Is that the idea that Professor Bolley intended to convey, that the number of persons referred to by him in this connection is less than "a few"? Or does he mean more than "a few"; or exactly as many as "a few"?

This array of logical discussion is of course mere quibbling, and is designed to bring out the writer's surprise, that a learned teacher, in a scientific disquisition in a scientific journal, should have introduced this slangy and meaningless expression, that has appeared of late years as a malevolent fungus growth on our "mother tongue," and become a sort of fad much affected by the "light weights" of our present social and literary world.

With apologies to all concerned.

T. G. DABNEY

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SCIENTIFIC BOOKS

The Fitness of the Environment. An Inquiry into the Biological Significance of the Properties of Matter. By LAWRENCE J. HENDERSON, Assistant Professor of Biological Chemistry in Harvard University. New York, The Macmillan Company. 1913.

This book is essentially a discussion of the nature and implications of organic adaptation, *i. e.,* of the relations between the living organism and the environment, but is written from an unusual point of view.

> Darwinian fitness is compounded of a mutual relationship between the organism and the environment. Of this, fitness of environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life. Such is the thesis which the present volume seeks to establish.

This quotation from the preface defines clearly the author's general purpose and indicates broadly the general nature of his treatment. In his discussion he inverts the order of procedure customary with biologists. Adaptation, he points out, is a reciprocal relation, depending quite as much on the existence of special conditions in the environment as in the organism. This environment—nature, or the physical cosmos—exhibits in its ultimate constitution certain characteristics which are of such a kind as to favor the production and continued or stable existence of living systems or organisms. The world, in other words, is, and was from the beginning, fitted for the abode of life. This was the contention of Paley and the other natural theologians. It implies a biocentric conception of nature—a conception once familiar and, indeed, historically the first to be formed, but which has fallen into disrepute since the rise of the theory of evolution. Dr. Henderson aims at rehabilitating this view and supporting it by an appeal to the results of modern physical science. His conception of nature has thus some of the characteristics of Paleyism in a modernized form, but is essentially uncolored by theological and philosophical prepossessions. The greater part of the book is devoted to an account of the chief physico-chemical peculiarities of the environment. This is largely a description of the general properties of matter, with especial regard to their biological fitness. Attention is called to many conditions favorable to the production and continued existence of living beings. Carbon, hydrogen and oxygen, the most abundant and widely distributed of the elements, and their chief compounds, particularly water and carbon dioxide, possess a variety of properties and modes of behavior which render them ideally adapted to the formation of systems having the characteristics that we call vital. What is insisted on as remarkable is not merely the existence—in such a substance as water—of single properties that are biologically favorable; it is the possession of a unique *combination* of characteristics shown by no other substance, and which so far as we can see could not possibly be possessed by any other substance, that gives water its unique fitness as a component of living matter. Similarly, with carbon dioxide and the other chief compounds of carbon with hydrogen and oxygen: they are uniquely favorable as constituents of protoplasm and no substitutes are conceivable.

In support of these contentions, the author proceeds as follows: He first reviews the distinguishing characteristics of the living organism. All organisms are primarily complex, *i. e.*, the number of distinguishable structural and functional components is large; they are the seat of continued chemical change involving constant interchange of matter and energy with the environment—in a word, of metabolism; and they exhibit durability or stability in an environment more or less subject to change; in other words, the possession of an automatic power of adjustment to changing conditions, or of *regulation*, is typically highly developed. Complexity, regulation and an energy-yielding metabolism are thus essential to organisms. The question is then asked: "To what extent do the characteristics of matter and energy and the cosmic processes favor the existence of mechanisms which must be complex, highly regulated, and provided with suitable matter and energy as food?"

