful colors could not have been produced by natural selection. He refers their evolution to sexual selection. He claims, however, that the highly colored males are, as a rule, given to combat with each other for the females, so that combat instead of beauty would be the principal factor in these cases. There are no facts going to show that the most beautiful birds would, on the average, be most successful in combat, and unless this were true I do not see how sexual selection could increase the beauty of the males. It would be useless for a more highly colored male to attempt to obtain possession of a mate if a less highly colored but more vigorous male were present to dispute the possession.

Mr. Darwin says: "It is evident that the brilliant colors, top-knots, fine plumes, etc., of many male birds cannot have been acquired as a protection; indeed, they sometimes lead to danger. That they are not due to the direct and definite action of the conditions of life, we may feel assured, because the females have been exposed to the same conditions, and yet often differ from the males to an extreme degree."*

He thinks that "it is possible that at first there existed a tendency to transmit the successive variations equally to both sexes; and that the females were prevented from acquiring the bright colors of the males, on account of the danger to which they would have been exposed during incubation."

But, as already stated, the bright colors would also subject the males to greater danger, and this being true, it would have prevented the males from becoming ornamented. The arguments that apply to the one sex in this respect apply to the other. The natural tendency of a variation would be to change both sexes alike. The many differences between the sexes of the higher invertebrates and of the majority of vertebrates must be accounted for on certain general principles if the doctrine of evolution is true.

If it were granted that sexual selection might be more or less efficient in producing changes among animals so highly organized as birds, yet this could not be a sufficient reason for extending the principle to the lower vertebrates and to the invertebrates where sexual differences prevail.

* Descent of Man, Vol. 2, p. 224.

Male spiders are smaller than the females, a fact which natural selection cannot explain, for I know of no advantage that would be gained by the decrease, sometimes very great, in the size of the males, and it is simply an assumption to claim that sexual selection has produced the difference in size.

With regard to fishes, both sexes of which are highly colored, Mr. Darwin says: "On the whole, the most probable view in regard to the fishes, of which both sexes are brilliantly colored, is that their colors have been acquired by the males as a sexual ornament, and have been transferred in an equal or nearly equal degree to the other sex."*

He admits that brilliantly colored fishes would be more exposed to danger from enemies, and that, consequently, their colors could not have been developed by natural selection. He therefore adopts the theory of sexual selection which he supplements with the theory that the ornament has been transmitted from the male to the female. This theory he applies also to birds † and to reptiles.‡

Again he says: "With the species in which the sexes differ in color, it is possible that at first there existed a tendency to transmit the successive variations equally to both sexes; and that the females were prevented from acquiring the bright colors of the males, on account of the danger to which they would have been exposed during incubation." §

Yet there are many instances in which the females are brilliantly colored, and others in which the highly ornamented males incubate the eggs.

To try to account for the many differences of color, etc., between the sexes is quite bewildering. To each theory offered there are so many exceptions that they

* Descent of Man, Vol. 2, p. 17. † Ibid, Vol. 2, p. 163.
‡ Ibid, p. 35. § Ibid, p. 225.

seem to me to render the theory worthless. One conclusion, however, seems to be justified, and that is that most of them could not have been evolved by natural selection.

As to sexual selection and the law of combat, I think that they are entirely inadequate to account for the wide range of differences between the sexes.

Back of all secondary sexual differences are the primary sexual differences, in explanation of which evolution has offered no sufficient theory, and until this is done her work will be incomplete.

With this very brief and inadequate reference to a few of the difficulties involved in sexual selection, I leave the subject.

XIV.

INSTINCT.

In the Honey Bee we find so many and such remarkable instincts that it seems to me impossible that they could have been acquired by the process of evolution.

I will enumerate some of the most important facts concerning bees, and then draw such conclusions as these facts seem to justify.

Three kinds of individuals exist in a colony of bees; namely, the queen, whose sole work it is to lay eggs; the drones, or males, whose only function it is to fertilize the queen; and the workers, which are females, undeveloped sexually.

When a colony of bees first enters a hive which is to become its future home, the workers proceed to rid it of all dirt. Other workers gather propolis, a kind of gum, which they bring to the hive entangled on their legs, which they are unable to remove themselves, but which is removed by their fellow-workers and placed in the cracks and on internal projections of the hive. Having prepared the hive sufficiently with propolis, the workers gorge themselves with food and suspend themselves in a mass from the top of the hive, in which position they remain for a considerable length of time in order to secrete wax. The wax is secreted in sacs in the abdomen, and it exudes in thin plates from between the joints.

When sufficient wax has been secreted, the bees manufacture cells. Each cell is a very perfect hexagon, composed of the smallest amount of wax that can furnish the required strength. The free ends of the cell walls are kept thickened so that they will not be broken, and the angles of the cells are strengthened by the addition of propolis. When the cells have been filled they are sealed up, each with three rhombic plates which, it has been proved by mathematicians, are placed in the best possible position.

Most of the cells are intended for the reception of honey; larger than these are the cells for the bee-bread. Three kinds of cells are constructed for rearing the young. The smallest and most numerous are for workers; some are for drones; while from one to a dozen or more large vertical cells are for the rearing of queens. All cells except the last are placed with their axes in a nearly horizontal position.

The queen lays one egg in the bottom of each cell which has been prepared for the purpose of rearing the young. The eggs which are to produce queens and workers are precisely alike, both being fertilized, while those which are to produce drones are not fertilized. The drones are, therefore, produced by the process of parthenogenesis.

The receptacle for the sperm communicates by a tube with the oviduct, and the queen has the power to fertilize the eggs or to refrain from doing so, and she makes no mistakes.

At the proper temperature the eggs are hatched in three days, and in five or six days more the larvæ have acquired their full size. The larvæ which are to become workers and drones are fed on bee-bread, and those which are to become queens are fed on royal jelly.

Only one queen is permitted to live in the colony at the same time, there being a mortal antipathy between the queens. The queen is continually guarded by a number of workers, and her wants are carefully supplied. If two queens are in the same colony they enter into combat, being urged by the workers, and fight till one stings the other to death.

When a young queen is ready to leave the cell in which she has been reared, she is not permitted to do so, but she is guarded by the workers until the old queen has abandoned the hive with a swarm, and then she is permitted to leave her cell. When the queen has fully matured in her cell, the workers cut away the wax from the end of the cell till it is an exceedingly thin film.

If the colony is deprived of its queen, the workers, after searching in vain for her, set to work to rear a new queen. For this purpose they select a larva that would develop into a worker, remove some of the neighboring cells and construct for it a large vertical cell. By feeding this larva on royal jelly it becomes a queen.

If two queens during combat acquire a position in which they might destroy each other, thus leaving the hive without a queen, they refrain from giving each other the mortal stroke.

When the swarming season is over, the old queen is permitted by the workers to sting to death all the queens that are in the cells.

If the queen loses both of her antennæ she is unable to properly deposit her eggs, and the workers permit her to perish.

At the close of the swarming season all of the drones are killed by the workers. They are no longer needed, for the old queen has already been fertilized, and new drones can be reared in the following spring; thus food is saved for the use of those bees alone that will be of future use to the colony.

If they lose the queen when swarming, they return to the hive which they have left—seeming to realize that their efforts would be fruitless without a queen. If the hive has no queen, the drones are permitted to live through the winter.

When the drones are destroyed the larvæ and pupa which would produce drones are also destroyed. If pressed for food, a colony will attack a weaker colony or a hive without a queen, and, if the attack is successful, the vanquished colony joins the conquerors, thus strengthening the hive.

If bees have been fed on stimulating food and the supply is discontinued, they destroy the eggs and young larvæ.

The workers ventilate the hive by holding to the floor with their feet and vibrating their wings rapidly. When they leave the old hive to form a new colony, they follow guides which have already selected a place.

In building cells the axis of a cell on one side of the partition at the base is placed opposite the junction of three planes of cells on the other side, thus giving greater strength to the structure.

If circumstances will not lead to swarming, only eggs that will produce workers are laid. The queen in laying frequently passes from drone-cells to worker-cells, and yet she makes no mistakes in depositing the eggs.

If drones are needed and no drone-cells are in the hive, the queen will lay drone-eggs in worker-cells, and she will also lay worker-eggs in drone-cells in case it is necessary.

In case the queen becomes unable to lay impregnated eggs the workers rear a new queen and destroy the old one.

"If the bees are abundant and honey needed, or if there is no queen to lay eggs, drone-comb is invariably built; while if there are few bees, and, of course, little honey needed, the worker-comb is almost as invariably formed."

A queenless colony gathers less pollen than a colony with a queen. The pollen which has been stored up in cells is not used until emergency requires.

Workers do not generally live more than six weeks during their period of greatest activity. They can, at will, convert nectar into either honey or wax.

The queen seldom uses her sting except to destroy other queens. This fact is of great importance in her preservation, for the loss of her sting would result in her death. While the worker has seven prominent barbs on its sting, the queen has but three very short ones, and she is thus enabled to withdraw her sting the more readily, thereby insuring her preservation. A. J. Cook says, "I have often tried to provoke a queen's anger, but never with any evidence of success."

The queen after her impregnation never leaves the hive except to lead forth a swarm. The large number of drones insures her speedy impregnation with as little exposure to danger as possible.

The legs of the queen have neither brushes nor baskets for carrying pollen. She differs also in many points of structure—especially in the relative size of organs—from the workers.

The drones have no stings and "no suitable proboscis for gathering honey from flowers, no baskets on their thighs for holding bee-bread," and no pouches for secreting wax.

A check in the yield of honey may cause the destruction of inchoate drones and queens. "If the signs of the times presage a famine, they stay all proceedings looking to an increase of colonies." A. J. Cook says: "The conditions which lead to the building of queen-cells and the peopling of the same are:

Loss of queen, when a worker larva from one to four days old will be surrounded by a cell; inability of a queen to lay impregnated eggs, her spermatheca having become emptied; great number of worker-bees in the hive; restricted quarters; the queen not having place to deposit eggs, or the workers little or no room to store honey; or lack of ventilation, so that the hive becomes too close. These last three conditions are most likely to occur at times of great honey secretion." *

The workers gather and prepare or secrete several different substances—wax, propolis, pollen, honey and royal jelly.

In the above facts we see a combination of many most remarkable instincts and peculiarities of structure which look to the good of the community. How could they have been produced by evolution? The workers are sterile and leave no offspring, consequently their instincts cannot be inherited from bees of their own class. Each generation of workers is isolated from all succeeding generations.

The queens and drones do not possess the instincts of the workers. Shall we assume that they formerly possessed them, but that they have lost them by disuse or otherwise?

The theory of evolution necessarily assumes that at some former time only the sexually perfect females and males existed in a community of bees, and that the neuters were evolved from the fertile females.

It is evident that the neuters and queens now possess certain instincts which could never have belonged to either the males or perfect females.

The following are, I think, examples of instincts which could not have originated until after the workers were evolved as a distinct class.

* Bee-Keeper's Guide, p. 69.

First, all those instincts which the workers have towards the queen, inducing them to guard and feed her, to go in search of her when she has been absent a certain length of time, to prevent her from destroying the inchoate queens, and the instinct which leads them to permit her to destroy such queens after the swarming season is over.

Also, the mortal antipathy which exists between the queens could not have existed before the workers were evolved, for its existence would have resulted in the destruction of the colony.

Nor could the instinct to rear a new queen have existed when the colony was composed of fertile females and drones alone, for the reason that the emergency requiring a new queen could not have existed in a hive where there was no queen and where a large part of the colony must have consisted of fertile females.

As stated above, A. J. Cook says that any one of five different conditions in the hive will lead to the rearing of new queens. Each of these conditions indicates an acquired instinct in the workers which looks to the good of the colony and the preservation of the species.

Again, the workers build drone cells, or worker cells, regulating their work according to the necessities of the case—taking notice of the numbers of different kinds of bees in the colony, the supply of food, and of probable future requirements. If the hive is destitute of a queen they gather less pollen than when a queen is present, thus regulating the supply to meet the probable demand. If the supply of food becomes insufficient, they destroy the inchoate young, which would otherwise perish by famine.

The instinct of the workers to destroy the drones after the swarming season is over, or, in case the hive is queenless, to permit them to live through the winter, could not have existed before the workers were produced.

Without dwelling on this further it is evident that many of the instincts of workers must have been evolved, if at all, after the workers were evolved as a distinct class. In assuming this, however, we are met by the insurmountable difficulty of accounting for numerous instincts of the highest order without the advantage of heredity. The workers possess many remarkable powers entirely different in kind from those which any of their ancestors ever possessed. They cannot have improved these instincts and thus have built them up by inheritance from the queens and drones, for the latter never possessed them. And since the workers leave no offspring the possibility of heredity is excluded.

We see, therefore, the impossibility of applying the principle of heredity in order to account for the accumulation of these many high instincts. It is evident also that their existence cannot be explained by the principle of reversion, for no ancestors could have ever possessed these instincts.

I see no possible theory, therefore, by which to account for the evolution of this class of instincts in the workers among bees.

That which produces the differences now between queens and workers is, so far as we can discover, the difference in the size and position of the cells, and the fact that the queens are reared on royal jelly, while the larvæ of the workers are fed on bee-bread. The feeding of the larvæ lasts less than a week, and their residence in the cells, when the temperature is favorable, is something more than two weeks. In this short time, and by these physical differences in the kind of food and cells, are developed, from eggs that are exactly alike, the queens and the workers with their various widely-different instincts. That the instincts of the workers could have been produced suddenly by a change of food and cell is beyond anything that has ever been claimed for natural selection; and, in fact, there is no possibility for this law to act since the principle of heredity is excluded. Whatever might be the instincts of any generation of workers they could not be transmitted, nor is there any conceivable means by which these instincts could so affect the queens and drones that they could, in cousequence thereof, produce other workers possessing still more highly developed instincts. The theory of evolution, it seems to me, must make this latter claim, and yet I know of nothing to support it.

The instincts of the working bees could not have all been evolved at once, for they are too numerous; nor could they have been evolved one by one, for each is essential to the existence of the community.

A colony of bees is not like a community of civilized human beings in whom many of the wants are artificial, and which may remain unsupplied, with simply a certain amount of discomfort, but the wants which the instincts of bees supply are imperative, and, therefore, the instincts themselves, as a whole, are necessary to the existence of the bees.

Their instincts are all linked together as a necessary chain, so that if one should fail the community would perish. Each kind of work is perfectly done, and yet the workers are totally unconscious as to what will be the results of their labors. For the most part they work for future generations of their colony, and not for themselves, and yet they are as careful and diligent as if they were guided by the highest intelligence and the most selfish motives.

There is nothing more wonderful and mysterious in nature than the instincts of bees. What can be more remarkable than that instinct of the workers which causes them to prevent the queen from stinging to death the young queens in their cells? Here we see the instinct of the workers opposing that of the queen, and thus saving the colony and insuring the propagation of the species. And yet at other but proper times the workers permit the old queen to kill the young ones in their cells. How could these instincts in the workers, which act in exactly opposite ways at just the right times for the welfare of the community, have ever been evolved? Or how could that instinct have arisen which causes two queens when engaged in combat to refrain from inflicting the mortal sting if they would mutually destroy each other, and thus leave the hive without a queen?—acting as if they knew that the life of one of them was necessary for the welfare of the community.

Mr. Darwin attempts to account for modifications of structure and instincts by natural selection as follows: "Thus I believe it has been with social insects; a slight modification of structure, or of instinct, correlated with the sterile condition of certain members of the community, has been advantageous to the community; consequently the fertile males and females of the same community flourished, and transmitted to their fertile offspring a tendency to produce sterile members having the same modification. And I believe that this process has been repeated, until that prodigious amount of difference between the fertile and sterile females of the same species has been produced, which we see in so many social insects." *

The fact that "the fertile males and females" flourished, if it were true, could not induce them to transmit to their offspring a stronger tendency to pro-

* Origin of Species, p. 228.

duce sterile offspring that would have more highly developed instincts. I have already dwelt upon this subject at sufficient length.

At the close of his chapter on Instinct, Mr. Darwin says: "I do not pretend that the facts given in this chapter strengthen in any great degree my theory, but none of the cases of difficulty, to the best of my judgment, annihilate it." *

I will next consider briefly certain instincts of birds which, it seems to me, could not have been evolved. First, the instinct which causes the bird to incubate its eggs. While the eggs of cold-blooded vertebrates are hatched by the heat of the elements in which they are deposited, the eggs of birds are generally developed by the heat of the mother's body.

In passing from reptile to bird by evolution, it is necessary to account for the changes in the instincts of the bird as well as for its changes in structure.

The act of incubation is one of self-denial, during which the bird gives up its liberty for from two to four weeks. How could the instinct that such an act was necessary have been evolved? That the instinct is necessary in order to develop the eggs of most birds there can be no doubt, for if left simply to the elements they would perish. Did the instinct arise before the necessity for incubation was evolved, or *vice versa?* If the instinct arose first, then it existed at a time when there was no use for it, and the bird imposed upon itself a useless task—a thing which we do not find occurring among animals, for every existing instinct serves some good purpose.

Besides, we could not account for the preservation of the instinct by natural selection unless it served a good purpose. If the necessity for the instinct arose before the instinct itself was evolved, then the species would have perished for lack of the instinct.

*Origin of Species, p. 231.

If the two were evolved *pari passu*, then there must have been some necessary relation between their growth. That the necessity in the egg for the instinct in the bird could not have produced the instinct is evident. That the instinct in the bird could have so modified the egg as to render incubation necessary, I see no reason to believe. It may, of course, be claimed that a bird was hatched with a slight disposition to incubate, and that it laid an egg with a small necessity for being incubated—both at the same time by chance—and that these two things increased through many generations. This is mere assumption.

The instinct to incubate is of extreme antiquity, as is shown by the fact that it is almost universal among birds. The original avian stock must have incubated, otherwise the existence of the instinct among birds now living could not be universal. This shows that the instinct is not transient, and it implies that it could not have been suddenly acquired by evolution. While the birds themselves have changed greatly in their structure, yet the instinct to incubate has survived.

In this case, then, we have an extremely long record, extending from the ancestors of Archæopteryx, which began somewhere in the Paleozoic, during which the instinct to incubate has persisted in the birds. An instinct so enduring could not have sprung up suddenly from habit or by natural selection. If it was evolved it must of necessity have originated at the time when the cold-blooded reptile with a three-chambered heart and a sluggish circulation of blood had been changed by natural selection into a warm-blooded, feathered bird, with a four-chambered heart and with a much more active circulation of the blood. The change in the temperature of the evolved bird, as compared with the temperature of its reptilian ancestors, would have rendered incubation necessary.

What assurance was there, however, that a change from a cold-blooded to a warm-blooded animal would be accompanied by the evolution of an instinct so persistent and necessary? The same question arises in case of the great number of instincts of animals which are accompanied by peculiarities of structure which render the instincts useful. I do not think it possible that they could all have originated by chance —the instinct and the structure being perfectly adapted to each other, yet neither being the cause of the other.

A colony of bees, with their peculiarities of structure, and their numerous instincts adapted to their organization, is like a complex machine, from which, if a single wheel were omitted, the whole would be rendered useless. It is just as inconceivable, to my mind, that a colony of bees could be evolved, with all of their highly-developed and perfectly adapted instincts and structures, as that a watch could be thus produced.

The hen during the time of incubation turns her eggs over every day. This is said to be necessary in order to keep the yolk of the egg in the proper position. The instinct to turn the egg is necessary on account of the structure of the egg itself. But it is evident that the instinct and the structure of the egg do not bear to each other the relation of cause and effect. To claim that this and the vast number of other similar instances are due to correlation of growth is to make a claim without a shadow of proof.

The yolk of the egg is held in position by tougher portions of albumen extending from the ends of the egg to the yolk. The latter turns on its axis, so that the germ-yolk is kept on top near the warm body of the bird. Enclosed in the larger end of the egg is a supply of air for the chick. On the end of the upper mandible of the chick is developed a hard point, with which it bores through the shell. These several points of structure co-operate with the instincts of the mother in the development of the chick and its escape from the shell.

I have already dwelt sufficiently on the difficulties involved in trying to account by evolution for the existence of instincts and the adaptations to them which are necessary in the structure of the organism.

Instinct is blind and knows not the end for which it works. It cannot be improved by the experience of the individual, and consequently there is no gain by which heredity may profit. Mr. Darwin admits that "it can be clearly shown that the most wonderful instincts with which we are acquainted, namely, those of the hive-bee and of many ants, could not possibly have been acquired by habit." *

He refers their origin to "the natural selection of what may be called spontaneous variations of instincts;" but he also thinks that "use or habit" has been a factor in the origin of instincts.

If, however, "the most wonderful instincts" "could not possibly have been acquired by habit," we must look for their origin to "spontaneous variations."

Thus, not only the origination but the perfecting of the most highly-developed instincts is left to chance, and, in the case of neuter insects, without the aid of heredity. I think it impossible that the great number of instincts, together with the multitude of peculiarities of structures in animals, which render it possible for the instincts to be of use, could have thus been produced.

* Origin of Species, p. 202.

Many instances besides those already referred to, of instincts and of peculiarities of structure adapted to the instincts—cases in which the one would be useless without the other—exist. The Surinam Toad is a strange example. With regard to it I quote from J. G. Wood's Natural History. "When the eggs are laid, the male takes them in his broad paws, and contrives to place them on the back of his mate, where they adhere by means of a certain glutinous secretion, and by degrees become embedded in a series of curious cells formed for them in the skin. When the process is completed, the cells are closed by a kind of membrane, and the back of the female Toad bears a strong resemblance to a piece of dark honey-comb, when the cells are filled and closed. Here the eggs are hatched, and in these strange receptacles the young pass through their first stages of life, not emerging until they have attained their limbs and can move about on the ground.

"After the whole brood have left their mother's back the cells begin to fill up again, closing from below as well as from above, and becoming irregularly puckered on the floors. The cells in the middle of the back are the first to be developed; the whole process occupies rather more than eighty days."

In this instance the instinct of the male causing him to place the eggs on the back of the female, the instinct of the female which causes her to keep the eggs on her back, as if she knows that their presence there is necessary for their development, the formation of the cells in the skin of her back, and the changes in the mode of life of the young frogs without destroying them must be accounted for. All of these changes must have occurred simultaneously, otherwise this method of developing the young could not have originated. To my mind it is impossible to believe that these several changes could thus have been brought about by chance.

Among some fishes it is said that the males, Arius for example, carry the eggs in their mouth till they are hatched. How could this instinct have originated by natural selection? Why does not the male swallow the eggs as food instead of carrying them till they hatch?

In another fish, Aspredo, the eggs are attached to various parts of the body by slender stalks. The eggs of sharks have two tendrils at each end by means of which they can attach themselves to objects and thus be better protected.

The male sea-horse carries the eggs in a pouch on the under surface of the body till they are hatched. The pouch in this case is pectoral, while the pouch of the pipe-fish, which serves a similar purpose, is under its tail. As to how these pouches could have been evolved, together with the combined instincts of the males and females which cause them to use the pouches, is beyond my comprehension. It is indeed easy to say that they were evolved gradually by natural selection, but the evidence to support this assertion seems to me extremely insufficient.

The instincts of animals with regard to depositing their eggs in the most suitable places, the methods of protecting their eggs, and the care of the young are numerous and wonderful.

It is a general law that the number of eggs produced by an animal is in proportion to the risks to which they are subjected. Most fishes produce thousands of eggs, but they are eaten in large quantities by animals; also the young are destroyed in large numbers, so that if there were but few eggs the chances for producing mature fishes would be greatly decreased. The shark produces but few eggs, but on account of their structure they are well protected.

So throughout the animal kingdom we see that by a great multitude of eggs, or by peculiar structure, or by special means of preservation it is made certain that each species will propagate its kind. That these many adaptations are necessary for the preservation of species is evident, but we know nothing as to how they have originated.

There is no assurance in nature that if an animal lays fewer eggs, therefore they will be better protected; nor, on the other hand, that, if the eggs are better protected, therefore fewer will be produced.

The number of eggs and the degree of protection do not stand related to each other as cause and effect; they must, therefore, if they were evolved, have originated in all cases by chance—the number of such instances being equal to the number of species of animals. This leads me to emphasize my belief again that the wholesale origin of adaptations in nature, where there is no relation of cause and effect between the things that are adapted to each other—which is generally the case—could not have been brought about by chance.

The Water Spider presents difficulties to the theory of natural selection that I will notice. In this animal changes of structure and instinct are implied which I think cannot be explained by natural selection. Spiders are air-breathing animals which live habitually in the air. The Water Spider is also an air-breather, but it lives habitually under the water. A short distance under the surface of the water it spins an egg-shaped cell with an opening underneath through which it can pass. This cell is securely attached to some object so that it will remain submerged. The body of this spider is covered with hairs which inclose air, and this prevents it from becoming wet.

The cell having been constructed, the spider proceeds to fill it with air. The hind legs are covered with hair, and they are of such shape that they can secure a large bubble of air which it carries under the cell and releases. The air rises to the top of the cell, expelling the water. By repeating the process the cell is filled with air. In the upper part of the cell the eggs are placed and surrounded by a cocoon. About one hundred young are hatched and reared in a single cell.

In this case we see several things which must have been produced simultaneously if they were evolved. First, the peculiar hind legs of the animal which enable it to carry a large bubble of air would have been of no use to it for this purpose without its habit of living under water, and consequently this structure would not have been evolved in the absence of the habit. But it could not live under the water without a cell nor without the instinct to fill the cell with air. Each of these two instincts, together with the peculiar structure which enables it to carry air with its legs, would have been useless without the other, and consequently, if they were evolved, they were produced simultaneously. They must all have been produced before the spider could live habitually under water.

The instinct and the power to construct a perfect cell through which water would not pass and the instinct to fill it with air could not have been gradually acquired by natural selection, for they must all be perfect before the spider can live under the water. An imperfect cell, or an imperfect instinct failing to properly fill it with air, or inability to perform the work owing to defective structure would be fatal in attempting to make the change from a terrestrial to an aquatic mode of living. If such a change took place, therefore, we would be obliged to assume that it occurred in a single generation, otherwise it would have been a failure. That it could have thus suddenly occurred I presume that no one would claim.

The conclusion, therefore, is that the above changes could not have been produced slowly, by natural selection, nor suddenly, and that, consequently, they were not produced by the process of evolution.

I see no probable method by which the modifications of structure and the instincts necessary to produce the web of the spider could have been evolved. I copy the following from Orton's Zoology.

"Spiders are provided at the posterior end with two or three pairs of appendages called spinnerets, which are homologous with legs. The office of the spinnerets is to reel out the silk from the silk-glands, the tip being perforated by a myriad of little tubes through which the silk escapes in excessively fine threads. An ordinary thread, just visible to the naked eye, is the union of a thousand or more of these delicate streams of silk. These primary threads are drawn out and united by the hind legs."

From this we see that two special glands, capable of secreting a soft material that can be readily drawn into the finest threads of the greatest strength, requiring no perceptible time for drying, and two to four spinnerets perforated by more than a thousand of the smallest apertures, and hind legs modified so that they can be used to draw out the web through the spinnerets, and also the instincts which enable the spider to use its web to advantage, must all have been evolved.

