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The Neurological and Behavioristic Psychological Basis of the Ordering of Society by Means of Ideas

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WHAT, SPECIFICALLY, DOES IT MEAN to assert that human behavior and its attendant social institutions are significantly determined as to their form by ideas? For one thing, it means that human beings in society are reacting not merely to particular natural events occurring just once at a given time and place, but also to symbols, to socially conditioned symbols, which keep their meanings constant during the period of decades or centuries, as the case may be, in which a given normative social theory captures their faith and thereby serves as a norm for their social behavior and cultural institutions. But to say that human beings in society are reacting to natural events is to say that their behavior is determined by what is called a particular. And to say that human beings are reacting to symbols which keep their meanings constant through many events is to say that they are reacting to particulars which are the embodiments of universals.

This permits the basic problem of the present inquiry as a whole to be put more specifically. This problem has to do with the relation between ideological and biological factors in social institutions. It has been noted that social institutions embody normative social theories and that these normative social theories are a significant cultural factor in the ordering of social phenomena. But we have just noted, also, that normative social theories, unlike specific events in nature, exemplify universals rather than mere particulars. Thus, our problem of determining the relation between cultural factors and biological factors in social science becomes, in part at least, that of determining the relation between the processes of biological systems and the responses of people to particulars which embody universals.

But there is a second, more specific, portion of our over-all problem. When a given people are captured in the realm of their normative beliefs by a specific normative social theory, this theory serves in their behavior as an end. In other words, it defines a purpose. This means that if we are to clarify the relation between cultural factors and biological factors in social phenomena, we must determine the relation of normatively defined purposes to biological systems.

Previous attempts to solve this problem have produced two conflicting conclusions, which, nevertheless, rest upon a common assumption.

One conclusion was that, since human behavior exhibits responses controlled by purposes defined in terms of remembered norms which are universals rather than merely responses determined by physical events which are particulars, human behavior must therefore have its basis in extra-empirically verifiable extra-biological factors. The assumption here is that in the realm of the biological there are only mechanical causes and no purposes, only particular events and no remembered events with their persistent meanings and hence no universals. This has been the answer of the Cartesian and Lockean dualists on the one hand and of the idealistic philosophers and the German social scientists, with their distinction between the

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Naturwissenschaften and the *Geisteswissenschaften* on the other. Purpose, memory, and the existence of universals, they maintain, unequivocally establish the existence and reality of nonbiological minds or mental substances or of a priori autonomous moral principles in human nature and social phenomena.

The other conclusion, represented by the early mechanistic biologists, the behavioristic psychologists, and the positivistic British and French social scientists and philosophers, was that, since biological systems and all natural systems, as known by the methods of natural and biological science, are mechanical systems responding to stimuli which are particulars rather than universals, purpose is a mere appearance or epiphenomenon, and all ideas are particulars. Hence, universals do not exist, being, like the normative theories defined in terms of them, mere semantically misunderstood symbols which, when correctly analyzed, turn out to be either mere pseudorationalizations after the nonpurposefully-caused particular social facts or expressions of purely hortatory and noncognitive significance.

No two schools of thought would seem to be more unqualifiedly opposed than these. Nevertheless, the important thing to note about these two traditional conflicting answers to our problem is the basic premise upon which they agree. This premise is that scientifically verified knowledge of biological and other natural systems provides no meaning for purposes, universals, or human behavior which is a response to, and specified as to its form by, a temporally persistent, normative social theory.

What is the present scientific status of this basic premise?

Recent investigations by Warren S. McCulloch and Walter Pitts show not merely that certain biological organisms, because of the character of the neuron nets in their nervous systems, must know universals, responding to symbols as their exemplars rather than as mere particulars. Other investigations by Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow show that not merely a human being but also robots with inverse or negative feedback mechanisms have purposes that define their behavior. When this purpose can be determined by information, such robots are called servomechanisms. In other words, the basic premise of both the traditional philosophical dualists and idealists and the traditional, supposedly scientific naturalists and mechanists, to the effect that natural and biological systems can have neither knowledge of universals nor normatively defined and behavior-controlling purposes, must be rejected.

The scientific demonstration of these exceedingly important conclusions of revolutionary significance for natural science, moral as well as natural philosophy, and for one's theory of the normative factor in law, politics, religion, and the social sciences, must now concern us.

The traditional theories rest upon an oversimplified notion of activity in the nervous system. They assume that neurons are always put together in the nervous system to form a path in or through the nervous system which is noncircular.