By a process of elimination the author defines water and carbon dioxide as those constituents of the environment which are most essential to life. The physico-chemical peculiarities of these two substances are then considered at length. The remarkable solvent, thermal and dielectric properties of water are shown to be indispensable to the complexity and stability of living protoplasm; the importance of its chemical properties, especially its ionizing and hydrolyzing action, is also dwelt upon. Similarly, the many remarkable properties of carbon dioxide are pointed out, in particular, its high solubility—a necessary condition for enabling organisms to utilize it in such large quantity—and its dissociation-constant, which has just the value that is most favorable to the preservation of an approximate neutrality in aqueous solutions containing its salts: protoplasm is thus protected against wide variation in its hydrogen-ion concentration; the constancy of reaction thus secured is a highly important factor in securing constancy of chemical conditions in cells, and hence in furnishing the conditions for a stable chemical organization. Other important constituents of the environment are salts: the abundance and variety of these in sea-water are pointed out, and their importance in vital processes—depending largely on their characteristic relations to the colloids—is emphasized. Water, carbon dioxide and salts are thus the essential constituents of the environment of living organisms, and it is ultimately from these substances that the living matter is synthesized. In correspondence with the importance assigned to these substances, special chapters are devoted to water, carbon dioxide and the ocean. The properties of substances in a state of solution are also discussed (osmotic pressure, diffusion, ionization). The following chapter reviews the chief features in the chemical behavior of the three chief elements and their compounds. The author insists that carbon alone, of all the elements, has the properties which render possible the formation of compounds sufficient in number, kind and complexity for vital processes. He also calls especial attention to the *mobility* of carbon—due to the gaseous nature and high solubility of its oxide—and to the importance of the high heat combustion of carbon and hydrogen and their compounds in the energetics of vital processes. By simple reduction, followed by polymerization, carbonic acid passes over into the sugars; and thus the first step from the simple gaseous oxide to complex organic substances, which at the same time are reservoirs of energy, is remarkably simple and direct. The close chemical affiliations of the sugars to many other compounds important to the organism are also briefly discussed. This part of the book is itself a concise summary and hence can not be satisfactorily summarized. The author's essential conclusion is that the foregoing characteristics of carbon, hydrogen and oxygen, which make possible the production of living protoplasm, constitute a series of maxima—are unique when compared with the corresponding properties of other elements. Hence they show the greatest possible fitness for life.

In Chapter 7 the argument is restated in more concise form, and in the final chapter, "Life and the Cosmos," the possible significance of living beings in the whole scheme of nature is considered. How comes it that the unique properties of carbon, hydrogen and oxygen should be so favorable to the organic mechanism? should fit the universe for life? Are cosmic and biological evolution one? Is there a teleology inherent in nature? There follows a brief discussion of vitalism. The views of Driesch and Bergson, which postulate a physical indeterminism in the organism—*i. e.*, maintain that guiding or activating factors other than physico-chemical intervene in life—are rejected. There is no evidence of gaps in the organic nexus. Yet the possibility of a vitalistic point of view, which is nevertheless consistent with a belief in the entire adequacy of physico-chemical analysis, is not thus excluded, and the author insists that this possibility must be recognized. Cosmic and biological evolution *may* be one. There remains as consistent and possible a teleological view, not of life alone, but of the whole cosmos and thus of life considered as a part or product of the cosmic process. The universe may after all be biocentric. It is not to be expected that scientific research will ever find any instances of complete discontinuity or indeterminism in nature, as the eloquent paragraph quoted from Royce rightly insists; all single events are rigidly determined; but the existence and characteristics of the natural process as a totality, including life as one outcome of this process, are not to be accounted for by purely scientific methods of explanation. A teleological and, by implication, a vitalistic interpretation of nature thus becomes possible. The philosophical questions thus raised are not, however, discussed in detail.

Such is an outline of this interesting, clearly written and thoughtful book. The author's style shows precision and definiteness throughout, and his treatment is clear and consecutive. The account of physico-chemical factors and processes is modern and accurate.[1] In so condensed a book it is easy to point out omissions. More space might well have been devoted to a consideration of the rôle of nitrogen in organisms; this element is fully as important as carbon, hydrogen or oxygen. The chapter on organic chemistry is probably too concise to be popularly intelligible. The section on sugars is perhaps over-technical and its concluding paragraphs are not very clearly expressed. Little space is given to proteins. The difficulties of popular presentation become almost insuperable here, and the author seems to hurry over this part of the task.

It remains to consider critically the general argument of the book. The author transfers the conception of fitness from the organism to the inorganic environment in order to emphasize the reciprocal character of biological adaptation. He then devotes almost his entire space to showing that the environment possesses characteristics favorable to life as we find it. Having shown this, he omits considering in corresponding detail the characteristics of the organism itself, and the general nature of the inter-relations between organisms and environment—in other words, what adaptation itself is, as a general condition or process; and this method of treatment gives a certain impression of incompleteness. Now it is quite clear that the universe must show itself, on examination, to be a fit environment for living beings, since they continue to exist in it; further, this fitness must show itself maximal in the case of organisms showing maximal adaptation to their surroundings; and thus the general outcome of the author's argument might have been foreseen. Granted that systems having the properties of living beings could not have arisen had the properties of carbon, hydrogen and oxygen, and of their combinations, been other than they are, what does this prove? Most biologists will probably consider the author's central thesis as either self-evident or inherently unprovable,[2] and will prefer to regard this book as essentially a scientific essay on the biological importance of the more general and

[1] On page 177 osmotic pressure is said to be proportional to the total number of particles (molecules *plus* ions) which are present in solution, instead of in unit volume of solution, but such inadvertencies are rare.