To evolve the silk glands would have required, as for most other organs, a long period of incipiency, during which they would have been useless. We can not assume that a substance so exceptional in its character as the web of the spider could have been suddenly produced by evolution. But the glands would be useless without the spinnerets. If the latter are homologous with legs, as has been claimed, then we must assume that two or three pairs of legs that were probably at one time useful for locomotion became so modified that they could perform the function of spinnerets. In what conceivable way could locomotive legs have become so modified and pierced with more than a thousand apertures through which the web is drawn?

True spiders are found in the Carboniferous Age, and, if they were evolved, they must have appeared in the Silurian. The fact that insects and scorpions have been found in the latter renders it the more probable that spiders existed at that time. The spiders of the Carboniferous had, no doubt, the web-making structure. I infer this from their appearance and from the fact that all living spiders make web. The existence of the structure necessary to manufacture web, at a period so remote, renders it the more difficult to believe that this structure could have been evolved.

If we assume that living spiders have had a common origin by evolution, then the instinct to manufacture a special form of web, such as that of the Garden Spider, is very ancient, for we find other species, for example, Acrosoma arcuta, which differ greatly in structure from the garden spider, but which construct a nearly similar web. According to the assumption the instinct has existed during the long period necessary to evolve the great physical differences between the two species. In this instance, therefore, as in the case of birds, already discussed, evolution necessarily assumes the existence of instincts through immense periods of time. On the other hand, the great differences in the habits of spiders might be taken to show that instincts change.

Similarity of instincts, however, cannot be taken to indicate, of necessity, a common origin.

Mr. Darwin says that there exist "cases of instincts almost identically the same in animals so remote in the scale of Nature, that we cannot account for their similarity by inheritance from a common progenitor, and consequently must believe that they were independently acquired through natural selection." *

Again he says: "Many instincts are so wonderful that their development will probably appear to the reader a difficulty sufficient to overcome my whole theory."

Instances may be enumerated indefinitely which show the difficulty of accounting for changes of structure and at the same time the origin of instincts that render the acquired structures useful. Among fishes, take the Sting Ray, which has a long prehensile tail, and above the base of the tail a barbed spine pointing backwards, on which it impales its enemies by the use of its tail as a lasso. It seems to me entirely improbably that the tail, the barb, and the instinct tó use them were evolved either simultaneously or in succession.

How was the singular instinct evolved which causes the male hornbills of Africa and India to plaster up the female in a hole in a tree, leaving only a small aperature through which they feed the female and her young? It is evident that this serves for protection, but I cannot see how it could have been gradually evolved by natural selection. The work must be quite complete before it can serve its purpose.

In what way could the strange instinct of the Aus-

* Origin of Species, p. 226.

tralian Jungle Fowl have been evolved? This bird does not incubate its eggs but deposits them in a great heap of decomposing organic matter, sometimes fifteen feet high and sixty feet in circumference, which it piles up by throwing backwards with one foot while it stands on the other.

Each egg is deposited in a separate hole several feet long in the mound, after which the hole is filled with loose material and the egg left to incubate. It is evident that this bird could not have abandoned the usual method of incubation until its instinct caused it to construct a tumulus of organic matter sufficient for the purpose of incubation. It would not be claimed that it did this suddenly, but gradually. It must have at first brought together sufficient material to relieve it of part of the work of incubation, and the habit of doing this must have grown, because it was useful, until it finally ceased incubating its eggs. It also lost the instinct, common to birds, of placing all of its eggs in close proximity with each other, for it deposits but one egg in each hole.

The fact that these changes in its instincts and habits are conceivable can only show the possibility and not the probability that they have taken place. It is conceivable that trees might become men, and yet this does not even suggest the possibility of such a change.

The various instincts which cause animals to provide in advance for the young that they never see nor recognize as their offspring cannot, I think, be satisfactorily accounted for by evolution.

Take, for example, the well-known beetle, which prepares a ball of animal excretion in which it deposits an egg and then buries the ball in a deep hole which it makes in the earth, where it is hatched, and the larva feeds on the organic matter which has been prepared in the ball.

Here we have a series of instincts serving a common purpose. The deposit of the egg in the organic matter, the shaping of this into a ball, the preparation of a hole in the ground, and the moving of the ball into this place of safety, are all done for the benefit of offspring that can never be known to the parent.

To account for these wonderful instincts, we are told that "necessity is the mother of invention," that the struggle for existence is so severe that the production and preservation of new instincts are a matter of necessity. The fact that the first beetle deposited an egg in such decomposing organic matter by accident was no assurance that the egg would produce a beetle which would repeat the accident. But we must assume that the first deposit of an egg thus made was on account of a new-born instinct which was strong enough to be inherited by the offspring. Strangest of all, however, is the instinct which causes this beetle to move this ball, considerable distances frequently, by standing on its front legs and pushing backwards with its hind legs. These balls are several times as large as the beetles themselves. Sometimes two beetles join in moving a single ball, one pushing, while the other climbs on to the opposite side of the ball, thus disturbing its equilibrium. But moving the ball would be useless to the species unless it were deposited in the ground in a place of greater safety, so that the instinct to move it and the instinct to deposit it in a more secure place by digging a hole in the ground must have been evolved at the same time. I see no reason to believe that this could have taken place. It is no argument to say that such changes take place by chance, and that they are preserved because they are useful. That they might be preserved if they took place need not be disputed, but the evidence, in my estimation, is totally inadequate to show that such changes occur.

As I have said elsewhere, it is easy to imagine that any finite existence may originate by starting with nothing and adding atom by atom. So it may be imagined with instincts.

The Beaver furnishes one of the most remarkable examples of instinct among vertebrates. It lives in communities and constructs dams, sometimes as much as three hundred yards long, across shallow streams of water. These dams are built of sticks of wood, generally about three feet long and six or seven inches in diameter, which the animal cuts with its teeth. They are put in the water and held in position by means of mud, stones and moss which are placed upon them. The dams are ten or twelve feet thick at the base, and when the streams are wide, instead of extending straight across, they are made to curve up stream against the current, thus enabling the structure to better resist the force of the water. The amount of labor necessary to construct a large dam is enormous, and requires an incredible number of logs of wood and great skill in engineering.

Near the dam the beavers build their houses. Each house is about seven feet in diameter on the interior and three feet high in the center and the walls are of great thickness. Each lodge is large enough to accommodate five or six beavers.

The outside is plastered with mud and carefully smoothed, and the mud is renewed each year in order to keep the houses in good repair. All the houses of the colony are surrounded by a ditch which contains water, and each lodge is connected by a passage-way with the ditch.

As a supply of food for winter, they store up a large number of logs under the water, the bark of which they consume.

In this case we find an organized community working for the common good in constructing the dam and the ditch and storing up food, and then making special preparation for living in small groups by constructing their lodges and connecting them with the ditch.

Here we see highly-developed instincts that look to the future good of the organism. The building of the dam, the digging of the ditch, the storing of the food are all done to meet future emergencies.

It is evident that the construction of a dam could not have been evolved gradually, for a dam must be of sufficient extent to be useful before natural selection could act.

Are we to presume that beavers experimented for countless generations, thereby building up the instinct which leads them to construct a dam? If so, on what ground can we explain the preservation of the incipient instinct until it was sufficiently developed to be of practical use? In what way could they have known in advance, or had an instinct in advance, that a dam would serve their good? Shall we assume that their instinct in the first instance led them to construct a dam, they not having had any experience to evolve an instinct of this kind? If the instinct existed without having been evolved by experience, then we cannot account for its evolution. If evolved, then we must assume that the first dam made was of sufficient use to give its makers an advantage in the struggle for existence, and that the instinct which caused its construction was transmitted to their offspring.

In accounting for the evolution of this instinct, as in other cases, we necessarily begin with an instinct that is already useful, and thus we assume the existence of that for which we are trying to account. We are obliged to assume that in a single generation a beaver or a colony of beavers was produced which had a new instinct, and sufficiently developed to enable them to build a useful dam, and that in consequence of this they were the better preserved and the instinct propagated. If all this could have happened in a single generation, it is evident that no question need be raised as to the possibility of future evolution.

Besides this, the construction of a ditch for water around their lodges required a different instinct serving another purpose. Its evolution involves similar difficulties.

I will not dwell longer on the difficulty of accounting for the evolution of special instincts and of the changes of structure in organisms necessary to adapt them to the use of new instincts. The animal kingdom is full of difficulties of this kind. Volumes might be written describing the strange instincts of Insects alone.

In conclusion, I repeat that I regard the complex instincts and peculiar structure of the honey-bee as insuperable objections to the theory of evolution.

XV.

THE ORIGIN OF MAN.

CONSIDERED geologically, man has but a brief history. As to the length of time he has been here, judging from his remains and works of art, Le Conte says: "It may be 100,000 years or it may be only 10,000 years, but more probably the former than the latter." He further says that "The earliest men yet found are in no sense connecting links between man and ape." *

The Engis skull, one of the most ancient that has been discovered, is said to be "a well-shaped, average human skull."

The Mentone skull is of "average or more than average" size, having a facial angle of 85°, while the Neanderthal skull, which is also very ancient, is of lower type, but "is in no respect intermediate" between man and ape, being "truly human."

In the Aurignac cave in France were found the bones of several human skeletons mingled with those of various extinct mammals, such as the Cave-bear, Cave-lion, Cave-hyena, Mammoth, Irish Elk and others. The presence of the bones of these extinct mammals shows that the human remains are probably quite ancient.

Le Conte says: "The conclusion reached by M. Lartet is, that this was a family or tribal burial place; that in the cave along with the bodies were placed funeral gifts in the form of trinkets and food; and

* Elements of Geology, p. 601.

that the funeral feast was cooked and eaten on the level space in front of the cave; and, finally, that carnivorous beasts gnawed the bones left on the spot. It is evident that the Aurignac men practiced religious rites which indicated a belief in immortality.'' *

If such were among the oldest known men, how long must it have taken to evolve them, with their belief in immortality, from the highest known apes? And yet we have no evidence whatever from fossils that connect him with a lower form, that he has been evolved at all.

The ancient Egyptian paintings show that the Caucasian and Negro races have undergone little, if any, change in the last 4000 years. If this length of time has produced no appreciable change in these races what would be the period required to evolve man from an ape-like ancestor?

Mr. Wallace tries to account for the absence of physical change in man within the historic period by claiming that the mind of man enables him to adapt himself to a changing environment, thus relieving him from the necessity of undergoing physical change.

He believes that the lower animals have been evolved by natural selection, but that mind is the creation of a superior intelligence.

He says: "The inference I would draw from this class of phenomena is that a superior intelligence has guided the development of man in a definite direction and for a special purpose, just as man guides the development of many animal and vegetable forms.'' †

The following are some of the objections which he offers against the theory of the evolution of man by natural selection:

* Elements of Geology, p. 596. † On Natural Selection, p. 359.

First, anthropologists have been divided on the question as to whether the different races of men have had a common or separate origins.

If the latter, then nothing so remarkable could be assumed to have taken place. No evolutionist would assume that it would be possible.

Again, the absence of a covering of hair from most of man's body cannot be accounted for by the theory of natural selection. If he was evolved, it was from animals that had a hairy covering. The loss of this covering could be of no use to man in the savage condition when he had no clothing. The hair is thickest on the backs of the lower animals, while it is almost entirely absent from the back of man. Most savages are comparatively naked. They need the covering of hair for protection, and in the absence of it they provide at least some slight protection for the back from rain.

It is evident, therefore, that the loss of the hairy covering in man cannot be accounted for by natural selection. The loss of a part while useful is opposed to that theory.

Again, all the quadrumana use the big toe as a thumb, while man cannot use it in this way. The loss of it as an organ of prehension could not have been useful to savage man, and it could not therefore have been brought about by natural selection.

The quadrumana are accustomed to go "on all fours" horizontally, or in a more or less stooping posture, while man walks upright.

Acquiring an upright position could not have been useful to man in his assumed low condition as he emerged from the animal, and consequently such a change cannot be explained by natural selection.

Again, the human hand is far more highly organized than is necessary to meet the demands of rude savages, and, therefore, natural selection fails to account for the existence of this highly perfect organ.

He also claims that the powers of the human voice have not been produced by natural selection, for savages are not accustomed to sing, but to howl and make unpleasant sounds.

One of the strongest points which he makes against the evolution of man by natural selection is that "the brain of the savage is shown to be larger than he needs it to be."

He claims that the size of the brain is probably the most important factor in determining mental capacity. The following are given as the average sizes of brains in cubic inches: Teutonic family, 94; Esquimaux, 91; Negroes, 85; Australians and Tasmanians, 82; Bushmen, 77.

Some of the largest brains have been found among savages. The largest Teutonic skull in a certain collection had a capacity of 112.4 cubic inches; an Auricanian, 115.5; an Esquimau, 113.1; a Marquesan, 110.6; a Negro, 105.8; and an Australian 104.5.

The European with a brain less than 65 cubic inches is invariably an idiot.

The brain of the Orang-utan is 28 cubic inches; that of the Gorilla, 30, while $34\frac{1}{2}$ cubic inches is the capacity of the largest Gorilla brain that has been measured.

Calling the average of the anthropoid apes 10, the size of the brain of savages is 26, and of civilized man 32.

"The Engis skull, perhaps the oldest known" is, according to Prof. Huxley, "a fair average skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage."

Speaking of the oldest known skulls, Wallace says: "But what is still more extraordinary, the few remains yet known of pre-historic man do not indicate any material diminution in the size of the brain-case."

Natural selection assumes that progress does not take place beyond what is demanded by environment. This being true, how is it possible to account for the large size of the brains of savages?

When man began to emerge he had to contend with nothing higher than brutes, and a small increase in brain would enable him to do this successfully.

Savages have capacities for education far greater than is demanded by their mode of living. The same is true of their moral and religious capacities. They have latent powers of mind which anticipate a more advanced state of existence than that of the savage condition in which they have existed for ages. Powers which have, therefore, been dormant for thousands of years, could not have been preserved because they were useful, but, on the other hand, they should have disappeared by disuse.

Max Müller says that "between the language of animals and the language of man there is *no* natural bridge, and that to account for human language such as we possess would require a faculty of which no trace has ever been discovered in lower animals.

"Rational language is to be traced back to roots, and every root is the sign of a general conception or abstract idea of which the animal mind is incapable. Mr. Darwin has said there are savage languages which contain no abstract terms; but the names for common objects, such as father, mother, brother, etc., are abstract terms, and unless Mr. Darwin is prepared to produce a language containing no such names, his statement, said the lecturer, falls to the ground as the result of a misconception of the real nature of a general idea as distinguished from an emotion." *

* Abstract of his Lecture on Nature, Dec. 1872, p. 145.

Professor Virchow is reported to have said in a recent lecture: "We seek in vain for the missing link. There exists a definite barrier separating man from the animal which has not yet been effaced—heredity, which transmits to children the faculties of their parents. We have never seen a monkey bring a man into the world, nor a man produce a monkey. All men having a simian appearance are simply pathological variants. It was generally believed a few years ago that there existed a few human races which still remained in the primitive inferior condition of their organization. But all these races have been objects of minute investigation, and we know that they have an organization like ours, often indeed superior to that of supposed higher races. Thus the Eskimo head and the head of the Terra del Fuegians belong to the perfected types."

In view of the evidence furnished by examining all the races and varieties of men, he says: "Thus we are repulsed at every line of the assault upon the human question. All the researches undertaken with the aim of finding continuity in progressive development have been without result. There exists no proanthropes, no man-monkey, and the 'connecting link' remains a phantom."

The fragments of a skeleton recently discovered, of a supposed man-ape, in the Pleistocene deposits of Java have not been proved to be such.

Dana says: "Man's origin has thus far no sufficient explanation from science. His close relations in structure to the Man-Apes are unquestionable. They have the same number of bones with two exceptions, and the bones are the same in kind and structure. The muscles are mostly the same. Both carry their young in their arms. The affiliations strongly suggest community of descent. But the divergencies mentioned on page 1018, especially the cases of degeneracy in man's structure, exhibited in his plantigrade feet and the primitive character of his teeth, allying him in these respects to the Lower Eocene forms, are admitted proof that he has not descended from any existing type of Ape. In addition, man's erect posture makes the gap a very broad one. The brute, the Ape included, has powerful muscles in the back of the neck to carry the head in its horizontal position, while man has no such muscles, as any one of the species can prove by crawling for a while on 'all fours.' Beyond this, the great size of the brain, his eminent intellectual and moral qualities, his voice and speech, give him his sole title to the position at the head of the Kingdom of Life."* He believes with Wallace "that the intervention of a Power above Nature was at the basis of Man's development."

Huxley has pointed out the many physical differences between man and the gorilla, which is the most man-like ape in size and structure.

Neither fossils nor living animals have been discovered from which man could have been immediately evolved.

All admit, however, that the greatest differences between man and the highest ape are psychic, and not physical. The evolution of the human mind with all of its wonderful powers must be accounted for.

Darwin has tried to explain their evolution. He says: "My object in this chapter is solely to show that there is no fundamental difference between man and the higher mammals in their mental faculties." †

Again he says: "Nevertheless the difference in mind between man and the higher animals, great as it is, is certainly one of degree and not of kind." ‡

* Manual of Geology, p. 1036.

† Descent of Man, Vol. 1, p. 34. ‡ Ibid, p. 101.

He claims that the lower animals show fear, terror, suspicion, courage, ill-temper, rage, revenge, love, maternal affection, a desire to be loved, shame, modesty, curiosity, the power to imitate, the power of giving attention, memory, imagination, and reason. Most of these powers he claims have been exhibited especially by dogs and monkeys.

He thinks that the higher animals dream, as "is shown by their movements and voice," and that this is evidence that they have "some imagination."

It might be admitted that animals possess most of the above named powers, and still the greatest difficulties would remain.

Mr. Darwin refers to them as follows: "It has been asserted that man alone is capable of progressive improvement; that he alone makes use of tools or fire, domesticates other animals, possesses property, or employs language; that no other animal is self-conscious, comprehends itself, has the power of abstraction, or possesses general ideas; that man alone has a sense of beauty, is liable to caprice, has the feeling of gratitude, mystery, etc.; believes in God, or is endowed with a conscience. I will hazard a few remarks on the more important and interesting of these points."

Having considered the evidence bearing on these points he says: "There can be no doubt that the difference between the mind of the lowest man and that of the highest animal is immense. An anthropomorphous ape, if he could take a dispassionate view of his own case, would admit that though he could form an artful plan to plunder a garden, though he could use stones for fighting or for breaking open nuts, yet that the thought of fashioning a stone into a tool was quite beyond his scope. Still less, as he would admit, could he follow out a train of metaphysical reasoning, or solve a mathematical problem, or reflect on God, or admire a grand natural scene. Some apes, however, would probably declare that they could and did admire the beauty of the colored skin and fur of their partners in marriage. They would admit that, though they could make other apes understand by cries some of their perceptions and simpler wants, the notion of expressing definite ideas by definite sounds had never crossed their minds. They might insist that they were ready to aid their fellow-apes of the same troop in many ways, to risk their lives for them, and to take charge of their orphans; but they would be forced to acknowledge that disinterested love for all living things, the most noble attribute of man, was quite beyond their comprehension."*

But he adds: "Nevertheless the difference in mind between man and the higher animals, great as it is, is certainly one of degree and not of kind." Also, "The moral sense perhaps affords the best and highest distinction between man and the lower animals."†

Again he says: "Self-consciousness, Individuality, Abstraction, General Ideas, etc.

"It would be useless to attempt discussing these high faculties, which, according to several recent writers, make the sole and complete distinction between man and the brutes, for hardly two authors agree in their definitions. Such faculties could not have been fully developed in man until his mental powers had advanced to a high standard, and this implies the use of a perfect language. No one supposes that one of the lower animals reflects whence he comes or whither he goes—what is death or what is life, and so forth." ‡

He attempts to explain the origin of these powers as follows: "If it be maintained that certain powers, such as self-consciousness, abstraction, etc., are

* Descent of Man, Vol. 1, p. 101. † Ibid, p. 100. ‡ Ibid, p. 60.

peculiar to man, it may well be that these are the incidental results of other highly advanced intellectual faculties; and these again are mainly the result of the continued use of a highly developed language."

He also thinks that man has been evolved from "ape-like progenitors." *

The admissions contained in the above quotations are, it seems to me, quite fatal to the general conclusions. If man has been evolved from "ape-like progenitors," it has been a long time since he branched off from that stock. In the meantime these progenitors have been called on by a perpetually changing environment to improve themselves, with the result that they still remain brutes, while man, during the same time, and in the same countries, and with similar environments, has developed God-like capacities of intellect. How can we account for the extreme difference of progress between the "ape-like ancestor" and man?

The fact that the ape still survives shows that there has been no necessity for his making progress, and, consequently, environment could not have rendered it necessary for any of the offspring of the apes to have changed into men.

The following is a summary of Mr. Darwin's admissions. The "anthropomorphous ape" taking "a dispassionate view" admits, that he has never thought of fashioning even the simplest tool; that he cannot follow out a train of metaphysical reasoning, or solve a mathematical problem, or reflect on God, or admire a grand natural scene; that "the notion of expressing definite ideas by definite sounds had never crossed their minds," that "disinterested love for all things, the most noble attribute of man, was quite beyond their comprehension;" that he had no knowledge of

* Descent of Man, Vol. 1, p. 81.

right and wrong, that he was totally ignorant of the meaning of that "imperious word ought," that he had no self-consciousness, nor idea of individuality, nor general ideas, etc., for these latter faculties imply mental powers "advanced to a high standard" and "the use of a perfect language."

Here, then, it is admitted that Self-consciousness, Individuality, Abstraction, General Ideas, etc., are not possessed by the higher animals, for the existence of these faculties depends upon "other highly advanced intellectual faculties," and these again are the result of the continued use of a highly developed language.

According to this, the highest human faculties are the offspring of other highly developed faculties, and the latter are the offspring of language.

We do not know that the native strength of the intellectual faculties is due to the language of ancestors. We cannot estimate natural ability of children by the vocabularies of their parents. An extensive education requires a large vocabulary, but the birth of high intellectual faculties is more than the birth of words. We do not know that the size of the brain is in any way dependent on language. Ideas precede words, and faculties precede ideas. Ideas invent words. If the ape had ideas he would invent language to express them—especially if he is the ancestor of man, who has invented a great multitude of languages.

It may be claimed that language greatly contributes to mental activity, that this improves the brain, and that this improvement is hereditary. We do not know to what extent this may be true, but if it is true, it does not dispose of the difficulty. The question is not how can faculties be cultivated and strengthened, but how can they originate?

It is claimed that self-consciousness and other faculties not possessed by brutes may be evolved from "other highly advanced intellectual faculties." As to how self-consciousness could thus be evolved, we are left wholly in the dark. No facts are given to justify this extraordinary conclusion. It is a necessary part of the theory of evolution, and consequently it must be assumed even in the absence of proof. Mr. Darwin, in speaking of the many high powers of the human mind which have been enumerated, says cautiously, "I will hazard a few remarks on the more important and interesting of these points." He does not claim to offer anything like conclusive evidence that self-consciousness and other high powers have been evolved from lower faculties, such as animals possess, but I think that he simply assumes it as a necessary part of his theory. To tell us that self-consciousness is evolved from certain high faculties which themselves have been mostly produced by the use of a perfect language may be a legitimate opinion, but I think that it is very far from conclusive evidence.

He refers to the low moral standing of savages in support of his theory. According to natural selection, savages ought not to have any capacities except those that have been constantly in use and that have been preserved because they have been useful. The moral standing of savages is low, and this fact would seem to indicate a lack of capacity for morals. It is found, however, that savages have natural powers which enable them to make great progress in morals, and in education in all directions. It is this native capacity for improvement, which could not have been evolved by their savage mode of life, that distinguishes them from animals.

The story has been told of Mr. Darwin that when he sailed past certain islands in the Pacific, he found them inhabited by cannibals, but that twenty-five years afterwards he found these cannibals converted to Christianity and enjoying the blessings of civilization. It is further said that in consequence of this great change wrought by Christian missionaries, he donated twenty-five pounds a year to the Missionary Society.

How many millions of years would it take for even Christian missionaries to convert a tribe of gorillas into man-loving, God-fearing, self-conscious beings capable of believing that they possessed immortal souls?

The fact of such great and sudden changes produced in the lives of the most degraded savages shows the infinite gulf between them and the highest brutes. The more degraded man is shown to be in his savage condition, the more wonderful becomes the contrast between him and the highest animals when he has the opportunities of civilization. Evolution, instead of gaining, loses much by hunting up degraded savages, for the lowest tribes have vastly more capacity than the theory calls for or can explain.

Mr. Darwin attempts to account for the moral sense as follows: "Philosophers of the derivative school of morals formerly assumed that the foundation of morality lay in a form of Selfishness; but more recently in the Greatest-Happiness principle. According to the view given above, the moral sense is fundamentally identical with the social instincts; and in the case of the lower animals it would be absurd to speak of these instincts as having been developed from selfishness, or for the happiness of the community. They have however, certainly been developed for the general good of the community. The term "general good," may be defined as the means by which the greatest possible number of individuals can be reared in full vigor and health, with all their faculties perfect, under the conditions to which they are exposed. As the social instincts both of man and the lower animals have no doubt been developed by the same steps, it would be advisable, if found practicable, to use the same definition in both cases, and to take as the test of morality, the general good or welfare of the community, rather than the general happiness; but this definition would perhaps require some limitation on account of political ethics." *

Again he says: "It is possible, or, as we shall hereafter see, even probable, that the habit of self-command, like other habits, may be inherited. Thus at last man comes to feel, through acquired, and, perhaps, inherited habit, that it is best for him to obey his more persistent instincts. The imperious word *ought* seems merely to employ the consciousness of the 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 hounds ought to hunt, pointers to point, and retrievers to retrieve their game. If they fail thus to act, they fail in their duty and act wrongly." †

He expresses the following doubt as to whether habit may be inherited or not. "My chief source of doubt with respect to any such inheritance, is that senseless customs, superstitions and tastes, such as the horror of a Hindoo for unclean food, ought on the same principle to be inherited. Although this in itself is perhaps not less probable than that animals should acquire inherited tastes for certain kinds of food or fear of certain foes, I have not met with any

* Descent of Man, Vol. 1, p. 93. † Ibid, p. 88.

evidence in support of the transmission of superstitious customs or senseless habits."

If the doctrine of heredity, as insisted on by Darwin and Spencer, is true, it is evident that any course of conduct long persisted in ought to become hereditary. And yet after diligent search he tells us that he has "not met with any evidence in support" of this necessary part of the theory of evolution. Why insist on a theory which he admits does not explain all the facts? If acquired habits of morality can be inherited, then special Hindoo habits which have been formed in successive individuals for thousands of years ought to be inherited, but they are not.

Spencer attempts to explain the origin of intuitions as follows: "These all have arisen from the organized and consolidated experiences of all antecedent individuals, who bequeathed their slowly-developed nervous organizations, till they practically became forms of thought apparently independent of experience.

"I believe that the experiences of utility organized and consolidated through all past generations of the human race, have been producing corresponding nervous modifications, which, by continued transmission and accumulation, have become in us certain faculties of moral intuition—certain emotions responding to right and wrong conduct, which have no apparent basis in the individual experiences of utility."