Consider the simplest possible case of a noncircular ordering of the nerve cells called neurons—namely, the case of one afferent neuron, *a*, joined by a synapse to one efferent or motor neuron, *b*. Assume, also, that the signal which is the firing of neuron *a* entails the behavioristic response which is the firing of neuron *b*. Then, assuming no further action upon *a*, the signal which is the firing of *a* perishes as soon as *a* has fire. Hence, the response of neuron *b* is a response to a signal which is a mere particular. The number of noncircularly ordered neurons does not alter this conclusion. It follows, therefore, that if there were no circular paths within or through the nervous system, a signal (*i.e.* the firing of a neuron) at any point within it could signify only what happened at a particular instant; there could then be neither purpose nor memory, and every action would be a response to a mere particular.

Suppose, however, for example, that there are 5 neurons, *a, b, c, d,* and *e,* ordered in a circle in such a way that the signal which is the firing of *a* fires *b,* which signal in turn fires *c,* which, by way of the firing of *d* and *e,* in turn fires *a*. Then, assuming that the time it takes the impulses to succeed one another around the circuit is sufficient to permit any neuron to restore its energy from the metabolic processes of the body, the signal which is the firing of *a* or of any one of the 5 neurons in the circular net will not perish. It will thereby persist through time. In other words it will signify a universal rather than a mere particular. Also, memory will be achieved.

More than a century ago Majendie and Bell had defined reflexive activity and indicated its circular path from a part of the body, through the nervous system, and back to the same part of the body. Cannon and his collaborator, Rosenblueth, were the first to call attention to this homeostatic property and to attempt to extend the concept to relations between the body and the world about it. But it was R. Lorente de Nó (*3*) who postulated and demonstrated the action of what he called reverberating chains of neurons, so arranged in closed paths that each excited the next one around the loop, the last finally exciting the first. Thereby the activity continued to regenerate itself around the loop.

Suppose, also, that an afferent neuron from a sense organ such as the eye excites one of the neurons in

the regenerative loop. And in order not to mix in the same sentence words from different worlds of discourse, let us assume, in addition, that the epistemic correlate (*4*) of the postulated momentary signal or impulse which is the firing of this efferent neuron is in the consciousness of the person in question, the sense datum or "idea" denoted by the word "blue." Assume, also, that an impulse from the eyes fires a neuron which is a member of a regenerative loop and that its impulse is the epistemic correlate of the introspected "idea" or datum, "blue." It follows from the character of a regenerative loop that this impulse will be transmitted continuously without ceasing around the loop, so long as the energy necessary to restore the neurons to a capacity to fire is maintained by metabolic activity. As McCulloch has put the matter, "a train of impulses in a regenerative loop preserves the form of the fact without reference to the one particular moment when it was experienced." In other words, one has the form of the fact remaining constant over time through different particular events. Hence, as McCulloch and Pitts have noted, one has (the epistemic correlate of introspected) universals.

In their first paper on the subject, entitled "A Logical Calculus of the Ideas Imminent in Nervous Activity," McCulloch and Pitts (*2*) have demonstrated, also, that very simply related neural nets made up of such regenerative loops have all the formal properties of the primitive ideas and postulates of the theory of the foundations of mathematics and deductive reasoning of Russell and Whitehead's *Principia Mathematica*. In other words, human nervous systems can reason deductively, and, in so far as they possess and use nervous nets with this formal character, they must reason deductively in precisely the manner specified by an analysis of deductive reasoning and calculation in modern mathematics and symbolic logic. No manifestation of the use of universals and of rationalistic reasoning with universals could be more pure or unequivocal than that occurring in the deductively formulated theories of mathematical physics and mathematics. This means that deductively formulated theories, whether they be the normative theories of social science or the factual, deductively formulated theories of natural science of a Newton, Willard Gibbs, or an Einstein, are not epiphenomena of no causal significance; they are not mere rationalizations after the facts. Instead, because of the formal properties of the neural nets with their impulses in the central nervous systems of human beings, they are scientifically verifiable factors and scientifically verifiable factors of causal significance.

McCulloch and Pitts, in their 1943 paper, proved one other exceedingly important theorem. This theorem is that any robot or organism constructed with regenerative loops possessing the aforementioned formal properties, and thereby being a Thuring machine, "can compute any computable number or, what is the same thing mathematically, can deduce any legitimate conclusion from a finite set of premises." It is not an accident that John Von Neumann and Norbert Wiener, in their designing of two of the most powerful contemporary machines for carrying through mathematical deductions and calculations, and McCulloch and Pitts, in their theoretical and experimental studies of the human nervous system, have influenced one another.

