*The living being and its environment (*milieu*)*[*]

Georges Canguilhem

The notion of environment (*milieu*) is becoming a universal and required way of capturing both the experience and the existence of living beings and we could almost speak of it being a category of contemporary thought. But it is difficult even today to give synthetic unity to the historical stages of the formation of the concept and the various ways in which it has been used, as well as the successive reversals of the environment-organism relationship, in geography, biology, psychology, technology, and economic and social history. For this reason philosophy must take the initiative for a synoptic search for the meaning and value of the concept. By this we do not mean merely the appearance of an initiative which would really consist in following on from scientific explorations in order to collate their pace and results; we mean a critical confrontation with several approaches, whose fruitfulness for a philosophy of nature oriented towards the problem of individuality is assumed, in order to find, if possible, their common point of departure. It is a good idea therefore to examine in turn the simultaneous and successive components of the notion of environment, the variety of uses of this notion, from 1800 to the present, the various reversals of the environment-organism relationship, and the general philosophical significance of these reversals.

Historically, the notion and the word *milieu* were imported into biology from mechanics in the second half of the 18th century. The mechanical notion, but not the word, appeared with Newton, and the word *milieu*, with its mechanical meaning, is present in the article "Milieu" in d'Alembert's and Diderot's *Encyclopedia*. It was introduced into biology by Lamarck, drawing on Buffon, but he only ever uses it in the plural. De Blainville sanctions this use. Etienne Geoffroy Saint-Hilaire in 1831, and Comte in 1838, both use the word in the singular as an abstract term. Balzac gives it currency in literature in 1842, in the preface to the Human Comedy, and Taine establishes it as one of the three analytical principles of historical explanation, the other two being race and the moment (*le moment*). The neo-Lamarckian French biologists after 1870 – Giard, Le Dantec, Houssay, Costantin, Gaston Bonnier, Roule – take the word from Taine rather than from Lamarck. They take the idea from Lamarck, but they get the word, as an abstract, universal term, from Taine.

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[*] This is a very rapid, and approximate, translation of Canguilhem's essay, "Le vivant et son milieu" from his *La connaissance de la vie* (Paris: J. Vrin, 1980 [1952]) pp. 129-154. The French *milieu* is translated as *environment* throughout, except where the author is specifically drawing attention to different meanings of the French word. In French the word can, of course, mean 'middle,' 'in the midst of,' 'environment,' 'medium,' 'between,' [social, cultural e.g.,] 'set' or 'circle' etc., and overlaps with English usage. Where *environment* translates *environnement*, the English is followed by the French in brackets. Canguilhem's essay was first given as part of a series of three lectures at the Collège philosophique in Paris in 1946-47 and was published in *La connaissance de la vie* in 1952.

18th century French mechanics called *milieu* what Newton understood by fluid, the classic example of which in Newton's physics, if not the sole archetype, is ether. In Newton's age the problem for mechanics was that of the action at a distance of distinct physical individuals. This was the fundamental problem of the physics of central forces (*forces centrales*). The problem did not arise for Descartes. For Descartes there was only one mode of physical action, collision, in a single possible physical situation of contact. This is why we can say that the notion of environment has no place in Cartesian physics. In no way is subtle matter an environment. But it was difficult to extend the Cartesian theory of collision and action through contact to the case of physical individuals occupying distinct points in space, for in that situation they cannot act without joining their action. We can thus imagine that Newton was led to pose the problem of the vehicle or medium of action. The luminous ether was for him the fluid medium of action at a distance. This explains the transition from the notion of fluid medium to its designation as environment. The fluid is the intermediary between two bodies, it is their *milieu;* and insofar as it penetrates all these bodies, the latter are situated in the middle (*au milieu*) of it. According to Newton and the physics of central forces it is because there are centers of forces that one can speak of an environment (*environnement*), of a milieu (*milieu*). The notion of environment (*milieu*) is an essentially relative notion. If the body on which action, transmitted through the environment, is exerted is considered separately, then we forget that the environment is *a between two centers* and only retains its function of centripetal transmission, and its surrounding (*environnante*) situation as it were. In this way the environment tends to lose its relative meaning and takes on an absolute meaning of a reality in itself.

Newton was perhaps responsible for the importation of the term into biology from physics. Ether not only served him in resolving the phenomena of illumination, but also in explaining the physiological phenomenon of vision and finally in explaining physiological effects of the sensation of light, that is to say, muscular reactions. In his *Optics*, Newton thinks of the ether as continuous in the air, the eye, the nerves, and even the muscles. It is therefore the action of an environment that assures that the reaction of muscular movement is dependant on the sensation of the brightness of a perceived source of light. This seems to be the first example of explanation of an organic reaction by the action of an environment, that is to say, of a fluid strictly defined by its physical properties.[1] Now the *Encyclopedia* article already cited confirms this point of view. All the examples of environments given in this article are taken from Newton's physics. And the term is given a purely mechanical meaning when it says that water is an environment for the fish which swim in it. Lamarck also understands the term in this mechanical sense.

Lamarck always speaks of environments (*milieux*) in the plural, and by this he explicitly means fluids like water, air and light. When Lamarck wants to designate the set of actions exerted on the living being from outside, that is to say, what we today call the environment, he never says environment, but always "influencing circumstances". Consequently, for Lamarck, circumstances are the genus of which climate, place, and environment are the species. This is why Brunschvicg, in *Les Etapes de la Philosophie mathématique*[2] could write that Lamarck took from Newton the physico-mathematical

model of explanation of living beings through a system of connections with its environment (*environnement*). The relationship between Larmarck and Newton are direct intellectually and indirect historically. Lamarck is linked to Newton through Buffon. We simply note that Lamarck was Buffon's student and his son's private tutor.

In his conception of the relations between the organism and the environment, Buffon actually combines two influences. The first is precisely that of Newton's cosmology, which Buffon always admired. The second is the tradition of the anthropo-geographers, the vitality of which was kept up, before him and after Bodin, Machiavelli, and Arbuthnot, by Montesquieu.[3] The Hippocratic treatise, *Of the air, water, and places* can be seen as the first work to give a philosophical form to this conception. These are the two components Buffon brings together in his principles of animal ethology, inasmuch as the habits of animals are distinctive and specific characteristics and can be explained by the same method used by geographers to explain the variety of human races and peoples on earthly soil.[4]

So, as Lamarck's teacher and precursor in his theory of the environment, Buffon seems to us to be at the meeting point of the theory's two, mechanical and anthrop-geographical, components. A problem of epistemology and of the historical psychology of knowledge arises here the scope of which goes well beyond the particular example in relation to which it is posed: Should the fact that two or several leading ideas are combined at a given moment in a single theory be interpreted as the sign that, although they may seem to be quite different when subject to analysis, they ultimately have a common origin whose meaning and often even existence are forgotten when they are considered separately? We will find this problem again at the end.