Thus, according to Spencer, the moral faculties are due to the "experiences of utility."

According to Darwin, "man comes to feel through acquired, and, perhaps, inherited habit, that it is best for him to obey his more persistent instincts. The imperious word *ought* seems merely to imply the consciousness of the persistent instinct."

He says: "We have now seen that actions are regarded by savages, and were probably so regarded by primeval man, as good or bad, solely as they affect in an obvious manner the welfare of the tribe." *

From this I presume he means that the most useful experiences have formed the most persistent instincts, so that there is no substantial difference between his and Spencer's theory. Both seek to trace the origin of the moral faculty to useful experiences.

Darwin says: "The moral sense perhaps affords the best and highest distinction between man and the lower animals." †

He thus defines a moral being: "A moral being is one who is capable of comparing his past and future actions or motives, and of approving or disapproving of them. We have no reason to suppose that any of the lower animals have this capacity; therefore when a monkey faces danger to rescue its comrade, or takes charge of an orphan monkey, we do not call its conduct moral." ‡

Here we have the admission that no animal is a moral being. Again he says that "man alone can with certainty be ranked as a moral being." §

From these quotations we see the method by which Darwin and Spencer attempt to account for the origin of the moral nature of man. The great gulf between man and brute is admitted, but it is claimed that a protracted education, supplemented by inheritance to preserve what is gained, will convert animal into man. It is easy to imagine that by infinitely small steps any two points, however distant from each other, may be traversed—that by infinitesimal changes any change, however great, may be made, but the practical difficulty of applying this theory is that the gulfs on the

* Descent of Man, Vol. 1, p. 101.

† Ibid, p. 85. ‡ Ibid § Ibid.

road of evolution are so many and so great that we see no possibility of passing over them.

Take Darwin's definition of a moral being and see what an infinite distance it elevates man above the brutes. "A moral being is one who is capable of comparing his past and future actions or motives, and of approving or disapproving of them." This definition involves the consciousness of one's own existence, the knowledge that he existed in the past, that he acted from motives, that he now has motives, that he can compare these two sets of motives and apply the "imperious word *ought*" or ought not, to his conduct, that conscience approves or disapproves, and that he expects to exist in the future.

Are we to be told that these high powers, which animals do not possess, are the fruit of animal instincts? On what ground are we to believe it?

The evolution of the mind of man from the instincts of animals involves ultimately the evolution of all psychic phenomena from simple sensations of low forms of life, and these again from matter destitute of sensation.

Mr. Spencer's "experiences of utility" began, I presume, with the inorganic matter involved in spontaneous generation, and pushed on up to man.

Are we to regard all psychic phenomena as one in quality, so that one faculty may be derived from another? Are touch, taste, sight, hearing, memory, imagination, the power of abstract reasoning, self-consciousness, conscience, faith, hope and love, all essentially alike, and can one be evolved from the other? Evolution assumes that they are essentially the same, and it is her task to prove it or fail. How can memory, or conscience, or reason be evolved from any or all the senses? If the power to reason is different in quality from other powers, then it could not have been evolved from those powers.

Spencer seeks to account for the origin of the moral faculty by "experiences of utility," but it is evident that experience can only educate and improve a faculty that exists, and not form a new one that is different in kind. Educating the special senses cannot create a mental power, nor can experiences of memory create the power to reason, nor do we know that any one faculty can create another, although the various powers may be of mutual benefit to each other.

The question is not, how can a faculty be improved? but, how can it be created?

If evolutionists can prove the identity of all psychic phenomena, then their theory may be true. If, on the other hand, these are so distinct in kind that one cannot be changed into another, then the theory fails. Spencer's "experiences of utility," accumulated and inherited for many generations, explains, if true, at most, the improvement of existing faculties, and not the creation of new ones.

Take, for example, the special senses. Would it be possible by using the eye to evolve an ear? Or could taste or smell or any other sense give birth to sight? It is easy to talk about accumulating experiences through many generations, in the nervous system, and thus evolving all senses and all mental powers, but experiences can be such only in relation to faculties that exist.

Again, could the diligent use of memory—a faculty necessary to all high mental operations—produce the power of abstract reasoning, or conscience, or the knowledge of right and wrong? However necessary memory may be to the reasoning faculty, yet how widely different they are in kind! The latter faculty implies the existence of the former, but memory does not imply the existence of reason. Many persons with great memories have been very deficient in power to reason.

I speak especially of memory here, because, if the mental powers were evolved, it must have been one of the first that appeared. This would seem to be true both on account of its relations to the other mental faculties, and, because, in some form, it is manifested in a large part of the animal kingdom.

We would, therefore, naturally look to memory as the faculty from which, or by the exercise of which, other mental powers might be evolved.

Memory is the conscious record of the past. It is entirely different in kind from reason, will, or conscience, and, therefore, they cannot be the offspring of memory.

Granting that there are definite relations between the nervous system and psychic phenomena, still it would seem that there would be no tendency of nervous matter with which memory is connected to organize nervous tissue that could perform other functions. The effect of cultivating memory is to strengthen memory in the individual, and not to create imagination or any other power.

The power to recall past experience is totally different in kind from the powers which plan with regard to the future. The memory of the fact that an apple fell on his head is different in kind from the reasoning power which enabled Newton to discover the law of gravitation.

Spencer says: "The proximate components of Mind are of two broadly-contrasted kinds—feelings and the relations between feelings. Among the members of each group there exist multitudinous unlikenesses, many of which are extremely strong; but such unlikenesses are small compared with those which distinguish members of the one group from members of the other." *

He also claims, "that the multitudinous forms of Mind known as different feelings, may be composed of simpler units of feeling, and even of units fundamentally of one kind." †

From the above it is seen that Spencer admits that there are "multitudinous" and "extremely strong" "unlikenesses" between mental phenomena, but he attempts to explain away the differences by assuming that each feeling is composed of simple units of feeling fundamentally of one kind.

As a supposed analogy for this argument he refers to the fact that most substances in nature are compounds made up of a few simple substances, and that different compounds may be used by grouping the atoms differently and by taking different relevant numbers of the same atoms.

It is evident, I think, that the supposed analogy will not hold good unless we assume Matter and Mind to be fundamentally alike, a proposition which Mr. Spencer himself would not affirm.

We see in the above the usual method which the evolutionist adopts in deriving the most diverse things, one from the other—namely, the addition or subtraction of atom by atom till the change is wrought. This subtle way of proceeding always leaves one in doubt as to just which atom he ought to strike out from the imaginary chain of evolution.

To simplify the subject he makes use of the supposition which has been made by others, that there is "but one ultimate form of Matter,"—so there may be "units of feeling" "fundamentally of one kind."

* Principles of Psychology, Vol. 1, p. 163. † Ibid, p. 156.

These are mere assumptions. Besides, if true of matter, it might not be true of mind.

Judging from psychic phenomena, the indications are that if faculties are compound, they are composed of many unlike units instead of simply one kind. The many powers of the mind stand out sharply and distinctly from each other, and we are totally unable to explain one in terms of another.

If, with Spencer, we say that all states of consciousness are feelings, yet this does not identify them. The question is, whence these feelings? Can one feeling originate another? Can the nerve center of one feeling produce a nerve center that can perform an entirely different function? Unless it can, the theory of evolution fails. The assumption that mind is made up of simple units of feeling that are fundamentally alike has nothing to justify it except the necessities of the theory which it is made to support.

The fact that the mental powers work in harmony and bear certain relations to each other is not proof of their fundamental identity, nor that the one can originate from the other,—no more than can the eye from the ear, or the foot from the head.

I cannot emphasize too strongly the fact that Mr. Spencer's theory of the evolution of the various powers of the mind is built on the assumption that all mental powers are made up of "units of feeling" that are "fundamentally of one kind."

By this mere assumption he sweeps away all essential differences between psychic phenomena. He introduces us to his psychic laboratory, where by the use of the simple "units of feeling" as agents and reagents, he proceeds to form as compounds all the wonderful and widely different faculties of the mind.

I may say just here that, so far as we know, the chemist with "units" of matter, or atoms, "fundamentally of one kind," can make little progress in building up material compounds. Allotropic conditions are few and comparatively unimportant, so that there is no certain foundation in material units for the assumed units of feeling of one kind only.

Spencer assumes that all the atoms of different kinds of matter are probably fundamentally alike. The positive teaching of chemistry is that there are many kinds of atoms fundamentally unlike. He then assumes that all mental phenomena are made up of "units of feeling," and then further assumes that these units of feeling are "fundamentally of one kind."

By calling all psychic phenomena feelings, and then resolving feelings into "nervous shocks" the science of Psychology is immensely simplified, if indeed it is not rendered more luminous.

He tells us: "Mind is, certainly in some cases and probably in all, resolvable into 'nervous shocks.'"* And yet he says, "That a unit of feeling has nothing in common with a unit of motion becomes more than ever manifest when we bring the two into juxtaposition."

This admission, it seems to me, renders it impossible to account for the origin of even the simplest feeling, from inorganic matter by the process of evolution. And yet it is necessary that the chasm between the dead unconscious world and the living conscious world should be bridged.

There is no mental process by which we can conceive the origin of any feeling from matter or from matter and motion.

Mind persistently refuses to be identified with matter. The Ego and the Non-ego—the subject and the

* Principles of Psychology, Vol. 1, p. 156.

object—the thinker and the object of thought stand forever apart.

Mr. Spencer says: "Nevertheless, it may be as well to say here, once for all, that were we compelled to choose between the alternatives of translating mental phenomena into physical phenomena, or of translating physical phenomena into mental phenomena, the latter alternative would seem the more acceptable of the two." *

Matter and mind cannot be identified with each other. Mind cannot spring from matter nor be explained in material terms.

Of course, I do not deny that there are intimate and definite relations between mental phenomena and the nervous system, but I do deny that matter alone or matter plus motion constitutes mind.

Mr. Spencer admits that "a unit of feeling has nothing in common with a unit of motion," so that all effort to identify mind as matter falls short of the truth. They stand at the two poles of thought.

The theory of evolution fails to account for the origin of even simple units of feeling; it fails to prove its assumption that the various widely-different mental powers are composed of simple units of feeling that are "fundamentally of one kind;" it fails to show how the higher mental powers could have been evolved from the lower powers which must have preceded them, and, above all, it fails to explain the evolution of the moral faculty in man.

Spencer claims that the "faculties of moral intuition" have been produced by "experiences of utility." I need not say that right and useful are not equivalent words. How widely different might be conduct when determined by the word ought, on the one hand, or by the word useful, on the other! It

* Principles of Psychology, Vol. 1, p. 159.

might be useful to put to death the aged, the insane, the deformed and helpless, and thus to relieve society of great burdens, but no one claims that we ought to do this.

Duty may not be useful to the doer; it may demand great sacrifices and even death, and yet it speaks with no uncertain voice. Duty looks to no earthly power to give it authority, nor does it seek the paths of pleasantness.

Conscience sits enthroned in the soul, ever active, ever seeking to guide the life in the way of righteousness. No external threats nor internal decrees can silence its voice. When we would have it silent, then it speaks loudest; if we would deceive it by false logic, it laughs us to shame; if we would flee from it, it goes with us; when we awake, hoping that it may have departed while we slumbered, we hear it whispering in the soul. It is ever present, ever clamoring to be heard—the voice of the Infinite calling us to duty.

Spencer uses the expression, "experiences of utility," in trying to account for the evolution of conscience. This does not necessarily involve even the existence of mind, much less any mental conception of the useful.

Plants have for millions of years been unconsciously doing work useful to the individuals, doing the work and serving to propagate their species. All animals have of necessity been having "experiences of utility" throughout the long history of animal life on the earth. Are we to conclude that "experiences of utility" have organized the various nervous systems of all the different kinds of animals?

How can the experience of an animal that has no nervous system whatever enable it to give birth to an animal that has a nervous system?

How can the useful experience of animals that are destitute of all mental powers produce animals that have these powers?

No animal acts with a clear mental conception that what it is about to do will be useful to itself or others, and, having acted, it can not understand that what it has done is useful. The moral sentiment could not, therefore, have been evolved in animals from the idea of the useful, for this idea does not exist in animals.

It is evident that not only experience of the useful, but also that a clear mental conception of the useful, must precede the moral sentiment if the latter has been evolved, as claimed.

We do not know that animals do things from a knowledge that what they do will be useful. They are driven by instinct, not knowing why they act, nor what will be the results of their conduct.

A wild fox hunts because he is hungry, and not because he feels or knows that it will be useful. He does not say before starting that if he does not hunt he and his offspring that are dependent on him will perish. Nor is there evidence that he hunts because he anticipates that it will give him pleasure to eat what he may capture; but he does so because he is driven by blind instinct.

Therefore, before talking about evolving conscience from useful experience, it would be well to prove that animals have well-defined ideas of the useful, and that these ideas, aside from instinct, are motives to action.

The instincts of animals are sufficient for them in their narrow spheres. They enable them to compete with other forms that are endowed with instincts, and, consequently, there was no demand for animals to rise above instinct, and to acquire the high mental powers of man.

Even if animals had clear ideas of the useful, it is not at all evident that they would ever be able to apply them except to themselves as individuals.

But I do not think that it can be shown that they have any abstract conception of the useful, and much less can it be true that they have a conscience which has been evolved out of their ideas of utility.

I quote again the following from Darwin: "It is possible, or, as we shall hereafter see, even probable, that the habit of self-command, like other habits, be inherited. Thus at last man comes to feel, through acquired, and, perhaps, inherited habit, that it is best for him to obey his more persistent instincts. 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 hounds ought to hunt, pointers to point, and retrievers to retrieve their game. If they fail thus to act, they fail in their duty and act wrongly." *

He thus uses the word *ought*, which expresses in the fullest way our sense of moral obligation. In hunting, hounds follow a persistent instinct, and this instinct constitutes the moral faculty, and yet Darwin admits that no animal is a moral being. They hunt without any intelligent purpose, and without freedom of choice, for instinct is blind and can not reason. If the instinct to hunt is similar to the moral quality in man, then all instincts are moral, and *ought* to be obeyed. If the hound *ought* to follow his instinct and hunt, then man *ought* to follow his instinct and slay his enemies.

* Descent of Man, Vol. 1, p. 88.

If instinct may use the word ought, then why should one instinct have more authority than another? for each is entitled to the use of the word. When we have followed one instinct and committed a deed, why should a "more persistent instinct" afterwards condemn us? Both are armed with the word ought. Why do we not reason thus concerning murder? I *ought* to follow my instinct. My instinct told me to murder an enemy, and I obeyed. I did my duty and my conscience is clear. Therefore, if another instinct says that I ought not to have done so, I answer that my instinct to murder *ought* to fulfill its purpose. Thus, according to conflicting instincts, I *ought* and I *ought not* to have committed murder. Thus morality annihilates herself—moral quality is gone—conscience has no right to exist—the whole matter of moral obligation is a delusion—a delusion, in fact, on the belief of which, more than on all else, depends the welfare of the human race.

With instinct as the basis of morality, there can be no freedom of choice, no deliberation, no forethought, and there ought to be no pangs of conscience. The high mental powers, which Mr. Darwin himself acknowledges are necessary to constitute a moral being, are absent from instinct, and by making the latter the foundation of the moral faculty, irresponsibility and fatalism are substituted for responsibility and freedom of the will.

If the instinct of morality is wholly inherited, then its possessor cannot be responsible for possessing it, nor for following where it leads, if it carries the word ought as authority.

If, on the other hand, the instinct may be acquired by cultivation, and we say that a person ought thus to gain it, then the word ought precedes instinct and exists independently of it.

In either case there is no foundation in instinct for morality. Intelligence and freedom of choice alone, and not blind instinct, give moral quality to conduct. It is evident that the word ought is used in a highly "figurative sense" when applied to the instinct of a hound to hunt.

The failure of the hound to hunt awakens no pangs of conscience. Conscience and instinct stand widely apart. The exercise of the former demands the use of the highest mental powers, while the action of pure instinct is independent of such powers.

Instinct may exist forever, as it has existed in all animals, without giving birth to conscience. I see no probable method of transition from the former to the latter. To call the moral faculty in man an instinct is not to show how it can be evolved from the instincts of animals.

The great gulf between the moral nature of man and the instincts of animals remains unbridged. I quote again what Darwin has said: "A moral being is one who is capable of comparing his past and future actions or motives, and of approving or disapproving of them. We have no reason to suppose that any of the lower animals have this capacity."

Nor do we have reason to suppose that the infinite chasm between man's moral and intellectual nature and the capacity of the highest animals could ever have been bridged by the process of evolution. Mr. Darwin's admissions, in speaking of the evolution of man's high powers, are sufficient to show the weakness of the evidence on which he relies.

Reason, the power to compare ideas and draw conclusions, the power to think about our past and present mental conditions, the power to form abstract ideas, the use of language, conscience, faith, hope and disinterested love—love for country, for humanity, for generations yet unborn—these high qualities are so different from anything that we find in the brutes, that it is impossible for me to believe that they could have been evolved by natural processes.

If it could even be shown that the physical man has been evolved from some lower form of animal, still this fact could not remove the difficulty of evolving man's mind from the few and feeble powers of brutes.

We may speak, if we please, of the continuity in the chain of natural processes, which is indeed well so far as we can show it to be true, but when we come to the creation of the mind of man, I believe that there was a break in the chain, and that it required the special act of the Supreme Intelligence. I can the more readily believe this when I see that it is the prerogative of mind to interfere with the works of nature and produce results that could never have taken place if it had not been for mind. "Will counts for something." The mind of man moving his body has modified the earth in infinite ways that never could have been, if they had not been produced by intelligence. The building of a locomotive is an interference in numerous ways with the course of events and with the arrangement of things as they would have been if it were not for the control of mind. And yet we are well aware that in constructing a locomotive no law of nature is interfered with. On the other hand, we know that in order to build it the laws of nature must be strictly complied with. Man produces his results by the intelligent use of his own body and by guiding the forces of nature so as to accomplish his purposes. He avails himself of chemical and mechanical laws—he uses some forces as instruments with which to overcome others—he, by his intelligence, produces conflicts between materials and forces where otherwise they could not exist—thus fulfilling his purposes. And so it is the prerogative of mind to interfere with the course of events, and this in conformity with nature's laws.

We cannot say that the creation of the mind of man by the Supreme Intelligence would be an interference with the laws of nature. To crown the earth with a ruling intelligence capable of high attainments is the one thing which above all else could give meaning to creation. The accomplishment of this highest purpose, by which a new quality of existence was introduced into the earth, could only be done by a special act of the intelligent, creative Power.

We are driven to this conclusion not only by our inability to explain the evolution of man's mind from the powers of the lower animals, but also by the fact that we cannot explain mind in terms of the physical factors in the universe.

If we attempt to account for mind by physical agencies alone, we are confined to matter, ether and force. The only known effect of force upon matter and ether is to impart motion to them. Given, atoms and molecules in motion, can we derive the phenomena of mind? Is mind simply matter in motion? Is the conscious Ego equivalent to moving molecules? Are reason, memory, will, love and all mental powers simply molecules in motion? Evidently to ask these questions is to answer them. We can see no resemblance between memory and heat, or between reason and electricity, or between imagination and gravity. When one physical force is converted into another, as heat into electricity, light, or mechanical motion, there is always a definite qualitative and quantitative relation between them, but we cannot affirm that any such relations exist between mental phenomena and the forces of nature.

If a definite quantity of heat can be converted into a definite quantity of will, then will may be converted back into heat. We do not know that heat and electricity are generated by mental activity. The only known effect of applying force to matter is to impart motion to the latter. We cannot by warming the brain artificially increase the power to think. The phenomena of mind are entirely different from molecular motion. Motion of little pieces of matter is not thought. Force and matter are related to each other, but they are not identical; and so mind is related to matter and force, but it is not identical with them.

We have already stated that modern physicists look upon the existence of ether as a fact, and yet ether is so subtle that we cannot discover its existence as matter. If we must assume the existence of an all-pervading form of matter in order to explain natural phenomena, is it more unreasonable to assume the existence of an all-pervading mind in order to explain mental phenomena? If we cannot explain mind in terms of matter, ether and force, *i. e.*, in terms of molecular motion, we may logically assume the existence of a cause sufficient to explain it—the existence of an intelligent cause.

The great forces of nature are ever at work silently and unseen, and the universe without them would be motionless. We judge that they exist by examining the results produced. We have better reason to believe in the existence of mind than of heat or light, for our knowledge of mind is direct and immediate. For the thinker to dispute his own existence is to annihilate the universe. The mind must judge of its own qualities first, and its decision in respect to the nature of its powers must be accepted. Looking at itself alone it might be constrained to believe that all existence is conscious,—that the universe is mind alone; but looking also at the extenal world, it invariably contrasts itself with matter and force, and judges itself to be essentially different. It is not difficult for even the most untutored savage to believe that his soul is different from his body and from all the external world. The common sense of mankind in all ages has given a uniform decision in the matter of the existence of the soul, and it has ever thought it necessary to explain mind by referring to some power beyond the physical forces of nature.

After all, if we were to affirm that matter is conscious it would be saying that mind is, so far as we know, indestructible and eternal. If mind and matter are identical, then mind is secure through eternity. If moving molecules are mind, then moving atoms are also mind.

If molecules of brain composed of carbon, hydrogen, oxygen, nitrogen, and phosphorus are conscious and think and will, then each of these five simple substances must embody in itself or be in itself a certain portion of consciousness, for the sum cannot be greater than all the parts that compose it.

To affirm that organized matter is conscious—that mind is a property of organized matter—is at bottom to affirm that simple forms of matter also are conscious. So far as it can be traced in the laboratory, organized matter consists of molecules made by the union of elementary substances.

Mind has a scope of conscious relations to time, space, matter, force, and to mind, that are entirely different, so far as we can ascertain, from the relations of matter and force to each other.

Mind alone looks backward and forward in time, searches space, determines the qualities of matter, studies the forces of nature, and understands the great multitude of its own conscious conditions. To attempt to resolve all mental phenomena into molecular motion, or into the properties of molecules, is entirely beyond all analogy. To say that a train of reasoning or a pang of conscience is due to the motion of small pieces of matter which compose the brain, is to affirm that which is beyond the power of thought and beyond belief.

That mind is in some way related to matter and force is beyond question, but it does not follow that it is identical with them.

The physical organism, with its mechanical powers, is but the servant of the mind. The dominion of mind is one of the most apparent facts in nature. That the ruling power is the offspring of that which it rules would seem to be impossible. That the soul is only "dust and ashes" it persistently shrinks from believing. There is a deep-set and ineffaceable repugnance—a rebellion of the soul against every attempt to identify it with matter, or to bring it under the control of matter. Consciousness of its supremacy is ever present and persistent. Our consciousness is that mind is different from all else, and that mind is supreme over all else, by reason of its ability to plan and to execute. This conscious dominion of mind over matter and the forces of nature and over all organic beings places it in a class distinct from the rest of the world. It realizes that it is the rightful and sole heir to the throne which it occupies.

Material phenomena are made known to the soul through the avenue of the senses, but we are conscious of mental phenomena that are not due to sensation. An apple fell on Newton's head, producing a sensation, and this was followed by a course of reasoning which resulted in the discovery of the universal law of gravitation. The pain produced by the stroke of the apple, together with all the other sensations aroused by the external world which Newton ever experienced, were not equivalent to the process of reasoning by which he deduced the law. The faculty with which we reason is not sensation.

Ten years ago we saw an object: an image of the object was formed on the retina of the eye, and the mind perceived the image and recorded it. To-day we remember that we saw the image ten years ago. How can we explain the act of remembering? The act of remembering is not simply the reproduction of a former mental condition, but it is also a recognition of the fact that the former mental condition existed. If the original impression made by seeing the object could be regarded as simply a sensation, still the subsequent act of remembering involves more than sensation.

If we claim that the sight of the object left a material record on the brain, and that this material record is memory, we are in total darkness. Granted that a material record is kept, what reads the record? Does the record read itself? Memory is the power which reads and identifies the record.

If we try to explain memory by supposing it to be the vibrations of molecules of nerve matter, we must suppose that molecules which vibrate to-day recognize the fact, by vibrating, that ten years ago entirely different molecules vibrated in a similar way. This theory of molecular motion is entirely inadequate to explain any mental condition whatever.

If we explain memory by saying, in general terms, that it is the recurrence of a former condition of the nervous system, this is insufficient, for the evident reason that memory is more than this.

To explain memory, therefore, it is necessary to assume more than molecular motion and more than sensation. It is a faculty which cannot be derived from matter, nor even from the senses of man.

Reason makes use of materials furnished by the senses—compares, corrects and often rejects the testimony of the senses. Therefore, reason is not the offspring of sensation.

The will is frequently exercised in opposition to the strongest desires of the senses, thus showing that it is essentially different from sensation.

If these high mental powers are more than sensation, then they could not have originated from the senses, and we must conclude that they have had a different origin.

In conclusion I need hardly say that I see no possible method by which the mind of man could have been evolved. Its highest powers, I think, are essentially different from the faculties of animals. They could not have been evolved from instinct nor from sensation, for they are vastly more than these; nor could they have been evolved from experiences of utility, for such experiences imply the existence of faculties, and can therefore, at most, only account for the improvement of existing faculties; nor can they be explained in terms of molecular motion, for the relation between mechanical motion and conditions of the mind are totally inconceivable. I therefore refer the origin of the mind to the Infinite Intelligence which has created the universe.

Mind, which believes in the existence of the Infinite and the Eternal—which believes the universe to be under the control of a Supreme Intelligence, is more than a handful of dust—more than a transient breath. To put mind on a level with matter and the forces of nature, or with instincts and sensations is to drive it from its throne of conscious supremacy—it is to ignore our most certain experiences.

I see no reason why the human mind—the conscious king over matter and force, over instincts and sensations—should abdicate and descend from the throne.

Mind alone can give meaning to the universe. Without its presence flowers would bloom, stars would shine and worlds would revolve in vain. By mind and in the interests of mind all things are to be interpreted; it is the beginning and the end.

Mind, which declares the existence of an intelligent Creator, who has made and who sustains all things, must occupy as mind more than transient relations to this Creator.

I cannot close this chapter in a more appropriate way than by quoting the closing paragraph of the great Geology finished by Dana shortly before his death. It comes as the parting word of one of the greatest scientists and one of the noblest characters that the world has produced. It is as follows: "Whatever the results of further search, we feel assured, in accord with Wallace, who shares with Darwin in the authorship of the theory of Natural Selection, that the intervention of a Power above Nature was at the basis of Man's development. Believing that Nature exists through the will and ever-acting power of the Divine Being, and that all its great truths, its beauties, its harmonies, are manifestations of His wisdom and power, or in the words nearly of Wallace, that the whole Universe is not merely dependent on, but actually is, the Will of one Supreme Intelligence, Nature, with Man as its culminant species, is no longer a mystery." *

* Manual of Geology, p. 1036.

XVI.

A FUTURE LIFE.

It has been claimed that it is beyond the province of science to deal with the question of a future life. It seems to me that science may deal with all facts of nature within our reach and draw such conclusions as these facts may justify.

