THE RELATIONS OF PHYSICS AND BIOLOGY TO EPISTEMOLOGY

My thesis is that epistemological discussion must orient itself primarily to biological fact, and not to physical fact as it does now. My text is a very fine little book called Mind and Nature, in which Hermann Weyl publishes the lectures he recently delivered at Swarthmore College. Weyl’s topic is the relation of physical knowledge to its object, the physical world. He concludes that the subject and object of physical knowledge are not to be distinguished. “The world, the goal of our scientific endeavor, is not one existing in itself, but arises from and exists only by means of the meeting of the subject and object.” Notice incidentally how a study of exclusively physical science is taken to define the relation of all science to nature!

Weyl is one of the two or three great physicists qualified by philosophical training to speak on epistemological problems. His exposition is masterly, his historical comment is penetrating. Yet his conclusion, in spite of all the physical and philosophical competence of the argument, is void of meaning. If the subject and object of physical science are indistinguishable, what is the meaning of an analysis which assumes their distinction and discusses their relation? The problem is shown to be a pseudo-problem, one that arises from false presuppositions which preclude successful analysis. Like the classical epistemologies of Locke, Hume, and Kant, of which it is the epigone, Weyl’s little book serves only as a reductio ad absurdum of its own initial postulates. This would constitute a real advance, if others were persuaded by it to accept the reduction, and renounce the postulates.

Ever since Descartes, however, philosophers have been content to set up the postulates, and then knock them down again. What is wrong with the postulates, and what are the alternatives to them? Is it not apparent that if we are to discuss the subject-object relation, we must first distinguish subject and object by reference to something other than themselves? But our epistemology does not do this. It is precluded from doing so by its exclusive attention to physical science and the subject and object thereof. For subject and object are indissolubly integrate in the specific cognition. Epistemology really starts out from the naïve distinction of the human organism and its spatial environment; but it immediately abstracts from this richer context, calls the organism the subject and the environment the object, and places cognition in a vacuum. Where we draw the line between subject and object becomes now an arbitrary matter, so that some can call the subject what others call the
object. Small wonder no one reads epistemology save those who write it. We may recall that Greek thinkers avoided this pitfall by setting up several sorts of cognition, relatively independent of each other, in sensation, opinion, and reason. There is something to be said for an approach which did at least prevent the epistemological discussion from issuing in verbal nonsense.

The alternative to our bankrupt epistemology is suggested by the foregoing. Let us hold fast to that distinction between the human organism and its environment which gives to the subject-object distinction its whole real content! Instead of starting with contemporary physical science plus a meaningless subject-object dichotomy within it, and referring only incidentally to the complex of living activity which is the matrix of physical cognition, let us start with the living human process and regard physical investigation as one specification of this process! Let us make epistemology a branch of biology, instead of some sort of psycho-physics! Are we philosophers not ready yet, even now that the nineteenth century has come and gone, to attribute reality to living process? One can forgive the physicist, dedicated as he is from youth up to severely physical speculation, for identifying human knowledge with contemporary physical theory; but that is not excusable in you and me, brother-philosopher! We ought to be able by this time to break away from the narrow Cartesian dogma which holds that physical reality, together with its scientific cognition, constitutes an exhaustive analysis of nature. It is true that the dogma is continually resuscitated by new physical theories, which suggest a fictitious need of bringing the form of the dogma up-to-date. But the dogma has really been an anachronism since the revival in modern times of the empirical sciences of living behavior.

