II. In jar of aquarium water + 2 drops of N/10 NaOH per 10 ccm water. No weed growths.

III. In jar of normal aquarium water without weed growths

Fig 8. Photographed Mar. 27, × 11/14. Typical animal from Jar I.
After being photographed this individual was replaced in the aquarium. The animals in Jars II and III were unchanged on Mar. 27.

Fig. 9. Photographed April 11, × 3/4. Animal which had been removed from Jar I to aquarium on Mar. 27.

L. J. Henderson on "The Fitness of the Environment"[1]).

By S. O. Mast.

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In earlier days when design and special creation were topics of the hour it was generally assumed that the environment had been especially created for the needs of the organism, and the foundation for many an argument favoring the existence and omnipotence of an all-wise Creator was based on statements concerning the fitness of its various factors. But with the appearance of "The Origin of Species" in 1859 this attitude changed and it came to be quite generally held that the organism had been gradually so molded as to fit that part of the world in which it was destined to live. Since that time this assumed molding process has dominated practically all investigation bearing on the relation between animate beings and their surroundings. Thus interest in fitness and adaptation from the point of view of the environment itself was all but lost. In the opinion of the reviewer the greatest value of Henderson's stimulating book lies in the bearing it has on again directing attention to the problem from this point of view.

The book may be divided into three parts. The first part, covering 72 pages, is devoted largely to a characterization of the organism and its environment and a statement of the fundamental problems concerning fitness. Our author recognizes that life has various aspects. In his argument however he aims to consider it only from the mechanical or physico-chemical aspect. He says (p. 31), Life as we know it is a physico-chemical mechanism[2]), and it is probably inconceivable that it should be otherwise. 'As such, it possesses, and, we may well conclude, must ever possess, a high degree of complexity."

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1) Published by The Macmillan Company, New York 1913, 317 pages.

2) The term mechanism is frequently used to designate merely the material parts of a machine. I assume, however, that Henderson uses the term in a broader sense, that he intends to include in his statement, that life is a mechanism, not merely the idea that it is a complex system of material parts, but that it is such a system in action. If this assumption is valid his definition of life is somewhat broader than that of Aristotle, Spencer and Brooks, in which they state that the essence of life is adjustment.

The environment is recognised as consisting of numerous factors. The most important of these the author holds, are CO_2 and H_2O, and his conclusions regarding the fitness of the environment are based on a treatment of these factors. Thus the author maintains (p. 63) that "Living things permit themselves to be simplified into mechanisms which are complex, regulated, and provided with a metabolism, the environment, by a series of eliminations, is reduced to water and carbonic acid." But he says, on the same page, "These are simplifications counseled solely by expediency. Neither logical process is necessary; each involves a disregard for many circumstances which might be of weight in the present inquiry."

The problem which Henderson has set for solution consists not only of the question as to how fit the environment is for the continuous existence of a complex, durable, automatically regulated system (life), but also of the question as to how it happens that it is fit at all. He says (p. 66), "Water is indeed a wonderful substance which fills its place in nature most satisfactorily, but would not another substance do as well? Is not ammonia, for example, a possible substitute?" and (p. 67), "It will be necessary to find out whether these substances are not only fit but fittest"; and again (p. 37), 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? If it shall appear that the fitness of the environment to fulfill these demands of life is great, we may then ask whether it is so great that we cannot reasonably assume it to be accidental. and finally we may inquire what manner of law is capable of explaining such fitness of the very nature of things."

The only point in this section of the book regarding which there is likely to be much controversy concerns the idea of necessity introduced in connection with the definition of life. Organisms have been observed to be very complex and relatively durable; and they have been seen to possess, within certain limits, the power of regulation (adjustment). But is this adequate reason for assuming that they must necessarily be as they are? Are they not as they are simply owing to the action of their surroundings, and could not living beings, radically different, exist if the environment were quite fifferent? These questions will come up again later.