In the preceding pages I have endeavored to show that the existence of the human mind can be accounted for only by assuming the existence of an Intelligent Cause; that it cannot be explained in terms of matter, ether and force; and that being different from these, its existence cannot be determined by them.

The physicist is driven to assume the existence of ether as a universal physical medium, and I think that it is no less imperative to assume the existence of God as a Universal Spirit.

The present existence of mind is the most certain fact in the Universe, and the present may give assurance for the future.

The human race has looked with steady gaze into the future, and has believed and hoped that death will not end all. This universal belief and desire to live in the future are an assurance that the soul may survive.

Why and "whence this strange desire, this longing after immortality" if it must remain forever unsatisfied? Does nature mock herself? Does she promise more than she can fulfill? That she has made the promise of a future existence in which the soul shall preserve its conscious identity is written in the universal desire and belief of the human race in all ages.

Nature affords the means for gratifying, in the most ample way, all of man's natural desires. If he is thirsty, she gives him water to quench his thirst. If hungry, she offers him nourishing and delicious food of a thousand kinds to satisfy his hunger.

If he would enjoy the beautiful, the world abounds in objects that gratify his love of the beautiful. If he seeks and longs for immortality, it would seem to be in harmony with the general workings of nature's laws that this greatest and most cherished of all desires should be gratified.

Matter and force do not perish; they may change their relations to each other, but not their essential nature. Why shall we assume that mind, the ruler of all, is an exception to indestructibility? Why shall we say that the highest product of creation—that without which creation would have been a failure, so far as we can judge—must perish, while thoughtless, senseless matter and force remain through the eternal ages?

> "I hold it truth with him who sings
> To one clear harp in divers tones,
> That men may rise on stepping-stones
> Of their dead selves to higher things."

Must we believe that mind which declares the existence of an Infinite, Intelligent Creator is the most transient of all things?

The mind feels that it was not born to die. It turns with abhorrence from the thought of annihilation and seeks refuge in the hope of a happy existence through endless ages to come.

How can we explain the inheritance of these sentiments which are a part of our nature? How have they originated and how have they been transmitted from age to age? How are mental characteristics transmitted from parents to offspring? Have the traits of father and mother combined been handed down through long ages by means of the few molecules of matter that constitute the beginning of each material organism? And what theory can satisfactorily explain the formation of the organic germs of living beings?

I need not say that heredity is one of the profoundest mysteries of nature. To explain it baffles the powers of the imagination. While we may look upon it as a natural process, yet in the deepest and truest sense I regard it as a constantly recurring exhibition of the Divine power. No miracle can be more wonderful nor incomprehensible than the results of heredity.

Nature is crowded with mysteries. Life is a mystery. We know that we live, but how or why we know not. That we may live in the future may as well be a part of the great plan as that we live now. Unless it can be shown that mind is necessarily dependent for its existence on organic matter, a thing which it is impossible to prove, then it may be possible for mind to exist after the body perishes.

A future life seems necessary in order that the soul may make the endless progress of which it is capable. The beast eats and lies down perfectly satisfied. It soon makes the limited progress of which it is capable. But the inquisitive mind of man is never satisfied. It searches the universe in quest of truth, and is ever anxious to enlarge its store of knowledge.

It would seem probable that future opportunity might be granted to enlarge the work begun here but left so incomplete at the close of even the longest life.

"Then we shall know," expresses an infinite longing of the mind of man. The mind seeks to exhaust the treasures of the universe. Has it been ordained that this insatiable desire which would search out God and bring to light all mysteries shall be buried in the dust at the end of the few brief years of our earthly pilgrimage? Would this not indicate an incompleteness that does not elsewhere exist in nature?

> "Thou wilt not leave us in the dust,
> Thou madest man, we know not why;
> He thinks he was not made to die,
> And thou hast made him, thou art just.
>
> "My own dim life should teach me this,
> That life shall live forevermore,
> Else earth is darkness at the core,
> And dust and ashes all that is."

Faith, hope, love, reason, conscience, imagination, all look to the future for the fulfillment of their desires. The boundless desires of the mind demand further time and opportunity for the accomplishment of their purposes.

We labor to-day that we and others may have future material blessings in this life. The present is made to serve the future. Man's superiority consists largely in the fact that his faculties cause him to store up knowledge and materials for future use. The man who lives for to-day only we count of little worth, and he is very liable to be a reckless and danous man to society. Human life is dignified and ennobled by making present conduct administer not only to present, but also to future good.

If the human race held the belief that death would end all, what a change would be wrought in human conduct! The belief in an infinite future for the soul has been most invigorating to mental and moral life. And shall we hold that this belief is but a dream, and that a dream, never to be fulfilled, has been necessary as a means of lifting man higher in the scale of being? Has the Creator of the Universe so ordered things that we must believe a falsehood in order that we may go forward on the road of progress?

I think it safer to hold that man's belief in a future state of existence is ennobling because it is a prophecy of the life to come. Nature is not out of joint, nor false to her most sacred promises.

If we hold the universal belief in a future existence to be but the result of an instinct inherited through countless generations, yet must we account for the instinct. The love of life is one of the strongest instincts, and instincts are quite infallible. Instinct comes by birth, and harmonizes with the facts of the nniverse.

Whatever be the origin of the universal belief in a future state of existence—whether instinct, reason or revelation—the fact that this faith exists shows the profoundest yearnings of human nature, and, from analogy, we may believe that the future holds in store the means of satisfying the boundless aspirations of the human soul.

Life and death go hand in hand. The Power that made life also ordained death. If life is good and desirable, we may also trust that death is equally good and not to be feared. Both are parts of the universal plan. We may trust that the Power that rules will make no mistakes—that all things through the endless ages will be wisely adjusted.

Time flows eternally, and events succeed each other without intermission; among these events are life and death, and they must be in harmony with each other. Death cannot be the contradiction of life. In the endless chain of events death can only be one link—a brief transition from the life that now is to the life that is beyond. The stream of life flows forever on. Death is not its end, but only the closed door that shuts it out from mortal view.

Nature proclaims with universal voice that things which are shall be. Change is not annihilation, but the establishment of new relations. Matter, force and mind exist for eternity.

The upward progress through the long ages indicates that there may be other steps in the future. Matter, plant life, animal life, grading from the simplest organism, a single cell, with no sense except that of touch, and that but feebly developed, on up through more and more complex forms till we reach the highest vertebrates, with all the senses highly developed and with marvelous instincts; thence on by the greatest of all steps of progress in creation to the mind of man—this upward march of purpose in creation speaks of something higher yet to come.

The purpose of the Creator, it seems to me, cannot be fulfilled by blotting out his noblest work, but rather may it be by advancing the soul to other opportunities for which the experiences of this life have prepared it.

XVII.

DESIGN IN NATURE.

Does nature furnish satisfactory evidence of design, and, therefore, of the existence of an intelligent Creator?

Nature seems to be a vast machine with infinitely complicated parts—with springs, and levers, and wheels within wheels, all nicely adjusted and lubricated, and seemingly capable of perpetual motion.

We know not when its operations began, nor can we tell when they will end. Through the long ages of the past it has been ceaselessly at work producing a series of results varying much in their nature. As the ages have passed slowly by her spindles have drawn out finer threads and her looms have woven more wonderful fabrics.

The stream of creation has flowed upward. Beginning in matter, it ended in mind. Matter and force, vegetable life, animal life, animal instincts, and mind constitute a series of steps upward that cannot be explained in terms of matter, motion and force.

This upward movement in creation, culminating in mind, which persistently refuses to be identified with all else in creation, gives the broad assurance that the Creator of all things is a God of Intelligence.

It seems reasonable to believe that the Creator is not of a less exalted nature than the mind of man which he has made. "He who hath made the eye can he not see? He who hath made the ear can he not hear?" He who hath made the mind of man can he not think?

I am aware that this is poor logic to those who attempt to explain all things in terms of matter, motion and force. If they choose to explain the highest by means of the lowest factors in creation, I can say that I prefer to explain all by means of the highest known power. Creation, as I believe, begins in mind and ends in mind, while all things are to serve the purposes of intelligence.

The creation of matter alone, with nothing further in view, would hardly seem to be an object. But a world crowned with a being of noble mind, of far-reaching intelligence, with capacities for interpreting and enjoying all things, would seem to be an object worthy of and demanding an intelligent Creator.

I will now present some of the facts pertaining to the existence of living beings upon the earth which are evidence of design.

The existence of the sun for many millions of years at a temperature favorable to life upon the earth, as shown by the presence of the great multitude of forms of animal and vegetable life through the long ages of geology, together with the probability that this condition will continue for millions of years to come, is a mark of intelligence. The fact that plants and animals have lived upon the earth for millions of years is conclusively shown by the geological record.

Sir William Thomson thinks that the sun has not probably illuminated the earth for more than 100,000,000 years, and that it has enough heat and light to supply the earth at the present rate of radiation for from 10,000,000 to 50,000,000 years to come.

When we remember the great extremes of temperature to which different parts of the universe are subjected—the almost absolute zero of interstellar space, the frigid moon, the sun with a temperature of thousands of degrees—and when we remember that a change of temperature of comparatively few degrees would destroy all known forms of life, and that for many millions of years the earth's temperature has been so uniform that life has existed in abundance, nothing short of intelligent purpose can explain these facts. Even if we accept the theory that the sun's heat has been generated by the bombardment of meteors, which is, indeed, the most plausible physical theory, yet it would seem to require Divine intelligence and power to keep the supply uniform.

In addition to the quite uniform temperature of the sun during this long period, certain conditions were necessary upon the earth in order to prevent its temperature from undergoing much greater variation than has taken place. The existence of the atmosphere around the earth and of moisture in the atmosphere is of the greatest importance in retaining the heat of the sun which has reached the surface of the earth. The rays of heat of high refrangibility readily pass through the atmosphere to the earth, but on striking the earth they are changed to rays of low refrangibility, which do not readily escape through the atmosphere into space.

Also, the large quantity of water upon the surface of the earth has much to do in rendering the climate uniform. The high specific heat of water enables it to absorb a large quantity of heat without undergoing much change of temperature, and this heat is slowly given up by the water to render the climate more uniform.

The production of a uniform climate through long periods involved not only a sun of uniform temperature, but also the existence of an atmosphere and of a large quantity of water on the earth.

In addition to these things, the fact that water expands on cooling from 4^0 Centigrade until it reaches O^0 and freezes, thus rendering the ice considerably lighter than the water, so that it floats on the surface, is a matter of much importance. If, instead of expanding when it freezes, it were to follow the almost universal law and contract on cooling to the freezing point, the ice formed would be heavier than water and would sink to the bottom of rivers and lakes, thus causing it to accumulate in much larger quantities than at present; so much would probably be formed, owing to the fact that the surface water would not be protected by ice as it now is, that it would probably destroy all life, at least in the fresh waters of the globe.

These large provisions in nature, adapting the earth to the existence of a countless number of organic forms, we cannot regard as having been produced by chance.

The distance of the earth from the sun is such as to give a temperature favorable to life. If ether exists, its resistance to the progress of the earth in its orbit is causing the earth to slowly approach the sun in a spiral orbit, and this gradual approach may possibly compensate for a decrease in the radiant energy of the sun.

The length of days and nights on most parts of the earth is of great importance in helping to preserve a uniform temperature which favors the existence of living organisms. If the days and nights were much lengthened, it is evident that this would produce much greater extremes of temperature than at present.

The fact, also, that the northern hemisphere of the earth, in which is much the greater part of dry land, is nearer the sun in winter than in summer, and that the reverse is true of the southern hemisphere, in which most of the water exists, is a wise provision for preventing those extremes of temperature which would occur if the sun were in aphelion in our winter and in perihelion in our summer.

Also, the various seasons of the year are well adapted to the growth of vegetation and to the welfare of animals. The seasons are due to inclination of the earth's axis to the ecliptic, and their length is determined by the time required for the earth to revolve round the sun.

The wonderful chemical laws to which atoms are subject—the law of combination according to atomic weights, and the law of multiple proportions, show the infinite wisdom and power of the Creator. Each atom of matter is stamped with power that is definite and invariable, so that it acts with absolute precision in all that it does. Thus the primary building materials of the universe show that they are the workmanship of an Infinite Intelligence. Can the chemist who understands the great multitude of ways in which elements combine according to well-known and invariable laws doubt that behind these laws there is a ruling Intelligence? I have already sufficiently considered these laws in the chapter on Matter.

If we consider the kinds and relative quantities of simple substances that are found in the earth, with reference to the existence of living beings, and finally of man upon the earth, I think that the evidences of design are unmistakable.

It is evident that many material conditions must be fulfilled before it is possible for any living thing with which we are acquainted to exist, and vastly greater must be the number of such conditions before a world, adapted not only to the existence of man, but also to the gratification of his innumerable desires, could be established.

A world which contains an almost infinite number of different objects which may contribute to the physical and mental well-being of man—a world furnished with many forces which he can use as instruments to accomplish his purposes—a world of infinite but harmonious complications of materials and forces, which, the better they are understood, the more they serve the highest purposes of intelligence—such a world cannot be separated from the idea of an intelligent Creator.

If we inquire concerning the possibility of the existence of living beings upon the earth, and more especially as to the possibility of man's existence and welfare here, with the idea of creation by chance on the one hand, and according to intelligent purpose on the other, I feel sure that we shall find the weight of facts to be greatly in favor of the latter.

For this purpose I will now consider the kinds and relative quantities of simple substances that enter into the composition of the earth.

About seventy elements are well known to the chemist. Of this number, carbon, hydrogen, oxygen and nitrogen are necessary in the composition of every living organism. In addition to these, in most animals, calcium, iron, sodium, phosphorus, sulphur, chlorine, and, perhaps, some other elements are necessary. In plants additional elements are found.

The human body contains sixteen elements, most of which exist in very small relative quantities. The soft parts of animals are composed almost exclusively of carbon, hydrogen, oxygen and nitrogen. In addition to these four elements, the earthy part of bones contains calcium and phosphorus, while shells are composed of calcium combined with carbon and oxygen. Plants are composed mostly of carbon, hydrogen and oxygen, with a small per cent of nitrogen, together with the ingredients of the ash.

Carbon, hydrogen, oxygen and nitrogen are preeminently the most important elements in the organic world. If any one of these elements had been left out of the earth, or if it had been bound up in certain compounds in the earth's crust, so that it could not be used by living beings, then life could not exist.

Considering them in detail: Oxygen constitutes more than one-fifth of the volume and nearly one-fourth the weight of the air, in which it is mixed, but not chemically combined, with nitrogen. It comprises eight-ninths of the weight of water, and from forty to fifty per cent of the solid crust of the earth. It is by far the most abundant element in the surface of the earth; and when we consider the fact that it combines with each of the seventy elements except one, we at once see the necessity for its great abundance. If there had been only enough to aid in forming the solid crust of the earth, then water and the free oxygen of the air would not exist, and life would be impossible.

If to the oxygen entering into the solid part of the earth there had been added the enormous quantity that is found in water, and no more, then the free oxygen of the air would be absent, and animal life could not exist, for all animals require free oxygen.

Hydrogen is another element that is necessary in the structure of every living thing. Its absence would mean the absence of life. It constitutes one-ninth of the weight of water, and it forms a part of certain other compounds that serve as food for plants. If it existed in only small quantity, as is the case with most elements, then it would all be locked up in compounds that compose the crust of the earth, so that there would be no free water, and life could not exist. If it had existed in much greater quantity than at present, it would have combined with all the free oxygen of the air, thus forming more water, and rendering animal life impossible.

Carbon is a third element that is necessary in every living being. It exists largely in carbonates, of which limestone is the chief; also, in coal, coal-oil, and "natural gas." One of its most important compounds is carbon dioxide, or carbonic acid, which exists in small quantity in the air, and from this gas plants obtain their supply of carbon.

If the quantity of carbon had been largely increased it would have combined with all the free oxygen of the air, converting it into carbon dioxide, thus rendering life impossible.

If the quantity had been much smaller than it is, then none would have been stored up in the form of coal for the use of man, and the supply in the atmosphere would long since have been exhausted by plants, thus rendering the earth lifeless.

Nitrogen is a fourth necessary element. Free nitrogen comprises about four-fifths of the volume of the air. It also helps to form certain compounds which exist in small quantities in the soil, and which are necessary food for plants. These compounds do not accumulate in large quantities in the soil, owing to the fact that they are very soluble and are consequently carried away by running water into the oceans. Besides, their presence in large quantities in the soil would be destructive to vegetation.

To keep up the necessary supply of nitrogen compounds in the soil, it is claimed that the free nitrogen of the air is, by the process of nitrification, being slowly converted into food for plants. The supply of free nitrogen is, however, so great that it will, no doubt, last for millions of years.

If the supply of this element had been very small, its compounds would long since have been washed into the oceans, thus rendering the growth of plants, and, consequently, animal life on the dry land, impossible.

Besides, if the quantity of nitrogen in the air were greatly decreased, thus leaving the atmosphere mostly oxygen, the destructive effect of conflagrations would be so great that cities could not exist, and the perils to property and to human life would be greatly multiplied.

If the quantity of nitrogen in the air were largely increased, then the oxygen of the air would be too much diluted to serve, in the best way, the purposes of breathing and combustion.

Phosphorus is a fifth element that is necessary to the organic world. It is found in greatest abundance in the seeds of plants and the bones of animals. It exists in small quantities, as phosphates, in all fertile soils. In the free state it is extremely poisonous, and its preponderance, as an element, in the structure of the earth would destroy all life, either directly, as a poison, or indirectly, by uniting with all the oxygen of the air.

The metal calcium is a necessary part of bones, and of the shells of animals. There is nothing, so far as we know, that could take the place of phosphate of calcium in the growth of bones, or of carbonate of calcium in shells and corals.

In addition to the above, iron, chlorine, sulphur, sodium and other elements are important and probably necessary in most plants and animals. If any one of the various metals of the alkalies had greatly preponderated in the composition of the earth, then its waters might have been alkaline and its surface an alkaline waste.

If chlorine were as abundant as oxygen, then the air would be laden with a deadly gas; or if bromine were as abundant, the streams on the surface of the earth would be liquid poison.

The various poisonous elements exist in such small quantities that they are all locked up in harmless and useful compounds. Many of the most useful compounds contain elements which, in the uncombined condition, would be destructive to life. Common salt, for example, is composed of two deadly elements.

Again, it was necessary in order to form stable continents that would remain permanently above the water of the oceans, that most of the minerals on the surface of the earth should be quite insoluble in water, otherwise the land would soon be carried in solution into the oceans. This object has been well accomplished by the great abundance of especially a few elements, such as silicon, aluminum, calcium, magnesium, iron, carbon, oxygen and others, which form harmless, insoluble compounds, and which are adapted, not only to give permanence to the continents, but also to form proper soils for the growth of plants.

I might continue indefinitely with regard to the kinds and relative quantities of elements in the earth as related to the existence and welfare of plants, animals and man. The number of relative quantities in which the seventy known elements might exist so as to render life impossible is inconceivably great, and when we add to this the probability that some one or more of the various elements necessary to life would, if left to chance to select, have been omitted, it amounts, I think, to a certainty that the creation of the earth cannot have taken place without the guidance of a Supreme Intelligence.

Let him who believes in the doctrine of chance in creation, calculate the probabilities for and against the proposition that matter, assuming it to exist, could be collected by chance, of such kinds and in such relative quantities that life of any kind would be possible, and then let him calculate the additional contingencies that are involved in the existence of man as an animal, and then of man as a being of lofty intelligence with many desires to gratify, and then let him add the difficulties involved in the existence of the sun at the proper temperature for millions of years, and of the earth's motions and relations to the sun, and I think that he will agree that the probabilities of creation by chance are few compared to those in favor of creation by an Intelligent Cause.

It will be noticed that I have been speaking of a very complex condition of things that must exist before living organisms, such as those with which we are acquainted, could originate and continue to live on the earth. These complex inanimate conditions could not have been evolved from each other. We know of no method by which any one of the seventy elements found in the structure of the earth can be produced from any other one.

The kinds of primary building materials and their relative quantities, as found in the earth, could not have been determined by the process of evolution. If the doctrine of evolution is true aside from a controlling Intelligence in the creation of the earth, then evolution must account for both the kinds and the quantities of the elements that exist in the earth—a thing which, I think, it is totally incapable of doing. I cannot too strongly emphasize my conviction that the extremely complex nature of physical conditions which must precede life, and which are well adapted to the existence of countless forms of living beings, and to the gratification of the innumerable desires of an intelligent, moral being, such as man, could not have been produced by chance nor by an evolution destitute of a controlling Intelligence. The argument in favor of design, I think, might safely rest on this branch of the evidence.

I will now consider the evidence of design as seen in the existence of man under present conditions. The doctrine of evolution is not opposed to the idea of design, unless evolution is atheistic—a thing which most evolutionists do not claim.

The same intelligence would be required to make a machine in a year that would be necessary to construct it in a day. The length of time occupied in creation cannot affect the answer to the question of design, one way or the other.

That the body of man is composed of matter there can be no dispute. That man would be just as noble if evolved from a gorilla as if created directly from inorganic matter, is also true.

The question as to how long it took to make man from inorganic matter—whether one minute or a hundred million years—would not seem to be a matter of great importance, and yet this question, I think, involves the essential difference between those who believe in creation by fiat and by evolution.

To lift a hundred pounds a thousand feet high in a vertical line requires the same amount and kind of force as to lift it a thousand feet high by rolling it up a long inclined plane.

If it would require intelligence to construct a full-grown living man in an hour from earth, water and air, it would require equal intelligence to make him in a million years. Unless time and intelligence are essentially the same, it is futile to attempt to substitute the former for the latter as a factor in creation.

If I were the only human being known to myself on the earth, and should go out some day and meet a man, and then begin to inquire and reason concerning his origin, what would be the logical conclusion to which I might come? Was he created by chance or by design?

For the purpose of answering this question I proceed to obtain all the possible facts. I examine him as a piece of mechanism, and find him exceedingly complex—composed of bones, muscles, nerves, cartilage, and various other tissues; I find that the muscles are more than five hundred in number, of many shapes and sizes, and so attached to the bones and other parts as to give infinite varieties of motion, and so arranged as to furnish strength and beauty.

I look more closely and see that each muscle is composed of fibers of microscopic size, each fiber of cells, and each cell of molecules formed by the union of many atoms of several elements.

I examine the frame-work of his body and find it composed of more than two hundred bones, differing much in size and shape, and joined together so as to permit the most varied motions, or firmly united in order to furnish the best protection to the most delicate organs. I find them to be of such shapes and sizes, and composed of such materials and occupying such relations to each other as to constitute a perfect mechanism for motion and protection.

I look with the microscope, and see that what before seemed to be solid bone is permeated by tubes and by small openings in all directions, which serve as highways for the passage of nourishment.

I find in him a complex alimentary canal, for the reception and digestion of food, connected with which are various complex glands which secrete from the blood peculiar juices that are capable of preparing the food to enter the blood.

I see all these organs working in perfect harmony, both by mechanical means and by the wonderful chemical processes of digestion, to prepare the food for the nourishment of the body.

I follow the digested food through certain organs which help to prepare it, into the blood. Then I see the heart, a double force-pump of wonderful structure, pump this life-giving blood through a most intricate system of channels into every part of the body, in order that every nerve, and fiber, and cell may renew its life. I see each separate tissue take from the blood, as if by instinct, just what it needs to renew itself, and nothing more, and transform it into new living tissue like itself. I see the blood gather and carry from all parts of the body the worn-out tissues that have been rendered useless by doing their work, and carry them to the lungs, kidneys, and skin, in which complicated organs the waste materials that would soon poison the body to death are removed from the blood and cast into the external world.

I see the lungs constantly at work pumping out deadly materials and pumping in oxygen to be used in liberating heat and other forms of energy for the use of the body.

I see the brain, an organ of most delicate and complex structure, connected with its intricate system of nerves, with their countless fibers, extending, like a system of telegraph wires, to every part of the body.

I see the various organs which compose his extremely complex body performing their numerous functions in perfect harmony. Each organ knows when and how to work, and how much to do. Each works for itself and for all the others. They constitute a well-organized, well-trained society of workers in which the division of labor is carried to perfection. They are so well trained that most of them perform their work without being under conscious control.

I look again and see within, seated upon the throne of the brain, a king of wondrous power and wisdom. I hear him say, "I see and know myself. I am king within this realm."

I see numerous messages of various kinds gliding noiselessly into him through the delicate nerve fibers, and I see him send back swift and unerring answers. Again I hear him say, "I rule also a realm outside of myself, and receive tribute from all things on earth and from afar."

I see him looking out through the windows and doors of his soul and holding communion with the external world. The morning breeze touches his brow and he smiles in recognition. The sense of taste adds enjoyment to the eating of his food. The ear reveals to him the world of sound and of harmony, and the eye that of form and color and of endless activities and beauties.

I see him with instruments of his own invention measure the distance to the sun, moon and planets, and hear him declare with mathematical precision the times of their coming and going in the heavens.

I see the streams of past experience flowing into his soul through the channel of memory, and the future brought near by the exercise of his imagination.

I see his heart glow with love for his fellow-men, his eye kindle with righteous indignation at the sight of outrage, and his conscience tremble at the thought of sin.

I see him going forth over the face of the earth and bringing all things into subjection to himself. The beasts of the field are conquered and made to serve him. By his hands forests are leveled, and the soil is made to yield her increase in a thousand useful fruits and grains. By his hands cities rise, railroads "annihilate space," telegraphs dispense with time, and ships bridge the oceans.

I see him leading in captivity at his chariot-wheels all the forces of nature, and sending forth the deadly lightning on messages of mercy and love.

I press to my ear an instrument which he has invented, and recognize his voice through a thousand miles. Through the phonograph I may hear the songs of the departed, or listen to the embalmed eloquence of orators who have been dead a thousand years.

I see this man reaching out in all directions, and with conscious intelligence laying hold on all kinds of matter and all the forces of nature, on infinite worlds and infinite time and infinite space, and binding them together into a harmonious universe.

I hear him declare that behind all that human eye has ever seen, or human ear has ever heard, there is one Power which has made all and which works in and through all. In a word, I see in man a body most intricate in the construction and arrangement of its parts, all delicately adjusted to each other so that they work in perfect harmony; self-regulating, capable of repairing themselves as rapidly as they are worn out, and of making known their need of rest; a body which, in structure and functions, is highly adapted to the wants of the soul that dwells within.

I see in him a soul of many powers, of unbounded desires, a seeker after infinite knowledge, a believer in the infinite and the eternal, with a hope that reaches within the veil, with aspirations as high as the heavens, with a faith that must ever outrun knowledge, and with a Christ-like love.

If we knew that this man was made from inorganic matter in a day, could there be any doubt of design by the Creator? If the power that made him prolonged the miracle through a million years, could this fact decrease the evidence of design? Is it possible that time alone may become a substitute for intelligence? If not, then the evidence of design is complete.

But the objector may claim that the creation of man in a day from inorganic matter would be a miracle, which implies the existence of a designing Intelligence, and that, on the other hand, the evolution of man in a million years requires the action of secondary agencies alone. To this I reply that the creation of man in a short time does not exclude the use of secondary agencies, nor does his creation in a long period exclude the action of the primary Cause.