Why has not philosophy been able to transcend the dogma of the Cartesian physicism? One reason is that the sciences of life, unlike physics, have not yet achieved a definitive theoretical form; so that it is still possible to argue, with Descartes, that there are no such sciences. But that reason would not hold up against the actual presence with us of the biotic sciences if there did not stand, behind and supporting the Cartesian dogma, a still older dogma bequeathed to us through it. The scholastic dogma that man’s reason is his essence, ostensibly renounced along with all the other essences three centuries ago, still weighs over us. It is what makes plausible the substitution, in our effete epistemology, of the relation of our most systematic knowledge to its object in physical reality for the whole relation of man to his natural environment. Out upon both dogmas! Man has other relations to nature besides that of physical enquiry. Man is not merely rational, nor is nature exhaustively physical.
Man builds, breeds, domesticates, loves, hates, governs, rebels, fights, eats, dies, thrives, pines, works, and plays; and all in many sorts. The problem of physical science, and of systematic enquiry in general, is correctly seen and indeed exists only when it is placed in this larger context covering the several relations of man to his world. Hume saw this, when he rooted the bases of thought in custom. Kant divined it, when he interpreted rational analysis as a specification of the moral sense. Pragmatists agree, when they understand science as the instrument of vital need. But none of these have done more than propose the conception of knowledge as an expression of the generic living process—or if they do propose more, they soon forget their objective, and are back in an analysis of the traditional sort, dominated by the Cartesian presuppositions.

It is time, God knows, to end our scholasticism, if we are to save philosophy from the philistines who would reduce all human aspiration to the baser animal urges. But how to do it? How present the structure of cognition as a specification of the more general structure of living activity, when we possess no definitive and adequate theory of living process? We could not explain chemical interactions as a specific form of electrical motion if we did not possess to begin with a fair knowledge of both chemical and electrical structure. Our logical analysis provides some insight perhaps into the structure of thought; but where is the relatively adequate biotic structure in terms of which this thought-structure is to be understood? We must admit that it does not yet exist. Biology has not yet advanced far enough to allow us to use its theory as the basis of a reconstruction of the higher cognitive processes. Yet without this biological basis, our epistemology is vain!

To those who have followed the argument thus far I therefore propose a really radical revolution in philosophy, a revolution not of doctrine, but of interest and objective. Instead of protracting the futile epistemology that has posed as philosophy from the time of Descartes down to our own day, let us devote our philosophical powers to the establishment of an adequate science of living behavior, in the insight that only when we have done this may we hope to phrase our epistemological problem in ways allowing its solution. The rest of this paper is devoted to an initial clarification of the nature of this study. It will show, however, that participation in this enterprise is the duty of the philosopher as well as his privilege and opportunity; for the prejudices preventing the construction of an adequate biology are the same as those which have confined us within a futile epistemology.

These prejudices arise out of the "physicism" imposed by Descartes on subsequent speculation. We must all revere Descartes as
the most influential metaphysician of modern times; but our reverence must not blind us to the fact that in clearing the way for modern physics, Descartes destroyed too much. The traditional philosophy, with its multiple essences and syllogistic logic, had to go, since it was incommensurate with mathematical physics and with modern dynamic science in general. But it was not necessary, in order to allow to physical analysis a universal extension and a status of scientific certainty, to wipe the slate of nature clean of life! The scholastic assumption of a hierarchy of essences is indeed irrelevant to the dynamic and particularistic assumptions of modern science; but the specific forms of animal and plant which were the empirical basis of the scholastic hierarchy are real and observable entities, and constitute the visible appearance of a natural structure which no comprehensive analysis may ignore. Their importance, that is to say their effective existence, is responsible for the appearance alongside the physical sciences of the biological and sociological sciences, sciences which resist inclusion in the physical system and which point rather to an evolutionary, genetic, historical dimension of nature that is incommensurable, and possibly incompatible, with the Cartesian metaphysic of a purely geometrical nature. We stand here with Plato of the Timaeus, distinguishing a motion determined by geometrical regularities from a motion determined by specific form or Idea.