The Newtownian origins of the notion of environment are therefore enough to account for the initial mechanical meaning of the notion and of the use that was first made of it. Origin commands the meaning and the meaning commands the use. The truth of this is attested by the fact that in 1838 August Comte, when putting forward a general biological theory of the environment in lecture XL of his *Cours de Philosophie positive*, is aware that he is employing "milieu" as a neologism and claims responsibility for establishing it as a universal and abstract notion of explanation in biology. And Comte says that henceforth he will understand by this notion not only "the fluid in which a body is immersed" (which confirms the mechanical origin of the notion), but "the total set of external circumstances necessary for the existence of every organism". But we can also see that in Comte, who is quite aware of the origins of the notion, as well as of the significance he wants to give it in biology, the use of the notion is still dominated by its origin, if not the word, in mechanics. In fact it is extremely interesting to note that Comte is on the point of forming a dialectical conception of the relations between the organism and the environment. We instance here the passages in which Comte defines the relationship of the "suited or adapted organism" and the "favorable environment", as a "conflict of powers" the action of which is constituted by the function. He lays it down that "the ambient system could not modify the organism without the latter exerting a corresponding influence on it". But, apart from the case of the human species, Comte holds the action of the organism on the environment to be negligible. In the case of the

human species, Comte, faithful to his philosophical conception of history, admits that humanity modifies its environment through the intermediary of collective action. But for living beings in general Comte refuses to countenance this reaction of the organism on the environment, simply judging it to be negligible. This is because he quite explicitly seeks a guarantee of this dialectical connection, of this relationship of reciprocity between the environment and the organism, in the Newtonian principle of action and reaction. It is clear in fact that, from the mechanical point of view, the living being's action on the environment is practically negligible. And Comte ends up posing the biological problem of the relationships between organism and environment in the form of a mathematical problem: "In a given environment, given the organ, find the function, and reciprocally [i.e., given the function, find the organ]". The connection between the organism and the environment is therefore that of a function to a set of variables, a link of equality which allows the function to be determined by the variables, and the variables to be determined separately on the basis of the function, "all things being equal".[5]

Comte analyzes the variables of which the environment is the function in lecture XLIII of the *Cours de Philosophie positive*. These variables are gravity, air and water pressure, movement, heat, electricity, and chemical species, all factors that can be studied experimentally and quantifiably measured. The organism's quality is reduced to a set of quantities, notwithstanding Comte's mistrust of the mathematical treatment of biological problems, a mistrust that, as we know, comes from Bichat.

To summarize, the advantage of even a brief history of the importation of the term environment (*milieu*) into biology in the first years of the 19th century is that it accounts for the originally strictly mechanistic meaning of the word. If the hint of a genuinely biological meaning and more supple use of the term appear in Comte, this immediately gives way before the prestige of mechanics as an exact science founding prediction on the calculus. The theory of the environment in Comte appears clearly as a variant of the basic project that the *Cours de Philosophie positive* strives to fulfill: first the world, then man; going from the world to man. If he presupposes the idea of a subordination of mechanics to the vital, as expressed later in *Le Système de Politique positive* and *La Synthèse subjective*, this is nevertheless deliberately repressed.

But there is still a lesson to be drawn from the absolute and unqualified use of the word *milieu* definitively established by Comte. In Lamarck, the equivalent of what the word will henceforth designate was circumstances; Etienne Geoffroy Saint-Hilaire, in his 1831 report to the Academy of Sciences said: the surrounding environment (*le milieu ambiant*). The terms *circumstances* and *ambiance* or *surroundings* suggest a particular intuition of a centered or focused formation. In the success of the word *milieu* the representation of the straight line or indefinitely extendable plane, both continuous and homogenous, lacking definite shape or privileged position, prevails over the representation of the circle or sphere, forms which are still qualitatively defined and, if one may say so, hitched to a fixed center of reference. Circumstances and surroundings still preserve a symbolic value, but *milieu* forgoes reference to any other relation than that of a position forever denied by exteriority. Now refers to before, here to its beyond, and

so on without cease. The environment is truly a pure system of relations without supports.

On this basis we can understand the prestige of the notion of environment for analytical scientific thought. The environment becomes a universal instrument for dissolving individualized organic syntheses in the anonymity of universal elements and movements. When the French neo-Lamarckians take from Lamarck, if not the word in the absolute sense and in the singular, at least the idea, the only thing that interests them in the morphological characteristics and functions of the living being is their formation by external conditioning and, as it were, deformation. It is sufficient to recall Costantin's experiments on the forms of the leaves of the arrowhead; Houssay's experiments on the form, fins, and metamerism[6] of fish. In a short book, *La Vie des Rivières*,[7] Louis Roule can write: "Fish do not lead their lives themselves, the river has made them lead it, they are persons without personality." We use here an example of the inevitable result of a strictly mechanistic use of the notion of environment.[8] We return to the thesis of animal-machines. At bottom Descartes said no different when he said of animals: "It is nature that acts in them by means of their organs."

From 1859, that is to say, from the publication of Darwin's *Origin of the Species*, the problem of the relations between the organism and the environment is dominated by the polemic between Lamarckians and Darwinians. It seems that the originality of the starting positions must be recalled in order to understand the meaning and importance of this polemic.

In his *Philosophie zoologique* (1809), Lamarck writes that if we understand the action of circumstances or environments (*milieux*) as the direct action of the external environment on the living being, then we are forcing him to say something that he did not mean.[9] The environment dominates and controls the evolution of living beings through the intermediary of need, a subjective notion entailing reference to a positive pole of vital values. Changes in the circumstances entail changes in needs, and changes in needs entail changes in actions. To the extent that these actions are durable, use or non-use develop or atrophy certain organs, and these morphological acquisitions or losses arrived at through individual habit are preserved through the mechanism of heredity, on condition that the new morphological characteristic is shared by both of the partners in reproduction.