We cannot know whether the creation of living beings was by means of secondary agencies or not, nor can we know the length of time occupied in the creation of any organism. Whether I do a given work without tools or with them cannot exclude my design in doing the work. Whether the Creator of man employed secondary agencies or not cannot affect the necessity of design.

There stands a magnificent temple composed of a million stones. If the architect built it in a day, it shows design. If he set in motion machinery which prepared and put in place one stone a year for a million years, the evidence of design would seem even more wonderful. And so it is true, I think, that the questions as to the length of time and as to secondary agencies in creation can have no bearing on the question of design.

I dwell on this for the reason that some people seem to imagine that by beginning with nothing, and adding little by little through the ages, we may obtain a given product from factors different from those that would be required if the work were done in a short time. Time alone cannot change the quality of the factors involved.

Design is not only seen in looking at man as an isolated individual, but also in his multitudinous relations. All things visible are made to contribute to his physical well-being or his intellectual growth, and the unseen powers of nature are his servants.

The world without him would, as a matter of ultimate design, seem to be incomplete. He fits into the place which, through the long ages, the Creator had been preparing for him. He came as the crowning act of creation to control and enjoy a world of conditions and objects which it had required ages to prepare.

Creation through its long geological history was a perpetual prophecy of something higher and better to come—a constant march upward toward mind as the goal. Each of the ten thousand things that could be of use to an intelligent being only, was a prophecy of the coming man; and when he came and converted these things, which had been so long in waiting, to his use, the prophecy was fulfilled.

Many things upon the earth are useless to all organisms below man. This is true of most elementary substances and minerals, and largely true of most plants and of many animals.

Man's appearance completed the divine purpose of bringing under the control of intelligence all created things. Design was fulfilled in the creation of a new designer. In him is fulfilled at once a multitude of the highest purposes, in that he possesses powers by which he can understand and bring into use all things, and make them contribute to the welfare of mind.

The existence of beauty in many forms, in every department of nature, and man's capacity to enjoy the beautiful, are marks of design indicating the wisdom and beneficence of the Creator.

The world might have been created by design, and everything made with a view to utility alone, but we find that creation goes far beyond this by furnishing the capacities and the means for enjoyment to a far greater extent than the existence of an intelligent being strictly demands. Man has been endowed with a great wealth of capacities which not only enable him to exist as an intelligent being, but also to enjoy to the fullest extent the countless beauties that fill the earth.

In whatever direction he turns his eyes, beauties of some kind greet him. The earth is clothed with beautiful green vegetation. Innumerable forms of plants bear flowers of infinite varieties of shapes and colors and sizes—flowers of delicate fragrance, and fruits delicious to the taste. The forests are composed of beautiful trees, among whose branches are birds of beautiful plumage.

The earth yields her many gems of beauty which vie with the rainbow in the delicacy of their tints. The sea abounds in beautiful corals, delicately-tinted shells of beautiful forms, and in objects innumerable that can delight the eye.

The heavens are flooded with clouds painted by the setting sun with crimson and purple and gold, and with a multitude of other rich and delicate colors, forming pictures so variable, gorgeous and sublime, that their imitation is beyond the dreams of the painter.

From the countless worlds that sparkle in the heavens at night, the eye, aided by the spectroscope and the telescope, gathers wondrous beauty, while the microscope reveals the beautiful workmanship of a world of objects that are almost infinitely small.

Beauty reigns everywhere—in the heavens above, on the earth, in the earth, and beneath the waters. In the world of beauty, and in the capacity of man to enjoy this beauty, is manifested a quality of workmanship that points to the existence of an intelligent Creator.

Design in the creation of man is also shown in his moral nature,—in his adaptations as a moral agent to his fellow-men, and in his ability to comprehend an ideal system of truth by which he can regulate his conduct. Without the moral nature, human life, even with all of man's intelligence would be a failure.

Again, design appears in the fact that man is a religious being, who seeks to know the Creator and to bring his thoughts and feelings and conduct into harmony with his purposes.

I am aware that there are those who regard man's religious nature as simply long-inherited superstition, which serves, perhaps, a very good temporary purpose in his present condition, but I look upon it as a fact which points to an intelligent Creator with whom man sustains spiritual relations.

The fact that law prevails everywhere in nature, and that man can understand and obey it, is evidence of intelligent purpose in creation. A lawless world would be a godless world. In such a world life could not exist.

The laws of nature are the methods by which nature does her work. The forces of nature do their work in certain definite and uniform ways, so that we can predict with certainty the results of a given set of physical conditions. In every law of nature is implied the idea that like causes produce like effects. and that unlike causes produce unlike effects. As the cause varies so must the effect vary.

Law prevails from atom to world. All true science is the embodiment of law. The natural sciences show nature's methods of doing her work. Man's existence depends upon the fact that the laws of nature are quite uniform. When he has learned them once his knowledge holds good for an indefinite time. They furnish a permanent basis for conduct and enable him to prophesy future results. Armed with the knowledge of law, man is prepared to live in the world and to make further progress.

The succession of events in nature is uniform only so far as the causes producing them are uniform. The causes of certain classes of events are uniform, and results in these cases may be repeated with mathematical exactness—as is the case with chemical actions which produce compounds that are absolutely alike.

In other cases the causes vary, thus producing unlike results, even where it might be supposed that they would be alike. This is seen in the animal and vegetable kingdoms, in which no two individuals of even the same species are alike. Parent and offspring always differ from each other.

In the organic world there is no such thing as uniformity in nature in the sense that nature repeats herself with absolute exactness. When we speak, therefore, of the laws of nature, we do not mean that the results of the operations of nature are necessarily uniform.

Events are chained together as cause and effect. When we see unlike effects we infer unlike causes, or if we know the causes to be unlike, we may predict that the effects will be unlike. Uniformity in the laws of nature means that like causes produce like effects—and this in turn means that matter and force are indestructible—that they are neither increased nor decreased. If nature had methods by which she could either increase or decrease her quantity of energy, then we could have no means of knowing what results would be produced, even approximately, for causes of events might constantly vary.

The fact that the events of nature succeed each other according to uniform principles is of the greatest importance to the welfare of man, and I regard this as evidence of the intelligence and wisdom of the unseen Power that controls all things.

I have considered man in relation to design, because I believe that in him as an isolated being, and also in his infinite relations of body and mind to the external world, it is most comprehensively manifested.

While this is true, it is none the less evident that every living organism shows by its structure, which adapts it to its peculiar mode of existence, the evidence of adaptation of means to ends, so that by considering these, the force of the argument is vastly multiplied. The earth is crowded with organic beings, mixed in endless ways, yet all are capable of obtaining food and they are nicely adapted to their environments.

That we do not understand why some of them were created is no evidence of the absence of design. It is only within recent times that man has learned much concerning nature, and the more he learns the more evident the fact of design becomes.

This is true especially in the relation of things to himself. Many things that were formerly regarded as worthless, have, in recent times, been made to minister to his welfare.

Many organisms that would seem to be useless serve to advance the general good of the organic world. Numerous humble forms, such as worms and insects, loosen the soil, thus adapting it the better for the growth of plants, while all organic beings by the decomposition of their bodies render the soil more fertile. In fact, the fertility of soils depends largely upon the decomposition of organic remains. Many organisms act as scavengers, thus helping to purify the earth and to render it a more fit dwelling-place for man.

The relations between minerals, plants and animals show a wise economy in the use of materials. Minerals serve as food for plants, and plants as food for animals; and when these organisms decay they give back to the air and the soil the materials of which they are composed, mostly in such inorganic forms as serve for the food of plants. In this way the same matter may enter in succession into countless organic beings.

Plants purify the air for animals by removing from it carbon dioxide, and animals exhale this gas for the use of plants. During the Carboniferous Age, the amount of carbon dioxide which plants removed from the air was enormous, as is shown by the great deposits of coal in many parts of the world, and in this way the air was the better adapted to the use of the higher animals, and coal was stored up in anticipation of the coming man.

Organic matter has also, by its deoxidizing power, played an important part in storing up in many places beds of iron ore for the use of man.

The wonderful adaptations of many flowers and insects to each other, as to the fertilization of the former, and as to the life of the individual insect and the propagation of its kind, are evidence of design. For example, there are certain species of plants that are dependent for their fertilization on certain species of moths which live in the flowers, and the moths, in turn, are dependent on the plants. They deposit their eggs in the ovaries of the flowers where the young are hatched and nourished. The moths in some cases carry the pollen and place it on the stigmas of the flowers, as if guided by intelligence. Their action is a most marvelous case of instinct.

We might consider the subject of adaptations indefinitely. The world is full of them. Every organism, viewed with regard to its own existence, is an example, for it has the capacity to obtain its food and to contend with other organisms in the struggle for existence. Every organism has also the capacity to adapt itself, to a certain extent, to varying conditions, and many of them exhibit it in remarkable ways, as is shown by the various methods by which they adapt themselves to different periods of their development and to the different seasons of the year.

Taking the great mass of facts bearing on the question of design, while there are some things that we do not understand, yet there is so much that is plain—so infinite are the adaptations in nature, many of which, especially the adaptations of the inorganic to the organic world, cannot be explained by the theory of evolution,—that it would seem to leave but little room for doubt.

Like other questions with which we have to deal, it must be decided by the weight of evidence, and one is not called upon, before making a decision, to answer every conceivable objection. If this were required in a court of justice, few cases could ever be decided.

I will now consider certain objections that have been offered against the theory of design in nature. One very commonly urged is, that design will not account for rudimentary organs. It is asked, for example, why is it that unborn calves have teeth in the upper jaw which never cut through the gums? I would answer this question by asking and answering this larger question, namely, why is it that the calf is here at all?

There are hundreds of parts in a calf which are not rudimentary and which are marvelously adjusted to each other in structure and function. In deciding the case as a juror, as to whether or not the calf is an indication of design, shall the fact that it has several rudimentary teeth in the upper jaw during the early period of its existence outweigh the hundreds of facts of perfect structure and function and adaptation on the other side? Is it not safe to say that the hundreds of facts which indicate design, ought to determine my decision in the face of the one fact in which I may not be able to see any design? If not, then the rules of evidence must be reversed.

Again, we are told that man has a vermiform appendix, which seems to be useless, and into which hard substances sometimes find their way and produce disease and death. Therefore, God did not make the vermiform appendix nor (by implication) did he make any other part of man. And so it happens again, that the thousand well known facts in favor of design are made to weigh less than one fact which might seem to be opposed to it.

If the thousand facts can be satisfactorily accounted for without assuming design, then the theory suggested by the one fact may stand, otherwise it must fall.

Rudimentary organs constitute one of the principal strongholds of the evolutionists against the theory of design. It is evident, however, that if an organ should become rudimentary by disuse, this fact is not opposed to design. On the other hand, it would seem to be in harmony with design, that, as a useful organ becomes useless, if this ever happens, it would gradually disappear. If this were true, however, it is no evidence that organs can arise *de novo* and be brought to perfection by the process of evolution.

Again, we are told that there are defects in nature which show the absence of design. The question as to whether anything in nature should be regarded as an imperfection or not, can arise only in regard to the relation of living beings to their environments. So far as the relations of the different kinds of inorganic matter to each other are concerned they are equally perfect, whatever they may be.

The world is adapted in infinite ways to the existence of countless forms of living beings. The fact that each organism is so well adapted to its environment shows the lack of imperfection. The great length of time through which many forms have existed with little change in their structure—the fact that animals and plants, similar to those now living, have lived through the long geological ages, shows the completeness of the adaptations of the earth to organic beings.

Conditions which may be perfect for some organisms may be imperfect for others. If the million species of living organisms could speak with regard to the conditions most favorable to their existence, there would be a great multitude of different answers. Some would declare the land, others the water, and others still the air, to be the only perfect place in which to live; and there would be an endless number of voices from every nook and corner and crevice of the earth—from under rocks and logs, from holes in the ground, from inside and outside of every species of vegetation, from caves and mountain tops, from the hottest desert and from the temperate and the frigid zones, from deepest ocean and from shallowest pool—each creature, from the smallest microscopic form to the huge whale a hundred feet in length, would declare that its mode of life and its place of existence are the most desirable. According to these answers there would be a countless number of standards of perfection.

We, however, are accustomed to judge of the perfection of nature from its relations to man. The infinite adaptations of nature to all organisms below man are presumptive evidence that nature is quite perfectly adapted to him.

The fact that he has been here for thousands of years, and that he has made, and is still making, progress—the fact that whatever work he desires to undertake, he finds the means for its accomplishment at hand, whether it is to lay an Atlantic cable, cut a Mount Cenis tunnel, suspend a Brooklyn bridge, blow up Hell-Gate, talk around the world, or bring distant worlds into view, the materials and forces for the accomplishment of these purposes have been prepared in advance. The Creator has anticipated all the wants of man's highest intelligence. The more fully his intelligence is developed the more perfect nature appears in her adaptations to him, and, judging from the past, we may well believe that in the future, as his knowledge becomes more perfect, the perfections of nature will be more and more revealed, until what now seem to be imperfections will wholly disappear.

The savage, judging from his low standpoint of knowledge, would probably decide that most things in the world are useless, many of which the civilized man has found to be of the greatest use.

Our adverse judgments of to-day against nature may be reversed by future generations. Because we do not understand the importance of certain things now, it is no evidence that they are useless. If we had lived in the Carboniferous Age, when the coal was being formed, we might have thought its formation a useless waste of vegetation; or if we had lived in the Silurian Age, we would have thought that the earth as a place for man was a failure, and that it would always remain a failure.

It has required whole geological ages to reveal some of the purposes of the Creator, and, doubtless, the process of revelation, made possible by the progress of man, will continue for ages to come.

The wisdom and purposes of the Creator in the things created are unfolded as rapidly as man is prepared to receive them. It is, doubtless, not the lack of perfection in the things created, but man's lack of ability, that causes the seeming discord.

With regard to man, it might seem that it would have been better for him if the world had been made so that it would require less effort on his part, and yet we do not know that this is true. The countless difficulties with which he must contend develop his physical and intellectual powers, and enable him to rise higher.

If the physical blessings of life were all given to him without any effort on his part, there would be little incentive to progress. We know that man is made happiest, wisest and best by engaging in necessary employments. The fact that blessings are made to depend on individual effort is one of the wisest provisions in nature.

Intelligence and virtue are the necessary attainments of him who would best adapt himself to the affairs of this world, and the greater his attainments in these things, the more perfect are the blessings that are meted out to him. And so it happens that in and around us is an ever present power "that makes for righteousness." Things are so ordered and arranged that they help draw man upward by holding out incentives to effort. The perpetual struggle for existence results not only in the preservation and propagation of the strongest, but also, on the average, of the wisest and best, so that humanity moves upward.

Thus it happens that the great end attained, and, as I believe, design fulfilled, is the development of man and the formation of human character. The greatest design of all this vast machinery of earth is to serve in the widest sense the well-being of man—a design that is consistent with the highest conceptions that we can form of the Creator.

XVIII.

EVIL AND ALTRUISM IN NATURE.

The existence of evil in the world is a problem that has taxed the greatest minds in all ages. What is evil? Can we reconcile its existence with the purposes of an all-wise, all-powerful and beneficent Creator?

We do not apply the word evil to the inorganic world. Whatever may be the conditions and relations of inorganic materials to each other, we cannot think of them as being the subjects of evil. Nor can we apply the term to plants, although their environment may be such as to dwarf or to kill them. Nor does it seem appropriate to apply the word evil to the lower forms of animal life, such as sponges, polyps, etc., which have no nervous system and which are capable of only the dullest sort of feeling.

The word is applicable in the case of all organisms which are capable of experiencing pain, especially in acute forms. By evil I think we commonly mean suffering, and we speak of an environment as being evil when it produces suffering. Is the mission of suffering wise and beneficent? Could not animals and man have been made without the capacity to suffer? is sometimes asked.

Organic beings may be graded according to their capacity to enjoy and to suffer. These two capacities increase and decrease together. The more elevated the animal in the scale of existence—the more highly organized its nervous system—the greater are its capacities for pleasure and pain.

Enjoyment arises largely from the adaptation of the organism to its environment, and suffering from a lack of such adaptation. Suffering comes, therefore, as an incentive to the animal to adapt itself to its environment. Without hunger the animal would starve without knowing it; without thirst it would perish even in the presence of water; without pain from cold it would freeze; without suffering from heat it would be destroyed by fire; and without pain from pressure the body would be crushed, with no warning. Pain from disease and injury is a warning that the body needs rest and change of environment.

Suffering in our present condition is absolutely necessary for our protection and preservation, and to this extent it must be pronounced good, and not evil, in a moral sense.

Suffering also arises out of man's ignorance of events that are to occur. Accidents are not foreseen, and injury and death follow. It should be remembered, however, that the laws of nature are invariable, and that in the true sense there are no accidents, but only results produced, according to fixed laws, and that such laws are necessary for man's welfare. Gravity by its action produces much suffering and many deaths, and yet it is the force which holds the stars and planets in their orbits, and it produces suffering only when sentient beings fail to recognize the universal law of its action. Would we banish this force and thus wreck the universe because of the suffering it produces? or would it not be better that we heed its existence and strive to regulate our conduct accordingly? Fixed laws of nature are necessary for man's preservation. They work injury only when they are violated, and the consequent suffering is necessary to induce man to acquaint himself with them. If it were not for this inducement he would make little effort. The fact that the laws of nature are uniform enables man to determine future results, and thereby to regulate his conduct. If they changed from day to day he would never be able to tell in advance what would be the result of any course of conduct—his labors would be fruitless, and he would speedily perish. If, therefore, fixed laws are necessary for man's existence, and if the failure to comply with these laws produces suffering, it cannot justly be claimed that the Author of Nature's laws acted unwisely in establishing them, nor that he was destitute of love for those who suffer. Suffering is incidental to the operation of laws that are necessary for man's existence and well-being. Besides, it is the schoolmaster who compels him to search out and obey these necessary laws.

The total amount of suffering is small compared to the amount of enjoyment among sentient creatures. Imagination, I believe, greatly exaggerates the real sufferings of humanity. Those who are most sensitive to pain interpret the sufferings of others through their own natures as standards, thus greatly exaggerating the facts. The man who has always been rich misinterprets the sufferings from poverty of the man who has always been poor, and if the rich man is suddenly reduced to poverty, his suffering is frequently so keen that he is led to commit suicide. The gratification of desires becomes painful when carried to excess, and this pain is necessary to save the organism from complete exhaustion and death.

If any finite creature—man, for example—were incapable of suffering, and if all its acts resulted in pleasure only, then its powers would speedily become exhausted. Suffering, therefore, seems to be the most effectual check to conduct that would lead to destruction, and is a consequent means of salvation. The office of pain is not to destroy, but to save. Its introduction, therefore, into the plan of nature ought not to be regarded as due to moral obliquity on the part of the Creator; it is but a part of the universal plan which works general good.

But it is urged that the ignorant suffer. This seems to be a necessity due to the establishment of general laws in nature, and such laws, we have seen, are necessary for the existence of man. Besides, if the ignorant were exempt from the penalties of nature's laws, while those having knowledge were punished for their violation, this would be the highest possible premium on ignorance, and the greatest possible discouragement to the acquisition of knowledge. If such were the case, man would feel it to be his interest to remain in ignorance—the wheels of progress would be blocked, and man would remain the most ignorant and degraded savage.

According to the present arrangement of things the Creator has placed the highest possible premium on knowledge, thus introducing a motive that is capable of leading man to the fullest development of all his powers.

Again, it is objected that the innocent suffer. Children, for example, inherit diseases and tendencies towards diseases from their parents. This, of necessity, arises from the fixed laws of inheritance, and we have reason to believe that these laws are beneficent. That the offspring shall closely resemble in structure, and partake of the qualities of the parents, is an organic law of the highest importance to man in enabling him to foresee and produce definite results in the propagation of plants and animals.

The law of inheritance in the human species is certainly as important as it is among animals. Much of the suffering and imperfection due to inheritance among men may be avoided by the application of possible knowledge to the subject. When man learns to give even as much attention to the propagation of his own species as to that of the domestic animals, human suffering will be greatly decreased.

It is not necessary that the laws of inheritance be changed, but it is of primary importance for the human race to increase its knowledge of these laws, and to regulate its conduct accordingly. The time will come, I have no doubt, when this subject will, of necessity, receive the attention which its importance demands. Man himself, and not the Creator, is morally responsible for the propagation of known hereditary diseases, and for the consequent entailment of suffering.

A large proportion of human suffering is produced by man's willful transgression of the law. Is this fact consistent with the existence of an omnipotent, beneficent Creator?

It has been stated that the Creator has established laws which are undoubtedly for the well-being of man. He has created man, who is the highest known work of his hands. Man is superior to all other creatures, not only physically, but especially by reason of his mental and moral powers.

The fact that he is a moral agent implies that he knows the difference between right and wrong, that he is free to choose his course of conduct, and that he has a conscience which approves or disapproves his motives.

If he were capable of only one course of conduct, he would not be a moral agent, he would have no conscience—he would be simply a machine. Can it be doubted that he is a far nobler being constituted as he is, with the power of doing both right and wrong, than he would be if he were not a moral agent? Sin is the transgression of law. The power to obey implies, in a free agent, the power to disobey. Man's sole duty is to acquaint himself with the laws of the Creator and to obey them.

But it may be objected that man would have been more perfect and elevated if he had been created with less disposition to transgress.

In answer to this it may be said that all of man's powers are intended for good, and they serve good purposes when properly used, and that it is possible for him to govern them.

The appetites and passions which stand on the lower plane of human nature, when made the servants of reason and conscience,serve noble and necessary purposes in human life. If, however, they become masters, and the higher powers become their servants, then human nature is debased.

It is man's duty not to eradicate the appetites and passions, but to subdue and govern them. There can be nothing irretrievably bad in the works of God. Our own moral natures tell us that there can be no wrong which shall not be righted. It is not conceivable that the moral qualities of the Creator are of a lower grade than those of man whom he has created. "To them that love God, all things work together for good."

It has been claimed that the struggle for existence has determined the course of organic evolution, and that this principle is one of selfishness, which causes much suffering. The weak are destroyed in countless numbers by the strong. Throughout the kingdom of living things, organisms not only contend with each other, but they destroy and devour each other as food. A large part of the animal kingdom lives exclusively by preying upon the bodies of other animals.

Judging from this, it might be concluded that "might makes right," or, rather, that there is no principle of right in nature.

As to suffering, it may be said that most animals are not capable of suffering to any great extent. The lowest forms have no nervous system, and a great multitude of others have only a slightly developed nervous system, so that sensation is dull, and acute pain is impossible.

It seems very probable that consciousness of pain is confined to the higher forms of life, and only the highest vertebrates, such as birds and mammals, have great capacity for suffering.

As already stated, the capacities for pleasure and pain increase and decrease together. This being true, man, by the greatness of his nature, far excels all animals in happiness and misery.

If the life of the individual organism be considered as a whole, on the average the amount of pleasure greatly exceeds the pain. Throughout the animal kingdom the duration of suffering is short compared to the length of life, and the amount of pain is small compared to the pleasures of existence. This of itself would be sufficient justification for the creation of such beings.

But I have already shown that suffering is beneficent, in that it is necessary for the preservation of the life of the animal.

Many organisms perish for lack of food. But little pain results from the deficient nourishment of the body, even in man. The body gradually wastes by the oxidation of its tissues until a painless death results. Perishing of cold is but a brief and painless process. As a rule, the duration of the pains of fatal disease is short compared to the length of life.

When death results from destruction by enemies,—as the killing of the bird by the hawk, or the antelope by the tiger—it is believed to be quite painless, owing to a partial paralysis of the nervous system.

If, therefore, in the great and ceaseless struggle for existence, many speedily, and all, finally perish, yet it is true, I believe, that when we look at the individual animal, or at the animal kingdom as a whole, we find that the amount of pain is small compared to the great amount of enjoyment.

As to man, the actual pains of life and the fear of pain are great incentives to the acquisition of knowledge and to right conduct. It is, perhaps, a necessary schoolmaster to man in his present condition. Remove from his mind the fear of suffering for disobedience of law, and the results would be most disastrous.

Pain chastens the spirit, and it heightens pleasure by way of contrast. The present enjoyments of life are heightened by the memory of past hardships and sufferings.

Looking at suffering, therefore, in its various aspects, I think that we may rightly conclude that it serves beneficent purposes, and that therefore its existence is consistent with the idea of a Beneficent Creator.

Beyond and above the selfish struggle for existence, which, it has been commonly claimed by evolutionists, is almost the only means of progress, is the principle of Altruism—a regard for the welfare of others—which is inseparably woven into the warp and woof of Nature. This great fact has been dwelt on with emphasis by Shaler, Drummond, and other authors. If we would find fault with Nature because she inflicts pain through the selfish struggle for existence, we must allow that she redeems herself and promises to yet more and more redeem herself by the unselfish struggle for the welfare of others which she has instituted.

The process of reproduction throughout the organic world, by which the parent gives part of its own substance for the propagation of its kind, is a prophecy of the great spiritual gifts that follow.

The preservation of the life of the young, in a large part of the animal kingdom, and especially in its highest part, is due to the care and affection of the parents—especially of the mother.

Many of the animals of the lower sub-kingdoms deposit their eggs in secure places, and in localities where food will be convenient, while many others protect them by cocoons or webs of silk. Others exercise great patience and care in feeding their larvæ.

Among bees the great care and anxiety for the interests of the queen seem to indicate an exceptional wealth of affection.

Some of the lower vertebrates, especially those which lay but few eggs, deposit them in places of security, but it is the rare exception that they care for their young.

It is not till we reach birds and mammals that prolonged care and great affection for the young are manifested. These animals are so helpless when born that they would speedily perish if it were not for the care of the mother.

Among these highest forms, therefore, Altruism in action, if not in motive, is a necessity for the preservation of the species. Helplessness and help must go hand in hand. If Nature ordains that the infant shall perish if left to itself, she with equal certainty ordains that help shall be furnished.

With what unceasing labor does the mother bird gather food for her nestling young, and with what affection does she protect them with her own body from rain and storm! Although by nature extremely timid, yet she will frequently imperil her life in their defense.

Our domestic animals often exhibit a strength of attachment to their offspring that might well be emulated by man.

Who can say that the affection of the cow for her calf is not purely unselfish and Divine? Her grief when she is forcibly separated from her offspring is of the intensest kind, and she can only be pacified by the restoration of her young. She will stand in its defense against the beasts of prey. By her caresses she shows a tenderness of feeling that seems to be truly human. In this unselfish affection of the lower animals we see something of the great power which, working in man, can alone redeem the world from selfishness and glorify man.

Altruism alone can found a true home and give permanence to a state. Homes are built in hearts, and hearts alone can give security to government. The mother's love is the strongest bond in human society.

Selfishness has seemed to hold almost universal sway in the animal kingdom, and it is still a great motive in man. But its right to rule over man is now disputed with new vigor. Altruism and Hedonism, Unselfishness and Selfishness, are the two gods which face each other on the battle-field for dominion over the human heart.

The contest has been long and painful, but we have every assurance that the redeeming power embodied in the Son of man will triumph.