What we have to do is to transcend our Cartesian physicism at least to the degree that we can see in the organism, the herd or colony, the species, the polity, the cultural form, etc., entities as natural and as metaphysically real as the molecule, the light-wave, and the quantum. It is possible to insist, of course, that the biotic entities of the first group must eventually reduce to the physical entities of the second group; but this verbal insistence will have scientific meaning only when we understand the biotic entities in their place in a biotic structure described by biotic theory. Reducing molecular entities to electrical entities does not mean reducing molecules to electrons; it means understanding the known molecular reactions in terms of the structure of electronic motion; and to do this we must first know the laws of molecular activity as such. The popular mind will always confuse the motion which is thinking with the motions which are thought about. Not to do so is to philosophize. But we should be able to make plain to all that we do already recognize in nature a distinctive pattern of organic movement, a pattern which to some extent at least is intelligible in its own character without reduction to physical structure. We use this empirical knowledge of biotic nature in our daily dealings with each other, and in our control of animal and plant growth. Our first business is the
extension and organization into a systematic science of this more immediate knowledge of organic behavior.

But is not this what the biologist and psychologist already do, or have done? How is the philosopher to assist in such matters? No, the life-sciences have not yet succeeded in laying the foundations of a systematic science of living movement. Their material lies, like quarried granite, much as it was taken out of the perceptual terrain, and such theoretical blue-prints as they have concocted are fantastic or meaningless. They lack the fundamental concepts required for the foundation of a dynamic biology worthy to stand alongside our modern dynamic physics. Nor will they find them until there arise among them philosophers, whether these latter be trained in the laboratory or in the seminar. They are precluded from the consideration of such concepts by their present presuppositions, which only a philosopher can remove. How can a biologist proceed to the erection of an autonomous biology if he is initially convinced that systematic knowledge and physical science are one and the same thing? This is the deepest conviction of contemporary biologists, as it is of all moderns except the few emancipate; and it means that every clear distinction of organic character is a subjective illusion, to be rigorously abstracted from in the course of scientific analysis. The biologist can not begin, of course, with this rigorous abstraction from organic character, since it is this character which defines his distinctive study, and which gives him his right to be; but he abstracts from it as he proceeds, throwing aside the observable organic characters one by one, until he emerges empty-handed, all the organic characters it was his business to correlate and arrange having been discarded in the analysis. He is compelled to this suicidal behavior by his initial presupposition, which is that the organism, although itself organic enough and clearly distinguishable from its environment by way of this organic character, moves in and reacts to a physical world. Quite correctly the biologist endeavors to relate the organic movement to the environmental conditions occasioning it; but the environmental stimuli he looks for are physical, so that their effects, the responses to them, are necessarily physical too; and in this way the organic character is lost in a complex of physical reactions. The whole organic activity becomes a chemical osmosis, the organism becomes its skin.

Why does the biologist postulate a physical environment for the organism? Well, that is what everybody does, in this year of grace, who wants to be scientific. Our tradition demands that we define the world that lies about the organism in physical terminology. Does not modern science mean just this, that we displaced the gods from heaven and earth, and put in atoms? God forbid, for that is
only what science means to the modern fool; and if our whole tradi-
tion is the fool, all the quicker should we end it. What tradition
has done is to confuse the method of physics with its content. We
want to be scientific, like physics; but this does not mean that we
must identify science with physics. Physical science is only one
group among a diversity of analyses of nature, analyses that are
equally modern, dynamic, and scientific. Let us recall a little his-
tory, to clear up the muddle!