According to Lamarck, the living being's situation in the environment could be described as disheartening and desolate. Life and the environment which is unaware of it are two series of asynchronous events. Things begin with the change of circumstances, but it is the living being itself which, at bottom, has the initiative in the effort it makes not to be rejected by its environment. Adaptation is life's renewed effort to "stick" to an indifferent environment. Being the effect of an effort, adaptation is not therefore a harmony, it is not providential; it is achieved and never guaranteed. Lamarckism is not a mechanistic theory; it would be inexact to say it is finalistic. In reality it is a naked vitalism. There is an originality of life of which the environment takes no account, of

which it is unaware. Here the environment is, truly, external in the proper sense of the word; it is extraneous, it does nothing for life. Lamarck's doctrine really is a vitalism because it is a dualism. Life, Bichat said, is the set of functions that resist death. In Lamack's conception life resists solely by changing its shape in order to survive. To our knowledge, there is no portrait of Lamarck or summary of his doctrine which surpasses that given by Sainte-Beuve in his novel *Volupté*.[10] We can see how far the mechanistic conceptions of the French neo-Lamarckians were from Lamarckian vitalism. The American neo-Lamarckian Cope was more faithful to the spirit of the doctrine.

Darwin constructs a completely different idea of the living being's environment (*environnement*) and the appearance of new forms. In the introduction to the *Origin of the Species*, he writes that naturalists continually refer to external conditions like the climate and food as the only possible causes of variations, but that they are right only in a very limited sense. It seems that Darwin later regretted having attributed only a secondary role to the direct action of physical forces on living beings. This comes out from his correspondence. M. Prenant, in his introduction to selected texts of Darwin, has published a number of particularly interesting passages.[11] Darwin looks for the appearance of new forms in the conjunction of two mechanisms: a mechanism of the production of differences, which is variation, and a mechanism of the reduction and criticism of these produced differences, which is vital competition and natural selection. In Darwin's view, the fundamental biological relationship is a relationship of the living being to other living beings; it takes precedence over the relationship between the living being and the environment conceived as a set of physical forces. The first environment in which an organism lives is a set of living beings that are enemies or allies, predators or prey. Relations of use, destruction, and defense are established between living beings. In this competition of forces, accidental morphological variations function as advantages or disadvantages. Now variation, that is to say, the appearance of small morphological differences by which a descendant does not exactly resemble his ancestors, arises from a complex mechanism: the use or non-use of organs (the Lamarckian factor only concerns adults), the correlations or compensations of growth (for the young); or the direct action of the environment (on the germ).

In this sense we can say therefore that according to Darwin, unlike Lamarck, the initiative for variation sometimes, but only sometimes, belongs to the environment. The idea we get of Darwin differs somewhat depending upon whether we give more or less importance to this action, and according to whether we confine ourselves to his classical works or refer instead to the whole of his thought as given in his correspondence. However that may be, for Darwin, to live is to submit an individual difference to the judgment of the set of living beings. This judgment comprises only two sanctions: either to die or be part of the jury for a time. But insofar as one lives one is always judge and judged. Consequently we can see that in Darwin's work, as he left it for us, the thread linking the formation of living beings to the physico-chemical environment may seem rather tenuous. And when a new explanation of the evolution of species – mutationism – finds in genetics the explanation for phenomena (which Darwin knew about but underestimated) of directly hereditary specific variations, the role of the environment will be reduced to the elimination of the worst without playing a part in the production of new

beings which are normalized through their unpremeditated adaptation to new conditions of existence, monstrosity becoming the rule and originality provisional ordinariness.

It is instructive to note that in the polemic between Lamarckians and Darwinians the arguments and objections have a double meaning and a double entry, that now one and now the other denounces finalism and celebrates mechanism. This no doubt indicates that the question is badly posed. In Darwin, we can say that finalism is in his words (he has often been reproached for his use of the word selection) and not in the things. In Lamarck, there is less finalism than vitalism. Both are genuine biologists to whom life appears as a datum which they seek to describe without being too concerned about accounting for it analytically. These two genuine biologists are complementary. Lamark thinks of life in terms of duration, and Darwin thinks of life in terms of interdependence; a living form presupposes a plurality of other forms with which it enters into a relationship. The synoptic vision that gives the best part to Darwin's genius short changes Lamarck. Darwin is more akin to the geographers, and we know how much he owed to his voyages and explorations. The environment in which Darwin represents the life of the living is a biogeographical environment.

At the beginning of the 19th century, two names sum up the advent of geography as a science conscious of its method and its dignity: Ritter and Humboldt.

In 1817 Ritter published his *Géographie générale comparée, ou Science de la Terre dans ses rapports avec la nature et l'histoire de l'homme.* Over a dozen years starting in 1845 Alexandre de Humboldt published the book whose title exactly sums up its spirit, *Kosmos*. In these two authors are combined the traditions of Greek geography, that is to say, the science of the entire human world, the human *oikoumenē*, since Aristotle and Strabo, and the science of the coordination of human space in relation with the celestial configurations and movements, that is to say, the mathematical geography of which Eratosthenes, Hipparchus and Ptolemy are thought to be the founders.

According to Ritter, human history is unintelligible without man's connection to the soil and the whole surface of the Earth. The Earth, considered as a whole, is the stable support of the vicissitudes of history. Terrestrial space and its configuration is consequently not only the object of geometrical and geological knowledge, but also of sociological and biological knowledge.

Humboldt is a naturalist traveler who several times crossed those parts of the world it was possible to cross in his time and who applied a whole system of barometric, thermometric, and other measures in his investigations. The interest of Humboldt lies above all in the division of plants according to different climates: he is the founder of botanical geography and zoological geography. *Kosmos* is a synthesis of knowledge whose object is life on Earth and the relations of life with the physical environment. This synthesis does not aim to be encyclopedic, but strives to arrive at an intuition of the universe, and it begins with a history of the *Weltanschauung*, a history of the Cosmos the

equal of which is difficult to find in a work of philosophy. It contains a completely remarkable inventory.

It is absolutely important to note that Ritter and Humboldt apply the category of totality to their object: the relations between historical man and the environment. Starting from them, the idea of a determination of historical relationships by the geographical support is consolidated in geography, ending up, in Germany, with Ratzel and anthropogeography first of all, and then geopolitics, and through contagion it invades history, starting with Michelet. We are thinking of the *Tableau de la France*.[12] Finally, as we have already said, Taine helps to spread the idea to every milieu, including the literary milieu. The spirit of this theory of the relations between the geographical environment and man can be summed up by saying that doing history consists in reading a map, understanding by map the representation of a set of metrical, geodesic, geological, climatological, and descriptive biogeographical data.