A neuron in a regenerative loop of neurons may be so related to a motor neuron that it not merely fires the neurons in the circle of its own loop, but also fires a motor neuron, thereby producing a specific overt response of the system. When this happens, the constant universal becomes manifest in a particular again, as a specific event here and now, but conforming to its universal.

Furthermore, with many regenerative loops in a single nervous system there can be many universals, and by joining these loops universals can be related. Thereby the postulates of any deductively formulated theory in natural science or any normative theory in social science can be constructed. As long as this related system of impulses in reverberating circuits never fires a motor neuron, it remains a covert universal, a mode of possible action, rather than a particular, or an overt, act. But when it fires a neuron leading out of the circuit, it generates a particular objective event. Thus, we are able to understand how an abstract normative social theory—itself a mere universal and a possible—can, if it gets into a nervous system so as to define the form of its activity, determine the pattern of firing of motor neurons, and so, literally, causally, and neurologically determine an overt, objective, social and institutional fact.

Furthermore, if such a deductively formulated set of postulates is a theory in natural science, it can generate behavioristic responses upon the part of a physicist which put the theory to an empirical test with respect to particular events or facts in nature. Thereby the universals of the deductively formulated theory considered as a possible become related to particulars in a manner which introduces the quantifiers "all" and "some" of Russell and Whitehead's logic of propositional functions into the formal properties of neurological human behavior. This occurs when, as McCulloch has put it, "the universals are referred to the semels (the onces)."

There is, however, nothing to prevent man from constructing several different deductively formulated theories in natural science or in normative social science out of the universals which regenerative loops

provide for him. It may, and does, happen that the firing of a motor neuron prescribed by one normative social theory is proscribed by another. Witness the capitalistic and the communistic theories known to all representatives at the recent Conference of Foreign Ministers. Two such theories in one brain make choice obligatory for action. McCulloch, in his James Arthur Lecture (*1*) delivered on May 2, 1946, put the matter as follows:

> How can the structure of the nervous system embody the possibility of choice? Clearly, if each circuit had a path separate from any other path each would go its own way to its own end. But many paths share nervous parts and others would result in contrary acts of some effectors. A few, like swallowing and drawing breath, working at once would destroy us. Conflicts and mental collisions are barred by inhibitory links from one circuit to another so that when both are excited only one works. Thus the net embodies the possibility of these decisions.

In their 1947 paper, McCulloch and Pitts have carried their neurological theory of our knowledge of universals even further. Newton, among others, pointed out that the structure of sensed space and time is relative to the particular observer and quite different from the structure of public, mathematical space and time to which the theories of experimentally verified physics refer. Einstein continues this Newtonian distinction. An adequate, neurologically grounded theory of knowledge must account, therefore, for the manner in which the knower distinguishes the public, indirectly verified, postulationally designated structures and entities of natural science from the immediately sensed ones. This entails an account of how the nervous system, which receives impulses epistemically correlated with images varying from moment to moment and standpoint to standpoint, arrives at invariant entities and relations holding constant through the changing, immediately apprehended particulars. McCulloch and Pitts have shown that such invariants can be achieved by complicated neural nets which scan and average over a group of transformations. In their 1947 paper not merely do they draw complicated neural nets which have this capacity, but they also give empirical neurological evidence that certain neural nets of actual nervous systems are of this character. Clearly, human nervous systems have the formal properties necessary to know universals and to construct deductive theories in natural science and in factual and normative social science which can causally determine particular human behavior and, through that human behavior, the character of cultural institutions.

It remains to see how neurological systems can be purposeful systems.

In any scientific inquiry the question being asked is crucial. With respect to the study of any behaving system, be it man, beast, or machine, Rosenblueth, Wiener, and Bigelow (*6*) note that there are two different but complementary types of scientific inquiry which one may pursue. The first type they term behavioristic; the second type, functional.

In a behavioristic inquiry one ignores the inner constituents of the system and their relations within it. One concentrates attention, instead, upon what happens with respect to the response of the system when, everything else being kept constant, some specific stimulus or input is brought to bear upon it.

In a functional study, on the other hand, the central subject matter under investigation is the intrinsic structure and internal properties of the system itself. In such a study the input and output are used merely to throw light on the character of the system which connects the one to the other.