Love will ever be the golden rule—the supreme organic law of the Universe.

XIX.

AGNOSTICISM.

THE human mind believes and affirms that space is infinite. Of this we feel absolutely certain and nothing can convince us to the contrary.

If, in imagination, we travel to the most distant star, we feel certain that space extends beyond, and if we could repeat this process an endless number of times in all directions, we feel certain that we could nowhere find a limit to space. Can it be said that we have no true conception of the quality of infinite space? The mind feels certain that all space is alike. This unalterable belief concerning infinite space is justly founded on our knowledge of a limited portion of space. It can be truthfully said that the human mind cannot form an image of infinite space or of anything that is infinite. It may be said that the laws of pure logic forbid that we should declare space to be infinite. But the experiences of the human mind are greater than the laws of logic. The legitimate beliefs of the mind are not limited to things acquired by the logical process.

Mr. Spencer says: "But of Space and Time we cannot assert either limitation or the absence of limitation. We find ourselves totally unable to form any mental image of unbounded space; and yet totally unable to imagine bounds beyond which there is no space." *

The mind feels conscious that it might take any

* Synthetic Philosophy, p. 48.

finite unit of volume and multiply it by any finite number, and that it would not occupy all space. Our inability to set bounds to space is, I think, regarded by the mind as conclusive that space is infinite.

For a similar reason we regard time as infinite. The belief that space and time are infinite is so firmly fixed that we rightly regard it as positive knowledge.

Again, Mr. Spencer says: "It results, therefore, that Space and Time are wholly incomprehensible. The immediate knowledge which we seem to have of them proves, when examined, to be total ignorance. While our belief in their objective reality is insurmountable, we are unable to give any rational account of it." *

I think it will occur to the common sense of mankind that an "insurmountable belief" is quite good enough to be accepted as a part of any philosophy. Why waste words in talking about time and space, doubting their existence and declaring total ignorance as to their nature, if we have an "insurmountable belief" that they exist, that we know their qualities, and that they are infinite? Why use the words time and space if they are simply expressions denoting total ignorance?

The fact is, that the attempt to subject all phenomena and all faculties and all human experiences to logical processes is a failure, for the reason that logic cannot comprehend all of them. The logical faculty has no rightful claim to absolute supremacy over all other powers of the mind. When we are told that we have an "insurmountable belief" which we dare not assert to be true according to the laws of logic, then the common sense of mankind will say that logic must stand aside.

A universal "insurmountable belief" is all that

* Synthetic Philosophy, p. 50.

man needs for any legitimate intellectual purpose. Logic does not make the facts with which she deals. There are certain primary facts that must be accepted as true before logic can have any material with which to work.

Many of our "insurmountable beliefs" are formed without reference to any logical process, and they are in no wise dependent on reason for their existence; nor can we form any mental picture as to the exact methods by which these beliefs are produced.

If we are required to form a "mental image" of infinite space before we can count our belief as knowledge, then it must be admitted that we fail, and that our belief is a phantom. It is also evident that if we can accept nothing but mental images as knowledge, then we have no claim to any valid knowledge whatever; for our knowledge consists of mental conditions, the formation of which we are totally unable to form a "mental image" of.

It is not for reason to say that because she cannot understand and explain the methods by which the other faculties are enabled to do their work, therefore their conclusions are illegitimate and to be banished from the realm of knowledge.

Notwithstanding Mr. Spencer's statement that we are in "total ignorance" as to the objectivity of time and space, yet practically he is obliged to proceed as if his "total ignorance" and "insurmountable belief" were valid knowledge. Practically we must act from data that cannot be compassed by logic and reason.

Time and space are objective realities, and the belief that they are infinite is as firmly fixed as is the belief that they are objective. We do not need to comprehend the infinite before we may legitimately declare its existence and its quality.

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the death-blow to all worship, for what human being would erect an altar to the Unknowable, and how could he engage in any act of worship whatever? What could he think or say or do more than to repeat this short creed expressing his hopeless ignorance? But Mr. Spencer tells us that this creed is the reconciliation of religion and science—that by it the essentials of both are saved to humanity.

I need not say that a more universal slaughter of religions could not have been devised. It reminds me of Nast's cartoon showing the reconciliation of the lion and the lamb in fulfillment of the Scripture which says that "the lion and the lamb shall lie down together." The lion was represented in the picture, while the statement was appended that the lamb was inside of the lion. This creed may do for science, but it swallows religion. If reconciliation means death, then it would be best not to be reconciled.

His method of reconciliation is stated as follows: "This method is to compare all opinions of the same genus; to set aside as more or less discrediting one another those various special and concrete elements in which such opinions disagree; to observe what remains after the discordant constituents have been eliminated; and to find for this remaining constituent that abstract expression which holds true throughout its divergent modifications."

Religion being asked her creed, says, "I believe that there is an inscrutable Power." Science says the same. How can we know that the inscrutable Power is identical in the two cases? I submit that this is no reconciliation, but only an expression of inability to reconcile—an expression of total ignorance.

The assumption underlying it all is that there is an irreconcilable conflict between Religion and Science, and that by pushing the two off into a region of absolute darkness, of which the human mind can know nothing whatever, they will discuss their differences, shake hands and agree to dwell in peace.

In deriving this creed, Mr. Spencer claims to have eliminated from Science and Religion everything that they could not hold in common. It is evident, I think, that his eliminations were too numerous. Those things only ought to have been eliminated that were clearly in conflict. Those that were not in conflict needed no reconciliation. Science and Religion occupy different fields and embody different facts, and, for the most part, they need no reconciliation. So far as the most of the facts embraced in them are concerned, we might not be able to see either harmony or discord, and yet both sets of facts might be true. Chemistry and astronomy are two well-defined sciences, and yet the two classes of facts with which they deal are so different, and there is such little relation seemingly between the two, that if we affirm harmony, it might be very difficult to determine in what the harmony consists.

It is evident that the unifying of all natural phenomena must be done by tracing all to a common cause, but when the sciences do this, as I think they have fairly done, must it be by ignoring the special facts that compose each science? So if religion traces herself to the same origin, must she, of necessity, ignore all of the special facts that have been sacred to man through the ages?

If, for example, the facts of science may be harmonized without referring them to an intelligent, final Cause, is it necessary that religion should sacrifice her belief that the Ultimate Cause is intelligent? Intelligence in the Creator is not inconsistent with the facts of science, although science might deem it expedient to stop short of affirming this attribute. It may be that the attribute exists, although she fails to affirm its existence. Religion may demand attributes in the Creator over and above those that answer the purposes of science, and still both may be right.

Science is generally satisfied with secondary causes, while religion always seeks the primary Cause. If religion believes in supernatural acts—such as miracles and revelations—we do not know that they are in conflict with the facts of science.

The possibility of miracles is simply a question of fact. If the evidence shows that miracles have been performed, it is not for science to deny the possibility of miracles on any ground whatever.

We do not know that miracles are opposed to the processes of nature, or that they are a break in the continuity of the processes of the universe. They may be a part of the plan of the Creator.

The question as to whether miracles have been performed or not depends for its solution on the value of human testimony, and not on *a priori* affirmation as to the continuity of natural processes. The scientific method of determining whether miracles have been performed or not, is not to declare, without investigation, that miracles are impossible, but to examine the evidence, *pro* and *con*, in each particular case, and to decide accordingly. Our knowledge of the universe is not so complete as to enable us to declare that miracles are impossible. Even if we believe in the Unknown and Unknowable Power, I do not know on what ground we might affirm that it is impossible for that Power to perform a miracle, or to reveal truth to the human mind. Science becomes dogmatic when she affirms the impossibility of a miracle or of a revelation.

It may be possible to believe in the continuity of natural processes and also to believe in miracles. I do not see that the raising of the dead by supernatural power would be any more of a break in the continuity of the action of natural forces than would be the lifting of a stone by the hand of man. In each case a superior force is introduced to overcome physical forces and to produce a result that would not otherwise have been produced.

When we lift a stone there is no break in the continuity of the action of gravity, and in raising the dead there would be no break in the action of the forces of nature, but, in spite of the action of these forces, a new result would be produced by the action of the superior force.

Miracles, special providences, and revelations, may, for ought we know, have a place in the universe with as much consistency with the laws of nature as has the mind of man in the affairs of the earth. Nor is it necessary to regard these things as "patch-work," or "tinkering" with the laws of nature, or "afterthought," but they may be a part of the infinite plan and consistent with all else.

These things are consistent with the indestructibility of matter, with the correlation and conservation of energy, and with the uniformity of law, and the continuity of natural processes.

The action of mind destroys neither matter nor force, nor the laws of nature, nor continuity of action of the forces of nature; and yet, mind, by its control of matter and force, produces an endless number of diversified results.

Agnosticism, by denying our right to affirm the existence of an Intelligent Creator, sweeps away at one stroke all that flows from a belief in the existence of such a Power. Revelations, miracles and special providences—all are impossible. All human testimony that has been given to prove the truth of these things is not answered, but is simply ignored, because it is regarded as testimony advanced to prove that the impossible has occurred.

That man can comprehend the infinite no one would affirm. But this does not preclude the belief that the Creator might reveal truth with regard to himself to a finite mind.

Mr. Spencer, in speaking of the Ultimate Cause, says: "And 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?" *

Mr. Spencer here shows a due spirit of reverence for his Unknown and Unknowable God, and he advises us not to degrade him by assigning to him any attributes. Are we to refrain because it will degrade the Unknowable? or because it will degrade us? I presume he means the latter.

Our highest duty is, according to his creed, to worship "The Unknowable." But to worship such a power would be folly, for we cannot know how to worship the Unknowable. And yet we are told that this worship is elevating, compared to the worship of a God to whom we attribute omnipotence, omniscience, justice, mercy and love,—that the worship of a God with these attributes is degrading to human nature. I think the facts of history show that the belief in a God with these attributes has done more to elevate the human race than all other beliefs.

Mr. Spencer professes to have great respect for the wide-spread and long-standing beliefs of mankind, and for this reason he gives religion a place in his philosophy.

* Synthetic Philosophy, First Principles, p. 109.

He, however, ignores this great fact in history, namely, that the human race has universally and persistently attributed intelligence to their objects of worship. It is just as natural for man to attribute intelligence to his god, of whatever kind, as it is to worship at all. Why eliminate this universal testimony of humanity in formulating a creed? The belief in a God with attributes is not opposed to science. Science may not affirm the existence of such a God, but it cannot deny it, and, therefore, there can be no conflict.

By the Agnostic creed man's duty is as follows: "By continually seeking to know and being continually thrown back with a deepened conviction of the impossibility of knowing, we may keep alive the consciousness that it is alike our highest wisdom and our highest duty to regard that through which all things exist as The Unknowable."*

The highest wisdom and the highest duty of our lives is to continually strive to know "The Unknowable," with the ever-growing consciousness that the task assigned is utterly impossible to be accomplished. Why this hopeless task should be regarded as the highest wisdom and duty of humanity I feel sure that the great mass of the race will never be able to comprehend.

Mr. Spencer admits that "An immense majority will refuse, with more or less of indignation, a belief seeming to them so shadowy and indefinite."†

Also that "Very likely there will ever remain a need to give shape to that indefinite sense of an Ultimate Existence which forms the basis of our intelligence. We shall always be under the necessity of contemplating it as *some* mode of being; that is, of representing it to ourselves in *some* form of thought,

* Synthetic Philosophy, First Principles, p. 113. † Ibid.

however vague. And we shall not err in doing this so long as we treat every notion we thus frame as merely a symbol, utterly without resemblance to that for which it stands."*

From this it would seem that he thinks that the constitution of the human mind is such that it must represent the Ultimate Existence as being like things that are known, and that this is very good mental exercise, and innocent if we only remember that there can be no truth in what we think. But how can he know that our symbol is "utterly without resemblance to that for which it stands?"

The most that Agnosticism would be justified in affirming is not lack of resemblance, but that we can not know that there is any resemblance between our symbols and the Ultimate Existence.

But Mr. Spencer admits that his creed is adapted only to man in a highly developed condition, and that the religions of the world have served and are still serving a good purpose.

He says that the imperfections of religion "have been imperfections only as measured by an absolute standard, and not as measured by a relative one. Speaking generally, the religion current in each age and among each people has been as near an approximation to the truth as it was then and there possible for men to receive."

I think that this last statement is incorrect. According to this the various savage tribes scattered over the earth at present have religions which embody as much truth as they are capable of receiving. The fact is, however, that the lowest tribes of men are sufficiently developed to receive the Christian religion; and there is nothing more remarkable in history than the changes wrought by Christianity among such people.

* Synthetic Philosophy, First Principles, p. 113.

Again he says: "Even now, for the great mass of men, unable through lack of culture to trace out with due clearness those good and bad consequences which conduct brings round through the established order of the Unknowable, it is needful that there should be vividly depicted future torments and future joys—pains and pleasures of a definite kind, produced in a manner direct and simple enough to be clearly imagined."*

Thus he settles the long-mooted question as to whether a lie is ever justifiable or not. The preacher, if he finds it necessary to move his hearers, is, in duty, bound to threaten them with the tortures of fire and brimstone, for the reason that the end justifies the means, and at the same time he knows that what he threatens is utterly false. Thus, systematic lying may be the best possible practical teaching and the highest morality.

I do not see why Mr. Spencer might not consistently and conscientiously become a preacher under any existing religious creed whatever. If, as he contends, each people has a religion as near an approximation to the truth as it can receive, and if each religion is practically best for the people professing it, then it would be the duty of every missionary to forsake Christianity, and to proclaim the religion of the heathen to whom he is sent.

His claim is that all religions are practically good, but that their fundamental teachings are utterly false. These conclusions are the logical results of Agnosticism. The Agnostic creed, he says, is the only true one, but we must abandon this absolutely true creed until, by the teaching of false creeds, we have elevated humanity to a position where it can accept the one true belief in The Unknowable.

* Synthetic Philosophy, First Principles, p. 117.

It would seem that there must be something fundamentally wrong in the structure of the universe when it is necessary to systematically teach falsehoods in the form of religion, for ages, in order to elevate man morally, religiously and intellectually. If this is true for Religion, it is strange that the teaching of untruth has not been best in Science.

Mr. Spencer says again: "Indeed, were it not that throughout the progress of the race, men's experiences of the effects of conduct have been slowly generalized into principles—were it not that these principles have been from generation to generation insisted on by parents, upheld by public opinion, sanctified by religion, and enforced by threats of eternal damnation for disobedience—were it not that under these potent influences habits have been modified, and the feelings proper to them made innate—were it not, in short, that we have been rendered in a considerable degree, organically moral; it is certain that disastrous results would ensue from the removal of those strong and distinct motives which the current belief supplies. Even as it is, those who relinquish the faith in which they have been brought up, for this most abstract faith in which Science and Religion unite, may not uncommonly fail to act up to their convictions."*

Here we have again the unqualified admission that the creed of Agnosticism is not adapted to the human race in its present condition. The most that can be claimed for it is that it might be adapted to an imaginary world of philosophers. For practical, efficient work in elevating humanity he admits that we must fall back on the old false creeds. He also admits that a general acceptance of Agnosticism would be very destructive to morality.

What is truth? and why should truth be demoraliz-

* Synthetic Philosophy, First Principles, p. 118.

ing? Are the affairs of the universe so out of joint—is mind so distorted in its relation to facts that fictions must be substituted for them?

I cannot believe that this has been made necessary through the long history of man, and that it must continue through the ages to come.

Mr. Spencer's teaching is that the race cannot be elevated by Agnosticism, but that this can be done only by the other creeds. Agnosticism is the only true doctrine, but we must not teach it because it would be destructive to morality. The creeds are false, but we must teach them to save humanity. The moral quality of teaching, according to this, does not consist in its truth, but in the fact that it will accomplish a certain purpose. Truth and falsehood are equally good if they perform a certain work.

If practical results are to determine the nature of the teaching, and if Agnosticism would be demoralizing to the great mass of humanity, on what ground can Mr. Spencer justify his teaching? Why not seal the creed of Agnosticism up and lay it away in the heart of an Egyptian pyramid until humanity is prepared to receive it? Even if the creed should be lost sight of for some millions of years, the mind of man will discover it at the proper time, for, according to his theory, all religions are evolved, and every people has as much truth as it is prepared by evolution to assimilate. Why, then, should the demoralizing creed of the Agnostic be introduced into the world at present? Looked at in relation to duty to humanity, I do not see any justification for the introduction and defense of Agnosticism.

Mr. Spencer justifies its announcement at present as follows: "He must remember that while he is a descendant of the past, he is a parent of the future; and that his thoughts are as children born to him, which he may not carelessly let die. He, like every other man, may properly consider himself as one of the myriad agencies through whom works the Unknown Cause; and when the Unknown Cause produces in him a certain belief, he is thereby authorized to profess and act out that belief." *

Let us see what these statements logically mean. All beliefs in the mind of man are produced by the Unknown Cause. The fact that a belief is produced by the Unknown Cause, gives authority not only to profess, but to act it out.

These propositions being true, man is not responsible for his beliefs nor for his acts; and, therefore, no belief nor act can have any moral quality. In other words, all beliefs and acts are equally good and true, even when they are opposed to each other, and when they produce the most dreadful results.

We have here the doctrine of fatality—the denying of human responsibility—the annihilation of morality—the responsibility of all beliefs and actions is thrown on the Unknown Cause. This is the justification for the promulgation of Agnosticism.

He may remember that "he is a descendant of the past," but he does not necessarily become a "parent of the future." It is in his power to determine whether he will leave progeny or not—and if children of the mind are born, he may determine whether they shall live or die. Nor can he escape the responsibility of destroying intellectual monstrosities by throwing the responsibility of their birth on the Unknown Cause. He owes no duty to the Unknown Cause which requires him to murder the moral natures of his fellow men by promulgating a destructive creed.

If Agnosticism is true, then its truth is a calamity

* Synthetic Philosophy, First Principles, p. 123.

to the human race, not only for the present, but must be for countless generations to come. If accepted, it would become the disorganizer of the most enduring and sacred human institutions, and the destroyer of human happiness. It takes away from life all that is dearest and best, and leaves humanity to gaze eternally into "the blackness of darkness," with no hope of ever receiving a single ray of light.

It is impossible that the human mind should ever make the Unknowable the ultimate foundation of a philosophy of life and duty.

What have I to do with thee, O thou Unknowable, thou impenetrable darkness, destroyer of my hopes and joys!—what canst thou demand of me or I of thee? Thou art darkness, and in thee is no light at all. Why should I prefer thee to the faith that "God is light, and in him is no darkness at all?" Surely the way of darkness is the way of death, but the way of light leadeth unto life.

So far as human duty is concerned, the Unknowable must be to me as though it were not. To make, as Mr. Spencer does, man's highest duty to consist in a ceaseless effort to know The Unknowable, is a totally impracticable creed, for the moment the creed is adopted, all effort would cease, unless man is so foolish as to regard wasting his time in an absolutely fruitless search after truth as the chief end of life.

If the creed of Agnosticism is good, it must be so for a race of beings that we know not of. If it is true, then its truth and human nature are eternally at war with each other. To call Agnosticism a reconciliation of all things is to make for it claims without foundation, for it is opposed to human nature itself. That which is fundamentally irreconcilable with the nature of man cannot be the reconciler of things which involve the highest interests of humanity.

Agnosticism is a negation—a destroyer. It tears down the house in which humanity dwells, robs man of the intellectual and moral fruit of ages, and leaves him in his individual helplessness to perish. It sweeps away the foundation of his religion, destroys his brightest hopes and most sacred beliefs. It tells him not only that knowledge is impossible, but that faith and hope are in vain. It breaks the backbone of morality by denying the divine authority of its precepts; and it abolishes religion by counting all acts of worship as due to ignorance and superstition. It destroys the highest incentives to virtue and truth by denying the possibility of a revelation from the Creator to man.

Its mission is that of the cyclone—destruction and death—while it brings naught of good in return. It constructs no system of religion, no system of morals, but denies the validity of our knowledge and abolishes faith and hope. It comes like the Arctic current in the ocean, leaving death in its track—freezing the noblest sentiments and aspirations of the soul.

Over against this most destructive creed of Agnosticism we place Christianity, which is not a negative but a positive religion, adapted to man in all places and in all possible conditions. It does not, like Agnosticism, demand a world of philosophers before it can be of use to man, but it comes to man as he is, and inspires him with infinite motives. It does not paralyze all effort by telling him that he cannot know, but it says, "You shall know the truth and the truth shall make you free." "And this is life eternal, that they should know thee, the only true God, and him whom thou didst send, even Jesus Christ."

If there is one thing that seems plain above all else, it is that the only inspiration which can cause humanity to move forward on the road of progress until it reaches the fullest possible development of all that is best in human nature, is the positive teaching of the Christian religion.

In conclusion, I repeat that no sane mind claims to comprehend the infinite, but we believe in the infinite —as shown by our belief that time and space are infinite—and we believe that we may know something of the quality of the infinite. And above all, we believe that it is possible for the Creator of the universe to reveal his nature to the mind of man: for "God created man in his own image, in the image of God created he him."

XX.

RECAPITULATION.

I WILL now briefly recapitulate some of the conclusions reached in the preceding pages. In the first place, I have called attention to some of the chemical properties of matter, showing that the elements act according to definite laws; that in combining they produce compounds, the nature of which could not have been predicted, and that the carbon compounds especially are indefinitely numerous and wonderful in their properties.

We have seen that the chemist can prepare from the elementary substances certain carbon compounds which are produced by animals and plants, but that he is not able to produce matter in the organized form, such as protoplasm, in which life manifests itself.

I next considered energy, or the forces of nature. Energy was defined as being that which can put matter in motion. It was seen that the transmission of energy seems to demand a medium of some kind, and that ether is believed by physicists to be a universally distributed medium.

The existence of this medium does not explain the action of the force of gravity.

It is believed that matter and ether fill all space, and that they are in constant motion; but the intensity of their motion varies at different times and in different places.

The energy stored up in matter is being gradually imparted to ether, and unless there is some method by which it can be concentrated in matter again, nearly all the energy of the universe will be imparted to the ether and dissipated through infinite space. Assuming an infinite past existence of matter, it ought, according to the theory of the dissipation of energy, to be at present destitute of energy and, consequently, to account for the concentration of energy in matter requires more than a dynamical theory.

It is evident that with matter, energy and ether, the condition of the universe is that of mechanical motion, and nothing more.

In order, therefore, to account for the present condition of the visible universe, it is necessary to assume the existence of some power other than the known dynamical agencies.

As to the theory of abiogenesis, or spontaneous generation, evolutionists admit that it has not been established, and they begin by assuming the existence of life.

As a dynamical theory it involves nothing but matter and energy, and these cannot account for the origin of even the humbler forms of organic beings, and much less for mind.

If abiogenesis has taken place once, then it ought by means of the same agencies to have occurred a countless number of times. The creation of the first living being was an extraordinary act, for which we find no analogy in nature, and it must have required an extraordinary agent.

The evidence derived from numerous experiments by Professor Tyndall and others is all against the theory of spontaneous generation.

Next followed a discussion of the theory of natural selection. It was seen that this theory involves two factors, namely, the fact of variation and the preservation of favorable variations. Mr. Darwin admits that the causes of variations are almost totally unknown.

This being true, the most that could be claimed for natural selection is that it preserves certain forms at the expense of others.

Mr. Darwin assumes that life was "originally breathed by the Creator into a few forms or into one." This admission opens the way for other miracles.

He denies that in nature there is any "innate tendency toward perfectibility or progressive development." If this is true, then I think that the evolution of man would have been impossible, involving as it would the preservation in all cases of the most perfect forms of an infinite series.

It has been seen that Mr. Darwin's argument has been founded mostly on facts derived from the study of animals under domestication, involving the selective agency of man, while in nature there is no such agent to separate and propagate new varieties.

Even under domestication, his argument proves, at most, that new varieties which freely mingle and propagate the species can be produced, whereas, the theory demands the production of separate species which are cross-sterile. I have endeavored to show the impossibility of the formation of such species in a state of nature, and have called special attention to the weakness of the assumption that varieties are born, the individuals of which are fertile with each other but sterile with the parent form—all the known facts being opposed to this view. The necessity for such an assumption shows that the theory is very "hardly pressed."

I have called attention to the fact that the number of instances of cross-sterility between parent and offspring would, according to the theory of slight variations, have been almost infinite, and that, therefore, this explanation of the preservation of variations cannot be correct.

I have claimed that isolation by barriers cannot account for the preservation of new varieties, for the reason that it is just as difficult to account for the preservation of a variety when formed from part of a species as when formed from the whole species.

I have enumerated the several things which must occur simultaneously before cross-sterility between parent and offspring could occur and become effective, namely, that a number of individuals must be born at the same time possessing the same variation, that the variation must be useful, that these individuals must be fertile with each other, that they must be cross-sterile with the parent form, and that, finally, the few, if any, individuals thus produced and being widely scattered through the species, must find each other before they could propagate. I regard it impossible that these things could all occur simultaneously.

I have quoted from Mr. Spencer, showing that "either there has been inheritance of acquired characters, or there has been no evolution." He admits, however, that there are but few known facts which go to support his theory. It is evident that the difficulties of preserving and propagating an acquired character are those already pointed out. I see no reason why acquired characters would not, in a state of nature, be speedily merged.

The lack of harmony in the teaching of evolutionists shows that there is much vagueness as to the details of the theory.

I next called attention to the difficulties arising from paleontology. The theory of evolution must assume that the first half of the history of life is entirely lost, for among the earliest fossils are found trilobites and cephalopods—"animals which can hardly be regarded as lower than the middle of the animal scale."

It must also assume that nearly all of the record since the Primordial period has been obliterated, so that the fossils which are known or can ever be known, constitute but a few links in the chain of evolution.

Species succeed each other, even where the rocks are continuous and without any evidence of breaks in their formation, as if by substitution and not by transformation, although the rocks may be full of well-preserved fossils. For this reason Professor Le Conte deems it necessary to assume that species have been formed suddenly—perhaps in one or two or a few generations.

In the preceding pages I have endeavored to show that throughout the various classes of the animal kingdom there has been little progress in structure during the whole of geological time, and I have insisted that this almost total lack of progress is entirely inconsistent with the enormous advance in structure and intelligence involved in evolving man from protoplasm.

I have called attention to the fact that many species of plants and animals have undergone but little change through long periods of time.

Professor Huxley says: "The significance of persistent types and of the small amount of change which has taken place even in those forms which can be shown to have been modified, becomes greater and greater in my eyes, the longer I occupy myself with the biology of the past."

The long endurance of many species, the persistence of types, the absence of generalized structures from which groups could have branched, are all opposed to the theory of evolution.

The absence of progress in structure in the various classes of the animal kingdom within the geological period, indicates a sudden and general arrest of progress inconsistent with the theory of evolution. Enormous progress is implied, the record of which in every instance is lost, in order to reach the oldest known members of any class, yet the rule is that from the time when such fossils are found till the present, little, if any, advance in structure has taken place. Evolution must assume enormous advance in structure, but lost record, in the history of almost every class till the times of the oldest known fossils, and then a sudden halt in progress through all subsequent geological time.