Treatment of the problems of anthropology and human ethology – increasingly deterministic, or more precisely mechanistic, the greater the distance from the spirit of the founders – goes hand in hand with a parallel, if not exactly synchronous treatment regarding animal ethology. The mechanistic interpretation of the formation of organic forms is followed by the mechanistic interpretation of the organism's movements in the environment. We recall only the work of Jacques Lœb and John Broadus Watson. Generalizing the conclusions of his research on phototropism in animals, Lœb views every movement of the organism in the environment as a movement into which the environment forces the organism. The reflex, seen as an elementary response of a segment of the body to an elementary physical stimulus, is the simple mechanism whose composition enables one to explain all the living being's conduct. Together with Darwinism, this exorbitant Cartesianism is incontestably at the origin of the postulates of behaviorist psychology.[13]

Watson assigned psychology the program of the analytical investigation of the conditions of the living being's adaptation to the environment through the experimental production of relations between stimulation and response (the stimulus-response couple). The relation between stimulation and response is one of physical determinism. The biology of behavior is reduced to neurology, and the latter is summed up in an energetics. The evolution of Watson's thought led him to a conception in which he simply disregarded consciousness as of no use, a conception in which it is purely and simply nullified as illusory. The environment is invested with every power with regard to individuals; its power dominates and even abolishes that of heredity and genetic constitution. Given the environment, the organism only makes of itself what in reality it receives. The living being's situation, its being in the world, is a condition, or more exactly, a conditioning.

Albert Weiss sought to construct biology as a deductive physics by advancing an electronic theory of behavior. It remained for the pscyho-technicians, extending Taylorist time and motion techniques, to perfect the work of behaviorist psychology and

skillfully construct man as a machine reacting to machines, as an organism determined by the "new environment" (Friedmann).

In short, due to its origins, the notion of environment was first of all developed and extended in a completely determined direction; applying to the notion itself its own methodological norm, we can say that its intellectual power was a function of the intellectual environment in which it was formed. The theory of the environment was first of all the positive and apparently verifiable translation of Condillac's fable of the statue. In the rose's perfume, the statue *is* the rose's perfume. Likewise, the living being in the physical milieu is light and heat; it is carbon and oxygen, calcium and gravity. It responds to sensory stimulations with muscular contractions, it responds to tickling with scratching, to explosion with flight. But we can and must ask ourselves: where is the living being? We can see individuals, but these are objects; we see actions, but these are movements; we see centers, but these are environments (*environnements*); we see machinists, but these are machines. The environment of behavior coincides with the geographical environment, and the geographical environment with the physical environment.

It was normal, in the strong sense of the word, that this methodological norm first found its limits and the occasion of its reversal in geography. Geography has to deal with complexes of elements with reciprocally limiting actions in which effects of causes become causes in turn, modifying the causes which gave birth to them. The trade winds give us a typical example of a complex. Trade winds move the surface sea water heated through contact with the air; the deep cold water rises to the surface and cools the atmosphere; the low temperatures engender low pressures, which give rise to the winds; the cycle is complete and begins again. This is the type of complex that we can also observe in plant geography. Vegetation is divided into natural sets in which diverse species reciprocally limit each other and in which, consequently, each contributes in the creation of an equilibrium for the others. The set of these plant species finally forms its own environment. In this way exchanges between plants and the atmosphere eventually create a sort of screen of water vapor around the plant zone which limits the effect of radiation, and the cause gives birth to the effect which checks it in turn, and so on.[14]

The same views should be applied to the animal and man. However, the human reaction to the challenge of the environment happens to be diversified. Man can bring several solutions to a single problem posed by the environment. The environment proposes without ever imposing a solution. Certainly, the possibilities in a definite state of civilization and culture are not unlimited. But the fact that what at one time is seen as an obstacle may later prove to be a means of action is ultimately due to the idea, the representation that man forms – collectively, of course – of his possibilities and needs, and this stems in fact from what he represents to himself as desirable, and this is not separate from the set of values.[15]

So, we end up turning the relation between environment and living being around. Man here, as an historical being, becomes a creator of geographical configuration; he

becomes a geographical factor, and we simply recall that the works of Vidal-Lablache, Brunhes, Demangeon, and Lucien Febvre and his school have shown that man does not know any pure physical environment. In a human environment, man is obviously subject to a form of determinism, but it is the determinism of artificial creations in which the spirit of invention which calls them into existence is alienated. In the same order of ideas, the works of Friedmann show how, in the new environment machines create for man, the same reversal has already been produced. Pushed to the extreme limits of its ambition, the psycho-technique of engineers, the product of Taylor's ideas, finally manages to grasp the presence in man of his own originality in the form of the meaning of values as an irreducible center of resistance. Man, even when subordinated to the machine, never manages to grasp himself as a machine. His efficiency is greater the more he is aware of his central situation with regard to the mechanisms intended to serve him.

Well before this the same reversal of the organism-environment relationship had taken place with regard to animal psychology and the study of behavior. Lœb gave rise to Jennings, and Watson gave rise to Kantor and Tolmann.

The influence of pragmatism is obvious and established here. If pragmatism functioned as the intermediary between Darwinism and behaviorism in one sense through the generalization of the notion of adaptation to the theory of knowledge, and in another sense by stressing the role of values in their relationship to the interests of the action, Dewey had to get the behaviorists to consider reference of organic movements to the organism itself as essential. The organism is considered as a being on which not anything can be imposed because its existence as an organism consists in proposing itself to things in accordance with specific orientations of its own. Prepared by Kantor, Tolmann's teleological behaviorism consists in looking for, in recognizing the sense and intention of animal movement. It appears to be an essential property of the movement of reaction that it persist through a variety of phases which may be errors, failed actions, until the reaction puts an end to the stimulation and restores rest, or leads to a new series of actions completely different from those which were closed on themselves.