In the investigations of both McCulloch and Pitts and Rosenblueth, Wiener, and Bigelow the subject under investigation is a behaving, biological system. The former's approach is functional; the latter's, behavioristic. Yet each throws light upon the other.

Behavior is defined by Rosenblueth, Wiener, and Bigelow as "any change of an entity with respect to its surroundings." The usefulness of such a broad definition appears only when behavior is classified.

Their first dichotomy is between that which is active and that which is passive. In passive behavior, "the object is not a source of energy; all the energy in the output can be traced to the immediate input. . . ." Active behavior, on the other hand, is that "in which the object is the source of the output energy involved in a given specific reaction." The response of a motor neuron not recently fired and fully stored with energy from continuous metabolic processes in the body is an example. The amount of energy necessary to fire such a neuron is a very small fraction of the total energy put out by the neuron. Thus, the motor neuron itself is the immediate source of the energy released in its firing. So, also, is the total action of the nervous system or of the whole man.

Active behavior in turn falls into two classes, termed nonpurposeful, or random, active behavior and purposeful active behavior. The latter they define as active behavior "directed to the attainment of a goal—*i.e.*, to a final condition in which the behaving object reaches a definite correlation in time or in space with respect to another object or event." They emphasize that "the purpose of voluntary acts is not a matter of arbitrary interpretation but of physiological fact. When we perform a voluntary action what we select voluntarily is a specific purpose, not a specific movement. Thus, if we decide to take a glass containing water and carry it to our mouth

we do not command a certain set of muscles to contract . . . ; we merely trip the purpose and the reaction follows automatically."

Rosenblueth, Wiener, and Bigelow do not tell us in their important paper what they mean by "trip [ping] the purpose." They would be the first to admit, I believe, that without McCulloch's and Pitts' theory of universals to define the goal which is tripped, a given system, such as a robot, would have to have its purpose assigned to it by certain instructions fed into the mechanism by some purposeful being outside the system or mechanism. But if the system has the property of being an active system in Rosenblueth's, Wiener's, and Bigelow's sense, and if this active system has reverberating circuits which permit the existence of universals and the construction of postulates or proposals out of these universals which can define ends, then the system itself has the capacity to project possible goals or purposes and the capacity to trip one of these purposes rather than another.

Purposeful behavior is again divided by Rosenblueth, Wiener, and Bigelow into two types called teleological and nonteleological. The important point to note with respect to this dichotomy is that mechanisms can be constructed which exhibit either type. The key to the difference between teleological and nonteleological purposeful activity is that, in the case of nonteleological purposeful activity, "no signals from the goal . . . modify the activity of the object in the course of the behavior." They give as an example a snake which may strike at its prey with no stimulus coming from the goal after the strike has started. Teleological purposeful activity, on the other hand, occurs in any mechanism in which signals from the goal alter the behavior after it has been initiated, so that it reaches its goal. The requirement of any mechanism in order to be thus not merely goal-directed, but teleologically goal-directed, is that it possess a "negative feedback" over the goal.

Feedback may be of two kinds, positive and negative. Both kinds involve activity in a closed path. Both kinds have this in common: "some of the output . . . is returned as input." When this output which returns as input has the same direction and effect upon the system as the nonreturning input, the feedback is positive. Thus, positive feedback reinforces the input. Negative feedback, on the other hand, counteracts the input "to restrict outputs that would otherwise go beyond the goal." In other words, negative feedback means that "the behavior of an object is controlled by the margin of error at which the object stands at a given time with reference to a relatively specific goal." Thus, the modern gun is automatically controlled to hit its target. Electromagnetic waves returning to the mechanism from both the target and the projectile during flight give the error or deviation of the projectile from its intended course. This alters the input of the mechanism in such a way that the gun puts its next shell nearer the target.

It appears, therefore, that purpose, teleology, and mechanism, as Rosenblueth, Wiener, and Bigelow emphasize, are compatible rather than mutually exclusive concepts. Teleology is opposed not to mechanism but to nonteleological mechanistic systems—that is, to mechanical systems not governed in their behavior by negative feedback over the goal. Similarly, purposes are not antithetical to mechanism, but only to those whose behavior is random. Put positively, this means that a teleological system can be—and in human nervous systems it is—a mechanical system. It is a mechanical system in which the behavior of the system is controlled by a negative feedback over the goal. In fact, Rosenblueth, Wiener, and Bigelow suggest that "the main function of the cerebellum is the control of the feedback nervous mechanisms involved in purposeful motor activity."