Modern dynamic science arose as an alternative to the static
analysis of earlier times. This earlier scholastic science explained
the behavior of a thing via its essence, which was to explain it in
terms of its supposed relation to the whole universe. The inade-
quacy of the scholastic analysis was most apparent in regard to
astronomical movements; and when Copernicus left the sun swing-
ing in the void, without intelligible relation to the universe of fixed
stars, scholasticism was doomed. Henceforth things could not be
explained by any reference to their position in a universe, they could
be explained only in terms of their relations to each other. Galileo
used this new sort of explanation in reviving the science of me-
chanics, and Newton used it, but with a very different set of rela-
tions, to explain the planetary motions. What Descartes did was
to generalize the mechanistic method so that it might be applied to
everything, and become a universal science. While Descartes did
d a good deal of violence to the physics of his day, his metaphysic has
had enormous success, and is astonishingly verified in contemporary
physics. We must recognize, however, that even in physics his con-
ception of an exhaustively geometrical cosmos has to be supple-
mented by pluralistic theories of energy. But let us emphasize here
only what distinguishes this Galilean or Cartesian conception of
nature from all earlier, from what we could call non-scientific con-
ceptions! The crux of the method lies in its insistence that every
observable bodily motion or state shall be understood by way of other
observable bodily motions or states occurring outside the body studied.
This principle says nothing about the nature of the relations con-
necting the motions of the bodies. These relations are specific,
and await discovery. Yet it carries a very important implica-
tion which I think has never been made sufficiently explicit. This
is that in using this method, you never explain only one thing
at a time. The analysis of the body studied is always an analysis
of the bodies affecting it. This means that the method involves
an analysis of the effective environment of a thing simultaneously
with the analysis of the thing itself, the two analyses being one,
and body and environment being explained in terms of each other.
This is what distinguishes modern science, and what should dis-
tistinguish modern philosophy in general, from the earlier thought which explained the behavior of a thing in terms of its own inner nature as determined by the cosmic whole. It explains why Descartes postulated a mechanical universe; for if mechanical analysis was to proceed, and not be brought up sharp against an insuperable barrier, it must postulate that each new environment in turn, as far as space extends, is mechanically related to the last. We may call this postulate the principle of congruity, since it requires a likeness of structure between the behavior of a body and the external conditions affecting it; and we see that the principle is maintained in each division of physical analysis, as well as in physical analysis in general. Thus chemistry postulates a world of chemical reagents, the analysis of the agent being no less an analysis of the reagent; mechanics postulates a world of mechanically stable bodies, geometry a world of contiguous geometrical forms, optics a world of geometrically related light-lanes, thermics a world of temperature-gradients, and so forth. Thus physics really postulates a dozen different worlds, rather than one. The principle of congruity, which constitutes the method differentiating modern dynamic science from all other analysis, is independent of the nature of the motion studied, that is to say, of the content of the particular science illustrating it.

Now let us apply what we have learned from this historical retrospect to the study of organic behavior. The organism is a thing, rotated and translated, bent and twisted in space by the insurgence upon it of forces originating in locable bodies outside of it. We recognize it as an organism by the distinctive forms of this motion, just as we distinguish a solid from a liquid, or a sound-wave from a cyclone. The organism is, of course, a chemical complex, too, but when we see it as such we are abstracting from its distinctive organic character. In the same way a stone is a chemical complex if we abstract from the macroscopic mechanical character belonging to it as a body which moves as a unit. To initiate a modern dynamic science of biology, we must accordingly postulate an environment congruous with and responsible for the distinctively organic character of the organic behavior. As Descartes was driven to postulate a mechanical universe, so we are driven to postulate a biotic universe, congruous with the organic motion. This the biologist has never been willing or able to do. He is willing to restore the organism itself to nature, but he leaves it naked and homeless in a physical world. He refuses to postulate in the environment the effective presence of those things, those energies, those forms which alone can intelligibly affect and effect the distinctively organic motion of a living body. He is forced, in consequence, to disbelieve the evidence of his eyes. It looks, he thinks, as if the organism moved
peculiarly, differently from inorganic bodies; but that must be an illusion of the senses; for if the organism responds to a physical environment, its response must be physical in kind. And having reached this conclusion, he will again point to the metabolism, the self-reproduction, the sensitivity, etc., which make the organism different from physical bodies; and he throws up his hands in despair. But we can see that the biologist has violated the first principle of dynamic science, and is himself responsible for his failure.