Before Tolmann, Jennings, in his theory of trial and error, had shown, against Lœb, that the animal does not react by summation of molecular reactions to a stimulant that can be broken down into units of stimulation, but reacts as a whole to total objects and that these reactions are regulations for the needs which govern them. Naturally, we must acknowledge here the considerable contribution of *Gestalttheorie*, and especially Koffka's distinction between the environment of behavior and the geographical environment.[16]

Finally, the organism-environment relationship is turned around in Von Uexküll's studies of animal psychology and Goldstein's studies of human pathology. Both of them carry out this reversal with the clarity that a fully philosophical view of the problem gives them. Uexküll and Goldstein are in agreement on this fundamental point: studying a living being in constructed experimental conditions involves making an environment for it, imposing an environment on it. Now the property of the living being is to make its

environment, to shape its environment. Certainly, even from a materialist point of view, we can speak of interaction between the living and the environment, between the physico-chemical system cut out from a vaster whole and its environment (*environnement*). But speaking of interaction does not cancel the difference that exists between a physical type of relation and a biological type of relation.

From the biological point of view it is necessary to understand that there is the same relationship between the organism and the environment (*environnement*) as between parts and the whole within the organism itself. The individuality of the living being does cease at its ectodermic borders any more than it begins at the cell. The biological relationship between the being and its environment (*milieu*) is a functional and consequently mobile relationship, the terms of which successively exchange their roles. The cell is an environment of infra-cellular elements, it lives in an internal environment which sometimes has the dimensions of an organ and sometimes of the organism, and the organism itself lives in an environment which, so to speak, is to it what the organism is to its components. So we need to acquire a biological meaning in order to judge biological problems and reading Uexküll and Goldstein may contribute much to the formation of that meaning.[17]

Uexküll takes the terms *Umwelt, Umgebung* and *Welt* and carefully distinguishes them from each other. *Umwelt* distinguishes the environment of behavior specific to an organism; *Umgebung* is the ordinary geographical environment, and *Welt* is the universe of science. The specific environment of behavior (*Umwelt*) for the living being is a set of excitations which possess value and meaning as signals. In order to act on a living being it is not sufficient for the physical excitation to be produced, it must be noticed. Consequently, inasmuch as the excitation acts on the living being, it presupposes the orientation of the living being's interest, it is not due to the object but to the interest. In other words, to be effective it must be anticipated by an attitude of the subject. If the living being is not seeking, it won't receive anything. A living being is not a machine which responds to excitations with movements, it is a machinist which responds to signals with operations. Obviously, there is no question of disputing the fact that this involves reflexes with physico-chemical mechanisms. This is not the question for the biologist. The question lies in the fact that from the exuberance of the physical environment producing a theoretically unlimited number of excitations the animal only holds on to some signals (*Merkmale*). Its rhythm of life orders the time of this *Umwelt*, just as it orders the space. With Buffon, Lamarck said: time and favorable circumstances gradually constitute the living. Uexküll reverses the relationship and says: time and favorable circumstances are relative to such and such living beings.

The *Umwelt* is therefore an elective sample in the *Umgebung*, in the geographical environment (*environnement*). But the environment (*environnement*) is precisely nothing more than man's *Umwelt*, that is to say, the ordinary world of his perspective and pragmatic experience. Just as this *Umgebung*, this geographical environment external to the animal is, in a sense, centered, ordered, and oriented by a human subject – that is to say, by a creator of techniques and values – so the animal's *Umwelt* is nothing other than a centered environment (*milieu*) relative to this living being as essentially a subject of

vital values. We should imagine a subjectivity at the root of this organization of the animal *Umwelt* which is analogous to the subjectivity we have to think is at the root of the human *Umwelt*. One of the most striking examples given by Uexküll is the *Umwelt* of the tick.

The tick lives on the warm blood of mammals. After mating, the adult female climbs to the end of a branch of a tree and waits. It may wait for eighteen years. At the Rostock Institute of Zoology ticks have remained alive, confined, and without food for eighteen years. When a mammal passes under the tree, the tick's lookout post, it lets itself drop. It is guided by the odor of rancid butter released by the animal's cutaneous glands. This is the only stimulant that can trigger the movement of its fall. This is the first stage. When it has fallen on the animal it attaches itself to it. If the odor of rancid butter is produced artificially, on a table, for example, the tick does not remain there but climbs back up to its observation post. What fixes it on the animal is solely the temperature of its blood. It is fixed on the animal through its thermal sense; and guided by its tactile sense, it seeks out by preference spots on the skin without fur where it embeds its head and sucks the blood. It is only then that the tick's eggs encapsulated in its stomach since the time of mating – and which may remain in that state for eighteen years – penetrated by the mammal's blood, burst open, mature, and develop. The tick may live for eighteen years in order to fulfill its reproductive function in a few hours. It should be noted that the animal may remain completely indifferent and insensitive for a considerable length of time to all the excitations of an environment like a forest, and that the only excitation that is capable of triggering its movement, to the exclusion of any other, is the odor of rancid butter.[18]

Comparison with Goldstein is inevitable, for the firm ground on which the latter constructs his theory is a criticism of the mechanical theory of the reflex. The reflex is not an isolated or unmotivated reaction. The reaction always depends on the opening of the sense towards excitations and on its orientation towards them. This orientation depends on the meaning of the perceived situation as a whole. Isolated stimulants have a meaning for human science, but not for the sensibility of the living being. An animal in a situation of experimentation is in a situation which is abnormal from its point of view, of which it has no need in terms of its own norms, which it has not chosen, and which is imposed on it. An organism is therefore never equal to the theoretical totality of its possibilities. We cannot understand its action without appealing to the notion of preferential behavior. And preferential does not mean objectively simpler. It is the other way round: the animal finds it simpler to do what it prefers. It has its own vital norms.

The relationship established between the living being and the environment is like a debate (*Auseinandersetzung*) to which the living being brings its own norms of assessment of situations, in which it dominates the environment and adapts to it. This is not essentially a relationship of struggle and opposition as we might suppose. That characterizes the pathological state. A life which affirms itself against is a life already threatened. Forcible movements, like muscular reactions of stretching, for example, express the outside's domination of the organism.[19] A healthy life, a life confident in its existence and its values is a flexible, supple, almost smooth life. The situation of the

living being controlled from outside by the environment is what Goldstein sees as typical of the catastrophic situation. It is the situation of the organism in the laboratory. Of all the possible relationships between the living being and the environment, those studied experimentally, objectively, have the least biological meaning; they are pathological relationships. Goldstein says that "the meaning of an organism is its being"; we can say that the being of the organism is its meaning. Certainly, the physico-chemical analysis of the living can and must be undertaken. It has both theoretical and practical interest. But it constitutes a chapter of physics. Everything remains to be done in biology. Biology must therefore consider the living being first of all as a meaningful being, and individuality not as an object but as a characteristic in the realm of values. To live is to spread out, to organize the environment from a center of reference which cannot itself be referred elsewhere without losing its original meaning.