The traditional argument of the dualists and idealists—that purposeful teleological behavior cannot be accounted for by means of scientifically verified psychology and neurology because the latter sciences give no basis for memory, universals, and purposes—and the argument of the early modern naturalists, mechanists, and their sociological followers to the effect that purposeful teleological activities and the theoretical ideas defining human goals are mere epiphenomena of no causal significance, representing mere pseudorationalizations after the fact, because again such factors are incompatible with mechanism and a scientifically verified theory of human nature, therefore apparently rest upon a common confusion and a false premise. This false premise is that teleology and mechanism are incompatible.

Rosenblueth, Wiener, and Bigelow have made it abundantly clear that this incompatibility is justified neither by logic nor by fact. When purpose and teleology are carefully defined, one finds that each represents a particular kind of mechanism and that the real dichotomies are (a) between purposeful mechanisms and mechanisms giving rise to random behavior, and (b) between teleological purposeful mechanisms which possess a negative feedback controlling their behavior and nonteleological purposeful mechanisms which do proceed toward a goal and hence have a purpose, but which do not have a negative feedback redirecting the behavior of the system on its way to its goal.

It remains to connect with the problem of our basic inquiry McCulloch's and Pitts' demonstration that

scientifically verified neurological man can know universals and Rosenblueth's, Wiener's and Bigelow's demonstration that scientifically investigated, behaving neurological man can have causally significant goals and teleologically controlled behavior toward those goals. This problem, it will be recalled, is that of the relation between ideological factors and biological factors in any culture.

Goals can be of two kinds. They may be some immediately apprehended particular, enjoyed aesthetically or used empirically to check a scientific theory of nature. But goals may also be the attempt to make the world conform to the theory of natural science, as in engineering, or to the normative theory of social science, as in education, religious conversion, new legislation, and other social reforms. The former orders the things of nature to serve man's ends. The latter attempts to alter the behavior and cultural institutions of men to fit man's normative theory. The present inquiry indicates that if the latter type of goal-seeking is to be effective, attention must be directed less upon external factors and overt behavior and more upon the preservation or removal of the traditional universals embodied in the brains of men.

In both types of goals postulated theories constructed out of McCulloch's and Pitts' universals are necessary. The manner, however, in which the negative feedback controls behavior is different in the two instances.

In the case of the deductively formulated theory of natural science, data from outside the organism coming through the sense organs of the scientist either do or do not correspond to what his deductively formulated theory, stated in terms of universals, specifies. If they do, the natural scientist, for the particular investigation in question, has reached his goal. His theory is verified. If they do not, the information fed back through the sense organs to the scientist forces him to reconstruct the postulates of his scientific theory. He may have to draw upon new reverberating circuits with their quite different universals or basic scientific concepts.

In the case, however, of a normative social theory, assuming the normative social theory to be accepted, it is this theory rather than the empirical social facts given through the senses which define the goal. Thus, the negative feedback comes from the normative theory itself to the motor neurons prescribing that the man's behavior conform to the prescriptions of the norm. It is in this manner that the censorship of personal and social norms arises and the prescriptions of an ideology for a given society operate through familial, educational, religious, commercial, and legal institutions and processes to mold *what is* in social institutions and behavior toward *what ought to be.*

Since the many reverberating circuits through the human cortex provide men with many different universals out of which to construct both their factual theories of nature and their normative theories of culture, one would expect rival hypotheses in natural science and the rival normative theories in the social sciences. That this is the case is well known. It is the presence of the latter which generates the ideological conflicts of the contemporary world.

It appears, therefore, that scientifically verified neurological theory of man makes both deductively formulated theory in the natural sciences and normative theory in the social sciences both possible and significant. One aspect of the significance of normative social theory remains to be noted. Studies of the social behavior of ants, by Theodore Schneirla and others, show that they have a remarkable social organization but a very rigid one. Norbert Wiener has emphasized that this rigidity is due to the fact that the ants have a very poor system of communications. They follow their leader by scent, *i.e.* they respond only to particulars and to particulars of but one sense organ. Human societies in the West, as the writer has noted elsewhere (*5*), radically reconstruct their social organization with the rejection of an old normative social theory and the acceptance of a new one. This is possible quickly only when a society or its leaders have reached majority agreement upon a systematic normative social theory and possess an excellent system of communications to aquaint and habituate the leaders of that society and, if possible, a majority of the people with that normative social theory.