The second part of the book covers 200 pages devoted to a detailed study of the properties (chemical and physical) of H_2O and CO_2, their elements, and various compounds derived from them with reference to their fitness for the use of living beings. It is concluded from this study that these compounds, forming the very essence of the environment, are not only fit but fittest, that there are no others which could be substituted without loss to the organism. Our author says (p. 272), "The fitness of the environment results from characteristics which constitute a series of maxima — unique or nearly unique properties of water, carbonic acid, the compounds of carbon, hydrogen, and oxygen and the ocean — so numerous, so varied, so nearly complete among all things which are concerned in the problem that together they form certainly the greatest possible fitness. No other environment consisting of primary constituents made up of other known elements, or lacking water and carbonic acid, could possess a like number of fit characteristics or such highly fit characteristics, or in any manner such great fitness to promote complexity, durability, and active metabolism in the organic mechanism which we call life."

The treatment of this subject is comprehensive, intelligent and intensely interesting. It is, in the reviewer's opinion, a valuable contribution to science, in spite of the fact that a thorough and altogether excellent treatment of the same general subject containing similar conclusions appeared in the "Bridgewater Treatises" approximately one hundred years ago, for it brings the whole matter once more up to date. It is very interesting to find that the results of the marvelous recent development in physics and chemistry so admirably incorporated by Henderson in his work serve only to strengthen the conclusion of the earlier authors with reference to the degree of fitness of the more important factors in the environment. It is to be regretted that other factors were not included in this thorough study, especially nitrogen and its compounds.

There seems to be no room for doubt regarding the conclusion that C, H, and O and their compounds are not only fit but fittest, that no other known elements or compounds could in any way be substituted without loss to the organism. But I think this does not necessarily mean, as the author appears to imply in the third part of the book covering 38 pages devoted largely to philosophic speculations, that the fitness of the environment is not solely due to adaptation on the part of the organism, that Carbon, Hydrogen, Oxygen, etc., are not fittest simply because the organism in the process of evolution seized upon the fittest factors in the environment. It does not show that complex, durable, self-regulating systems (life according to Henderson), perhaps less efficient in certain respects than we have at present, could not exist by making use of other elements. Nor does this or anything else in the book seem to warrant the author's final conclusion (p. 312) that, "the properties of matter and the course of cosmic evolution are . . . intimately related to the structure of the living being and to its activities"; and that "the whole evolutionary process, both cosmic and organic, is one, and the biologist may now rightly regard the universe in its very essence as biocentric", if he means to imply by this language, as he seems to, that the properties of the chemical elements (matter) are dependent upon life. It does however show that if fitness of the environment is due solely to adjustment on the part of the organism adaptation is even more nearly perfect than had been suspected.

The author admits that "existing knowledge provides no" explanation of the fitness of the environment. He says (p. 276), "There is, in truth, not one chance in countless millions of millions that the many unique properties of carbon, hydrogen, and oxygen, and especially of their stable compounds water and carbonic acid, which chiefly make up the atmosphere of a new planet, should simultaneously occur in the three elements otherwise than through the operation of a natural law which somehow connects them together. There is no greater probability that these unique properties should be without due cause uniquely favorable to the organic mechanism. These are no mere accidents, an explanation is to seek. It must be admitted, however, that no explanation is at hand." Ideology and vitalism, he maintains, do not help us. But he admits (p. 280) that "biological science has not been able to escape the recognition of a natural formative tendency", and holds that fitness of the environment also results from a "tendency, a bent, a direction of flow or development". This strikes the reviewer as being strongly charged with teleology, but Henderson says (p. 279), "ordinary teleology is dangerous doctrine is science", and he proceeds to annihilate it together with vitalists, another precarious doctrine.

