FRIEDRICH ENGELS AND NATURAL SCIENCE (ON THE 150th ANNIVERSARY OF HIS BIRTH)

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Lenin began his article about Friedrich Engels, written on the occasion of his death, with words that give an unsurpassed picture of Engels and describe the meaning and greatness of his activity: "After his friend Karl Marx.... Engels was the most outstanding scholar and teacher of the proletariat of the entire civilized world at that time" [1]. As an epigraph to his article, Lenin quoted the words of Nekrasov from his poem "Pamyati Dobrolyubova"—"What a shining light of intellect has been dimmed, what a heart has ceased to beat."

Now, 150 years after the birth and 75 years after the death of Friedrich Engels, magnified by historical perspective and by events which have taken place in the social world and in natural science during that period, the mighty figure of Engels stands out more clearly still as one of the founders of scientific communism and as one of the first leaders of the world proletariat, one of the creators of the new doctrine of mankind—dialectical materialism, a scholar with encyclopedic knowledge, the founder of modern theoretical science, a man with a warm heart and noble spirit, a truly great citizen of the future.

Years ago, when assessing the importance of great human discoveries for mankind and the activity of the persons making these discoveries, Engels wrote: "As Darwin discovered the law of development of the organic world, so Marx discovered the law of development of human history...." [2]. There is every justification for continuing this comparison, bearing in mind Engels' theoretical works in the field of science and his discovery of the laws of its development.

Before the importance of Engels' work can be fully assessed, it is essential to be absolutely clear about the state of natural science and philosophy at that time. The 19th century was a time of rapid development of the natural sciences, especially of physics, chemistry, mathematics, and biology. Three great discoveries, as Engels described them—the law of conservation and transformation of energy, the cellular structure of living matter, and the theory of origin of species—had shaken the scientific world and provided a new basis for the progress of science. Many new facts were being obtained in the various fields of science, and called for classification, analysis, and generalization. The severely analytical metaphysical approach to the interpretation of phenomena, based on concepts of the absolute immutability of nature, which was essential in the early stage of that period, was increasingly showing its worthlessness and uselessness. The ideas of Hegel's dialectics were steadily penetrating into the heart of science. However, even dialectics, for all its idealistic character and because of its incompatibility with metaphysics, frightened scientists of a philistine frame of mind, brought up in the "good, old" spirit. A "state of emptiness" had arisen, and as Engels showed in relation to the science of electricity, this made it impossible to establish any universal theory and led to the domination of a one-sided empiricism.

Under these conditions Engels assumed a task of gigantic proportions in its scale, significance, and responsibility. On the one hand, he had to prove the validity and applicability of the fundamental proposition of dialectical materialism in all fields of science, and thus to confirm the validity of the new doctrine and to expand and develop it. "Nature is the touchstone of dialectics" [3] wrote Engels on this question. It is obvious that the way in which he expressed this remark, by means of a classical phrase which became a catchword, has not become outdated even today, and it will retain its importance for as long as man discovers the laws of nature. On this aspect of the affair, Engels stressed: "....for me it is not a matter of

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introducing dialectical laws into nature from outside, but of seeking these laws in nature and wresting them from her" [4].

On the other hand, it was essential to create a methodological basis for a truly scientific and productive analysis and generalization of special data in particular fields of science, to find the inner links between them, the objective genetically based relationships between different fields of science, and to demonstrate the vital necessity for scientists to adopt dialectical materialism.

"Empirical science," wrote Engels, "has accumulated such an immeasurable mass of positive material that in every separate field of research there is now an insistent need for introducing order and system into this material to correspond to its internal connection. In precisely the same way it has become an essential task to bring the separate fields of science into regular connection with each other" [5].

Both these tasks merged into one common line of investigation: the study of the mutual relationships, influences, and interpenetration of philosophy and science. This line of research, so apparently strictly theoretical, had for its final aim a practical conclusion in the sense that its results supplied factual material for philosophical arguments and corrected them, while on the other hand, methodologically correct philosophical assumptions provided the correct approach to the solution of concrete research tasks and ensured the productivity of their results. The fundamental and lasting importance of the characteristic features of this line of investigation is obvious.