[2] That is, this world may be the best possible environment for the organisms that have come to exist in it, but it might not be so for the living beings of another and quite different cosmos!

elementary properties of the elements and compounds entering into the formation of protoplasm. Considered in this light alone, the book is remarkable for the breadth and ingenuity of its treatment and for calling attention to many facts and principles the importance of which is often overlooked. To many readers this will constitute its chief interest.

This, however, is not exactly the reviewer's opinion. The question of the final significance of biological adaptations is raised in a novel and interesting form, and some further discussion of this question seems called for here. What, after all, is meant by this conception of adaptation? Considered from the most general point of view, it seems best to regard adaptation as essentially an instance of *equilibrium,* though of a complex kind.[3] Equilibrium is a conception of physical science, and as such susceptible of exact definition; to regard adaptation in this light implies that the problems which it presents are essentially physiological in their nature, and hence relegates the teleological point of view to the background. This is always advantageous for physical science, however it may be for practical life or philosophy. To many, the statement that adaptation is an equilibrium may seem either metaphorical or a truism; to the physiologist it embodies a definite conception of the organism as a physico-chemical system which maintains its existence by a continued succession of automatic compensations. What we observe is that the adult organism preserves its characteristics intact, for a greater or less period of time, in spite of continual loss of material and energy to the environment. Now, the processes by which this loss is balanced by a corresponding intake, thus enabling the life-processes to continue, are just those which we characterize as "adaptive." The structural and functional adjustments necessary to maintain this balance are often delicate and complex in the higher organisms; they involve the existence of special mechanisms—such as the hand, the eye and many others; but these always correspond to certain constant features of the environment, and play a part which in the last analysis is essentially compensatory in the above sense. To put the matter in somewhat different and more general terms: if the characteristics of a system undergoing perpetual change of composition and loss of energy are to be maintained constant, it is indispensable that a set of processes antagonistic to and therefore compensatory to these changes should be maintained. The adaptive and regulatory, and most of the "purposive" activities of an organism form the conditions necessary to the existence of these compensatory processes. Evidently, this point of view implies a fitness in the environment as well as in the organism. The two must correspond as lock to key—or as the oppositely directed and mutually equilibrating components of *any* system in equilibrium—if any such interaction is to be possible. Hence the continued existence of any organism implies environmental fitness, *i. e.,* the existence of conditions and processes in the environment which correspond to or balance those in the organism. It is thus inevitable, if we consider the special peculiarities of any complex and stable system, and correlate them with those of the environment, that the latter should be found to exhibit a "point for point" and reciprocal correspondence with the former. The case of the organism has seemed exceptional simply because biological students have been so long accustomed to regard the organism as a system possessing unique "vital" properties and existing in an environment having totally distinct characteristics. To the human mind there is no more profound contrast than that between living and lifeless. Dr. Henderson's study shows that even in its ultimate constitution the environment possesses characters corresponding to those of the living organism, and the discovery of this truth will no doubt surprise many others, just as it surprised him. But what if this were not the case? Obviously, such systems as organisms could never have come into existence. The surviving organic forms are simply

[3] Adaptation is treated from this point of view in Paul Jensen's "Organische Zweckmässigkeit, Entwicklung und Vererbung vom Standpunkte der Physiologie," Jena, 1907.

those which can maintain an equilibrium with their environment. Of course conditions may arise which disturb this equilibrium. If, then, the organism possesses insufficient power of compensating these new conditions, it sooner or later ceases to exist. Natural selection is simply the process by which such imperfectly compensated living systems are eliminated. The conception of a selective agency as operative in this process of adapting organisms to environment is frankly anthropomorphic, and hence from the standpoint of physical science insufficiently exact. It is better to replace it by a conception in which the organism is regarded as a material system maintaining a dynamic equilibrium[4] with the environment. That the environment should have the character of fitness—that its processes should equilibrate those of the organism—is not surprising, is indeed self-evident. One chief aim of biological science, in fact, is to show how the characteristics of the organism are related to, and ultimately proceed from, those of the environment.

The task of biological science is thus left where we found it. To account for the characteristics of organisms on the basis of the physico-chemical characteristics of their component elements and compounds involves showing how the characters of living beings are derived from those of the environment. To do this in detail would involve retracing the course of evolution. Obviously, this can be done only in outline; but a necessary presupposition of any such undertaking is that the chemical elements which form the inorganic cosmos possessed from the beginning of organic evolution such a constitution and such modes of interaction as to render possible the production of living beings. By some thinkers this statement may be understood to imply that life was implicit or potential in the universe from the very first. But to the scientific investigator such a statement can have little meaning, since it is remote from the possibility of verification. He might even regard it as one more of the many useless and distracting freaks of verbalism. In point of fact, the course of scientific inquiry is little affected by such considerations.

