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CONTENTS

Organic Determinism: PROFESSOR G. H. PARKER 517

The Barro Colorado Laboratory: PROFESSOR W. C. ALLEE 521

Dr. William James Beal: R. S. B. 522

Scientific Events:

Exhibits at the Conversazione of the Royal Society; A Geological Field Trip; Symposium on Absorption of the Ithaca Meeting of the American Chemical Society; Dr. George de Schweinitz 523

Scientific Notes and News 524

University and Educational Notes 528

Discussion and Correspondence:

Present Status of Metric System in the United States: ALEXANDER MCADIE. *Physics Text-books:* A. BLESS. *The College Professor and His Pay:* F. W. STEVENS 528

Scientific Books:

Walsh on the Elementary Principles of Lighting and Photometry: DR. HERBERT E. IVES 531

Special Articles:

Probability-Increase in Shuffling and the Asymmetry of Time: DR. A. J. LOTKA 532

The North Carolina Academy of Science: DR. BERT CUNNINGHAM 536

The Indiana Academy of Science: DR. HARRY F. DIETZ 537

The Kentucky Academy of Science: DR. A. M. PETER 537

The American Mathematical Society: PROFESSOR R. G. D. RICHARDSON 538

Science News x

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ORGANIC DETERMINISM[1]

OUR daily life is chiefly made up of an array of activities determined in the main by our surroundings. The heart beats more or less vigorously in accordance with an uphill or downhill course. White corpuscles move about in our bodies much as amoebae do in ponds and gather in regions of foreign invasion. Our eyes blink at the quick movement of even a friendly hand. Breathing adjusts itself as heart action does and rebels against a self-imposed restraint. Our daily habits become so ingrained that dressing and undressing, eating, going to our occupations and returning from them follow the course of the sun.

But human life is also permeated by a kind of action that calls for a certain measure of freedom. Our choices and volitions appear to us to be in many respects quite free, and this seems especially true the more we attend to this aspect of them. Such freedom is usually regarded as the basis of our social responsibilities, for a person can not be held accountable for that which he is unable to control. Any complete scheme of nature must include a consideration of what seems to be constrained and of what seems to be free in human action.

Our bodies are made up of some twelve of the approximate hundred elements recognized by the chemist and of these the principal ones are carbon, hydrogen, oxygen and nitrogen. These four elements and in fact all others found in living bodies occur in abundance in inorganic nature. In brief there is no element exclusively concerned with life. The chemical elements are further resolvable into electric units, protons and electrons, which in varying combinations give rise to these elements. How can a constitution such as this make clear to us the diversity of human action?

Such a constitution lends itself with comparative ease to the understanding of many metabolic processes as, for instance, those that occur in digestion and the like, the reflexes and the tropisms and many allied organic operations. But will it make clear the human capacity of imagination, of memory, will it serve to elucidate the emotions, the affections and such other factors in human life?

From this standpoint some of the older evolutionists are responsible for an interpretation of nature

[1] This address, from which certain passages were omitted in consequence of an overcrowded program, was read at the annual meeting of the American Society of Naturalists, held at Cincinnati, December 29, 1923.

that appears to be quite false. Recognizing, as they did, the remarkable character of the human mind and the fact that we were evolved from the simpler states of lower organisms, and ultimately from molecules, atoms and, as we would say nowadays, from electric units, they proceeded to endow these simpler states with diminishing amounts of the qualities so evident in the final product and to speak of the molecular mind, of the atomic mind and so forth. But of this view, early advanced by Haeckel and later advocated by Lloyd Morgan, there is not a vestige of supporting evidence. The chemist weighs and measures carbon, hydrogen, oxygen and nitrogen, combines these elements into complex compounds and decomposes such compounds again into their elements, and all with such conformity to law and order that he never for a moment finds it necessary to introduce the conception of an atomic mind to make clear the action of the materials with which he works. Such experimental variations as he finds he attributes to the shortcomings of his technique, and as long as these variations lie within the error of his method, he does not concern himself with them, a procedure that has a pragmatic justification. But after his laboratory experience he returns to his fireside to learn from his wife that she has changed her plans and that instead of remaining at home for a quiet domestic evening, as agreed upon at the breakfast table, she has bought tickets for the opera and he, poor man, must don evening clothes and escort her to town. Yet this wife, as the chemist knows full well, is the same carbon, hydrogen, oxygen and nitrogen that yielded him such uniform and consistent results in the laboratory. Surely this is a real contrast.