However, in order to solve these two problems and to follow such a line of investigation constantly, titanic work was necessary to collect and analyze scientific material: the most widely varied facts from different regions of science. This truly gigantic task made Engels a scholar of gigantic scale and encyclopedic knowledge. There was literally no field of contemporary science which he did not feel called upon to investigate.

However, it is not simply the gigantic scale of his investigations which arouses wonder and admiration for Engels' creative work. An essential feature of his work was the way in which he rigidly adhered to the same research principle when studying widely different problems, a principle based on the dialectical unity of analysis and synthesis, the true and logical use of dialectics as a research method. The research method used by Engels must attract the attention of all scientists as a method of practical activity.

It would be wrong to imagine that all the scientific views held by Engels have preserved their importance today and that they must be the starting points of concrete investigations. They were formulated almost 100 years ago, and they naturally reflected the level of knowledge at that time. What really is remarkable is that, despite his relatively small stock of scientific data, Engels was able to foresee and predict the direction of development, not only of natural science as a whole, but of its individual branches. Any attempt to assess Engels' ideological legacy must be determined, not by what has become obsolete in his scientific views (which sometimes provides the pretext for superficial and short-sighted, and perhaps even deliberately unfair criticism, bearing in mind the ideological undertones). What is essential is how Engels developed his fundamental research methods, the discovery of his inner, dialectical logic, the logical use of the dialectical method as a means of analysis and synthesis and of generalization. Engels waged an unceasing war against various forms of speculation in philosophy and against the vulgarization of the propositions of dialectics. He repeatedly emphasized that philosophy, by itself, cannot solve scientific problems, but can only help to provide the correct environment for their solution and help the investigator to assess the essence of the phenomenon correctly.

The study of this aspect of Engels' creative activity is of the greatest importance today in connection with the study of the methodology and logic of scientific research and the principles of scientific generalization.

Just as everything in nature is interconnected, which is the essence of the objective dialectics of matter (the dialectics of nature), in every theory or generalization expressing subjective dialectics as a reflection of objective, all parts must be organically interconnected. The final conclusion of a theory is the result of this interconnection. Only under these conditions can a theory claim to be the reflection of reality. Engels gave a splendid example of this interpretation of a theory. Every conclusion from his theoretical analyses is at the same time the result of the interdependence of and the unity of all aspects of a single theory.

An essential feature of Engels' investigations is his use of the historical principle for the analysis of phenomena. The historical principle, incorporating the comparative method, which can reveal the essence of a phenomenon through the elucidation of its special features at different stages of its formation and under different conditions of its existence, also extends to the subjective dialectics of the investigation of a phenomenon at different stages of development of science. In this way, not only the essence of an object, but also the special features of its investigation and, as a reflection of this process, the development of the corresponding field of science, can be revealed dialectically, and the future prospects of the investigation and ways of development of this field of science can be predicted. The historical principle stems essentially from dialectical materialism and is a vital methodological principle of investigation. Besides Engels, it was developed by Karl Marx, who used this principle for the first time to study social processes. By this means Marx was able to discover the laws and prospects of development of human society. Lenin skillfully adopted the historical principle and used it in all branches of scientific and practical activity.

In his analysis of the development of forms of movement of matter from the lowest and simplest (mechanical) to the highest in nature (biological) and in society (social), Engels arranged the principal natural sciences in the corresponding order: mechanics, physics, chemistry, and biology. Obviously the role of the historical principle as a method of investigation differs for each science: it increases to correspond to the level of development of the science and reaches its maximum in biology. It is even more important for the social sciences, reflecting the highest, social form of movement of matter. The productivity of the historical principle in biology has been demonstrated by Charles Darwin, K. A. Timiryazev, and I. I. Mechnikov, although they used this principle in an elementary manner and incompletely, on account of the internal logic of the investigation itself, to the extent to which they adopted the principles of materialism and dialectics. The role of the historical principle as a method of theoretical investigation in general and as applied to biology, in particular, is particularly important at the present time in connection with the increasingly rapid development of natural science. It is therefore a vital necessity that the modern research biologist be proficient in the historical method.