He contends that those who postulate an "extraphysical influence" to account for adaptation in the organic must make the same postulation to account for fitness in the inorganic. But this reduces both to the same level and does away with vitalism. He says (p. 299), "The two fitnesses are complementary; are they then single or dual in origin? The simple view would be to imagine one common impetus operating upon all matter, inorganic and organic, through all stages of its evolution, in all its states and forms, and leading to worlds like our own through paths apparently purposeful and really not explained. Such, it seems to me, is the natural hypothesis for the vitalist to adopt. But then vitalism vanishes; only teleology remains, for the unique characteristic of life is gone". However if teleology is at work at all in the inorganic it is at work at the very "basis of physical science . . . Yet it is certain that physical science needs no teleology to explain its phenomena and processes" (p. 301). "If, then", he continues (p. 305), "cosmic evolution be pure mechanism and yet issue in fitness, why not organic evolution as well? Mechanism is enough in physical science, which no less than biological science appears to manifest teleology; it must therefore suffice in biology". Thus our author holds that he has relegated both vitalism and teleology to the rubbish heap and has established mechanism in their place. He maintains however that mechanism will not account for all, so he creates what he calls "a new teleology", a factor which is endowed with the very significant business of giving to energy and matter their original properties and other characteristics that may prove to be necessary. "Our new teleology," he says (p. 308), "cannot have originated in or through mechanism, but it is a necessary and preestablished associate of mechanism. Matter and energy have an original property, assuredly not by chance, which organizes the universe in space and time . . . Given the universe, life, and the tendency, mechanism is inductively proved sufficient to account for all phenomena".

After having carefully read and re-read this part, the reviewer leaves it with a feeling that he has been wandering in a circle, that at the close he is precisely where he was in the beginning. This may be due largely to limitation on the part of the reviewer or to the inherent obscurity of the subject-matter treated. But, in my opinion, there are other important factors involved here. The terms vitalism, mechanism, teleology, and the like, are at present used in so many different senses that it seems evident that every discussion bearing on them without a thoro-going exposition of precisely what ideas are intended to be conveyed by their use, is futile. It is the lack of such an exposition in the book before us that makes it quite impossible to get more than a superficial idea of what the author claims to have established regarding them. What is the essence of the vitalism and the teleology that have been banished and of the mechanism that has been substituted in their place? What does the author mean when he says" physical science needs no teleology to explain its phenomena and processes"? What sort of vitalism is it that is eliminated by the necessary postulation of" "extraphysical influences" to account for fitness in the inorganic realm? He says (p. 308), as quoted above, that matter and energy organise the universe, but he also says that given the universe, life, and the tendency, mechanism is sufficient to account for all phenomena, — implying that life is not part of the universe which is organised by matter and energy, that it is some extraneous entity. Must it not be concluded from this statement that there is a profound difference between animate and inanimate systems? And might not this be considered as the very essence of a vitalism?

The biological atmosphere is nowadays charged nearly to saturation with the terms referred to above, and signs of the times indicate that such illuminating discussions as have recently come from Driesch, Jennings, Lovejoy and many others will, in the near future, form a precipitate that can be handled with a considerable degree of precision, and that we may some day know more nearly what we are talking about when we use them. In the meantime there appears to be little cause for apprehension. The doctrines supposed to be lurking behind vitalism and teleology as well as mechanism may be far less dangerous than statements made here and there in the heat of argument would indicate.

The aim of Science is experimentally to ascertain the order of events in Nature, so that we may adjust our actions in such a way as to avoid disaster or alter events in accord with our desires. That the order of numerous phenomena in the biological world has been established with a fairly high degree of accuracy can not be doubted, and that there is every prospect that numerous other orders will be ascertained can likewise not be doubted. I am unable to understand how any doctrine short of one which denies this, that is, the prospect of being able to ascertain the order of many more biological phenomena, can seriously interfere with progress. Some doctrines of vitalism if not all state that there are biological phenomena, the order of which can not be ascertained, that is, they teach experimental indeterminism with reference to some vital phenomena, but none, so far as I know, states that the limit has been reached.