But, I hear some one ask, are human actions really as free as they seem to be? Are we not deceived in ourselves when we think we are free? This is by no means a simple question. Bergson and others have pointed out that our decisions depend much upon our past and that what seems to be a free present choice is as a matter of fact a step determined long ago. But such a proposal is no real solution of the question, for either it places the real act of choosing at some distant moment or it throws over the whole a cloud of obscurity through which no light can penetrate.

In approaching this problem we must divest ourselves of many of our preconceived notions, particularly of those that we have gathered from a study of purely lifeless nature. We must not be surprised if the kind of uniformity with which inorganic processes proceed should not reappear in its simplicity in the organic. The kind of test that applies satisfactorily to the inorganic may be insufficient for the organic. If an experimenter ask us to turn a given hand to the right or to the left that he may record in ten trials the number of turns in one direction or the other, we know perfectly well that it lies within our power to make all turns to the right or all to the left or some to the right and some to the left in proportion as we wish. We know further that we may decide on the outcome of the test much in advance or at the moment of action or we may even decide on one course and, in the midst of the operation, change to another. From a personal standpoint the freedom of turning the hand is unquestionable nor is the decision about such an act necessarily relegated to the past. Though many human operations are as circumscribed and mechanical as are the reactions in a test-tube, others, such as those just mentioned, show a certain degree of real freedom. "Men at some time are masters of their fates. The fault . . . is not in our stars but in ourselves." And Palmer, in discussing this problem, expresses much the same idea when he says, "the laws of determinism rule our lives more than the vitalist has been willing to believe. But we are free to choose between two alternative lines of necessity and to that extent at least our fates are in our own hands." And no less an authority than Huxley adds, "nobody doubts that, at any rate within certain limits, you can do as you choose." In my opinion, some human acts exhibit a limited amount of real freedom. To deny this is to fly in the face of fact.

I can not agree with Jennings that with less than this minimum of freedom social responsibility can really exist. Whether my hand goes into my own pocket or into my neighbor's may make all the difference between a moral act and an immoral one, and in the normal human being the freedom to decide in which direction the hand will go is, I believe, at times a real freedom. Disease or habit may prevent or remove this freedom, but that it exists under certain circumstances I have not the least doubt.

How can a freedom of this kind be thought of as a property of a body composed exclusively of such chemical elements as carbon, hydrogen, oxygen and nitrogen? The answer to this question is to be found, in my opinion, in the way in which these elements are assembled, in the organization of the compounds that they form. Who would suspect the properties of water from those of its component elements, oxygen and hydrogen? These two gases in no way suggest the liquid, water, with a maximum density four degrees above the freezing point, not to mention other physical properties. Yet we know that hydrogen and oxygen unite with a loss of energy to form water and that water with the absorption of energy may be resolved again into hydrogen and oxygen. This state of affairs is true of all other chemical combinations. The elements of which compounds are formed give no grounds for the prediction of the properties that the compounds show. This rule seems to hold in all

chemical reconstitutions. The properties of electrons and protons give no clue to many of the most conspicuous properties of the resultant atoms; nor do the peculiarities of given atoms foreshadow the characteristics of the molecules into whose composition they enter. Science may eventually discover what these relations are, but for the present it must admit that they are almost completely beyond range. In material evolution each step is marked by an abrupt and sudden change. Nature is not, as the older evolutionists would have us believe, a smooth ascent or descent in complexity, but each move is associated with abrupt alterations in which properties entirely novel and unpredictable appear. The changes suggest organic mutations such as biologists have been working with recently, and this resemblance may not be so superficial as at first sight it appears.

In fact, what goes on in the inorganic realm is abundantly met with in the organic. When organic molecules are assembled in a certain way they exhibit properties quite unlike those they show when they are brought together in another way. The same kind of food may be supplied to a cat and a dog with the result that there will be, not an increasing similarity between the two animals, but more cat and more dog, for in each case the added materials will be organized in a way peculiar to each animal. If it were possible to assemble in an appropriate fashion all the materials of which a given living organism is composed, their interaction would be such that life would immediately appear, for life is the expression of precisely such organization, just as the properties of water are the expression of a particular organization of hydrogen and oxygen. That living things have not been produced as water has is due to the enormous complexity of organisms and not to the necessary impossibility of the steps in the operation.