The distinction made by Engels between the four basic forms of movement of matter in nature was of enormous importance to philosophy and the allied methodology and logic of scientific investigation. Engels made an extremely important discovery in the field of philosophy and theoretical science when he formulated his law of interconnection between forms of movement of matter. The immediate scientific basis of this law was the law of conservation and transformation of energy, and its philosophical basis the fundamental proposition of dialectical materialism concerning the universal connection between and interdependence of phenomena in nature and society. Engels developed these propositions further, related certain qualitatively different forms of movement to particular qualitatively different types of matter, and then, on the basis of the general concept of dialectical materialism that movement is a means of existence of matter, thus defined the principle of unity of forms of movement and of the corresponding type of matter. This concept of Engels, with its enormous theoretical importance, was essentially the greatest discovery in theoretical science in the 19th century. It is to some extent the scientific expression of the proposition of dialectical materialism regarding the unity of form and content, but in turn, it reinforces this proposition and reveals new forms of its manifestation. These new forms include, in particular, the principle of unity of structure and function which is of the greatest importance in modern biology.

Engels paid particular attention to the examination of the principle of unity of structure and function, and repeatedly returned to it in its different aspects during his analysis of many scientific problems. "The whole organic nature," wrote Engels, "is one continuous piece of evidence of the identity or indissolubility of form and content. Morphological and physiological phenomena, form and function, each determines the other. Differentiation of form (of the cell) determines differentiation of matter into muscles, skin, bones, epithelium, and so on, while differentiation of matter, in turn, produces the differentiated form" [6].

As is clear from this concept, Engels did not simply assert the unity of form and content, but he assessed it in terms of the principle of development, emphasizing that the interdependence and dialectical unity of form and function are the cause of movement, which must be examined on the widest possible plane, from both ontogenetic and phylogenetic aspects.

The principle of unity of structure and function is significant as the methodological basis for the research in various fields of biology. It will suffice to remember the great attention paid to it by Pavlov, who was always speaking of the coordination of structure and function during his analysis of physiological processes. At the present time the principle of coordination of structure and function is obvious and generally accepted. However, it is by no means always used during investigations (especially where it is necessary), and it is not always a basic assumption for theoretical and experimental research. If this principle were always followed logically during the analysis of biological problems, the confusion and methodological uncertainties which at one time beset the problem of the special material carrier of the biological function of transmission of heredity, would not have occurred. Instead of doubting the existence of such a specialized structure, or even attempting to prove that it does not really exist, as many biologists did, the essential course was to discover the concrete material basis of this function and to study its properties, i.e., to examine how it performs this function.

The study of the material basis of the carrier of a function is of essential importance in many fields of biology, and it must also be undertaken in coordination with other methodological principles of research. On the basis of this same historical principle, it must be borne in mind that the meanings of concepts undergo changes at every stage of development of science, in all fields of investigation. This fundamental position is equally valid in relation to the problem of structure and function. Without abandoning the immutability of the concept of unity or coordination (the coordination is always incomplete) of structure and function, the ideas regarding the concrete expression of each of them change with the accumulation of knowledge and with the research methods available. With the introduction of electron microscopy into practice, our ideas regarding concrete forms of structure have been considerably broadened, and many physiological functions or pathological reactions have been correlated with structure. The erroneousness of views regarding the existence of "purely functional disturbances"—a term which simply cloaks ignorance of the mechanisms of the process—is becoming increasingly evident. In connection with the development of biochemistry and molecular biology, the concept of the structure of metabolic processes is becoming increasingly accepted. It must be admitted that metabolic processes themselves also possess a definite structure, the understanding of which differs from ordinary views regarding structure. Ideas of integrative structures of the organism, the structure of a process as an integral system, and of dynamic structure have been introduced, and theories of the structural levels of biological systems have been developed. We must be prepared for the appearance of new concepts regarding structure, or otherwise a situation may arise similar to that which occurred in science at the beginning of the present century, when some discoveries in physics were interpreted as the "disappearance" of matter.