At the same time as the reversal of the organism-environment relationship was taking place in animal ethology and the study of behavior, a revolution was taking place in the explanation of morphological characteristics which had tended to accept the autonomy of the living being in relation to the environment. We do no more than allude here to the now well-known works of Bateson, Cuénot, T. Morgan, H. Müller and their collaborators which have taken up and extended the research of G. Mendel on hybridization and heredity and which, through the constitution of genetics, have ended up asserting that the living being's acquisition of its form, and starting from its functions in a given environment, depends on its specific hereditary potential and that action on the phenotype leaves the genotype intact. The genetic explanation of heredity and evolution (the theory of mutations) converged with the theory of Weissman. The early isolation of the germinal plasma in the course of ontogenesis would nullify the influence of somatic modifications determined by the environment on the development of the species. A. Brachet, in his book, *La Vie créatrice des Formes*, was able to write that "the environment is not an agent of formation strictly speaking, but rather of realization,"[20] invoking in support of this the multiplicity of forms of living beings in an identical marine environment. And Caullery concluded his exposition on the *Problème de l'Evolution*[21] by acknowledging that evolution depends much more on the intrinsic properties of organisms than on the surrounding environment.[22]

But we know that the conception of an integral autonomy of the hereditary genetic assortment has not failed to arouse criticisms. To start with the fact was stressed that nucleoplasmic disharmony tends to limit the hereditary omnipotence of genes. In sexual reproduction, while each of the parents provides half of the genes, the mother furnishes the egg's cytoplasm. Now as the offspring of parents from two different species are not reciprocal, depending on whether one or other of the species is represented by the father or the mother, we are led to think that the power of the genes differs as a function of the cytoplasmic environment. On the other hand, H. Müller's experiments (1927) causing mutations on the drosophila through the action of an environment of X rays seems to throw some light on the external conditioning of a phenomenon perhaps too complacently used to emphasize the separation of the organism from the environment. Finally, a renewed actuality has been given to Lamarckism by the ideological as much as scientific polemics which have surrounded the indignant

repudiation of the "pseudo-science" of genetics by Russian biologists that Lysenko has drawn to the "healthy method" of Mitchourine (1855-1935). Experiments on the vernalization of cultivated plants like wheat and rye led Lysenko to assert that hereditary modifications can be obtained through variations in the conditions of feeding, care, and climate, involving the break up or breach of the organism's hereditary constitution which geneticists wrongly supposed to be stable. Insofar as one can summarize complex experimental facts, we should say that according to Lysenko heredity is dependant on the metabolism and this is dependant on the conditions of existence. Heredity would be the assimilation of external conditions by the living over successive generations. The ideological nature of the commentaries concerning this theory, quite apart from the possibility of the theory accepting let alone withstanding the experimental counter-proofs and criticisms which are the rule in scientific discussion, throws light on its meaning, all of which, of course, is outside our domain.[23] It seems that the essential aspect of the problem is technical, that is to say, agronomic. The Mendelian theory of heredity, by proving the spontaneous character of mutations, tends to curb the human, and specifically Soviet ambition of complete domination of nature and limit the possibilities of an intentional alteration of living species. Finally, and above all, recognition of the determinant action of the environment has a political and social bearing in that it sanctions man's unlimited action on himself through the intermediary of the environment. It justifies the hope of an experimental renewal of human nature. It thus appears to be progressive to the highest degree. Theory and praxis are inseparable, as they should be for the Marxist-Leninist dialectic. We can imagine then that genetics can be charged with all the sins of racism and support for slavery and Mendel appears in the front ranks of a retrograde, capitalist, and in fact idealist biology.

It is clear that the revived credibility of the inheritance of acquired characteristics does not justify the unqualified description of the recent theories of Soviet biologists as Lamarckian. For we have seen that the essential feature of Lamarck's ideas consists in attributing the organism's adaptation to the environment to the initiative of its needs, efforts, and reactions. The environment provokes the organism into orientating its becoming itself. The biological response prevails, and by far, over the physical stimulation. By rooting the phenomena of adaptation in need, which is at once pain and impatience, Lamarck focused on the point where life coincides with its own meaning, where through sensibility the living being is positively or negatively situated absolutely in existence, the indivisible totality of organism and environment.

In Lamarck, as in the first theorists of the environment, the meaning of the notions of "circumstances" and "ambience" were completely different from their meaning in ordinary language. They really evoked a spherical, centered arrangement. The terms "influences" and "influencing circumstances," also used by Lamarck, get their meaning from astrological conceptions. When Buffon, in *La Dégénération des Animaux*, speaks of the "color (*teinture*)" of the sky that man needs a long time to receive, he uses a term, no doubt unconsciously, taken for Paracelsus. Even the notion of "climate" in the eighteenth[24] and at the start of the nineteenth century is jointly geographical, astronomical, and astrological: the climate is the changing aspect of the sky by degrees from the equator to the pole, it is also the influence exerted by the sky on the Earth.

We have already pointed out that to begin with the biological notion of environment combined an anthropogeographical component and a mechanical component. In a sense, the anthropogeographical component was even the whole of the notion, for it included within itself the other astronomical component, which Newton had converted into a notion of celestial mechanics. Now geography was originally, for the Greeks, the projection of the sky on the Earth, the establishment of a correspondence of sky and Earth, a correspondence in two senses simultaneously: topographical correspondence (geometry and cosmography) and hierarchical correspondence (physics and astrology). The coordination of the parts of the Earth and the subordination to the sky of an Earth with a coordinated surface were underpinned by the astrobiological intuition of the Cosmos. Greek geography had its philosophy in the Stoics.[25] The intellectual relations between Posidonius, on the one hand, and Hipparchus, Strabo, and Ptolemy, on the other, are incontestable. The theory of universal sympathy, the vitalist intuition of universal determinism, gives the geographical theory of environments (*milieux*) its meaning. This theory assumes the identification of the totality of things with an organism, and the representation of the totality in the form of a sphere centered on the situation of a privileged living being: man. This biocentric conception of the Cosmos crossed over the Middle Ages to bloom in the Renaissance.