From separate organic compounds to organized living protoplasm we pass from one plane of organization to another and consequently from one set of properties to another. The essential properties of living protoplasm are at present no more to be understood from its constituent compounds than are the properties of water from those of hydrogen and of oxygen. The properties of living protoplasm are too manifold for description. They are those properties whereby living protoplasm acts otherwise than its chemical constituents do. They are as diverse as are the kinds of protoplasm. In specified forms of nervous protoplasm these properties include types of action in which a certain degree of freedom is involved, so that out of a given situation one of several possible and different lines of activity may result. This is the type of action that enables a person to turn his hand at will to the right or to the left. It is a type of action that determines its own direction. That this freedom is common to all living protoplasm is improbable. That it is the property of even all nervous protoplasm is unlikely. It appears to be characteristic of only certain kinds of nervous protoplasm. But that it is the property of such protoplasm seems beyond doubt.

This property disappears at once on the disorganization of the living nervous protoplasm that exhibits it. When thus disorganized such protoplasm breaks into its constituents, which in consequence of the change in organization exhibit very different properties as, for instance, those of lifeless bodies. Thus differences in organization are accountable for differences in properties in the organic and the inorganic alike.

According to this view a limited freedom of action results from a given organization. The activity may pass off over one of several possible courses instead of being restricted to a single course, as is common in the inorganic. The contrast between a single course and multiple courses may be made clear by a mathematical comparison. If we ask ourselves what constitutes two in any group of units, there is only one answer, namely, two units. But if we put the same question concerning ten, there are several answers, any one of which is equally true: a group of six plus a group of four, a group of seven plus a group of three, and so forth. The first condition typifies what is commonly met with in the inorganic, only a single possible course of action. The second condition represents what is found in certain kinds of nervous protoplasm, several equally possible courses. Thus, from a given state of nervous activity, rendered possible by the type of organization, one of several courses of action may be taken, the state of activity itself determining which course will be elected. This view contravenes nothing in the energetics of inorganic action. It merely extends the single course of action in the inorganic to several courses and sets the determiner as to which course will be elected in the process itself. This property of nervous protoplasm is at present no more to be explained than are other fundamental properties of material, such, for instance, as gravitation. Knowledge may eventually make clear to us the nature of these properties. At present they are open to observation and description rather than to explanation, if in fact explanation applies to such matters.

The view herein set forth is plainly not what Jennings and others mean by experimental determinism, for out of a given nervous activity may emerge any one of several lines of action without perceptual diversity preceding the given action. Within limits nervous activity determines its own direction. It exhibits what may be called limited indeterminism. This view is also not that expressed by Minot that con-

sciousness affects vital processes, for consciousness itself is a vital process and not an agent that influences vital operations from the outside. It is in the very midst of certain nervous activities and is as a matter of fact one aspect of them.

This view implies that the processes of nature are dependent upon the way in which natural elements are assembled and interrelated, that is, upon the way in which they are organized, for with each new plan of organization, be it from electron to atom, from atom to molecule, or from molecule to aggregate, a new type of action appears. The activities of each type of organization are peculiar to that type and are not, at present at least, predictable from the activities of the elements that enter into the new organization.

Is the view advanced in this address vitalistic or mechanistic? Within recent years all such general views have been put on one or the other side of the line supposed to separate these two fields. The authors of such views have suffered similar fates. They, too, have been ranged willy-nilly on one side or other of this imaginary line and often with incongruous and contradictory results. Some, however, are by their own confessions avowedly mechanists, others vitalists. But this has not prevented classifiers from arranging them quite differently. At times this matter has risen almost to the level of personalities. For a vitalist to call another a mechanist or the reverse seems to be a source of great relief to certain pent-up natures. Then, too, there are those who in conformity to the freedom argued for in this paper have taken the liberty of changing sides and after having been for a while advocates of one view have subsequently gone over to the other. Consequently, much confusion exists and, as Jennings says, persons holding the same views rally to different battle cries, while those with diverse opinions march in supposed alliance.

What constitutes the mechanistic view is not easy to say. Newton expressed the hope that the laws of celestial mechanics would eventually find application to all nature, including living things. Growth in this direction has been the characteristic of Loeb's mechanistic studies. These afford a safe basis for experimental research and require no defense such as Jennings has recently made for experimental determinism, and Neal for vitalism. It is plain, however, that the view advanced in this address includes more than the orthodox mechanism of to-day will allow. It is, however, conceivable that the modern mechanistic view may expand, as in fact it has done in the past, and absorb this and all other like views.