The correct and logical use of the principle of unity, indissolubility, and coordination of structure and function can play an important role in the solution of problems not only in general biology, but also in physiology, pathology, biochemistry, pharmacology, immunology, and other fields of experimental, theoretical, and practical medicine. In this connection Engels' interpretation of the role of specialized proteins as the substrate responsible for the function of sensation is interesting. "Sensation," wrote Engels, "is essentially associated with certain proteins, the more precise nature of which have not yet been established" [7]. As we know, modern physiology associates the process of stimulus reception with the activity of specialized protein structures. The use of the principle of coordination between structure and function can serve as an illustration of how general methodological concepts emerging from dialectical materialism may be of concrete practical importance in the solution of particular research problems.

The logical application of the law of inseparability of matter from movements, of their unity and of the coordination between each form of movement and its specific material carrier, inevitably led Engels to his definition of the substratum of the highest form of movement in nature, i.e., of life. The data of contemporary science enabled him to correlate life only with one qualitatively distinct substance in the whole organic world —with protein. "Life is the method of existence of proteins, and its method of existence is essentially the constant self-renewal of the chemical components of these proteins" [8].

At the present time, with the discovery of DNA and RNA and their role in protein synthesis, some scientists are stating that Engels' views regarding the nature of life are obsolete. Here, however, the following remarks must be made. First, Engels himself understood the inadequacy of this wording of the concept and its scientific limitations. He wrote: "Our definition of life is obviously very inadequate, because it by no means covers all the phenomena of life but, on the contrary, it is limited to the simplest of them" [9]. "The protein," Engels explained in connection with this wording, "in this case is understood in the sense of contemporary chemistry, so that it applies to all bodies analogous in composition to ordinary albumin and which are also called protein bodies. The term is an unhappy one, because of all the substances related to it; it is ordinary albumin which plays the most lifeless, the most passive role: together with the yolk, the albumin is simply a nutrient material for the developing embryo. However, while so little is known regarding the chemical composition of protein bodies, this term, as the most general one, must serve in preference to all others" [10].

Well aware of the limitations imposed by the current level of knowledge and ideas about proteins, their chemical properties, and their ability to multiply, Engels often spoke as if protein was the same as the cell protoplasm, thus stressing that he was concerned with the characteristic properties of life. It is clear that Engels, who investigated every phenomenon from the standpoint of the historical principle, not only accepted the possibility, but also understood the necessity of a more precise definition of the concept of proteins in general and of carriers of life in particular. His idea that "....so that special forms of differentiation of these living phenomena can take place, certain chemical compounds must be present in the living organism ...." [11] is a remarkable prediction. In another place, when comparing protein with protoplasm, Engels writes that "....there is no need to accept the existence of only one type of protoplasm" [12]. What is important, therefore, is not the concrete scientific understanding of the substratum of life at the stage of scientific development contemporary with Engels, but the principle of solving the problem of the nature of life as a special form of movement through a special type of material carrier of that movement (at the present time, incidentally, it is not a question of rejecting Engels' wording altogether, but rather of broadening it). This principle remains of vital importance to modern science and for determination of the direction of research in this field.

It must not be forgotten, however, as frequently happens these days, that Engels' definition of life contains not only a scientific definition of its material carrier, but also the essence of life itself as a special form of movement. Engels pointed out that nonliving bodies can exchange materials with the surrounding medium, but this exchange is the cause of their death; for living bodies, on the other hand, it is the condition of their existence, the condition of life itself. "....life....is a self-perfecting process, inborn and inherent in its carrier...." [13]. "From the exchange of materials through feeding and excretion—an exchange which is a vital function of protein—and from its characteristic plasticity, stem all the other simplest factors of life: irritability, revealed in the interaction between the protein and its food; contractility, revealed at a very low level in the ingestion of food; ability to grow, which at the lower level includes propagation by division; internal movement, without which neither the ingestion nor assimilation of food would be possible" [14].