We know what became of the idea of the Cosmos with Copernicus, Kepler, and Galileo, and how dramatic the conflict was between the organic conception of the world and the conception of a universe decentered in relation to the Earth of living beings and man, the privileged center of reference of the ancient world,. Starting with Galileo, and also Descartes, we had to choose between two theories of the environment, that is to say, basically of space: a centered, qualitative space in which the mi-*lieu* is a center; a decentered, homogenous space in which the *mi*-lieu is an intermediary field. Pascal's famous text, *Disproportion of man*[26] clearly reveals the ambiguity of the term in a mind which cannot or does not want to choose between its need for existential security and the requirements of scientific knowledge. Pascal knows full well that the universe has fallen apart, but the "eternal silence" fills him with dread. Man is no longer in the middle (*au milieu*), but *he is a "mid-point"* [un milieu]) (a mid-point between [*milieu entre*] two infinities, between nothing and everything, between two extremes); the "middle station" (*milieu*) is the *condition in which nature has placed us; we drift over a vast milieu* ["we are floating in a medium of vast extent"]*; man bears a proportion with some parts of the world, he has a relationship with all that he knows:* "He needs a place to contain him, time to exist (*durer*) in, motion in order to live, elements to compose him, warmth and food for nourishment, air to breathe ... everything in short is related to him." We can see therefore three senses of the term *milieu* interfering with each other here: median situation, sustaining fluid, and vital environment. In developing this last sense Pascal sets out his organic conception of the world in a return to Stoicism beyond and against Descartes: "Thus, since all things are both caused or causing, assisting and assisting, mediate and immediate, providing mutual support in a chain linking together naturally and imperceptibly the most distant and different things, I consider it as impossible to know the parts without knowing the whole as to know the whole without knowing the individual parts." And when he defines the universe as "an infinite sphere whose center

is everywhere and circumference nowhere," Pascal paradoxically tries, through the use of an image taken from the theosophical tradition, to reconcile the new scientific conception, which makes the universe an unlimited and undifferentiated *milieu*, and the ancient cosmological vision, which makes the world a finite totality that refers back to its center. It has been established that the image Pascal uses here is a permanent myth of originally Neo-Platonist mystical thought in which the intuition of the spherical world centered on and by the living being is combined with the already heliocentric cosmology of the Pythagoreans.[27]

Even Newton drew from his reading of Jacob Boehme and Henry More, "the Cambridge Platonist," and from their Neo-Platonist cosmology, a symbolic representation of the possible ubiquity of a radiating action from a center. Newtonian space and ether, the first as means of God's omnipresence and the second as support and medium of forces, preserve, as we know, an absolute character that eighteenth and nineteenth century scientists failed to observe. Newtonian science, which had to support so many empiricist and relativist professions of faith, is founded on metaphysics. The empiricism hides the theological foundations. Thus the natural philosophy which is the source of the positivist and mechanistic conception of the environment in fact turns out to be supported by the mystical intuition of a sphere of energy whose central action is identically present and effective at every point.[28]

If today it seems normal to any mind formed in the mathematical and physical disciplines that the ideal of the objectivity of knowledge requires a decentering of the view of things, the time seems to have come in turn to understand that in biology, according to J.B.S. Haldane in *The Philosophy of a Biologist*, "it is physics that is not an exact science." Or, as Claparède has written: "What distinguishes the animal is that it is a *center* in relation to surrounding forces which, in relation to the animal, are no more than stimulants or signals, a center, that is to say, a system of internal regulation, and whose reactions are controlled by an internal cause, momentary need."[29] In this sense, the environment on which the organism depends is structured and organized by the organism itself. What the environment offers to the living being is a function of demand. Thus, in ways that cannot be compared, several animals extract their specific and singular environment from what appears to man to be a single environment. Man's specific environment is the world of his perception, that is to say, the field of his pragmatic experience in which his actions, orientated and governed by values immanent to tendencies, separate out qualified objects and situate them in relation to each other and all of them in relation to himself. So that the environment (*environnement*) to which he is supposed to react turns out to be originally centered on him and by him.

But as a scientist, man constructs a universe of phenomena and laws that he takes for an absolute universe. The essential function of science is to devalue the qualities of the objects making up man's specific environment while putting itself forward as a general theory of a real, that is to say, inhuman environment. Perceptible data are depreciated, quantified, and identified. The imperceptible is suspected, then detected and

known. Measures replace evaluations, laws replace habits, causality replaces hierarchy, and the objective replaces the subjective.

Now this universe of scientific man, of which Einstein's physics offers the ideal representation – a universe the fundamental equations of intelligibility of which are the same as whatever the reference system may be – because it maintains a direct relationship with the living man's specific environment, albeit one of negation and reduction, confers on this specific environment a sort of privilege over the specific environments of other living beings. Living man draws from his relationship to scientific man, through the research by which normal perceptual experience is nevertheless contradicted and corrected, a sort of unconscious smugness which makes him prefer his own environment as not just having a different value but more reality than those of other living beings. In fact, as a specific environment of behavior and life, the environment of man's perceptual and technical values has no more reality in itself than the specific environment of the woodlouse or grey squirrel. The qualification of real is only rigorously applicable to the absolute universe, the universal environment of elements and movements established by science, whose recognition as such must necessarily be accompanied by the disqualification of *all* specific, subjectively centered environments, including that of man, as vital illusions or errors.

The claim of science to dissolve these centers of organization, adaptation, and invention, to dissolve living beings in the anonymity of the mechanical, physical and chemical environment (*environnement*) must be complete; it must encompass man himself. And we are well aware that this project has not seemed too daring to many scientists. But then, from a philosophical point of view, we must ask ourselves whether the origin of science does not reveal its meaning better than the claims of some scientists. For the birth, development, and progress of science in a humanity which, from a scientistic or even materialist point of view, is justly denied innate knowledge should be understood as a fairly bold undertaking for life. Unless we should accept the absurdity that life contains the science of reality in advance as a part of itself. Then we would have to ask ourselves to what need of reality could the ambition of a scientific determination of this same reality correspond.

But if science is the work of a humanity rooted in life before being enlightened by knowledge, if it is a fact in the world at the same time as a vision of the world, then it sustains a permanent and necessary relation with perception. And therefore man's specific environment is not situated in the universal environment like content in its container. A center is never resolved into its environment (*environnement*). A living being is not reducible to a meeting point of influences. Whence the inadequacy of any biology which, through complete submission to the spirit of the physicochemical sciences, would eliminate from its domain every consideration of meaning. A meaning, from the biological and psychological point of view, is an assessment of values in keeping with a need. And for who experiences and lives it, need is an irreducible and thereby absolute system of reference.

