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PRESENT TENDENCIES IN THE PHILOSOPHY OF BIOLOGICAL EVOLUTION.

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I.

Man has been called the problem-solver. This is increasingly true, for as our social organization is becoming more and more complex, new problems are arising and demanding solution. Although most certainly man must be credited with the solution of many vexing problems, his interest far out-strips the limited number of difficulties which his ingenuity has actually been able to meet. The mere contemplation of the formidable array of problems of human as well as mechanical engineering, many of which have arisen in the last century, is bewildering. There is yet so much to be done, and each day brings so many new problems that we often despair of the future and assume that we live in an age the peculiar characteristic of which is its difficult problems. But let us not fall into the error of believing that all of our problems are of recent origin, for some of them, if not many of them, perplexed early man as well as the modern scientist. One such problem is that of the origin and development of life. Darwin, as the uninitiated believe, was not the first to speculate concerning life and its development. The Greeks[1] and even the ancient Egyptians[2] and Babylonians, and the Sumerians and Semites who preceded them, were concerned with this most difficult problem—one of the as yet unsolved problems of our age.

[1]G. J. Dudycha: "What Is Evolution?" *Scientific Monthly*, 29: 317–332, October, 1929.

[2]G. J. Dudycha: "Ideas of Origin Among the Ancient Egyptians and Babylonians," *Scientific Monthly*, 32: 263–269, March, 1931.

We can not here review that interesting history of the ideas concerning the development of life—a history which covers a period of nearly six thousand years. During this long period many careful thinkers grappled with the problem of how-did-things-come-to-be-what-they-are and each contributed, from his individual point of view and from his meager or intimate knowledge of the phenomena of nature, such ideas and such principles as he thought gave meaning to life. In spite of the fact that numerous solutions have been offered for the problem of development, none has satisfied all the searchers after truth. Yet, there is hope! New views are still being presented and new light is constantly being shed upon the perplexing problem. We are still grappling with the history of life!

II.

In this paper, we shall deal with four outstanding, contemporary ideas concerning biological evolution. The first of these is that of Mr. John Langdon-Davies which appeared as an article in *Harpers* under the title, "The Loves of Orchids."[3]

After a severe criticism of Darwinism, Mr. Langdon-Davies raises the following question for which he supplies the following answer: "How, then, are we to 'save the phenomena'? There is only one way and that is by limiting the power of 'blind chance' and assuming the dominance of 'mind' and memory in all these strange happenings; in believing, in short, that an animal has the organism and uses it in the way it does because it remembers from past experience, when, instead of being itself, it was its ancestors, that just that organism is useful, and just that way of using it is best."[4]

The question which immediately arises in our minds is, What is here meant by the terms "mind" and "memory" and how do they operate so as to promote development? Let us again examine our text and see if we can find an answer. Again I quote. "When the living being is faced with a given situation it behaves as it did when it last found itself in that situation. What happens when it meets a new situation? Either it dies because it can not think of anything to do or it makes some necessary alteration in its organism to meet the

[3]J. Langdon-Davies: "The Loves of Orchids," *Harpers*, 160: 374–381, February, 1930.

[4]J. Langdon-Davies: *loc. cit.*, p. 380.

new situation. Its offspring remember in their turn what to do and change their organism in the same way, and we have what we call an inherited variation, the product of mind and memory working out sensible solutions to the problems of life. . . . . And to memory must be added the ability to think for itself, that is, to vary and to act upon its thought so far as environment will permit."[5]