He has failed to apply the principle of congruity, he has not postulated a biotic environment structurally continuous with the observable organic movement; and the consequences of this omission are disastrous. Instead of pursuing a genuinely causal analysis of organic motion, the biologist attempts a merely casual dissection of the organic matter into members, tissues, cells, chromosomes, or other entities visible to the aided or unaided eye. In place of the analysis of the environment which should supplement the analysis of the organism, the biologist offers us nothing, referring us instead to the analysis of the physicist—an analysis which is quite irrelevant to strictly biological study, since the physicist has been religiously careful to analyse the environment exclusively in terms of its effect upon inorganic bodies. Ultimately the biologist is driven to some form of vitalism, a doctrine which is nothing more than a revival of that scholastic pseudo-science which modern physics has forever invalidated. All modern biologists, however violently they may deny the allegation, are vitalists in practice; for their practice invariably assumes that the organism may be intelligibly affected from within, but never from outside itself. Some of them are even beginning to talk about the “internal” environment, which being translated means the “inside outside” of the organism—a nice way indeed to get rid of the basic problem of biology, which is the relation of the organism to its external surroundings. It should be said, however, that all our orthodox philosophy is the accomplice of the biologist in this obscurantism. It has done nothing to help him, but opposes and impedes the rise of an autonomous biology exactly as the scholastic philosophy opposed and impeded the advance of an autonomous physics. It does this by perpetuating a conception of the human organism that is grounded in scholastic dogma, as was shown earlier in this paper, and by explicitly offering to the biologist an organismic metaphysic as a rationale for his vitalistic practice. The biologist is told that all natural units, atoms and molecules as well as living creatures, are organisms, acting as wholes and thereby determining their own behavior; so that he need not hesitate to think of the living organism as similarly determining itself from within. All this is plain misuse of language. Atoms
and molecules are in some respects natural units; but organisms they are not, nor do they determine their own behavior in any way. Their whole behavior is responsive to determinate external conditions, and all that is meant by saying that they are natural units is that when they respond to external conditions, they do so as atoms, say, of copper or molecules of chalk, and not like a cow or the Prince of Wales.

The word "organism" really refers us to the distinctive behavior of living creatures, and no one has the slightest right to apply it to anything else. Let us hope that only logicians, and no scientists, are capable of converting "All organisms are natural units" into "All natural units are organisms." It should be noted that the units of modern science, such as atoms, electric charges, or organisms, are unitary in two respects—first as unitary types, then as unitary individuals; but in both respects the unitary character signifies a permanence or integrity in their response to external changes, and so refers us to some unitary pattern in the environment. The atom can be broken up, which means that there are environmental patterns careless of or incompatible with the atomic unity; but we are justified in calling the atom a unit if in certain determinate respects, i.e., in its response to certain environmental sets, it acts as an integer. So with the organism, which responds to many environmental patterns in its organic character, but fails to respond so, and dies, when subjected to others. Our study is to learn the environmental patterns stimulating the organism to greater life, or compelling it to death. The environment rules in intelligible ways over life and death, health and disease.

At this point we should notice several praiseworthy attempts of recent years to establish a genuinely scientific biology, by insisting upon the dynamic continuity of organism and environment. One of these is biophysics; but since this mode of analysis abstracts from the distinctively organic characters of living behavior, it is truly a branch of physics and not of biology. A second is behaviorism. This study starts out well in its postulation of an exhaustive correspondence between organic motion and environmental pattern; but it has succeeded thus far only in the correlation of some reflex motions to their stimuli, and very soon proceeds to the quite unscientific concept of a reflex conditioned by a private history. A third attempt is Gestalt-psychology, which conceives of organism and environment as the abstracted factors of a dynamic field, to be understood by analogy with electrical phenomena. Gestalt-psychology, influenced by certain realistic theories of perception, has overshot the mark. In order to establish the continuity of the organism with the environment, it has postulated their identity, and
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ignored their differences. A fourth attempt, once more carried into the field of human behavior, is psycho-analysis, which shows how certain dominant and typical momenta in human behavior are shaped in the individual by the immediate social environment. This would seem to be genuinely dynamic method; but the value of the particular hypotheses so far advanced is open to question.