This part of the definition of life as a special form of movement, effected through constant exchange with the environment, is of the greatest importance. The modern view of the living body as an open system is linked with it. It lays the foundations for the study of life, for as Engels repeatedly emphasized, a body can be studied only when it is in movement. "Bodies," wrote Engels, "are inseparable from movement; their shapes and forms can be identified only in movement....the study of different forms of movement is the study of bodies. The study of these different forms of movement is therefore the main object of natural science" [15].

The proposition that bodies can be investigated only in movement must be and still is one of the guiding methodological principles in the system of scientific research. Medicine has now left behind its metaphysical period of development, when the basis for diagnosis was the discovery of rigidly outlined, visible signs of the disease, and the concept of normal was defined as an aggregation of quantitatively averaged indices. Nowadays, to define the normal or pathological state of an organism, the course of a pathological process, the stage or degree of recovery, a dynamic range of possibilities of the organism and its functions must be deduced; the concept of normal or pathological is not defined in general, but in accordance with the concrete conditions of existence of the organism. New methods of "functional diagnosis" are being developed, and the result of their application is determined not only by the number of functions investigated, but also by the possibility of forming a dynamic stereotype of investigation on the basis of the methods used. The treatment process itself requires constant and dynamic observation on the course of the processes studied. It accordingly becomes necessary to introduce fundamentally new methods of diagnosis and investigation permitting the use of computer techniques.

There is one more vitally important biological aspect of the problem of life in the analysis of which Engels introduced fundamentally new ideas. This is the relationship between life and death.

"Life and death. The physiology which does not regard death as an essential moment of life, which does not understand that the negation of life is essentially contained in life itself, so that life is always regarded in relation to its essential result, the seeds of which have been present ever since the embryo, i.e. death," wrote Engels, "is no longer considered scientific. This is essentially the dialectic understanding of life" [16]. These brilliant words, so strikingly penetrating in their implication, are of considerable interest in many respects, and, like all true scientific theories, because they correctly reflect the objective dialectics of matter, they are vital to the practical solution of research problems. The definition of natural death as an essential and obligatory moment of life reveals the sterility not only of idealistic interpretations of the immortal soul, but also of attempts at scientific analysis of death as the result of a special pathological process. Death is defined not as something final and instantaneous, but as the essential and constant result of life, its essential moment without which, consequently, life is impossible. Thus it is that one of the meanings of Engels' well known statements "to live means to die" is very similar to the words of Claude Bernard "life—that is death."

The fact that death is embodied in life, exists in it constantly in the embryo, determines the attitude of the investigator to the problem, makes it essential to seek the mechanism of natural death in the mechanisms of life itself; on the other hand, the study of death as a process must be of great help to the investigation of the fundamental processes of life. Recent advances in physiology, in general and molecular biology, in genetics, pathology, and resuscitation, give abundant evidence of the fruitfulness of this approach to the problem. Yet the dialectical unity of processes does not imply their identity, but on the contrary, it assumes that they are different, a factor of fundamental methodological importance when the finer points are defined during analysis of the problem. It has already been reflected to some extent in the appearance of a new discipline, reanimatology (with its own special problems).

Engels attached the utmost importance to gnosiological problems. His constant fight, on the one hand, against idealism and, on the other hand, with featureless metaphysical materialism and positivism was also determined by the fact that followers of both idealism and vulgar materialism in principle deny that the world is capable of explanation. Having investigated the relationship between absolute and relative truths as applied to philosophy itself, and then to the natural sciences, Engels discovered the inner dialectics of the cognitive process. On the examples of the scientific achievement of that time he showed how during the process of investigation "things in themselves" are converted into "things for us" and how practical factors—experiment and industry—play a decisive role in this process. It is a remarkable fact that Engels regarded experiments as a form of practical activity in scientific investigation. Engels established the social and gnosiological roots of idealism, and showed how, in the case of Dühring, for example, both militant positivism and featureless, vulgar materialism, by denying the dialectics of nature and dialectical thinking, sink into idealism.