Now that we have the essential ideas of Mr. Langdon-Davies in mind, let us consider them critically. First, what does he mean by "memory?" This term is sometimes given two meanings, the one, biological and the other, psychological. From the point of view of biology, a modification which is made, perpetuated and inherited is said to be remembered. In this concept consciousness is not present. If this is what the writer of, "The Loves of Orchids" means, then we can raise no objection, but does he? From the psychological point of view, memory refers to a conscious process—the consciousness that a present experience is more or less intimately related to an experience in the past. Is this what Mr. Langdon-Davies means by memory? We may suspect that it is when we recall the statement: "Either it dies because it can not think of anything to do or it makes some necessary alteration in its organism to meet the new situation." The significant word here is "think." If thought is a conscious process, as we know it to be, and if orchids are capable of exercising thought, then their memory is also very likely conscious. If this is true, then perception would also seem to be a necessary characteristic of the orchids. In the end, it seems, we have been quite successful at personifying the orchids. Also we must note that memory in the psychological sense does not merely imply retention, as the biological use of the term does, but recall and recognition. It is not merely the retention of a modification made at some time in the past, but the ability on the part of that individual to consciously relate that modification or experience to the present. Is this what is done by the orchid, by the protozoan, and shall we be so bold as to say, by the star?

There is a second problem which we must consider. Mr. Langdon-Davies tells us that the orchid "makes some necessary alteration in its organism to meet the new situation" and that the "offspring remember" this change and thus make the

[5] *Ibid*, p. 381.

corresponding change in their organisms. Thus we have an "inherited variation." But again this raises a number of difficulties. Out of all the possible modifications, how is the particular initial modification effected? By taking thought! According to the language of the author of "The Loves of Orchids," the orchid must take cognizance of its problem—it perceives the problem, appreciates the need for its solution and "thinks" out a way of escape. The offspring "remember" the profound solution of the parent and ergo, we have an inherited modification in spite of the fact that not even man can add one cubit to his stature by taking thought. It is just this thought process that we would like to know more about, but unfortunately, we are told nothing about its nature.

The last problem to which we must call attention is the problem of mind. Although Mr. Langdon-Davies tells us that we shall probably have to change our notion of mind, he does not offer to define it for us and thus we are left with the unanswered question, What is mind? If the writer of our text, conceives mind as the force or drive which is responsible for the activity of the creative, developmental process, then another problem looms into view, namely, the problem of distinguishing mind as the go-of-events from mind as the end-result or emergent. From the way he uses the term mind we are led to believe that he is trying to use mind—the end-result, product or emergent—as the drive in all development. This does not seem possible for mind, as he uses it, is itself a resultant. Although there most certainly are formative forces, the term mind should be reserved to designate the end-product, the result, the fruition of the creative process. If the meaning and the use of the term mind were definitely designated, some of our difficulties in understanding this point of view of development would be eliminated.

We had anticipated that after understanding Mr. Langdon-Davies' point of view of development we would have the answer to his question, "How shall we save the phenomena?" But now that we have examined his ideas carefully and critically, we are disappointed. We expected an answer to our problem, but instead we discovered new problems. But let us continue our search for an answer to the problem of how-did-things-come-to-be-what-they-are. Since we have merely considered the first of our four points of view, let us turn to a careful consideration of the second.

III.

Dr. Austin H. Clark, who has labeled his point of view "Zoogenesis,"[6] begins with two assumptions: (1) only life begets life, (2) all living things begin their life as a single cell in which there is not any discernible trace of the adult form. Thus in order to discover the order in the living world, we begin, first, with the idea of the continuity of life from its origin down to the present, and second, with the idea of the common origin of all life in the primitive single cell. Thus all life must have come from this primitive cell by some process. What was the nature of this process? Dr. Clark tells us, "that from the primitive single cell there *simultaneously*[7] appeared through mutation as many different types of animals as were capable of successful existence."[8] And thus, "all of the major groups of animals were formed at the same time as the result of following different developmental paths from the primitive single cell."[9] In support of this contention, he draws his evidence from embryology. "The several major groups exhibit a great variety of conditions in the relation of their different balance in their various essential organs. In their embryonic stages the representatives of the various major groups show a close approximation to each other in the gastrula, but are wholly similar to each other only in the germ cell."[10] To this first phase—simultaneous appearance of all the phyla from the primitive cell by mutation—of his point of view, Dr. Clark gives the name "eogenesis."