These theories, however, for all their brave attempt to understand organic behavior as the correlate of an environmental structure, still labor under the incubus of the old Cartesian dogma which denies the relevance of the non-living environment to the distinctive and observable motions of living being. This dogma it is which prevents the behaviorist from perceiving in the environment anything more than the immediate physical occasion of the momentary organic response; which limits the Gestalt-psychologist to a psychophysical parallelism and to a survey of sensible perception; which allows the psycho-analyst to regard as real only the animal instincts, all the distinctively human behavior being explained away as a subjective sublimation of these drives—a return, be it noted, to the conditioned reflex of the behaviorist; and it is this dogma which, of course, leads the bio-physicist to ignore the movement of the organism in its proper character. We must break with the whole post-Cartesian metaphysic, and not only with nineteenth-century psychology, if we are to perceive the basic connection between organism and environment. We must know that all the basic rhythms of organic life, such as breathing, hunger, thirst, sex, sleeping and waking, action and repose, sociability and its opposite, growth and decay, appearance and disappearance of species, rise and decline of cultural forms, war and peace, are the expression of organic periodicities as effectively controlled by prevailing environmental constants as is the swing of a pendulum! It is these great periodicities which control, under the flotsam and jetsam of our individual response and immediate perception, the tides of human behavior; and until we know something of them, both introspection and laboratory experimentation are a meaningless waste of time. It is to the largest, most general, and most constant characters of organic behavior that we must look for our first clues to the environmental patterns determining living behavior; and all our effort so far has begun at the wrong end. We are not afraid to attribute the motion of the pendulum to the action upon the latter of the whole earth. Why then should we fear to search in this larger environment for the conditions of the pendulum-like periodicities of the organism! Is it not apparent that sleeping and waking are accommodated to the diurnal rhythm, and sex to the seasonal rhythm? Sun and earth are participant, as the ancients so well knew, in the organic process;
and if so, we must attribute to them a biotic character intelligible to us at present only in these, their observable effects on terrestrial organisms. We must seek to understand the solar system and the organisms about us in terms of each other, in obedience to the scientific principle of congruity. It is patent to all of us that the movement of life on this planet has conditioned climate and erosion, and thereby the topography of ocean and mountain-chain. Why then do we hesitate to draw the implications of this fact, which is the scientific necessity of understanding terrestrial structure in terms of a distinctively organic growth?

I have said enough perhaps to indicate the nature of the metaphysic which must replace our Cartesianism, if the sciences of life are to be given the foundation they need. Many decades, possibly some centuries, will be needed to free our minds completely from the dogma and sophistication now obstructing thought, and to open our eyes to the full diversity and structural integrity of the biotic dimension of nature. This biotic conception, it may be emphasized, carries no reflection upon the physical conception, which is recognized to be valid but refused as an exhaustive analysis of natural structure. But the biotic conception, I am aware, must remain somewhat of an esoteric doctrine until it has delivered itself of its burden, which is a detailed reconstruction of the visible movements of the organisms known to us; by which time it will have been stereotyped into something it is not, and become in its turn a dogma of the vulgar. But we are busy bringing the conception to birth, and need not be too much concerned about its mortality.

To this work then I call all philosophers who, whatever their age as measured by the planets, are young in spirit and intelligence, and who in their hearts are prescient of the sterility and the anachronism of what passes for philosophy today. We shall do for the sciences of life what Descartes did for the sciences of physical structure! Is that not more worth while than another pseudo-psychology of perception? We shall postulate this biotic universe as the background suggesting hypothesis and controlling analysis in our study of the smaller visible movements of organic life. Do not despise the conception because it is simple—this is its token of truth, and it will lead to reflections intricate enough for the logician to pore over and confuse. If it does not immediately inspire some large volume studiously transposing into a new terminology the accumulated refuse of the past, remember that all the important books have been little books, that a fragment of one Platonic dialogue, conserved through the Middle Ages, undid all the tomes of Aristotle and his commentators; and that Socrates, having written nothing, had a civilization writing for him! And if the concept seems vague,
remember that it is the business of thought to make vague concepts clear, and not to turn concepts already clear upside down and inside out!