From another point of view, however, such a statement ceases to be a truism, and acquires significance as one form of the philosophical insistence on the essentially unitary nature of the cosmos. The problem of vitalism is then seen in a clearer light. On the interpretation of natural science the evolutionary process can have followed only one course. Just why evolution has followed the course leading to the present outcome is a problem for philosophy rather than for science. Most scientific men agree that natural science aims at describing phenomena and tracing their interconnections, and does not try to account for the existence of nature itself. Now the problem of the place of living beings in nature has both its scientific and its philosophical aspects. The biological vitalists have tried to account for the physico-chemically unanalyzed peculiarities of organisms by assuming the existence of special extra-physical vital agencies (entelechies and the like). Dr. Henderson's discussion of this problem regards all such solutions as inadmissible. Since we can not separate living beings from their environment, it is clear that organisms must, from the scientific point of view, be considered and investigated in the same manner as the environment, *i. e.*, as the rest of nature. The vitalism of Driesch and Bergson is thus discountenanced, and insistence is made on the adequacy of the physico-chemical methods of investigating life-phenomena. The author believes that the only possible form of vitalism is one which regards the entire cosmic process as in its essence and from its inception biocentric in character. This is obviously a philosophical rather than a scientific point of view, but it has the advantage of interfering in no way with a scientific consideration of life or of any other natural process; and in the reviewer's opinion also it is the only tenable form which vitalism can assume. It is difficult to see how scientific exception can be taken to such a doctrine. It has, in fact, been held

[4] Equilibrium of processes, and not simply of static conditions, *e. g.*, a whirlpool, candle-flame, etc.

by various philosophers, though hitherto by relatively few scientific men.

It is evident on closer consideration that the existence and peculiarities of organisms must become completely unintelligible *except* on the assumption of a rigid and unvarying uniformity in the essential character of the processes taking place in living matter. The existence of material systems of such extreme complexity, which nevertheless maintain a stable existence and act in a manner which is uniform and within limits predictable—so that each human individual has a definite personal character—is in fact the most convincing proof that could be asked of the uniformity and invariability, as regards both their nature and their interconnections, of the innumerable substances, conditions and processes underlying the vital manifestations. Not only is the assumption of an extra-physical entelechy unnecessary, but it renders more difficult instead of easier the task of biological analysis, since it introduces a factor whose operation is *ex hypothesi* inconstant and unpredictable, and hence incompatible with the stability that vital conditions require. The assertion of Bergson that the living organism is characterized by a maximum of indeterminism[5] makes the organic mechanism completely unintelligible, and to a physiologist seems almost the precise inverse of the truth. It is evident that in any physiological process any even momentary variation or deviation from a constant physico-chemical mode of action—say any inconstancy in the law of mass-action—would derange the whole interdependent system of processes, and render continued life impossible. The organism constitutes in fact the most impressive illustration that nature offers of the unfailing constancy of natural processes. The course of embryonic development is as essentially constant a process as the revolution of the moon about the earth, besides being far more complex; and this stability of the organic processes is fully as necessary to the continued existence of the species as is that of the inorganic processes. The usual forms of vitalism are hence inherently unintelligible and self-contradictory. It is certain that the advance of physical science, and especially of biological science, offers no escape from the deterministic dilemma. Experience shows everywhere not only interconnection between phenomena, but an invariability in the modes of interconnection. Constant repetition always exhibits itself as the order of nature, when the elementary constituents and processes are observed. The question inevitably arises: how then is it possible to reconcile teleology and the existence of will and purpose in nature with the existence of a physico-chemical determinism which appears the more rigid the further scientific analysis proceeds? Such problems are usually left on one side by scientific men, and this is not the place for their fuller discussion. Obviously, however, they require biological knowledge for their solution—if, indeed, they are ever to be solved; and one chief merit of the book under review is that it directs the attention of biologists once more to the importance and urgency of these questions.

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[5] "Creative Evolution," Chapter 2.

The Interpretation of Dreams. By SIGMUND FREUD. Authorized translation of third edition by A. A. BRILL. New York, The Macmillan Co. 1913. Pp. xii + 510. Price $4.

The "Interpretation of Dreams" is one chapter in Freud's theory of the neuroses, and was arrived at by the same methods which proved so useful in the study of the latter. This study revealed principles of even wider application than the sphere from which they were derived, and led to the author's illuminating psychopathology of every-day life. Similarly the dreams of normal people have become much more intelligible in the light of the analysis of psycho-neurotic symptoms and of the dreams of psycho-neurotic patients. Those who are familiar at first hand with the mechanisms of the neuroses and who are at home in the literature of the subject will find the "Interpretation of Dreams" an extremely stimulating monographic treatment of one aspect of a very large subject. To those who