It is also equally plain that the view herein expressed falls short of the requirements of even a moderate vitalism. In his defence of this doctrine Neal states that human experience includes phenomena without spacial attributes and implies that these are the peculiar subject-matter of vitalism. No such elements are involved in the doctrine advanced in this paper. According to this view no entelechy slows up or hastens on the processes of living nature. Neither does a psychoid nor an elan vital find a lodgment in this scheme. Types of organization, not the addition of new elements, characterize this view and in this sense remove it from the pale of vitalism.

Mast in a recent paper has intimated that a declaration in favor of vitalism or of mechanism would be premature at the present time. This statement carries with it the implication that one or other of these views will eventually prevail. But in my opinion, in addition to vitalism and mechanism, there may be a tertium quid, or, if I may be allowed such expressions, possibly a quartum or even a quintum quid. The view advanced in this paper is some one of these. It is not the animism of such psychologists as McDougall nor does it agree with Bertrand Russell's opinion that the universe is composed of something in nature between thought and material. If it must be named, it might be called organicism, to use a term introduced about a century ago and recently revived by J. S. Haldane. But it is not Haldane's organicism, for this is based on his belief that the world with all that lies within it is a spiritual world. It is a materialistic view which, however, recognizes in certain types of organized matter a degree of free action consistent with human behavior and the resultant responsibility.

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Postscript: Since this address was read, the author's attention has been called to two recent books in which much the same principle that has been advanced in these pages has been independently advocated. They are R. W. Sellars's "Evolutionary Naturalism" (Chicago, 1922), and C. L. Morgan's "Emergent Evolution" (New York, 1923). It is evident from the latter volume that Morgan has profoundly changed his views as compared with those attributed to him in this address and taken from his "Comparative Psychology" (1894).

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THE BARRO COLORADO LABORATORY

I HAVE just returned from two months' work on Barro Colorado Island, the site of the new station for tropical research in Gatun Lake, C. Z. Barro Colorado Island was the largest of the old hills rising above the valley of the Chagres River and consequently is now the largest of the islands in the man-made Gatun Lake. It is located about an hour's ride, either by outboard motor or by native boatman, from Frijoles which in turn is about an hour by train from Panama City. One can commute from civilization at Ancon and spend from 9:15 to 3:30 on Barro Colorado.

Comfortable living quarters have just been erected and equipped on the island so that a small party can now live and work with comfort in the jungle itself.

The jungle spreads over the five square miles of the island without natural openings. It is more dense on the more distant southern side than around the new building. The lower slopes of the hills around the margin of the present island were formerly under cultivation to a considerable extent and on the far side a few hectares are still under cultivation although all such work by natives is now a thing of the past. Remnants of the plantings of bananas, oranges, limes, guava, etc., are still encountered in the bush and the abandoned sites of several native huts can still be distinguished.

There has been some chopping above the cultivated region but, to all appearances, the central and higher part of the island is virgin although one hesitates to state that it has not been cut over in the four centuries during which the isthmus has been occupied by white people.

The jungle is of the rain forest type but its height and density is of course affected by the fact that the rainfall is only about a hundred inches annually. The usual height is about a hundred feet to the main jungle roof which is overtopped by scattered trees. The growth is so dense that one can rarely obtain a good view of the lake even from the hillsides near the water. On the southern side much machete work is necessary in order to make one's way, but on the northern side the growth is more open.

The "laboratory" just finished is admirably equipped for living in the jungle and to serve as a base for collecting and for field observations. It can readily be used for extended and much-needed studies in tropical life histories of animals living in rapid streams and in Gatun Lake as well as of the jungle animals themselves.

Ants and termites are the most conspicuous insects and offer excellent opportunities for the study of habits and for the collecting of commensals. Several new species of the latter have been taken in the short time since work began about the laboratory. *Peripatus* also occurs on the island, although it is not easily come by in the dry season, and the general physiology of this much talked of animal can be studied here.

The birds are the most noticeable of the higher animals, with lizards a close second. There is much need of life history work on these groups both of the older natural history type and of the newer type of studies into the physiological requirements during different stages of development.

Armadillos, conejos, nequis, peccaries, raccoons, night monkeys, white faced monkeys, and black howling monkeys are common and relatively tame. Tapirs, large cats and deer are also known to occur. Sloths, anteaters, etc., are found nearby and are probably on the island.

The station also affords an opportunity for the study of the physical conditions under which animals live in this sort of jungle and for comparison with life conditions in the dryer regions on the Pacific coast and the more moist jungles of the Atlantic side. In connection with such studies or independent of them one can readily work out the local distribution and association of animals in the manner that has become fairly standardized in making ecological surveys in temperate regions.

Probably the greatest value of this new station for