The suddenness with which many kinds of highly organized fishes appeared, with no geological record showing their evolution and the appearance of most of the orders of mammals in the Tertiary, with no geological evidence as to their method of evolution, are remarkable facts.

The evolutionist must assume that the early history of every class and order of vertebrates has been wholly lost, although each must have begun within the authentic geological record, and at times when fossils are abundant.

The survival through long periods and geological ages of the lowest members of classes has been dwelt upon to show the inability of such forms to progress or to produce offspring which could make the enormous strides of progress implied in the evolution of man. Forms which are pointed out by evolutionists as being extremely archaic and closely like certain links in the chain of the evolution of man are still living, having made little change and no progress through the ages, and these facts I regard as conclusive that man could not have sprung from such progenitors.

Under the subject of Embryology, on which some evolutionists rely largely, I have considered some of the difficulties attending the application of the theory. Embryology does not bridge the wide chasm between the Protozoa and the Metazoa, nor between the Invertebrates and the Vertebrates, nor between the three divisions of the vertebrates.

The claim that the changes in the embryo of the individual are an epitome of the history of the class to which it belongs is simply an assumption, and it cannot, therefore, be evidence to establish the theory of evolution.

The theory of embryology as applied to evolution is weak also in that it eliminates the unseen but essential differences between eggs and embryos, and magnifies the importance of certain transient resemblances.

I next called attention to some of the special objections to the theory of evolution. This theory must account for every part of every organism. Mr. Darwin himself acknowledges the great difficulty of trying to account satisfactorily for the origin of the many complex organs of animals.

The electric organs of certain fishes, the various kinds of wings which had separate origins, the numerous kinds of eyes and eye-spots which could not have had a common origin, the several kinds of ears differently located, the varieties of apparatus for breathing, including different kinds of gills, trachea and lungs have been considered. The general conclusion which I have drawn from these and other organs is that it is impossible to account for the preservation, by natural selection, or by any other plausible theory of evolution, of organs through their incipient and long rudimentary stages, during which time they could have served no useful purpose. I regard this as fatal to the theory of evolution.

I have claimed that the rudimentary mammæ of males could not have been evolved by natural selection, nor by any known method, and that, therefore, Mr. Darwin's claim that "Rudimentary organs declare their origin and plain meaning in various ways" is not correct in this case, and may not be in others. The rudimentary mammæ in males could never have been functional. They have undoubtedly existed through an immense period of geological time as the merest rudiments. This fact shows that it is impossible for such organs to totally disappear, and yet evolution claims that most of the mammæ which have existed in females have not simply become rudimentary, but have entirely disappeared.

If it be granted that functional organs may become rudimentary, yet this is not an argument to prove that rudimentary organs may become useful.

In the chapter on secondary sexual differences I have endeavored to show that there is no probable method by which horns, spurs, and other sexual differences could have been evolved, and much less that the fundamental differences between the sexes could have been thus produced.

The instincts of animals give rise to other difficulties. Among the most serious of these is that growing out of complex instincts which require complex adaptations of structure before the instincts could be useful. That they could have been either simultaneously or successively formed in many cases seems impossible, since the instinct and the adaptive structure are not related to each other as cause and effect. It seems to me impossible that chance could have produced the wonderful instincts of bees and the various peculiarities of structure which render them useful. In the case of the workers I have called attention to the fact that many of their instincts, if evolved, must have been produced after they had become sexually imperfect, and that, consequently, the transmission of the instincts by heredity was impossible, and that, therefore, they could not have been perfected by natural selection.

The instincts of birds with regard to incubation and the structure of their eggs, rendering these instincts necessary, present similar difficulties.

Other instances have been given to show that instincts and their adaptive structures could not have been evolved.

As to the origin of man, we have seen that he is of very recent geological origin, that no fossils have been found which connect him with any lower form, and that his various physical peculiarities render it improbable that he has been evolved.

But I have dwelt especially on the psychic differences between man and the lower animals, and have endeavored to show that man possesses faculties which do not belong to the lower animals.

I have called attention to the fact that Mr. Darwin proceeds with great caution with regard to the evolution of the higher powers of man, as is shown by his language when he says that he will "hazard a few remarks" concerning them. He admits that "man alone can with certainty be ranked as a moral being." This puts an impassable gulf between man and animals.

The effort to evolve the moral or any other faculty from experiences of utility, fails, for the reason that experience can, at most, strengthen existing faculties, and cannot, therefore, create new ones.

I have called attention to Mr. Spencer's theory, that all psychic manifestations are composed of "units of feeling" that are "fundamentally of one kind." By this assumption he attempts to account for the origin of all the faculties of the mind.

I have endeavored to show that there are essential differences between the faculties, so that one could not have been derived from another.

The theory of evolution fails to show the possibility of evolving psychic phenomena from the inorganic world. These phenomena cannot be explained in terms of matter and motion, which are the only factors in the ontology of the dynamical theory of the universe.

Starting with inorganic matter, evolution must explain the origin of life, of sensation, of the special senses, of instincts, and of the various powers of the mind. The evidence along this line is, I think, extremely inadequate.

I have called attention to the fact that our knowledge of mind alone is immediate, and that mind has persistently refused to recognize itself as matter.

Mind is a cause, as is shown by its ability to control matter, and from this we may conclude that there is a Supreme Mind which controls the material universe. The future and eternal existence of the soul is assured by the fact of its present existence and the eternal existence of God.

The indestructibility of matter and force serves as a foundation for the faith that mind, which can control these things, is itself indestructible.

Mind is not matter, but a controlling power in the universe, and we can form no conception as to how it may cease to exist. God cannot die, nor can the soul of man, made in his image, cease to be. The persistent and universal desire for a future existence of larger opportunities is a divine assurance of a future life. Change is not annihilation, but the unfolding of the universal plan.

In the chapter on Design in Nature I have called attention to the comparatively uniform temperature of the earth during the whole geological period, covering possibly fifty millions of years, without which life could not have existed. A change of only a few degrees in the climate of the earth would destroy all living things.

We have seen that the movements of the earth and the inclination of its axis to the ecliptic are favorable to the existence of living organisms.

As indicating design, I have dwelt with emphasis on the fact that the simple substances which constitute the earth are of such kinds and are found in such relative quantities as not only to render life possible, but also to contribute to the well-being of man as an intelligent and moral agent. I look upon the concurrence of all these things, according to any theory of chance, as being entirely impossible. The conditions that must be fulfilled before living beings are possible are so complex that nothing short of the wisdom of a Supreme Intelligence could have produced them.

I have claimed that the existence of man with his wonderful physical structure and his marvelous powers of mind, whether he was created suddenly or by the slow process of evolution, is unmistakable evidence of the existence of God. The question as to the length of time involved in his creation does not affect the question of design in his creation.

The adaptation of man physically and mentally to nature—of man as a being of unfolding desires and growing intelligence—has been dwelt upon.

And so the countless adaptations throughout the organic and inorganic worlds furnish an infinite number of arguments in favor of design. Each species is perfect with regard to its environment.

With regard to suffering, it has been claimed that the amount is small compared to that of pleasure and happiness; that it is necessary for the protection of the body; that it results from disobeying the laws of nature which are themselves beneficent; that it is a great and, perhaps, necessary incentive to improvement; and that man by elevating himself physically, mentally and morally by more perfectly obeying the laws of nature, can continually decrease the amount of suffering.

We have seen also that Altruism is woven into Nature, and that it is the great redeeming power of moral creatures.

Lastly, I have called attention to the creed of the Agnostic as presented by Mr. Spencer. I have claimed that a belief in the existence of infinite time, infinite space, and an Infinite Intelligence are legitimate.

I have endeavored to show that his effort to reconcile religion and science by referring them to The Unknowable is not a reconciliation, but the destruction of all religion; that his method of elimination is too sweeping, for the reason that it eliminates essential parts of religion with which science is not in conflict.

Agnosticism confesses its own worthlessness as a creed for man in his present condition, and Mr. Spencer adopts the theory of fatality in order to justify himself in defending it.

Finally, it is an infinite negation which, if accepted, would reduce the human race to a helpless condition, by destroying the high faith and sacred hopes which alone can inspire man to the noblest living.

In conclusion, I will say that whether or not the doctrine of evolution be accepted, yet to my mind the universe as it exists is but the expression of the thought, wisdom, power and will of the Divine Architect whose working extends through the eternal ages.

That the theory of Theistic evolution by which through the long ages God is represented as perpetually creating new forms of living beings from those already existing is fascinating and sublime I can easily admit, and the force of the arguments in favor of this view I have deeply felt, yet the difficulties involved in creating the present order of things are, in my estimation, too great to be explained without assuming miracles, or exceptional acts, which cannot have been caused by the ordinary agencies of creation.

The vital question at issue in this whole matter is not the method of creation, but the nature of the power that creates. Method is of interest in so far only as it reveals the Creator.

Miracles, to my mind, are no more divine than the ordinary events of nature, for both are due to the power of the Creator, yet, as evidence of the exhibition of such power, the miracle is far more convincing.

Lastly, I cannot hold to any theory of the universe that degrades man and burdens his soul with darkness and despair. I do not, of course, charge that Theistic evolution does this, but I do believe that this is the result of Atheism and Agnosticism.

I believe that the facts of the universe must tend to man's highest good; that they are consistent with the joyful hope and the boundless faith; that the endless future is fraught with good for man,—in a word, I believe that the facts of nature are in harmony with the nature of man, and that the existence and workings of the Universe are due to the Divine Will.

XXI.

GENESIS AND GEOLOGY.

Does the account of creation given in Genesis conflict with the geological record? I shall not enter upon a lengthy discussion of this much-debated question. To begin with, I will state that I do not think that the known evidence will justify the conclusion that there is a conflict between these two records.

It must be admitted that the geological record of creation extends over millions of years, and this renders it necessary to interpret the word "day," in the first chapter of Genesis, as an indefinite period. It is so used, I think, in the fourth verse of the second chapter, where it is said, "These are the generations of the heaven and of the earth when they were created, in the day that the Lord God made earth and heaven."

Our knowledge of the geological record is very imperfect. As already stated in the chapters on Paleontology, Darwin, Romanes and other evolutionists insist that the known part of the record is as nothing compared to the unknown. According to their theory, the entire first half of the record, that preceding the Primordial period, in geology, is entirely lost.

Romanes speaks of the whole geological record as being so imperfect that it merits the name, "a chapter of accidents."

We have seen that, according to the theory of evolution, it is necessary to assume that every class and order of animals originated at a much earlier period in geology than that in which the oldest remains of such class or order have been found—that they originated, in fact, at unknown times.

It is probable that, within certain general limits, we may be justified in drawing certain conclusions as to the chronological order in which some kinds of plants and animals were introduced.

It seems to be quite probable that water plants preceded land plants, that nothing higher than conifers existed in the Paleozoic, and that the highest type of plants first appeared in the Mesozoic. It is also probable that the invertebrates preceded the vertebrates, and that the latter began as fishes; that, after the latter appeared, amphibians and reptiles were introduced, and later, mammals and birds. Finally, man came in at the close of the geological record.

The evolutionist assumes that most of the organic forms that existed during and since the Primordial are lost. If this is correct, it is impossible for us to tell what those lost forms were, and it is, therefore, evident that he is in no position to assert that an unknown lost record conflicts with one that is known.

The evolutionist admits—and he must do so, for it is vital to his theory—that nearly all of the geological record has not been discovered.

It is evident that, if this is true, the small amount that is known cannot be used as a substitute for the vast amount unknown. If one makes use of this fragmentary account in this way, the burden of proof is on him to show that the small fragments of geological history which he uses give a correct idea of the enormous lost volume.

If we are told that this or that conflicts with the geological account of creation, we may well ask, what is the geological account? To this the answer must follow, most emphatically and heartily by the evolutionist, "I do not know." He can tell you that he has small samples which he believes represent more or less fairly the great unknown record. At the same time he must tell you that the unknown is unlike the known, and that it consists largely of the lost links in the chains of evolution.

It is evident that there might be a conflict between the known geological record and some other account of creation, owing to the incompleteness of the former, whereas, if it were complete, such a discrepancy might not exist.

He who asserts a conflict between the account in Genesis and the geological record, must show that his knowledge of the latter is quite complete and correct. This he will be both unable, and, generally, unwilling to do, for the interest of his theory, if he is an evolutionist, demands a most fragmentary known record.

It is evident, therefore, that no one is in a position to prove that there is a conflict between the cosmogony in Genesis and the great unknown cosmogony of Geology.

The cosmogony in Genesis is very general. It is an outline painted with a few bold strokes. It was given to a people who were in the infancy of civilization, the masses of whom were ignorant and illiterate. A complete history of creation, as it occurred through the long geological ages, would have been useless to them. They could not have understood it because of its length and complexity, and because they were totally ignorant of the facts on which the geological account must be based. If it had been fully written for them, it would have been bewildering.

What object could have been accomplished by telling that people that Trilobites and Brachiopods abounded in the Silurian, that Fishes of many kinds were very numerous in the Devonian, that Labyrinthodonts basked in the sunshine on the shores of Carboniferous swamps, that mighty Frogs croaked in the Triassic, that the Marsupial, greatest great, great, etc., grandfather of the Opossum, was then engaged in his craft of robbing the nests of the long-tailed Archæopteryx, that the Zeuglodon sported in the Gulf of Mexico, in the Eocene, that three and four-toed horses of various kinds played base-ball with boulders in the Rocky Mountain region, thus ridding themselves of their surplus toes, during the Tertiary; that Bears, Tigers and Lions of huge size fought each other like the Kilkenny cats in England during the same period; that Monkeys chased each other up and down the trees and played "hide and seek" in the forests of the Pliocene, and that, by accident or otherwise, the Anthropomorphous, Gorilla-like Ape lost his tail and took to intellectual and moral habits, so that some time during the Quaternary Period he became Adam?

All of these things, with a great multitude of similar facts, which can hardly be numbered, are of interest to the geologist and the evolutionist with their knowledge of modern science, but to the people of the time of Moses it would have been unprofitable reading.

The cosmogony of Genesis had an infinitely higher and nobler aim than the teaching of the long list of incomprehensible facts contained in the geological record. It was given to impress upon the minds of that people and of the world, the fact of the existence of the One omnipotent, omniscient, righteous God as the Creator of all things, and to whom all men are responsible for their conduct.

This teaching of Monotheism came upon the infant race as a revelation, as a flash from Heaven, more marvelous than the creation of physical things. It was the one great fact that, above all others, must be driven into the heart of the race—branded upon its mind. The account in Genesis was for moral and religious purposes. To serve these purposes in the best possible way, it was necessary that the account should be but an outline.

Some writers have attempted, in elaborate ways, to place the cosmogonies in Genesis and Geology side by side in detail. I regard such efforts as a waste of labor. The one record is so general, and the other so imperfect, that we have no certain basis for detailed comparisons. If we cannot see that they perfectly harmonize, still, as shown above, we are not justified in asserting that they conflict. It being impossible to show the existence of a conflict, an attempt at reconciliation becomes unnecessary.

The conception of Monotheism, comprehending the origin and the control of the infinite Universe, is the most comprehensive that can enter the human mind. It came of necessity by revelation—I say, of necessity, for there is no other conceivable way by which it could have entered the human mind, especially in that early age.

The broadest conclusion of the most perfect science is, I think, that there is One Cause in the Universe. The people of that age knew no science, and, therefore, their Monotheistic belief could not have been based on science. Philosophers are still disputing as to the nature of the Final Cause. There was no congress of scientists and philosophers who agreed that "In the beginning God created the heaven and the earth."

The minds of the great masses of mankind in all ages, ignorant of the laws of nature, have invented a multitude of gods in order to account for the many seeming conflicts among natural phenomena. Polytheism has been the inevitable result of the ignorance of the laws of nature, from which there could be no possible escape except revelation.

Monotheism was born into the human mind from above. It came early in the authentic history of the race. It has survived through the darkest periods of human history against all the assaults that could be brought against it,—survived as the central idea of religion and ethics, and this in the minds of a people, the masses of whom were extremely ignorant, and who, at every opportunity, lapsed into polytheism. But the holy fire of inspiration, kindled from above, ever burned on the altars of the hearts of the chosen few, by which the fact of Monotheism, with its all-important consequences, was kept and nourished in the minds of the people.

The Monotheism of the Bible came by revelation, for the reason that it could have originated in no other way. The highest civilizations of antiquity did not reach it. There is no reason to believe that the learned men of any age within the historic period originated the idea. The belief in One God as the Creator and Moral Governor came suddenly in all of its perfection and splendor. There is no effort in Genesis, nor in the Bible, to prove by methods of logic, science or philosophy, the existence of God. And yet the writers speak with unwavering faith in the existence of the One God. They write as if it were not at all a matter of faith, but a matter of immediate knowledge, that God spoke to them and through them. "Moreover, the word of the Lord came unto me, saying, Jeremiah, what seest thou?" "The word of the Lord came expressly unto Ezekiel, the priest." "The word of the Lord that came to Joel." "The burden of the word of the Lord to

Israel by Malachi." These are the unqualified expressions by which the great teachers in Israel begin their teachings.

No shadow of suspicion that there is no God, or that there is a multitude of gods, is ever expressed. Their minds, one and all, from the beginning to the end of their writings, are clear and most emphatic as to the One God, and his relation to them and to humanity. As witnesses of their divine knowledge they were ready to surrender their lives. They rightly have their places in history among the heroes who have forsaken all else for the truth.

If, therefore, the idea of Monotheism originated and survived by revelation through the long, dark periods of the world's history, the oldest record that contains this greatest of all facts, the revelation of the One God, may be regarded as true in other respects.

If the cosmogony in Genesis needed confirmation, which, so far as we can probably ever know it does not, the Monotheism of the record would be sufficient. He who in the first sentence could write "In the beginning God created the heaven and the earth," could from the same source of knowledge write that on the third day, or period of creation, "the earth brought forth grass, herb yielding seed after its kind, and tree bearing fruit;" and that on the fifth day the waters were made to "bring forth abundantly the moving creature that hath life," and that the earth brought forth "the living creature after its kind, cattle and creeping thing, and beast of the earth after its kind," and that, finally, "God created man in his own image."

As in Geology, so in Genesis, life begins with plants and moves upward to higher forms till it culminates in man. A multitude of details which would have been burdensome to the minds of the people is omitted, while the great central fact of the existence of God and his creative, ruling and moral power are emphasized.

His fatherhood is implied in the language, "Let us make man in our image, after our likeness." "And God created man in his own image, in the image of God created he him."

It has been said that the author of the cosmogony in Genesis made an evident mistake in representing that the sun and moon were not created till the fourth day, while light was created on the first day. This may be answered, as has been done, by claiming that the Mosaic account represents creation as it would have appeared to an observer stationed upon the earth and viewing the process as it took place.

That the earth was once melted is shown by the facts of science. At that stage of its existence all the water now in the oceans was in the form of steam and clouds above the surface of the earth.

The sun, for a long period, was obscured by dense clouds. Long before it could have been seen, the light, at first small in amount, but ever increasing, owing to the constant cooling of the earth, and the settling of the condensed waters upon the land, pierced in visible quantity through the clouds, so that it could have been seen by an observer on the earth. To such an observer, it could then, for the first time, have been said in language that he could have understood, "Let there be light."

As the earth cooled more and more until the air lost most of its moisture, a well-defined, visible region appeared between the earth and the clouds.

"And God made the firmament and divided the waters which were under the firmament from the waters which were above the firmament."

While a permanent sheet of cloud still covered the earth, and while the sun was still invisible, there was sufficient light for the growth of plants, and they were created on the third day, while the sun and moon were still invisible.

The waters, according to both Genesis and Geology, at first covered the whole earth. "And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear, and it was so."

Thus, beginning with an earth that "was waste and void," shrouded in dense darkness by means of impenetrable clouds and vapors, as time passed slowly on the waters settled by condensation, the light that found its way through the cloud increased more and more, the visible firmament appeared, dry land was permanently established above the waters, land plants were created, and then, on the fourth day, after the lapse of the long periods that had gone before, the sun and moon first became visible between the rifted clouds.

It seems proper that the inspired seer of the panorama of creation should state that the sun, moon and stars were created on the fourth day, or period, the earliest time at which they would have been visible to a person on the surface of the earth.

It may be, however, that the creation of the sun and moon is included in the language of the first verse, "In the beginning God created the heaven and the earth," and that on the fourth day, becoming visible upon the earth, they were designated as being from that time the rulers and sources of light for the earth.

I cannot consider the various theories which have been advanced in connection with cosmogony. Volumes have been written on the subject. I know of no reason why it can with truth be asserted that Geology and Science conflict with the cosmogony in Genesis. The latter is certainly marvelous, considering the time of its origin, and its great central truth, Monotheism, stamps the whole as of Divine origin.

APPENDIX.

"THE PRIMARY FACTORS OF ORGANIC EVOLUTION," BY E. D. COPE, EXAMINED.

Since writing the preceding, I have examined the volume entitled, "The Primary Factors of Organic Evolution," by E. D. Cope, recently issued.

This book having been written by a leading author on paleontology, endeavors to throw new light upon the subject of evolution derived from that source. It also endeavors to explain the origin of variations. For these reasons, especially, I deem it proper to review the volume at some length.

In the introduction the author says: "The doctrine of evolution may be defined as the teaching which holds that creation has been and is accomplished by the agency of the energies which are intrinsic in the evolving matter, and without the interference of agencies which are external to it. It holds this to be true of the combinations and forms of inorganic nature, and those of organic nature as well. Whether the intrinsic energies which accomplish evolution be forms of radiant or other energy only, acting inversely as the square of the distance, and without consciousness, or whether they be energies whose direction is affected by the presence of consciousness, the energy is property of the physical basis of tridimensional matter, and is not outside of it, according to the doctrine we are about to consider.

"As a view of nature from an especial standpoint, evolution takes its place as a distinct science. The science of evolution is the science of creation."

As to the "energy of evolution," he says: "If the tendency of the catagenic energies is away from vital phenomena, it is impossible that they, or any of them, should be the cause of the origin of living matter. This logical inference is confirmed by the failure of all attempts to demonstrate spontaneous generation of living organisms from inorganic matter. Further, the principle of continuity leads us to infer that the energy which produced organic matter must be identical with or allied to that which is the efficient agent in progressive evolution of organisms, and is, therefore, anagenetic. Such a conclusion may seem to lead to a dualism which is itself opposed to the principle of continuity or uniformity, and which is opposed to experience of the phenomena of energy in general.

"Since facts and logic do not support the derivation of the anagenetic from the inorganic energies, can the reverse process, the derivation of the catagenic from the anagenetic be and have been the order of nature? In support of this hypothesis, we have the universal prevalence of the retrograde metamorphosis of energy in both the inorganic and organic kingdoms. Phenomena of structural degeneracy are well known in the organic world, and purely chemical phenomena in both organic and inorganic processes are degenerate. It appears then much more probable that catagenesis succeeds anagenesis as a consequence, and does not precede it as a cause. In other words, it is more probable that death is a consequence of life, rather than that the living is a product of the non-living." *

* Page 482.

With regard to the function of consciousness, he says: "The relation of consciousness to the physical basis is as yet a profound mystery, but that they exercise over each other a definite mutual control is unquestionable. The processes which produce thought, as conception, judgment, etc., are however, not qualitatively related to the amount of nutritious proteids consumed in the central nervous system, but only quantitatively; yet it is the outcome of these processes that directs animal movements, when they are not automatic.

"In other words, the forms of thought, which have no weight, direct the movements of muscles which have weight. This is not in accord with the doctrine of the correlation of energy. But what has the formation of a concept or the development of a judgment to do, *per se*, with the correlation of energy?

"While, therefore, every mental process is expensive as a whole, the mental content is obedient to the forms of thought rather than to the correlation of energy. This is what mind is." *

Again, "The formal statement of this phenomenon may be found in the thesis, that *energy can be conscious.* If true, this is an ultimate fact, neither more nor less difficult to comprehend than the nature of energy or matter in their ultimate analyses. But how is such a hypothesis to be reconciled with the facts of nature, where consciousness plays a part so infinitesimally small? The explanation lies close at hand, and has already been referred to. *Energy become automatic is no longer conscious*, or is about to become unconscious. That this is the case is a matter of every-day observation on ourselves and on other animals. What the molecular conditions of

* Page 506.

consciousness are, is one of the problems of the future, and for us a very interesting one. One thing is certain, the organization of the mechanism of habits is its enemy. *It is clear that in animals, energy, on the loss of consciousness, undergoes a retrogade metamorphosis.*

"To regard consciousness as the primitive condition of energy, contemplates an order of evolution in a large degree the reverse of the one which is ordinarily entertained. The usual view is that life is derived from inorganic energies as a result of high or complex molecular organization, and that consciousness (= sensibility) is the ultimate outcome of the nervous or equivalent energy possessed by living bodies. The failure of the attempts to demonstrate spontaneous generation will prove, if continued, fatal to this theory. With our present evidence it may be affirmed that not only has life preceded organization, but that *consciousness was coincident* with the dawn of life."

Again he says: "I think it possible to show that the true definition of life is, *energy directed by sensibility or by a mechanism which has originated under the direction of sensibility.*" *

The above quotations with regard to final causes, life and its origin, indicate that the author is not a materialist. As to the object of the volume, he says:

"My aim will be to show, in the first place, that variations of character are the effect of physical causes; and second, that such variations are inherited." †

In this view he follows Lamarck. Darwin thought that, for the most part, the causes of variation were unknown.

The first chapter in the book treats of variation.

* Page 507. † Page 14.

In this he considers the variations in color of closely related species of beetles, snakes, and lizards. If all that he claims here be true, yet it would be of little importance in establishing the truth of the theory of evolution, for it is well known that color has little, if any thing, to do with structure, and that it is with changes of structure that evolution is concerned.

He next considers variations in North American birds and mammals in relation to locality. He shows that certain species of birds and mammals vary in the size of the individuals composing them, and that the latter vary somewhat in the relative size of certain organs. Size alone of individuals does not determine species.

Then follows a brief statement of a few variations in structural characters, in which it is shown that among dogs the number of teeth varies somewhat, and, also, that their structure varies slightly. The same things occur among the teeth of different men.

It is not certain that the different kinds of dogs have all been derived from one species, and this may help to account for fewer teeth in some.

He endeavors to show, by comparing their skeletons, that the various species of Batrachia (= frogs, toads, etc.), have had a common origin. The origin of species cannot be determined by simply comparing skeletons. Such comparisons are, of course, necessary for the theory of evolution, but much more is required than this in order to account for new species.

He attributes to isolation a large share in the formation of species. He says: "That existing types of all grades are the result of the isolation of variations of species, is shown by the frequent examples of incomplete isolation, which follows inconstancy of the definitive characters." *

* Page 62.

To have thus formed all species would have required hundreds of thousands of isolations, which were impossible. Besides, it is evident that isolation could not produce variations, but could simply keep varieties apart after they were formed.

Chapter II. treats of the "phylogeny or genealogy of organisms," which, he says, "can only be determined by paleontologic research."

