respect either to its scope or its degree-conferring power—its constitution, in a word, as an institution of the "university type"—and, while it may be necessary to begin as he suggests, the writer deems it important to keep the ideal before the country, and so lets the paper stand as written.)

Kepler Hoyt

4114 Fessenden Place,
Washington, D. C.

Neo-vitalism and the logic of science

To the Editor of Science: In the discussion to which you have recently given space concerning the availability for science of the system of implications to which vitalism and the conception of entelechies lead, it is important to refresh one's memory concerning the general methodological postulates of science, for in the final analysis every special argument in such a case is nothing but the assertion of a specific point of view in regard to the system of conceptions with which science works in reducing the world of phenomena to order.

The conception of intelligible order is the product of a slow intellectual development which is reenacted by every human society in its progress toward civilization and by every child in its growth toward mental adulthood. Between the theoretical limits of a world of anomy and the assumption of necessary law the evolution of this concept presents an infinite series of modifications. The universal presence of law is the underlying assumption on which all investigation proceeds, and the advancement of science is measured by the field which it has redeemed from chaos and conceived in terms of intelligible order. But in certain of its relations this conception is scarcely more than a theoretical postulate which expresses a logical conviction as to the nature of the world and inspires the persistent search after new laws. It expresses the belief, in regard to each unreduced phenomenon, that the logical canons which have guided investigation to a triumphant conclusion in other fields must ultimately be found valid here also.

As to the phenomenal basis of such conceptions common observation sufficiently establishes the fact of recurrence, both of elements and complexes. Familiarity with these connections of experiences, however, does not carry the mind inevitably toward their uniformity. Man's first uncritical reflection leads only to the general expectation of recurrence. Failures and fulfilment must equally be accepted as facts. In one field order prevails, in another, caprice. It is an empirical inference which no more assumes necessary connection as its reflective postulate in the one case than it does anomy in the other. But the human mind is not content to rest at this stage. The world of phenomena is not a pure object of contemplation. It is endowed with energy and penetrated with living potencies and purposes, conceived in terms of agents and active causes. These spiritual powers in whom change is grounded are unique as well as individual, and each is marked by a characteristic activity. The world must be taken as it is found; if unpredictable as well as dependable successions occur, the causes to which they are referred must correspondingly vary. Arbitrary and capricious wills appear on the theater of events along with those which are consistent and inalterable. Wonder and miracle lie embedded in the world's structure alongside of established and predictable order.

The habit of thus conceiving phenomena in terms of disparate principles dies hard. It yields only before the slow extension of law as the investigations of science are pushed farther and farther and one range of phenomena after another is brought under control. At first it is not perceived by the scientist himself that the postulate of universal and necessary law underlies all his procedure, that the conception of uniformity is not confirmed by the slow accumulation of evidence but constitutes the basis of every conclusion he draws. The principle of all scientific method is established only when this relation is first clearly apprehended. As the connections of phenomena are more widely discerned the region of anomy undergoes progressive limitation and the world of miracle gives

place to a universe of law. Order replaces disorder, necessity supplants chance in the thoughts of men, until the realm of experience is finally viewed as a consistent and rational whole, wherein every change is conditioned by uniform antecedents and expressible in terms of natural law.

The application of this point of view, it may logically be said, implies a preliminary treatment in which phenomena are organized in a unitary system of classifications on the basis of specific resemblances and differences. But the process of defining and naming, of conceiving individuals in terms of fixed characteristics and referring each to its place in a logical scheme may be said merely to provide the data for the mind's final operation whose field is the interaction of things. The world is treated dynamically as well as statically. The subject of specific characteristics is also the origin of certain effects. It has its place in a causal series as well as in a classificatory system. The logical relations of likeness and difference must be supplemented by the empirical relations of genesis and historical origin. To connect events in this way is to explain them. The world as a system of objects can only be described; to be explained it must be conceived as a system of orderly successions in time. The universal principle of explanatory science is thus to be found in what is termed the conception of causal relation, since it is simply the generalization of this idea of uniformity in historical succession. Natural science therefore rests finally upon the assumption of mechanism and excludes all other conceptions.

