"THE ORIGIN AND EVOLUTION OF LIFE"

A NOTICE OF HENRY FAIRFIELD OSBORN'S BOOK

BY THEODORE ROOSEVELT

IT is well to be cautious in statement about any contemporary book; and yet it is difficult not to speak of Henry Fairfield Osborn's "Origin and Evolution of Life"[1] as one of the great scientific books, as a book that is permanent in the sense that Darwin's and Huxley's books are permanent, and influential in a sense that is not true of the books of writers, like Cope, whose profundity of thought is not accompanied by lucidity of formulation and expression. I believe that the sober judgment of scientific men will confirm this statement. Previous students during the one hundred and fifty years since, with Buffon, the first serious study of the problem began, have almost invariably approached the subject from the standpoint of the naturalist. Osborn approaches it from the standpoint of the physicist. He treats of the origin and evolution of life from the standpoint of the action, reaction, and interaction of energy. The pure naturalists treated the forms of living matter as practically the sole subject of study; Osborn thinks rather of the phenomena of living energy. Where the most illustrious of his predecessors reasoned backward from matter and form towards energy, he and the other students of his type reason from energy onwards towards matter and form. These modern investigators of the stamp of Osborn and Jacques Loeb treat physicochemical research as vital to the successful handling of the energy concept which must lie at the base of every serious attempt to treat of the beginning and development of life.

One of the great merits of Mr. Osborn's book is the entire absence of that confident dogmatism which has completely marred the work of so many otherwise great scientists. He has the openness of mind, and the willingness to admit lack of knowledge, which were among the contributing causes of Darwin's greatness. He explicitly states that he does not even pretend to offer a clearly developed energy-conception of the origin of life or of all the marvelous facts of evolution, adaptation, and heredity. All that he does is to blaze the path of knowledge a few rods forward in the right direction.

Of course Osborn accepts evolution as a natural law, no more disputable than the law of gravitation; the non-believers in one of these two great natural laws are of exactly the same stamp as the worthy persons who a century ago still disbelieved in the other. This law of evolution is now inseparably connected with the name of Darwin; and in a sense justly so, for Darwin did more to establish it as one of the fundamentals of human knowledge than any of the other learned men who from the days of Aristotle to our own time have groped after its significance. But Darwin's theory as to the dominant cause of evolution now receives less support than it did half a century ago; and neither the opposing nor the supplementing theories of his antagonists and disciples have received even as much acceptance. The chief positive recent addition to our understanding of the forces of evolution is the sharp distinction now universally admitted to exist between the general body organism itself and the reproductive cell or cell group within it—germ plasm, as the latter is generally called, although Osborn styles it heredity-chromatin. We have, however, made the negative gain of eliminating the Darwinian idea of chance selection, which seems to be refuted by the palæontological record of many different groups of animals—the titanotheres offer an early instance. It seems to be clearly proved that life evolves in an orderly way; and this is one reason for believing that the energy which keeps the universe in order is, in some way which we do not comprehend, also responsible for the orderly procedure of life.

All of the theories hitherto propounded to account for evolution, even if taken together, fail to account for it. It is possible that our intelligence is not such as to enable us to account for it any more than we can resolve the law of gravitation into its causes. But Osborn and the other profound scientific investigators of his school believe that there is at least a chance that the cause may be found; and they have taken the indispensable first step in this direction by clearly grasping the fact that *energy*, and not *form*, lies at the beginning of the evolution of life. In other words, the task they set before the scientific investigators of the twentieth century is a task primarily for the biochemist and physicochemist rather than for the naturalist. They seek to establish a closer connection between the

[1] The Origin and Evolution of Life. By Henry Fairfield Osborn. Charles Scribner's Sons, New York. $3.

energy shown in the stellar universe and the energy shown in life.