In making out the general phylogeny for the animal kingdom,* he depends on embryology, and not on paleontology. He claims that embryology shows that such animals as star-fishes, oysters and snails, craw-fishes and beetles, and all animals with backbones, including man, have been derived from worms,—hence the truth of the claim by theologians, that "man is but a poor worm of the dust."

Again he says: "If we could study the embryology of the many extinct forms of life, the missing stages would be found, but as we have not the opportunity of pursuing this important research, we have to rely on paleontology for our phylogeny. Paleontology is, and always will be, imperfect, but all that we get is palingeny, or the phylogeny itself, and not an inverted and distorted record of it." †

It would seem from this language that the author discards embryology in determining phylogeny, and that he would depend exclusively on paleontology, and yet, as stated above, he bases general phylogeny on embryology.

The reason is evident, and that is, paleontology furnishes no evidence whatever as to the origin of the sub-kingdoms of animals, and consequently, he must lean upon the mere assumptions of embryology.

The author shows ‡ some of the shortcomings of embryology. It should be remembered that the old-

* Page 81. † Page 210. ‡ Page 209.

est known fossil representatives of the different subkingdoms are widely apart in structure, and paleontology has furnished no evidence, whatever, in the form of fossils, to show that they had a common origin. Nor is there any hope that she will be able to do so.

He next proceeds to manufacture a phylogeny for the vertebrates. He remarks that, "Embryologists are especially apt to construct impossible phylogenies, as they are generally not systematists, and frequently not anatomists."* The first half of this is, no doubt, true.

He continues: "The Amphioxus (genus Branchiostoma) is generally regarded as the ancestral vertebrate. There are many reasons why this position must be accepted, although it possesses a few secondary modifications. Whether Branchiostoma derived its descent from an annelid worm, or from a tunicate, is a vexed question." †

I suggest that the degraded tunicate, grown fast to a rock by what was once his head, be relieved of the responsibility of having been the ancestor of man. He evidently saw that the worm was ahead of him in the race, and he attempted suicide by jamming his head against a rock and holding it there till it grew fast and, finally, disappeared, while he lived on.

But the origin of the Amphioxus, our oldest vertebral ancestor, is uncertain—the honor of having been his father being divided between the writhing, wriggling, squirming worm on the one hand, and the leathery, stupid, motionless tunicate on the other, with odds in favor of the former. I am sure that Amphioxus, if called on to-day, would hardly be able to recognize his own father, so much has he grown away from him in appearance.

* Page 85. † Page 86.

This doubt as to the pedigree of our most ancient back-boned ancestor, will, no doubt, wound the pride of some of the blue-bloods, but they may console themselves with the knowledge that this slight doubt as to the record arose some fifty, or, possibly, a hundred million years ago.

As to the origin of mammals he says: "It is evident that Mammalia were derived from some type probably referable to a Permian reptilian order of the Theromerous series, although to which one is not yet known." *

Why the above "is evident," is not at all clear to me, except that the necessities of the theory of evolution make this claim necessary. So far as we know, reptiles were the highest animals that preceded mammals, and, granting that the theory of evolution is true, it follows that mammals were probably derived from them. But paleontology has little, if anything, to show as to the origin of mammals. How a cold-blooded reptile with nucleated red corpuscles and no milk glands, could have become warm-blooded with non-nucleated red corpuscles and have acquired milk glands, is not even guessed at by the author.

Cope does not agree with Hæckel in deriving Batrachia from Dipnoi, but he is in doubt as to their origin.

As to reptiles: "The Reptilia have been supposed by Hæckel to have taken their origin from the Batrachia." † With this opinion the author agrees. "And it is from the Triassic Dinosauria that I suppose the birds to have arisen."

Thus it is seen that paleontology furnishes no conclusive evidence as to the origin of either fish, amphibian, reptile, bird or mammal. A great multitude

* Page 88. † Page 88.

of intermediate forms necessary to connect these classes has not been discovered.

Concerning reptiles, "The vertebræ are not introduced into the definitions of the orders, since they are not so exclusively distinctive as many other parts of the skeleton." * Besides, it is not certain how their various kinds of vertebræ could have had a common origin.

Again, "The paleontology of the birds not being known, our conclusions respecting the character of their evolution must be incomplete." The derivation of feathers from scales of reptiles needs to be explained.

He claims that the monotremes, the lowest known mammals, have lost their teeth and "their condition is evidently one of degradation." How did they lose the numerous well-developed teeth of their reptilian progenitors?

Again, "In the marsupial order we have a great range of dental structure, which almost epitomizes that of the monodelph orders. The dentition of the carnivorous forms is creodont; that of the kangaroos is perissodactyle, and that of the wombats is rodent. Other forms repeat the Insectivora." How was it possible for so many independent evolutions of teeth to have taken place in which similar teeth were produced in marsupials and true mammals. The fact that they were independently formed is the strongest possible argument against the theory that they were evolved. The author, in another place, tries to solve this difficulty, and many others, on mechanical principles.

He admits that the phylogeny of Cetacea, Sirenia, Edentata and Marsupials has not yet been cleared up,

* Page 121.

but he claims that the phylogeny of most of the other orders is known.

The earliest known mammals (of the Triassic and Jurassic) "are already highly specialized. They probably represent the Monotremata of their time." The fact that they were then "highly specialized" is very significant. How long had it taken them to become so? When did they depart from the reptilian type? Paleontology is silent as to their origin. Again, he says, "The immediate didelphian ancestors of the monodelphous Mammalia have not yet been certainly discovered." How do we know then that the ancestors were didelphian?

Again, "The history of the Monotremata is not made out, but the earliest forms of which we know, the skeleton, Polymastodon (Cope) of the Lower Eocene, is as specialized as the most specialized recent forms. The dentition of the Jurassic forms, Plagiaulix, etc., is quite specialized also, but not more than those of the kangaroos. The premolars are more specialized, the true molars less specialized than in those animals."*

From this it is seen that the oldest known monotremes are found in the Eocene, and yet it is assumed that monotremes were the ancestors of marsupials a whole long age before the Eocene began.

The oldest known forms of monotremes and marsupials were as specialized as living ones of the same orders.

Again, he says: "In conclusion, the progressive may be compared with the retrogressive evolution of the Vertebrata, as follows: In the earlier periods and with the lower forms, retrogressive evolution has predominated. In the higher classes progressive evolution has predominated." †

* Page 142. † Page 146.

It is remarkable that it must be assumed that retrogression in the animal kingdom has been quite as general as progression. This principle is called in to explain the existence of the various rudimentary organs and numerous modifications of organs that exist among animals. By adding and subtracting organs and parts of organs from assumed ideal forms, it becomes easy to derive any known form by the use of the imagination.

As to the origin of man, he says: "I have advanced the further hypothesis that the Anthropomorpha (which include man and the anthropoid apes) have been derived directly from the lemurs, without passing through the monkeys proper." *

"The frequent presence of the tritubercular molar in man suggests the superior claim of the lemurs over the monkeys to the position of ancestor." A great consolation.

But man "cannot be traced through any existing type of Lemuridæ, but through the extinct forms of the Eocene period." He then gives a picture † of the lower jaw of our possible ancestral lemur. It differs much in shape from man's jaw. It contains ten teeth on each side, there being but eight in man. The teeth, for the most part, look very different from those of man.

It will be noticed, however, that the author only advances a hypothesis, and that he does not claim positive knowledge that man was derived from lemurs.

Concerning man and anthropoid apes he says: "The sole difference between these families is seen in the structure of the posterior foot: the Simiidæ having the hallux opposable, while in the Hominidæ

* Page 154. † Page 156.

the hallux is not opposable. This is not a strong character,'' etc.

If this is true, I suggest that a slight surgical operation will convert gorilla into man, and then he can be put on the high-road to civilization. When his big toe is made to grow in human fashion, he will, of necessity, abandon his arboreal habits, and he can be kept within bounds by his teachers.

But Huxley claimed that the structural differences between man and apes were many and great, instead of being confined to some little difference between the big toes.

He says: "I find, in fact, that those who endeavor to teach what nature so clearly shows in this matter, are liable to have their opinions misrepresented and their phraseology garbled until they seem to say that the structural differences between man and even the highest apes are small and insignificant. Let me take this opportunity then of distinctly asserting, on the contrary, that they are great and significant; that every bone of a Gorilla bears marks by which it might be distinguished from the corresponding bone of a man; and that, in the present creation, at any rate, no intermediate link bridges over the gap between Homo and Troglodytes.'' *

Cope has, in this instance, saved his imagination the slight trouble of bridging the chasm between man and the apes by denying its existence, while Huxley, equally distinguished as a comparative anatomist, emphasizes its existence.

Again, the author says: "It is then highly probable that Homo is descended from some form of the Anthropomorpha now extinct, and probably unknown at present, although we do not yet know all the characters of some extinct supposed Simiidæ, of which

* Cyclopedia of Science, Vol. 2, p. 232,

fragments only remain to us." Here we have it "highly probable" that man originated from some unknown ape.

He next considers the remains of man that are regarded as being the oldest known, and attempts to bridge the chasm. The skulls of "the man and woman of Spy," are compared with the Neanderthal skull, and he concludes that they all belong to the same race. He concludes that the peculiar characters of these skulls, their jaws and teeth, "go a long way toward justifying the separation of the Neanderthal race as a distinct species, as has been done by some author under the name of Homo neanderthalensis." He afterwards speaks of it as a distinct species. In this case comparatively small variations in structure are given sufficient weight to separate part of the genus Homo as a distinct species, while between man and apes, "the sole difference" is in the position of the big toe. To fill the gap between man and ape, the ape is lifted in structure by ignoring the differences. When he comes to consider the remains of man, a similar purpose is served by degrading individuals that are well known to have been human, so as to form a lower species. Differences in structure become great or small according to the necessity of the theory of evolution. The Neanderthal and Spy skulls are of good capacity, a fact which the author neglects to state. The capacity of the former is 75 cubic inches, or about 1,053 cubic centimetres, which, Huxley says, "Is the average capacity given by Morton for Polynesian and Hottentot skulls. So large a mass of brain as this, would alone suggest that the pithecoid tendencies, indicated by this skull, did not extend deep into the organization; and this conclusion is borne out by the dimensions of the other bones of the skeleton given by Professor Schaffhausen, which show that the absolute height and relative proportions of the limbs were quite those of an European of middle stature. The bones are indeed stouter, but this, and the great development of the muscular ridges, noted by Dr. Schaffhausen, are characters to be expected in savages. Patagonians, exposed without shelter or protection to a climate possibly not very dissimilar from that of Europe at the time during which the Neanderthal man lived, are remarkable for the stoutness of their limb bones. In no sense, then, can the Neanderthal bones be regarded as the remains of a human being intermediate between Man and Apes. In conclusion, I may say, that the fossil remains of man hitherto discovered do not seem to me to take us appreciably nearer to that lower pithecoid form, by the modification of which he has, probably, become what he is." *

Such were Huxley's views with regard to men and apes, and no fossils have since been discovered which, if he were still living, would cause him to change these views.

The latest discovery of the supposed connecting link was made by Dr. Dubois, in Java, near Trinil.

With regard to these bones, Cope says: "The characters of the skull are closely similar to those of the men of Neanderthal and Spy, but the walls are not so thick as those of the former, and more nearly resemble those of the latter." † The cranial capacity of the gorilla is 500 cubic centimetres, that of the man of Java 1,000, and that of the lowest normal man 1,500 cubic centimetres. This last statement, with regard to the least capacity of the normal skull of man, is not correct, as the author himself shows on the same page.

* Cyclopedia of Science, p. 253. † Page 169.

But, alas for the theory of the missing link! "Virchow has pointed out that some of the Nigritos possess a remarkably small cranial capacity, as little as 950 cubic centimetres, and an inhabitant of New Britain only 860 cubic centimetres, a capacity even smaller than the man of Trinil. Until we learn the characters of the lower jaw, we shall be in doubt as to whether this individual pertains to the Homo sapiens or the Homo neanderthalensis." *

It is admitted, then, that these bones are human, and that their possessor was not more degraded than the Neanderthal man of whom Huxley wrote.

The skulls of Neanderthal, Spy and Trinil, all have a capacity of 1,000 cubic centimetres, or more, which is considerably more than that of various living men.

So eager were Dubois and Hæckel to supply the connecting link between men and apes that, for the man of Trinil, they proposed "a new genus, Pithecanthropus," "and even a new family, Pithecanthropidæ, without having shown that he is not a member of the genus Homo." It is certain, from what has been said, that paleontology has not shown how man originated.

Cope, however, does not hesitate to make out the genealogy of man, extending through all the geological ages.† I will repeat this genealogy, giving mostly the common, instead of the technical names, which he uses, and I will add certain details which the author omits. Man began away back beyond the oldest known fossils as a Protozoan, which was simply a gelatinous cell, floating in the ocean. In due time he became a jelly-fish, or, possibly, a polyp, much like those that make coral. Desiring to lead a more active life, he stretched his body, in his numerous

* Page 169. † Page 171.

efforts at locomotion, until it developed into a squirming worm that groveled on the bottom of the sea.

But, as a worm, he was discontented with his condition, a characteristic which the human race inherits from his wormship, and so he aspired after a backbone to aid him in fighting the battles of life. After much meditation, he concluded that he could best acquire this new organ by shifting his habitation and changing his diet; so he moved northward into deeper and colder water, and he added to his diet, once a day, small pellets of rock which would serve as food for backbone. After endless shiftings, from place to place, and the devouring of numerous kinds and of numberless pellets, he succeeded in permanently establishing a rudimentary backbone. He was then an Amphioxus, the vertebrate ancestor of all the vertebrates. His backbone at this time was extremely weak, and he soon realized that a greater quantity and a firmer quality were desirable, and so he doubled the frequency of taking the calcareous pebbles, using them at both his morning and evening repasts, in as large quantities as his stomach could digest. At the same time he entered the sub-marine gymnasium and gave himself up to bending his body from side to side, in order that the rapidly forming backbone might be kept flexible while it increased in strength. By this continual exercise, the hardening bone was developed into distinct vertebræ.

In this condition he was a fish. While swimming near the shore one day, he was cast by a great wave upon the beach, where he gave himself up as lost. But his partner in the sea, chancing to hear his moans of despair, encouraged him to use his fins for legs, which he immediately did, to the good purpose of soon reaching the water. The view which he obtained when cast ashore, brought to his mind the knowledge of the existence of another world, with which he longed to become acquainted. So he decided that he would proceed cautiously to explore the neighboring land. Riding upon the crest of the highest wave, he permitted himself to be cast upon the beach much higher than before. Having viewed the world from that point, he regained the water as at first. His experience in trying to use his fins as legs gave him the knowledge that they would need to be changed a good deal in order to adapt them to locomotion on land, and he also felt a certain shortness of breath while on land which he desired to overcome, in order that he might remain long out of water and make extended journeys.

By much flapping of his fins edgewise against the rocks he gradually narrowed and elongated them, and he also succeeded in breaking their hard parts into joints.

By holding his mouth full of compressed air he succeeded in expanding a part of his gullet into a sac which finally developed into a lung. After thousands of generations, involving infinite labor, and skill, and patience, he was able to claim as his birthright four good legs and two good lungs; but he retained also his gills, for, as yet, he was afraid to trust his fortunes entirely to the dry land. He was then an Amphibian—a water-dog, in his habits.

He reveled in luxury on land. He gorged himself day and night with fat flies and juicy bugs. He basked in the sunshine of the cool morning, and, at noon, he escaped the scorching rays of the sun by stretching his weary limbs beneath the cooling shades of the Carboniferous ferns. When he first sought the land, he returned regularly to the sea. But by and by he became so wedded to the luxuries of the land, that he neglected for days and even months to return to the water, and so his gills gradually disappeared, from disuse. He was then a Reptile, somewhat like the crocodile. But he did not lose his taste for fat flies and juicy bugs. He began to be more human-like. He entered into contests with his fellow-crocodiles in order to determine who could eat the greatest number of a certain species of very luscious flies. In this way he so inflated his stomach with rich diet that some of the chyme oozed out through the ventral surface of his body. This leakage soon attracted the notice of the young crocodiles, and they began to lick off this rich chyme in order to prevent the waste. In this way the first milk glands were developed—so to speak, by accident—and thus originated the first mammal.

The hot sun dried up his scales, the winds split them into threads, and thus hairs were evolved. He was then the lowest mammal, something like the duck-mole of Australia, except that he had numerous well-developed teeth. He laid eggs and hatched them, and hovered his young at night. By-and-by the youthful duck-mole, not liking to be left so much at home by the mater familias, succeeded, after much toil, through many long and weary nights, in developing a projection of the skin into an udder, which he firmly grasped by his mouth, and thus he was carried from place to place, and learned "to view the landscape o'er."

The mother, being delighted with the pluck of the youthful ancestor of future man, determined to make him as comfortable as possible, and so, in order to carry him with more comfort and to shield his youthful back from the inclemencies of the weather and from the assaults of enemies, she drew the surplus skin of her ventral region over his body and pinned it with a thorn, and, thus, in a short time was evolved the pouch of the oppossum, the utility and comfort of which we witness in our day.

But the land became so thickly peopled with crocodiles, lizards, water-dogs, frogs, duck-moles and opossums, that it became extremely difficult to obtain enough fat insects to serve as food. This led to violent contentions among these, our early ancestors, as to who should have the first choice of the most toothsome bugs. Angry words soon led to war, and war, as usual, resulted in bloodshed. The sight and smell and taste of blood soon became familiar. Some of them, having swallowed the blood of their fellow-men by accident, learned that it would nourish their bodies, and from this beginning, an appetite for flesh and blood was speedily formed. From this time on, a cannibal race lived and prospered at the expense of their inoffensive neighbors.

But it must be evident to the most superficial observer, that the opossum, weighted by carrying her numerous young, at first in her pouch, and, afterwards on her back, was not in the best condition to outstrip her competitors in the race of life. She was carrying far more than the legal burden prescribed by the modern race-course for an animal of her size. So she explained to her infant family the necessities of the case, and they, with unanimous voice, agreed to remain at home and stay within doors, while she fought the battles, captured her neighbors as prey, and ran the race of life.

A few generations of disuse caused the pouch and the marsupial bones to disappear, and thus came into existence the ferocious flesh-eating animal, our great, great grandfather, who roamed through the primitive Mesozoic forests, "seeking whom he might devour."

Time moved apace. The inhabitants of the earth became more and more crowded, foód was more scarce, and conflicts were so numerous and savage that to many a poor soul life seemed not worth living. In this extremity, our dog-like or creodont ancestor, exercising the usual wits for which our whole line of progenitors has ever been noted, with an aspiring mind began to look heavenward in hope of some sort of relief. He viewed the silvery moon and the twinkling stars, and was pleased with their brightness. He also observed that on the trees hung luscious fruits, some of which, partly decomposed, he had picked from the ground, and that numerous glossy, fat birds flitted by day among the foilage and roosted on the boughs of the trees by night. He said to himself, "What a feast if I could only climb!" The intense desire soon became father to the deed. He soon selected a peach tree of that Age on which there hung much golden fruit. His first effort at climbing was extremely awkward, and he fell to the ground. Again he renewed the effort with all his strength, in doing which he so jarred the tree that some of its best fruit fell to the earth. This he eagerly devoured. Encouraged with his success he repeated the process "until his stomach was fairly filled." His mind was then fully made up to seek the things that were above—to climb into a world where none of his close kindred had ever been. So he gave himself up to the severest course of training. He hugged the trees for hours at a time in order to give his arms the best shape for grasping. He patted his fore feet and hind feet against stones in order that they might be flattened into hands for grasping and feet for biped locomotion. He pulled his fingers to increase their length, and placed wedges between what are now the thumb and the forefinger, in order to make the former stand out as a thumb. In like manner he developed the big toe into a grasping

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the characters of individual animals and plants. These influences fall naturally into two classes, viz., the physico-chemical (molecular,) and the mechanical (molar). The modifications so presented are supposed to be the result of the action of the causes in question, continued throughout geological time." He gives the names Physiogenesis and Kinetogenesis to the above causes. "In the animal kingdom we may reasonably suppose that kinetogenesis is more potent as an efficient cause of evolution than physiogenesis." *

Under physiogenesis the author shows the effects of light and of certain kinds of food in modifying the colors of a few animals; also, the effects of changing the saltness of water on two or three species; and, finally, he considered the blindness of animals that live in caves.

If all that he claims in this chapter is true, yet it has but little bearing on the question of evolution. Change of color has little, if anything, to do with change of structure, and loss of vision by disuse cannot explain the origin of eyes.

The chapter on Kinetogenesis occupies 140 pages. The author, relying on this as the principal cause of variations, attempts to explain the origin of organs and the great changes which have, according to evolution, taken place in the structure of animals.

I can only refer to a few parts of this chapter, which will give some idea of the author's method.

As to the origin of lungs, he says: "The habit of holding in the œsophagus large quantities of air while engaged in seeking food in foul water, or on land, on the part of vertebrates which normally oxygenated the blood by means of gills, was probably the mechanical cause of the development of a pouch, and after-

* Page 225.

wards of a diverticulum of the œsaphagus, which became ultimately a swim bladder or a lung."*

"The segmentation of the limbs of vertebrata is a simple mechanical problem. Paleontology and embryology concur in proving that the limbs originated in primitive folds in the external integument, and that their connection with the internal skeleton was of later accomplishment, has been shown by Widersheim." † The origin of the limbs of vertebrates, with their complicated structures, is a very difficult problem. Embryology, I believe, teaches nothing on this subject, nor does paleontology, as far as I have been able to learn, show that the "limbs originated in primitive folds in the external integument."

The author claims that the original limbs were "slender-rods which were segmented by interruptions at suitable points." Strange indeed is it that folds of the skin were developed into slender segmented rods. One would have expected that such folds would give rise to broad limbs of some kind.

Again, he says that "the articulations of the finrays of fishes, as shown by Ryder, are fractures, due to flexures during motion in the water medium."

By the process of fractures, I understand that the author intends to explain the origin of the joints in limbs. If this is true, it indeed becomes marvelous when we try to account, in this way, for the origin of all the joints in the arms and hands, legs and feet of man. Between one and two hundred fractures, all made by accident, with exact regularity in the corresponding parts of limbs, must have occurred. If this is true, what has become of the doctrine of chances? How have four complex limbs, alike in pairs, and all four closely alike, with a great number of corre-

* Page 363. † Page 366.

sponding bones and joints,been evolved? No plausible explanation has been given.

Again: "The limb of land vertebrates was derived from one of the forms of fins of water vertebrates" . . . "the limbs of the first land animals were segmented and flexible at the joints between the segments."* The joints of the first land animals were, then, if I understand the author, the joints of the fins of fishes which had originated from accidental fractures.

He continues: "The terminal flexure, that of the wrist or ankle, has been evidently due to a similar mechanical cause, viz., the flexure due to the pressure of the weight of the body on the terminal segments when in contact with the earth. The distal segments are the most slender in all types, and least able to maintain a linear direction under pressure, hence, they have flexed easily, and thus the line of separation between leg and foot had its origin."

He then gives a general theory to account for the origin of joints in both exo and endo-skeletons: "If we imagine that either the integuments, or an axial rod, of a worm-like animal, has become the seat of a calcareous or chitinous deposit, it is evident that the movements of the animal, in swimming or creeping, must have interrupted the deposit at definite points of its length. The lateral flexure of the body would be restricted to certain points, and the intervening spaces would become the seat of the deposit. At the lines of interruption joints would be formed, and if the movements were habitually symmetrical, these interruptions would be equi-distant. In this way the well known segmentation of the external skeletons of Arthropoda, and the internal skeletons of Vertebrata would be formed." †

* Page 366. † Page 368.

He claims that a primitive backbone * was formed in this way, composed of wedges of bone, with their bases placed alternately above and below. The folds made in the thick cloth of a coat sleeve, by bending the arm, illustrate, he says, the mechanical principles involved in making this backbone. From this double row of wedges, the author imagines that two distinct kinds of vertebral columns have arisen; from the lower row, the backbone of the fish, and, from the upper, that of the higher vertebrates.

Having derived these two kinds of vertebral columns in this way, it becomes easy, by a still more liberal use of the imagination, to account for the various styles of vertebræ; viz., concave in front, concave behind, concave at both ends, and plane at both ends, with various modifications of these forms. In a word, it may be said that all the joints of the body, and the shapes and sizes of all the bones, have been determined by impact, strain, friction, and torsion.

The same is true of teeth: "The history of the incisor teeth of the Mammalia exhibits three processes,"† hypertrophy, specialization and atrophy. The "more severe, direct irritation from use than any others in the jaws," ‡ will account for the increased diameter of the molars. "The origin of the canine" teeth "is due to the strains sustained by them." ‖ "The progressive lengthening of the incisors" § has been through use. As to the Artiodactyla, "Why the superior incisors should have disappeared in this group, is not yet clear to my mind." ¶ It is, indeed, refreshing, to find even one case which the author can not explain readily by impact, strain, and friction, nor by disuse.

It is claimed that the crowns of teeth, which differ widely in structure, have been produced by wear, and

* Page 370. † Page 328. ‡ Page 331. ‖ Page 331. § Page 346. ¶ Page 357.

that the effects of wear have been inherited. To this it has been objected by Tomes, "that it is quite impossible that the crowns of the teeth could have been altered by impacts and strains, since their form is determined in the recesses of the dental grooves, entirely removed from all the mechanical influences which affect the external surfaces of the jaws." *

The existence of similar structures, which must have had independent origins, has been regarded as very strong evidence that they could not have been evolved; yet the author enumerates † nine important modifications of the skeleton, four of which have had two distinct origins; one has had three; another, four; two have had five; and one, six, and, probably, eight, separate origins. Among these "The tongue-and-groove ankle joint" "has been developed independently along four distinct" lines. This is highly improbable.

The author concludes this matter by saying, "From the preceding facts I have inferred that in biologic evolution, as in ordinary mechanics, *identical causes produce identical results*." ‡ That the mechanical causes in the above cases have been similar, is an assumption. Besides, it is by no means certain that mechanical causes could produce a tongue-and-groove ankle joint once, and much less, four times. According to this theory, this kind of joint ought to have been produced in other kinds of animals also, and in the knees as well as the ankles. The principle, if true, is of general application, and it ought to have produced a greater number of similar results than we actually find. His argument proves too much.

In order to make his mechanical theory of variations available in evolution, it is necessary to prove that slight changes thus produced are inherited by the

* Page 381. † Pages 360, 361. ‡ Page 361.

offspring. Thus, the effects of wear on the crowns of teeth must be transmitted to offspring. We have no proof that this is the case. It is well known that mutilations of the body of the parent seldom exhibit themselves in the offspring. In a few cases of serious injuries, the offspring have been affected. On the other hand, it is known from accidents, experiments on animals, compressed feet of the Chinese during hundreds of years, flattened heads, and circumcision, which has been practiced thousands of years, that mutilations of parents are not inherited by the offspring. Until this is shown to be true, the theory that mechanical forces have been the principal agencies in producing permanent variations among animals cannot be accepted.

In conclusion, I will say, that this volume by Cope will probably be regarded by evolutionists as greatly strengthening their theory. With most of them, however, the doctrine of evolution has ceased to be a theory, and they simply regard it as a fact to which all biological facts are to be legitimately referred, and by which they are to be explained.

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