The analysis made by Engels of the causes of idealism in science is remarkable and important to the investigator. One of these reasons is the helplessness of the investigator as he passes from the study of one form of movement of matter to another, his incomprehension that qualitatively different forms of movement and types of matter require adequate methods of investigation, his attempts to reduce higher forms of movement to lower, quality to quantity, the nature of life to mechanical movement, as was the case with Dubois-Reymond. Engels wrote that "physiology is, of course, physics and, in particular, chemistry of the living body, but besides that it has ceased to be specially chemistry: on the one hand the sphere of its action is limited in this case, but on the other hand it is elevated to a higher plane" [17]. At the same time, on the assumption that life, as a method of existence of proteins, is determined by the chemical properties of its carrier, Engels declared: "Here chemistry leads to organic life, and it has moved forward sufficiently to assure us that it can explain to us the dialectical approach to the living organism" [18]. He goes on: "If the chemist succeeds in preparing this protein in that particular state in which it evidently arose, as protoplasm,.... the dialectical change in this case will also be demonstrated really, i.e., entirely and completely. Until now the matter has remained in the region of thought, as an hypothesis" [19]. This time has now come to pass. Modern science has learned to synthesize such important proteins as insulin and ribonuclease, with their specific biological activity. Moreover, very recently an individual gene—the specific material carrier of the function of protein synthesis—has been synthesized from chemical substances (nucleotides obtained in the laboratory). Again and again Engels stressed the specificity of methods of investigating each qualitatively different form of movement of matter. "Without any doubt," Engels wrote, "somehow or other we shall reduce thought experimentally to molecular and chemical movements in the brain; yet this can hardly fully explain the nature of thought" [20].

As Engels pointed out, the real and permanent possibility of agnosticism in science is the result of the inability of methodologically untrained investigators to find their correct bearings in the increasing flood of theoretical arguments. "The number and constant succession of different hypotheses can easily give rise to the notion in logically and dialectically untrained scientists that we can never explain the essence of things" [21]. This remark made by Engels is particularly important at the present time in connection with the tremendous and increasingly rapid development of science.

His examination of the nature of the relationship between the sciences, based on the principle of reflection of the objective dialectics of development of nature by the subjective dialectics of investigation (the dialectics of science) must inevitably have brought and did, in fact, bring Engels to his important prediction of the appearance of intermediate sciences, borderline disciplines, in which the object studied must be the transformation from one form of movement to another. The appearance of these sciences reflects the objective process of revolution of the dialectical contradiction between different forms of movement, and also between the scientifically produced links reflecting them. The intermediate sciences must therefore be particularly important for the progress of science as a whole. Engels illustrated this point brilliantly by the example of electrochemistry, which, born of the union between chemistry and physics, has spread beyond the bounds of investigation and beyond the capabilities of both physicists and chemists: "Both declare their incompetence at this point of contact between the science of molecules and science of atoms, yet it is there where the greatest results must be expected" [22].

This proposition, so remarkable in principle, has been completely confirmed. New intermediate sciences have arisen and are continuing to do so, on the borderline between the principal disciplines, the points of most rapid growth, and they have yielded particularly important results so far as the future investigation of nature is concerned. They inclue molecular biology, a new branch of science which alone can provide the key to an understanding of the nature of life and its artificial creation.

On the basis of his proposition of the genetic link between the sciences and their sequence of development, reflecting development of forms of matter and qualitative aspects of the corresponding forms of movement, Engels put forward a working classification of the natural sciences, one aspect of which is particularly interesting. He distinguished five groups of sciences, arranging them in order of succession; the series begins with astronomy and mechanics and ends with plant and animal physiology, anatomy, and eventually with therapeutics and diagnostics.