Since "we are forced to the conclusion that all the major groups of animals at the very first held just about the same relation to each other that they do today," we must also assume *concurrent evolution*. Thus the ground is prepared through eogenesis, but the growth of the trees—the phyla—is known as evolution. We have, then, the introduction of a second term, that is, *evolution* which is not used to designate a single process, but the individual history of each type of life. Thus

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[6]A. H. Clark: *The New Evolution Zoogenesis*. Baltimore: Williams and Wilkins, 1930.
A. H. Clark: "Zoogenesis: the New Theory of Evolution," *Scientific American*, 143 (2): 104–107, August, 1930.

[7]Italics are mine.

[8]A. H. Clark: *The New Evolution Zoogenesis*, p. 220.

[9]*ibid*, p. 212.

[10]*ibid*, p. 216.

we have as many evolutions, all of which are running concurrently, as we have types of life.

Yet a third question presents itself: How do animals change their form? For this there are three things necessary: first, there must be the production of variants or mutants; second, these variant characters must be heritable; third, the mutants with their heritable characters must be capable of meeting the conditions under which they live to such an extent that their kind is perpetuated. Since specialization is a function of progressive subtraction, the more remote the particular manifestation of life is from the primitive type the less the possibility of producing extensive mutants which vary greatly from the parent type. Thus, "the primitive single cell, having within the potentiality for the production of all types of animals, might be assumed to be possessed of the ability to produce simultaneously mutants which would be widely different from each other, both by structural changes in the single cell and through development involving cell multiplication in various directions."[11]

We see, then, that the process which results in the simultaneous appearance of all types of life is known as eogenesis; the development of many animal forms from the single original type is known as evolution; and the process by which new forms appear is known as mutation. Life is not to be thought of as a single tree with its branches arising from a common trunk, but as a forest of trees each of which has its roots in the soil prepared by eogenesis.

Although the above description of this second point of view might be greatly elaborated, we have Dr. Clark's essential thesis. Let us, then, examine it more carefully. A number of questions arise in our minds. What does he mean by *simultaneous* appearance of all types of life? What are the conditions which were responsible for the simultaneous appearance? What was potential in the primitive cell? Let us return to the first question. What is meant by "simultaneous"? Are we to understand that all types of life appeared from the single cell at the same instant, or that all appeared at some time during pre-Cambrian times? Again we ask, Did all the types of life come from a single cell, or from primitive cells, or did some separate later from the gastrula? If we shall return to our text, we shall find the following statment: "The

[11]*ibid*, p. 220.

only possible conclusion is that there is not now, and there never has been at any time in the past, any linear relationship between the major groups of animals at any stage later than the gastrula."[12] This seems to indicate, as we also find in the figure on page 246, that some of the phyla had their origin in the gastrula, which is a later development from the primitive cell, and not directly in the primitive cell itself. Thus we find that our notion of what is meant by "simultaneous appearance" is vague.

The second question which we raised was concerning the nature of the conditions which gave rise to the simultaneous appearance of all the phyla. It is difficult for us to imagine how certain conditions, obtaining at this early time, could be responsible for the sudden appearance of numerous types differing widely, and then not continue to produce additional types. In other words, why did the whole thing occur once and for all and never again? It seems that Dr. Clark would have us believe that the original diversification of life was cataclysmic and not gradual as it seems to have been subsequently.

There is yet another objection which we must note. Paleontology, as Dr. Matthew[13] points out, does not warrant Dr. Clark's conclusion concerning concurrent development from the original appearance of all of the types of life. Although it is fairly evident that there are various independent lines of development, which have been more or less parallel, since Cambrian times, it does not follow that they were equally independent in pre-Cambrian times. We must admit that our knowledge of the history of life in pre-Cambrian times is very sketchy and incomplete, but what little is known does not seem to point in the direction of Dr. Clark's thesis. It is probable that the laws of nature, which we observe are operating now, operated then, and that all the types of life did not appear suddenly and miraculously.

We have examined *Zoogenesis* and have found that it too is wanting. We had hoped that we would find a solution to the problem of the development of life, but instead we are faced with more questions. We are not ready, however, to give up our quest. Let us turn to our third point of view.

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[12]*ibid*, p. 248.

[13]W. D. Matthew: "The Pattern of Evolution," *Scientific American*, 143: 192–196, September, 1930.

IV.