Osborn first poses the questions as to the origin of life; and here again his complete freedom from the obsessions of dogma deserves allusion. He does not attempt to furnish more of an answer than the facts permit, and is careful always to indicate that the answer is partial or merely suggestive—or perhaps as yet entirely non-existent. He treats of the energy concept of life, and he bases the theory of the evolution of life upon the action, reaction, and interaction of four kinds of energy, namely: (1) the inorganic environment—that is, the energy of soil, air, water, sun-heat; (2) the organism or energy shown in the living body itself, whether simple or complex; (3) the germ cells or energy shown in the sharply segregated portion of the body which has to do with reproduction; and (4) the life environment, the energy of the other living things which surround any one evolving life unit. This means that each evolution consists in reality of four simultaneous and interacting evolutions.

The bulk of the book is divided into two parts: first, the adaptation of energy; second, the evolution of animal form. This second part is presented with admirable interest and clearness, and in the principles set forth Osborn shows his usual characteristics of seizing with well-nigh unerring skill the essentials, the things that underlie and are basic, and of flatly refusing to be led into sacrificing his grasp of the whole aspect of the matter by absorption in one minute phase thereof. In other words, he possesses the rare gift of generalizing boldly and on a large scale, but never recklessly, and never on insufficient data; so that he stands equally far from the crude generalizer whose work is worthless, and from the laborious specializer whose work has a real, but an exceedingly limited, value. His whole discussion of "character evolution" in the chapter on mammals offers a case in point.

This second part is the easier and in some ways the more interesting to read. But it is the first part which represents the greater and more original contribution to scientific thought. In this part Professor Osborn deals with the adaptation of energy to the formation of life. He is dealing with matters as to which it is, at this stage of our knowledge, imperative to feel our way tentatively; and the number of unknown factors is so large, and so many of the known factors are familiar only to experts, that it requires close attention for a layman clearly to grasp what is set forth. We have long passed the stage when men thought that Darwin had discovered a solution, at once entirely complete and entirely simple, of the origin of species and the development of life—the stage when well-read men who were in no sense thorough scientific students (men like Fiske, for instance) produced smooth offhand solutions of problems for which at present we at least know that we have discovered no solution. A half-truth is often of extreme simplicity; but the whole truth is usually of such complication that the utmost effort is necessary in order merely to state it.

This first part of his book Mr. Osborn divides into three chapters. The first chapter treats of the lifeless earth, air, and water of the primordial globe, which differed chemically from the world of to-day; and Professor Osborn shows that life has taken up and made use of almost all the chemical elements which occur frequently in the soil, the water, and the atmosphere. He shows that life doubtless originated in water, and probably in fresh water on the primitive continents.

The second chapter is in some ways the most important in the book, for it treats of the effect of the sun on the physico-chemical origin of life. Professor Osborn lays special stress on the chemical side of life energy; on the "chemical messengers" which produce special and general interaction among the various parts of the organism. The light and the heat of the sun were captured by the primordial life forms, which thus transformed lifeless into living energy. This transformation meant that the properties of the chemical life elements in the lifeless world became functions of the organisms in the world of life. The electric energy of life depends on the original heat energy of the sun or earth; and apparently life at its outset thus captured heat energy, whereas the capture of the light energy by life occurred only much later, through the agency of chlorophyl, the green coloring matter of plants. Bacteria appear when only heat has been captured by life; but all higher life energies are dependent directly or indirectly upon the capture of light also. Then as life developed the interaction of the various chemical life elements became infinitely more complex. All of this is fact. But the mode of the actual origin of life is pure speculation, and this Mr. Osborn explicitly states at the same time that he sketches five hypotheses, representing five successive physicochemical stages, of the origin and earliest stages of the evolution of the life organism out of some ten of the chief chemical life elements.

The third and concluding chapter of the first part of Mr. Osborn's book treats of the early energy evolution as seen in bacteria, algæ, and plants. Doubtless the world during uncounted aons of time was habitable only for organisms as simple as bacteria, while these were slowly making it ready for the lowest forms of plant and animal life. The lowest bacteria derive their energy and nutrition directly from the lifeless world. At the higher levels of bacterial life the protoplasm (the body form) and the chromatin (the reproductive substance) are developed; and then these become the two structural components of the living world.