The answer to the basic question of our inquiry may now be summarized: Cultural factors are related to biological factors in social institutions by the biologically-defined purposeful behavior of human neurological systems containing negative feedback mechanisms and the normative social theory defined in terms of the universals which are the epistemic correlates of trains of impulses in neural nets that are reverberating circuits. Because overt behavior can be tripped by impulses from reverberating circuits whose activity conforms to universals, as well as by impulses coming immediately from an external particular event, the behavior of men can be, and is, causally determined by embodiments of ideas as well as by particular environmental facts. And since the brains of men in early so-called primitive societies are provided with reverberating circuits, just as are the brains of men in so-called modern societies, it follows, though the specific universals may be different, that normative social philosophies will be significant in any culture. In short, in any culture embodied ideas defining purposes or ideals really matter.

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NEWS and Notes

John N. Adkins, assistant professor of geophysics at Massachusetts Institute of Technology, has been granted a year's leave of absence to head the Geophysics Branch, Physical Sciences Division, Office of Naval Research. His activities in ONR will include directing research in meteorology, oceanography, and earth sciences being carried on under contract in leading university, government, and industrial laboratories throughout the country. The Geophysics Branch also directs the scientific aspects of various expeditions. Dr. Adkins succeeds **Roger R. Revelle,** who will return to the Scripps Institution of Oceanography as associate director after a leave of absence from that institution.

C. Merrill Whorton and **Frank C. Womack** will join the faculty of the School of Medicine, Louisiana State University, as assistant professors of pathology on July 1. Dr. Whorton is at present associated with the Mallory Institute of Pathology, Boston City Hospital, and is on the staff of Tufts Medical College, and Dr. Womack is an instructor in pathology at Vanderbilt University School of Medicine.

Carroll L. Mann, who has headed the Department of Civil Engineering at North Carolina State College since 1916, will retire on June 30.

G. B. MacDonald will retire as head of the Forestry Department, Iowa State College, on July 1 but will continue as professor in the Department. The chairmanship will be taken over by **George B. Hartman,** a 1917 graduate in forestry from Iowa State College, who has been associated with the Long Bell Lumber Company in Louisiana.

Thomas C. Poulter, associate director of the Armour Research Foundation, will join the staff of the Stanford Research Institute in a similar capacity later this year. In addition to the research he has done in many scientific fields, he is a well-known Antarctic explorer.

Carl Nielsen, associate director of research at Abbott Laboratories, North Chicago, Illinois, has been made a knight of the Order of Dannebrog by Frederik IX, King of Denmark, in recognition of his work in promoting closer relationships between Denmark and the United States, especially in the scientific and pharmaceutical fields.

Robert E. Dickinson and **Henry M. Kendall** have been appointed full professors in the Department of Geography, Syracuse University. Dr. Dickinson, formerly of the University of London, will have charge of work in political geography, the development of geographic thought, and the geography of Europe, while Dr. Kendall, formerly of Amherst, will be responsible for introductory work in geography and climatology.

Donald M. Hester, former assistant professor of mathematics at the New Mexico School of Mines, has joined the faculty of the Northeast Missouri State College, Maryville.

Roger M. Herriott, associate in general physiology at the Rockefeller Institute for Medical Research, Princeton, New Jersey, has been appointed professor of biochemistry at the Johns Hopkins University School of Hygiene and Public Health, effective July 1. Dr. Herriott will succeed **Reginald M. Archibald,** who has accepted a position at the Rockefeller Institute.

Robert J. Lowry, assistant professor of botany at Michigan State College, has been appointed to a similar post at the University of Michigan for the academic year 1948–49.

Sergio De Benedetti, of the Clinton Laboratories, Oak Ridge, Tennessee, has been appointed associate professor of physics at Washington University, St. Louis.

John Phillips, head of the Botany Department, Witwatersrand University, Union of South Africa, has been named director of the British Overseas Food Corporation, which is to handle all food production developments in the British Colonial Empire. An authority on South African soil conservation, Prof. Phillips will direct Colonial agricultural policy and research. He will take up his new post next November.

Lawrence H. Aller, assistant professor of astronomy at Indiana University, has been appointed associate professor of astronomy at the University of Michigan beginning August 1.

Visitors to U.S.

N. P. Allen, superintendent of the Metallurgy Division, National Physical Laboratory, Teddington, England, arrived in this country on April 21 for a two-month visit.

D. J. Watson and his wife, **M. A. Watson,** both members of the staff of the Rothamsted Experimental Station, England, after spending several months in Australia, have arrived here and are now visiting various research centers. They are traveling under a fellowship awarded them by the Ministry of Agriculture.