But while our immediate business is perhaps the entertainment and extension to others of this biotic conception of nature, we should ourselves begin its application to the particular data of biology as they now exist. We might do best perhaps to consider first the interactions within our own species, where the congruity between action and reaction is most apparent to us, since both parties to the transaction are at once animal and human. What are the biotic forces holding together or forcing apart the members of human groups? But it is evident that we shall not proceed far with this analysis without calling upon both infra-social and ultra-social forces or relations. The human process overlaps the vegetable and the animal processes, and overlaps also, we have it on excellent authority, those processes our fathers in their ignorance called divine. For an understanding of the infra-social processes we should surely turn to the animals themselves, not forgetting that in our social development we have sacrificed something of animal genius. The animals then we shall seek to understand not in their visible morphology, but in their visible interactions with members of their own and other species. We shall proceed in the opposite direction from the biology of the past, from function to stuff instead of from stuff to function. We shall note how the whole animal world is ultimately parasitic to the vegetable, and determined in its functions by this relationship. We shall note how in each case the animal function moulds itself upon the behavior of other animals and plants. But again, as we proceed in this way, we shall be led to consider the prior process, in this case vegetative, embodied in modified form in the animal reaction. Thus hunger relates the animal to animal or plant, but thirst relates it to the inorganic environment. Thirst is essentially a vegetative response; the root creeps towards water, the animal walks towards water. Thirst relates the organism to a biotic complex of river and lake, snow and rain, climate and topography. Terrestrial nature hides forms relevant to organic growth, and intelligible only in terms of this growth.

As our biotic reconstruction proceeds, we shall find ourselves learning our philosophy over again, in ways that reveal its true significance. What was the whole scholastic hierarchy, for example, but a rather absurdly foreshortened snapshot of the genetic movement of the species of life on this planet. What was Plato’s Idea but a rather literary allusion to the biotic pattern of universal nature, in its distinction from the more mechanistic structure discovered by terrestrial physics? The age-old problems of philosophy
will take their place in a context allowing some degree of solution. Our animal perception, for example, we shall understand as a fragment or cross-section of the time-taking biotic reactions of metabolism, reproduction, and the like; for the most basic processes of animal life existed before the senses were sharpened by differentiated end-organs. We shall understand the basic philosophical problem to be the problem of human health, in the largest meaning of these words; and we shall solve the problem by distinguishing the biotic patterns which at any time stimulate to motions issuing in madness and death from those which stimulate to integrity and growth. We shall understand what science means as a response to nature, as well as what it means as a description of nature. We shall know the diversity of man and the diversity of nature in terms of each other. There will be some sense then in studying the relation of physical science to its object, the world.

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BOOK REVIEWS


The bulk of this work is devoted to studies of various problems concerning the Epistles; but there is also a complete translation of the Epistles themselves with notes. The question of authenticity in general is dealt with in the first chapter; but in addition, the authenticity of each Epistle is taken up in a separate chapter or a note. The author, who handles the evidence very well, takes the position that some of the letters are certainly spurious, some doubtful, and some genuine. One of the genuine class is VII, and there is an illuminating chapter on the theory of knowledge in this letter. Also, the picture of Plato facing the concrete perplexities of actual existence in Athens and Syracuse is extremely well drawn, and deserves to be read as a companion piece to the political philosophy of the Dialogues. The author does not adopt any clear-cut position with regard to the question of development in Plato's views; but in several places he draws attention to the fact that both the style and the ideas of the Epistles agree best with the last group of Dialogues, with which they were contemporary. The text used for the translation is Burnet's, and the rendering is smooth and unusually clear. The notes do not pretend to be an adequate consideration of all the