Historically the explanations of science have been supplemented at every stage by principles dependent upon the assumption of purpose or function, but every such recourse represents a failure in the scientific undertaking or a loss of the scientist's vision. Its interpolation indicates either the presence of an unresolved problem or a confusion as to the nature of scientific explanation. The ideal of science is, from the methodological point of view, perfectly clear; it is to determine the atomic constitution of the world and to formulate the mechanics of its changes. The particular constitution of the units and formulas with which the scientist works may vary from age to age, since these are necessarily provisional and relative to the level of analysis attained at any given time; but the formal ideal of all analysis is unaffected by such changes and remains theoretically constant. The unit must be simple, the formula universal. No ultimate difference among the constitutive units, and no partition of the world between irreducible forms of change can be admitted. This is the fundamental assumption from which the scientist can not allow himself to be swerved by any complication of the phenomena to be treated or any difficulty in their resolution.

Such a postulate can be maintained only in view of the fact that science is not an attempt to exhaust the account of reality, and that its presuppositions constitute but a necessary methodological delimitation. Reality is viewed by man in a series of differing relations, each of which involves a specific set of such presuppositions. With none of these other points of view, however, can science have even contact; and the penetration of his own field by the conceptions to which they give rise can mean only the disorganization of his results.

The traditional form in which this adulteration of scientific method has been manifested is an employment of the conception of creative spirits, essences and powers as explanatory formulæ. Angels and demons, entelechies and souls, function and purpose, force and will; vitalistic, morbific and soporific agencies have been invoked in turn as explanatory hypotheses. It may be that human reflection has need of this whole class of conceptions in its complete review of reality; but in the special work which science in general undertakes they can afford no help whatever. Each relapse into such modes of thought marks the point at which scientific analysis has stopped and amounts to nothing more than the confused recognition of an irreducible element in experience. This the scientist must recognize as well as any other, but it is absurd to make

of it a constitutive or explanatory principle. It affords no means of analysis; it determines no specific change; it contributes no formula of relation. At whatever level it appears this conception stands only for the unresolved residuum by which reflection is faced.

Thus in the study of organic life it may be that the biologist is unable to state the facts of development in terms of the known chemistry of the cells, or of the local relation of parts in the segmented ovum and their polarities and bilateralities, or of the influence of external agents upon the organisms; but it is nevertheless inadmissible to formulate the problem in terms of a conception which falls without this whole system of principles and to say that, since the chemical and mechanical conceptions which we are now able to apply to organic development have proved inadequate to the statement of that process in its entirety, we must conceive it as autonomous and treat it in terms of entelechies. Autonomousness is a conception which falls without the domain of science altogether, because it applies to the thing only in its self-dependent totality—with which philosophy deals—and not to the thing in its relations to other things, as science must conceive it. Only in terms of their interaction can the empirical reason explain things at all; and in the case of organic development, as of all other processes, explanation must be through the determination of specific causal relations.

This mechanistic conception of science is of course a purely methodological assumption into which no ontological meaning is to be read. Its nature is misunderstood when, for example, it is called materialistic. The mechanistic conception applies to all facts which fall within the domain of science, whatever the metaphysical interpretation which may be given to them.

Robert MacDougall
New York University,
October 14, 1912

A PROTEST

To the Editor of Science: Permit me to offer an emphatic protest against the closing paragraph of Dr. Dorsey's letter in this week's Science (December 6). It is Dr. Dorsey's right, if conscience and judgment impel him, to express disapproval of missionaries in respect to either their purpose or methods or both, but to accuse them of "distortions," made from mercenary motives, is an utterly unjustifiable bit of spite. It not only reveals lamentable ignorance of facts, but betrays that intolerant and biased attitude of mind against which scientific men are supposed to particularly guard, and which in my judgment vitiates Dr. Dorsey's whole argument.

Hubert Lyman Clark

QUOTATIONS

THE EFFICIENCY NOSTRUM AT HARVARD

There has been a great deal of groping in the dark over the problem of raising the quality of our universities and colleges. But light has appeared at last. There will no longer be any futile casting about for improvements here and changes there, no more mere scratching of the surface. Somebody at Harvard has gone straight to the heart of the matter. Indeed, he has solved the whole problem in point of principle, though of course the details of the beneficent revolution he has started remain to be worked out. What has been needed all along has been some simple and yet profound guiding principle, and this is what the new move at Harvard supplies. See that you get your money's worth out of each professor —this is the philosopher's stone, which, firmly and steadily applied, is going to transmute into gold all the baser metal of our university faculties.

Seldom has a great reform been ushered in so noiselessly. "Harvard professors and instuctors," so goes a newspaper account, "are thoughtfully rubbing troubled brows to-day while they ponder over an intricate network of blanks and spaces whereon Assistant Controller Taylor has requested them to record the exact disposition which they make of all time spent in the interests of the university." The assistant controller states that he desires these data for the purpose of using them "as