Translated by Graham Burchell

[1] On all these points, see Léon Bloch, *Les Origines de la Théorie de l'Ether et la Physique de Newton*, 1908.
[2] p. 508.
[3] *Spirit of the Laws*, xiv to xix: relationships between laws and climate.
[4] The chapter on "The degeneration of animals" in *Histoire des Animaux* studies the action of the habitat and food on the animal organism.
[5] Tolman, in his behaviorist psychology, also conceives of the relations between organism and environment in the form of a relationship of function to variable.
[6] "consisting of several similar segments or metameres" OED (G.B.)
[7] Paris: Stock, 1930, p. 61.
[8] There is a striking summary of the thesis in Houssay's *Force et Cause* (Paris: Flammarion, 1920) when he speaks of "certain sorts of units that we call living beings, that we designate apart as if they really had a specific, independent existence, whereas they do not have any isolated reality and cannot exist except in absolute and permanent connection with the surrounding environment of which they are a simple local and momentary concentration" (p. 47).
[9] The question concerns animals above all. Lamarck is more reserved with regard to plants.
[10] "Over ten days I went several times to M. de Lamarcks's lectures on natural history in the Jardin des Plantes ... M. de Lamarck was like the last representative of that great school of physicians and general observers that reigned from Thales and Democritus to Buffon ... His conception of things had great simplicity, plainness and sadness. He constructed the world with the least elements, the least crises, and the most duration possible ... His genius of the Universe was a long blind patience ... Similarly, in the organic order, once the mysterious power of life was admitted, as small and as elementary as possible, he supposed it developing itself, gradually shaping itself over time; gnawing need, the sole habit in diverse environments (*milieux*) gave birth at length to the organs, unlike the constant power of nature which destroyed them, for Lamarck separated life and nature. Nature in his eyes was rock and ash, the granite of the tomb, death. Life entered only as a strange and singularly industrious accident, a prolonged struggle with greater or lesser success or equilibrium here and there, but always vanquished in the end; cold immobility prevailing after as before."
[11] *Darwin*, Paris: E.S.I., 1938, pp. 145-149.
[12] In Lucien Febvre's *La Terre et l'Evolution humaine* there is an historical presentation of the development of the idea and a critique of its exaggeration.
[13] Tilquin, *Le Behaviorisme* (Paris: Vrin, 1942) pp. 34-35. The basic information used here is taken from this well-documented thesis.
[14] See Henri Baulig, *La Géographie est-elle une science?* in *Annales de Géographie*, LVII, January-March 1948; and *Causalité et Finalité en Géomorphologie*, in *Geografiska Annaler*, 1949, H, 1-2.
[15] A very interesting clarification of this reversal of perspective in geography is found in an article by L. Poirier, *L'Evolution de la Géographie humaine*, in the journal *Critique*, nos. 8 and 9, January-February 1947.
[16] On this point, see P. Guillaume, *Psychologie de la Forme*, and M. Merleau-Ponty, *Structure du Comportement*.
[17] J. von Uexküll, *Umwelt und Innenwelt de Tiere*, Berlin, 1909, 2nd edition, 1921. *Theoretische Biologie*, 2nd ed., Berlin , 1928. Uexküll and G. Kriszat, *Streifzüge durch die Umwelten von Tieren und Menschen*, Berlin, 1934.

Goldstein, however, only accepts the views of von Uexküll with considerable reservations. Not wanting to distinguish the living being from its environment (*environnement*) makes all investigations of relations impossible in a sense. Determination disappears to the advantage of reciprocal penetration and the consideration of the totality kills knowledge. If knowledge is to remain possible, it is necessary that in this organism-environment (*environnement*) totality a non-conventional center appears on the basis of which a span of relations can open up. See Kurt Goldstein, *La Structure de l'Organisme*, pp. 75-76, critique of any exclusive theory of the environment (*environnement*); English translation, *The Organism. A Holistic Approach to Biology Derived from Pathological Data in Man*, Foreword by Oliver Sacks (New York, Zone Books, 1995).
[18] Von Euxküll's example of the tick is summarized by L. Buonore in his *L'Autonomie de l'Être vivant* (Paris: P.U.F., 1949) p. 143.

[19] For a discussion of this thesis of Goldstein, see F. Dagognet, *Philosophie biologique* (Paris: P.U.F., 1955), Conclusion.
[20] Alcan, 1927, p. 171.
[21] Payot, 1931.
[22] An anticipation of these ideas will be found in Nietzsche. See *La Volonté de Puissance*, trans. Bianquis (Paris: Gallimard) tome 1, p. 220. In truth, Nietzsche's criticisms of Darwin are more justly directed at the neo-Lamarckians.
[23] On the presentation of the question, see *Une Discussion scientifique en U.R.S.S.* in the journal *Europe*, 1948, no. 33-34; and C. C. Mathon, *Quelques Aspects du Mitchourinisme*, etc., in *Revue générale des Sciences pures et appliqueées*, 1951, nos. 3-4. On the ideological aspect of the controversy, see Julian Huxley, *La Génétique soviétique et la Science mondiale* (Paris: Stock, 1950). Jean Rostand has devoted a good historical and critical presentation to the question, *L'Offensive des Mitchouriniens contre la Génétique mendelienne,* in *Les Grands Courants de la Biologie* (Paris: Gallimard, 1951), followed by a bibliography. Finally, see Hovasse, *Adaptation et Evolution* (Hermann, 1951).
[24] See the article "Climate" in the *Encyclopedia*.
[25] See the excellent short history of Greek geography in Theodor Breiter, Introduction to vol. II (Commentaries) of *Astronomicon* of Manilius, Leipzig, 1908.
[26] *Pensées*, ed. Brunschvicg, II, 72; *Pensées*, trans. A.J. Krailsheimer, Section One, XV, 199
[27] Dietrich Mahnke, *Unendliche Sphäre und Allmittelpunkt* (Halle: Niemeyer, 1937). The author devotes some interesting pages to the use and meaning of the expression in Leibniz and Pascal. According to Havet, Pascal would have taken the expression from M^{lle} de Gournay (preface to the 1595 edition of Montaigne's *Essays*) or from Rabelais (*Third Book*, ch. xiii).
[28] See A. Koyré, *La Philosophie de Jacob Boehme*, pp. 378-379, and "The significance of the Newtonian synthesis" in his *Newtownian Studies* (Chicago: University of Chicago Press, 1965).
[29] Preface to *Pscyhologie des Animaux* by Bujytendijk (Paris: Payot, 1928).