Professor Osborn explicitly disclaims any attempt to interpret the phenomena of life appearance with dogmatic assertion as to whether there is or is not something that can be dissociated from the functioning of energy as we understand it. The point is far less important than it has seemed both to certain theologians and to certain scientists, for the excellent reason that there are plenty of phenomena unquestionably proceeding from natural law which nevertheless have in them an element totally incomprehensible to, and probably totally incapable of comprehension by, our intelligence. All successful scientific discoveries have been anathematized by certain pietistic theologians, and exultantly screamed over by certain materialists, as marking the end of religion. The discovery that the earth was round, the discovery that the world went round the sun, the discovery of enormous geological ages, the growth of appreciation of law in the natural world, the discovery of the law of gravitation, and recently the understanding of the law of evolution (which, incidentally, had been at least strongly suspected by thinkers as far apart as Aristotle and St. Augustine), were all in succession treated as mischievous heresies by certain champions of orthodoxy, and were also, with equal folly, accepted by certain skeptical materialists as overthrowing spiritual laws with which they had no more to do than the discovery of steam-power has to do with altruism.

The outcome of the working of purely natural law often shows some element which no explanation on our part enables us to interpret and which no speculation would explain save by the substitution of one form of verbiage for another; a line of uninterrupted and gradual causative changes may result at the end in something of which there was no vestige at the beginning; and with our brains we may show with flawless logic that something cannot occur when, as a matter of fact, it does occur. Three examples will illustrate these three statements.

Hydrogen and oxygen combine into water, which contains nothing but the total elements of the two gases and yet also contains qualities totally different from either; for example, it freezes or solidifies at a temperature which has no effect on either of them; and to explain that this probably implies some rearrangement of the speed or position of chemical atoms leaves us precisely where we were before.

The tracing of an unbroken line of descent from the protozoan to Plato does not in any way really explain Plato's consciousness, of which there is not a vestige in the protozoan. There has been a non-measurable quantity of actual creation. There is something new which did not exist in the protozoan. It has been produced in the course of evolution. But it is a play on words to say that such evolution is not creation.

Very intellectual Greek philosophers were able to prove that there could not be any such thing as movement; just as equally wise persons to-day are able to prove that there is no such thing as freedom of the will, and therefore no individual responsibility; and one statement is as flawlessly logical, and as utterly absurd, as the other. This fact is worth pointing out, because in the world of thought there are just as mischievous dogmatists among twentieth-century scientists as ever there were among mediæval theologians—exactly as, in the world of action,

the Bolsheviki of liberty, at home and abroad, are as mischievous as the Romanoffs of reaction in politics and industry. As an instance, most scientific men nowadays disbelieve in the inheritance of acquired characteristics, and in consequence a British scientist and Socialist blatantly insisted that habitual drunkenness in the father had no effect on the children. Immediately afterwards experiments on guinea pigs showed that alcoholism in the parent induced physical degeneracy in the offspring. It was then explained by the scientists that this was not the inheritance of an acquired characteristic, but merely the inheritance of an acquired pathological condition which made it easy for the characteristic to be subsequently acquired. There was a certain warrant for the distinction as a matter of scientific speculation; but as a matter of practical action the value of the lesson lay in inculcating a lively distrust of dogmatism among those men of science who believe that with our limited intelligence, and after utterly insufficient investigation, we are able to lay down laws of sweeping application to thought and conduct.

One of the prime merits—one among the many prime merits—of Professor Osborn's book lies in his absolute refusal to be led into this type of statement. He combines to an extraordinary degree wise boldness and wise caution in his speculations and his conclusions. He is never afraid to say that he does not know; and this trait is one of the contributing causes in enabling him to add so richly to our store of knowledge and of wisdom.

This is not a "review" of Professor Osborn's book, in the ordinary sense; for the book comes in that very small class which cannot be "reviewed," save as we can say that Huxley "reviewed" Darwin, and for this the present writer is not competent. I am not trying to review the book. I am merely calling attention to a really great work of productive scientific scholarship.