Professor H. J. Muller,[14] who in a recent article entitled "The Method of Evolution" discussed some of the results which he has obtained from his noteworthy experiments on the fruit-fly, *Drosophila*, makes a very interesting suggestion which may throw light upon our problem. He has found that by treating the fruit-fly, *Drosophila*, with X-rays a large variety of mutants, some of which have favorable and others unfavorable characteristics, may be produced. In addition to X-rays, he believes that radium rays, gamma rays and cosmic rays affect organisms in a similar way and thus produce variations. With this idea in mind he draws the following conclusion: "This being true, there being no evidence of a minimal or 'threshold' dosage, we are forced to conclude that the minute amounts of natural radiation present almost everywhere in nature—some of it of terrestial origin, derived from the radium and other radioactive substances in the earth, water and air, and a smaller part of it of cosmic origin, apparently derived from the diffuse and distant factories of matter—all this natural radiation *must* be producing some mutations in the living things on the earth. These mutations must be very scattered and very infrequent in proportion to the total non-mutated population, just because the amount of natural short-wave-length radiation is very small at any one place, but, considering the extent of the earth and the multiplicity of living things, the total number of mutations so produced per year must be very considerable. It can, therefore, scarcely be denied that in this factor we have found at least *one* of the natural causes of mutation, and hence of evolution."[15]

Recently attempts have been made to test this hypothesis that radiations of the earth cause mutations in genes. As the result of experiments, it has been found that fruit-flies, which were reared in a tunnel in the mountains where radiation was strong, produced more mutations than were produced in the laboratory where radiations were weak. We must note, however, that not only do radiations of the earth affect the rate of the appearance of mutations; but also that temperature, as has been pointed out by Professor Muller, determines their

[14]H. J. Muller: "The Method of Evolution," *Scientific Monthly*, 29: 481–505, December, 1929.

[15]H. J. Muller: *loc. cit.*, p. 496.

rate of appearance in much the same way that temperature speeds-up a chemical reaction. In view of this, Dr. Davenport says:

"Also, it seems probable that radiations are not the primary cause of gene mutations but that they accelerate processes that are initiated by the internal structure of the genes.

"That the essential nature of gene mutation is determined primarily by internal conditions is well shown by the experiments of Demerec. . . The gene has internal capacity for mutation just as an alarm clock has an internal mechanism for ringing a bell at a particular time. Gene mutation can arise from the very mechanism of the gene."[16]

Apparently, then, according to Davenport, the real cause of mutation is in the very nature of the gene and X-rays or the related waves of shorter wave-length, as gamma and cosmic rays, are merely conditions which hasten the process.

No doubt, Muller would refute this objection by pointing out that the powerful rays which affect the gene cause changes there-in which lead to its reorganization. He says: "For the electron, shot out like a bullet (except far faster), tears its path through thousands of atoms that happen to lie in its way, leaving in its wake a trail of havoc before it is finally stopped. In this process, many of the atoms through which the electron tears have one or more of their own electrons torn out or dislodged from their proper places; this change in the structure of the atoms often causes them to undergo new chemical unions or disunions that in turn alter the composition of the molecules in which the atoms lay. If a gene is a molecule, then, with properties depending upon its chemical composition, it can be shot and altered by the electrons resulting from the absorption of X-rays or rays of shorter wave-length."[17]

Here, then, we find in Muller's conception of cosmic energy as the cause of the process of development *one* of the possible methods of development. Since his conclusions are based upon extensive laboratory studies rather than upon pure speculation, and since they do seem to be so highly suggestive, we are greatly inclined to believe that perhaps we have found here something significant, and that some light is being shed upon our difficult problem.

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[16]C. B. Davenport: "Light Thrown by Genetics on Evolution and Development," *Scientific Monthly*, 30: 307-314, April, 1930.

[17]H. J. Muller: *loc. cit.*, p. 491.

V.