If this be true the aim of every vitalist, no matter of what shade or stripe, must be to ascertain the order of vital phenomena as far as possible, but this is precisely the aim of every mechanist. Thus all sorts of vitalism as well as all sorts of mechanism demand the employment of every means at our command, in attempting to ascertain as far as possible the order or sequence of biological phenomena. The essential difference between these two schools of thot lies in the fact that the former holds that there are phenomena associated with animate systems the order of which cannot be ascertained; in other words, that there are, in the series of some vital phenomena, factors which are not amenable to experimental analysis, while the latter school holds that there are no such phenomena in the processes of life; or, at any rate, if there are, they are of the same nature as some found in the inanimate world. It is held by not a few that it is this peculiar characteristic of the doctrine of vitalism that is dangerous. It is maintained that those who believe in this doctrine are likely to be careless workers, for their principles, it is asserted, leads them to ascribe phenomena to mysterious factors rather than to exert themselves to trace back as far as possible the sequence of events.

This assertion, in fact, ordinarily takes the most prominents place in arguments against vitalism, rather than, in my opinion, the far more significant question as to the validity of the evidence given in support of the doctrine under consideration; that is, the foremost question in such arguments usually concerns not the truth of vitalism but the effect of its adoption on investigation. Before much importance, however, can be attached to the assertion mentioned, it must be demonstrated that the rejection of vitalism and the adoption of mechanism actually results in investigation of a higher order. There are, no doubt, many professed vitalists who are very weak scientific investigators, but there are also professed mechanists who are equally weak in this pursuit. Do the doctrines these men hold make them weak? That is the question. However one may be inclined to answer this question it is well to remember that some of the most fruitful investigators have been vitalists of one type or another. I need only to mention Johannes Müller, frequently referred to as the greatest physiologist of all times, Gregor Mendel, the father of our most famous doctrine in heredity, and Abderhalden, a leader in the synthesis of proteins.

Eine neue Weberameise, Polyrhachis armata le Guillou.

Von W. Karawaiew (Kiew).

(Mit 1 Figur.)

Bekanntlich werden als Weberameisen solche bezeichnet, welche ihr Nest vermittelst des Spinnsekretes ihrer Larven spinnen, wobei sie die Larve als ein Weberschiffchen gebrauchen. Die bisher bekannten Formen sind *Oecophylla smaragdina* Fb. (Indien, Ceylon, Sunda-Ins., Malakka, Cochinchina, Timor, Molukken, Neuguinea, Bismarck-Archipel, Ostafrika), *Oc. smaragdina* subsp. *subnitida* Em. (Neuguinea, Salomo-Ins.), *Oe. smaragdina* subsp. *virescens* Fb. (Aru, Key-Ins., Neuguinea, Ozeanien, Australien), *Oe. longinoda* Latr. (Gabon, Senegal, Sansibar, Kongo), *Camponotus senex*, F. Sm. (Brasilien, Zentralamerika, Mexiko) und *Polyrhachis dives* F. Sm. (Malayische Ins., Indochina, China, Papua). Auf Grund eines indirekten Beweises (kolossale Entwickelung der Spinndrüsen der Larve) können wir dazu auch *Polyrhachis mülleri* For. rechnen, deren Spinnest ich auf Java erhalten und beschrieben (4) habe[1]). Wahrscheinlich gehören noch viele andere *Polyrhachis*-Arten zu den Weberameisen, z. B. solche, welche ihr Kartonnest mit einer seidenen inneren

1) Dagegen bietet meine Arbeit (4) keinen Grund dazu, auch *P. alexandri* Karaw., wie das Wheeler (9) tut, als eine Weberameise zu betrachten, denn das beschriebene und abgebildete (Fig. 14) junge Nest dieser Ameise ist, im Gegensatz zu dem von *P. mülleri*, ein typisches Kartonnest.