The last point of view concerning the possible methods of development which we are to consider is that of a cytologist. Dr. Philip R. White in his recent article, "A Disease and Evolution,"[18] points out that hybridization is most certainly one of the methods of evolution. Due to the extensive losses which have been sustained on the banana plantations which have been caused by the ravages of the "Panama disease," Dr. White studied Gros Michel, our edible banana, with the idea that immunity might be produced by hybridization. If one of the parents is immune, he reasoned, why could immunity not be produced by breeding the parent again? Thus the first problem was to discover the parents of Gros Michel. After a careful examination of the nuclei of the cells of the banana, he found that each contains thirty-two chromosomes which, of course, should give at syndesis, if the parentage has been proper, sixteen pairs. This, however, did not happen for only twelve pairs were observed and eight extras which were scattered and unattached. Thus when the daughter cells were formed these eight extras were often unevenly distributed. Since this is true, the question is, Who are the possible parents of Gros Michel?

Because of what happens at syndesis in the banana, it seems quite apparent that it received twelve chromosomes from the one parent and twenty from the other, which thus gave rise to the twelve pairs and eight extras. Since each parent, except in unusual cases, contributes one-half of its chromosomes to its off-spring, one of the parents of the banana must have had twenty-four chromosomes and the other forty, unless, for some unknown reason, one of the parents contributed all of its chromosomes. With this assumption, Dr. White proceeded to look for the possible parents of Gros Michel and as the result of an extensive search found 38 individuals with twenty-four chromosomes, two with twenty, one with twelve and a single forty. In addition to these possible parents of the banana, Dr. White studied 108 other varieties all of which were discarded. Although he did not find definitely which of the possible parents of Gros Michel were the actual parents, he did make one very significant observation, that is, that we

[18]P. R. White: "A Disease and Evolution," *Scientific Monthly*, 31: 306–318, October, 1930.

have here in the banana a polyploid series the basic number of which is eight and that all of the 150 varieties studied, whose chromosomes range from twelve to forty-eight in number, may be accounted for by some process of combination and hybridization which began with the original banana with eight chromosomes.

Thus we have here another "method" of evolution presented. "In a recent issue of this journal," says Dr. White,[19] "there appeared a paper by Professor H. J. Muller entitled 'The Method of Evolution.' I should prefer that he had entitled it 'A Method of Evolution,' for though the evidence of the existence of mutations is unquestionable and the evidence for the activity of cosmic and earth rays in producing these mutations grows from day to day so that I should certainly not concur with Professor Jeffrey in ridiculing this method, I nevertheless feel that the evidence for concomitant evolution by hybridization is even better established, and that, while perhaps it is not so fundamental in scope as is the 'ray' evolution, it has played a much more obvious and far-reaching role than has the former. This polyploid genealogy is not an isolated example but is typical of whole family groups and also occurs (perhaps of a different origin?) in Professor Muller's own fruit-flies."

Here, then, we have another highly suggestive point of view, based upon extensive experimentation and research, which can not be readily refuted. Thus we see that Dr. White in emphasizing that the changing pattern of life is due to the changing pattern within the cells, which results from particular kinds of combinations, has shed more light upon our vexing problem.

VI.

Now that we have considered four contemporary points of view concerning biological evolution, we come to grips with the problem of development itself. Mr. Langdon-Davies, we found, posited mind and memory as the two important factors responsible for the progressive development in the history of life; but he failed to tell us how these two factors operated, let alone what they are. To merely say that a plant or an animal in the presence of a given difficult situation thinks out a way of

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[19]P. R. White: *loc. cit.*, p. 318.

escape and that its off-spring remember its solution tells us nothing. We do not know why the organism thinks, how it thinks or for what reason it remembers. We merely have two words "mind" and "memory"—magic words—which have worked a potent charm and thus we have all the various forms of life. This view of things is certainly not satisfying, nor is it particularly new. Mind has too long been invoked as a mysterious *cause* of things.

Zoogenesis, we have also found, is but little better than the first point of view which we considered. By some mysterious means all the types of life burst forth simultaneously from the primitive single cell. There certainly is no conclusive evidence that such a thing ever did occur, nor can we comprehend how it could have been the case since that has quite apparently not been the method of nature during historic times. Again we find in Zoogenesis the idea of the potentiality of all things in the primitive cell. "The single cell has inherent in itself the potentiality for development, through selective and progressive reduction in various directions and in various ways, into every form of life which at any time may be capable of existence and of self-perpetuation under the conditions obtaining at that time.

"All animal types are therefore to be regarded, in their relation to cosmic evolution, simply as varied and varying manifestations of the inherent potentialities of the fundamental substance protoplasm. Such a concept contemplates the animal world as in reality but a single unit finding its expression in an infinity of equations all of which, no matter how complicated they may seem, reduce themselves to the same fundamental term."[20]

This by no means is a new idea for St. Augustine expressed essentially the same idea centuries ago. Putting Augustine's idea in modern terms: "In the beginning God made" the first single cell—germ or seed—in which all things that are found in the world today were implicit, and by a process, governed by natural laws with which the Creator endowed this first piece of matter, have become and are becoming explicit. The first cell was the potential universe with all things that are found therein. But Augustine's idea is no longer tenable; it is not adequate as a philosophy of development.

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[20]A. H. Clark: *loc. cit.*, p. 216.

Hence Zoogenesis is also inadequate. It may appear to be serviceable when one is dealing with the development of life, although we have found difficulties even here; but it is wholly inadeqate when one deals with the whole of development of which biological evolution is merely one phase. Hence Zoogenesis has but little to offer us for a philosophy of development.

The last two methods of evolution which we considered—that of cosmic radiation as the cause of development, and hybridization—are the most significant for the philosophy of evolution. In order to have a process we must have a drive of some kind which is the go-of-events. This drive has been variously termed by philosophers—vital urge, *elan vital*, nisus, etc. Perhaps we might be so bold as to include cosmic radiation, but this is still somewhat hazardous. Although we may quite readily see that cosmic rays are at least one of the causes of biological evolution, it is not so easy to see the relationship between this short-wave-length radiation and other more extensive aspects of the development of the universe. There may, however, be a significant relationship which only future study will reveal. On the other hand, hybridization is directly in accord with one of the outstanding present-day philosophical concepts of development—namely, *emergent evolution*. An hybrid is an emergent. Professor Nabours[21] says:

"It has long been known, and is every day becoming more obvious, that sexually reproducing organisms, including man, are generally heterogeneous (we now know not exclusively heterozygous) for a wide range of genes. It has also been ascertained that each discrete characteristic is due to the interactions of several or many different genes, whether in heterzygous or homozygous doses, or distributed over one or more pairs of chromosomes. This fact having been well established and universally acceded to by geneticists, it may, with good reason, be suggested that such characteristics are not merely the additive sums, mosaics, or resultant combinations of the activities of the respective genes, but they are emergences in the same sense that ethyl alcohol and ether are emergences of the respective syntheses of the elements hydrogen, carbon and oxygen."

Thus we have here an idea concerning the method of development which is not only serviceable in biology, but one which

[21]R. K. Nabours: "Hybrid Emergence," *Eugenical News*, 15, July, 1930.

is also in accord with a more general process which includes many other aspects of the universe than merely life.

When we are dealing with biological development, we can not avoid turning our attention to the broader aspects of development, to cosmic evolution. As the careful thinker directs his attention away from his immediate surroundings to the infinite spaces, and contemplates the nature of the universe with its gigantic, heavenly bodies moving at incredible speeds, and with its vast interstellar spaces, its detailed organization and perfection in operation, he asks, "What is man?" But then, courage rises for not only that brightly beaming star and yonder planet, but man and even the lone daisy in the grass, all are a part of this vast and intricate system. Truly it is a *universe!* This being true, there must be some cosmic process—a single process—which is not only responsible for the suns and our earth, but also for the atom, the molecule, the crystal, the organism and for society with all its ramifications. The most apparent difficulty in the history of thought concerning evolution is that too many thinkers—profound thinkers—are interested in but a limited portion of the universe—life. They have propounded many theories of biological evolution, which often appear to be adequate concerning the development of life, but which can not be stretched to fit the universe. No theory of biological development is adequate unless it is in accord with the more general aspects of cosmic evolution.