The merger between two fundamental and opposite tendencies of scientific development which Engels predicted, the differentiation and integration of sciences, reflects the dialectics of development of science itself and the objective dialectics of matter, and today it has become an obvious and necessary process in connection with the rapid development of science. This process has been supplemented substantially and organically by the appearance of a new and complex scientific movement known as cybernetics, which defines the common principles governing control over processes in complex dynamic systems of various types and uses them for its practice. In accordance with the historical principle developed by Engels, the appearance of cybernetics at the present stage of development of science must be regarded as a perfectly consistent phenomenon resulting from the character of development of nature and reflecting its scientific basis.

Engels' assessment of the great discoveries is an example of the use of the dialectical materialistic method for the investigation of nature. His analysis of each of the three discoveries in 19th century science mentioned above not only pointed out their significance for the final confirmation of materialistic dialectics, but also opened up prospects on the methodological plane for further research in appropriate areas. Engels showed a high regard for Darwin's theory and demonstrated its importance to philosophy and science. He concludes that the essence of this theory and, consequently, the essence of the evolutionary process can be regarded as evidence of "...Hegel's concept of the internal link between necessity and chance" [23]. This observation made by Engels is of great interest for the further analysis of problems of evolutionary development. Analysis of the principles governing the onset of mutations and concrete forms of their manifestation along these lines would seem to be particularly productive.

The analysis of man's origin occupies a special place in Engels' writings. Essentially, Engels pioneered the analysis of this problem in the form in which it exists today: he created a fundamentally new, social theory of anthropogenesis. He could not be satisfied by the then existing biological approach to the problem, because that approach could not reflect its specificity. On the basis of his historical principle Engels concluded that the problem must be analyzed at a new level, using the highest (social) form of movement of a specially organized form of matter as the test object. Hence the search for the specific key to the solution of the problem in the form of the role of the social factor, i.e., work activity, in the process of conversion of monkey into man. This classical work of Engels, written almost 100 years ago, has not aged and has not lost its significance, because Engels' discovery in this field reflects objective truth.

Engels constantly emphasized that the investigator cannot avoid the influence of philosophy. "Experimental scientists argue that they are freeing themselves from philosophy when they ignore or abuse it. However, since they cannot advance a step without thought, and since logical categories are essential for thought, and they uncritically borrow these categories either from the ordinary common conscious experience of so-called educated persons, who are under the domination of the remnants of long since dead philosophical systems, or from the crumbs of university courses in philosophy (which are not only the fragmentary views, but also a hodge-podge of the opinions of people belonging to widely different and, for the most part, dubious schools) which they were compelled to attend, or from the uncritical and unsystematic reading of philosophical works of some sort, in the long run they are still held captive by philosophy. Unfortunately, however, it is mainly a dubious philosophy, and those who abuse philosophy more than all the rest are slaves of the worst and most vulgarized remnants of the worst philosophical teachings" [24].

Unfortunately, Engels' "warnings" went unheeded. Soon after his death, in connection with the appearance of what were basically new data, which would not fit snugly into the framework of the old metaphysical ideas, science once again found itself in a very difficult situation, which many, even the greatest, theoretical and experimental scientists could not correctly evaluate because they lacked the necessary philosophical training, and which they regarded as a true crisis in science. Under these (but more complex, of course) conditions Lenin found it necessary to analyze the state of science once again, not only to examine current problems, but also to show, as Engels had done before, how the only way out of the difficulty is to reinterpret ideas and facts on the methodologic basis of dialectical materialism. It is noteworthy that Lenin had to contend with the same difficulties and problems on a basic methodologic plane as those which confronted Engels [25].

At the same time, Engels was convinced that sooner or later, because of the development of science, scientists would come to dialectics and it would become the natural method of thought and the method of interpretation. However, this natural process is long and painful, and in order to shorten it, an active mastery of dialectics is essential. "The road to dialectics," Engels asserted, "can be opened spontaneously and simply by the pressure of scientific discoveries themselves, no longer capable of remaining constrained within the old metaphysical framework. However, this is a long and arduous process and an infinite number of pitfalls have to be avoided. This process is now largely completed, especially in biology. It can be considerably shortened if theoretical scientists will take a closer look at dialectical philosophy in its historically distant forms" [26].

When dialectics, as a system of thought, is introduced in the strongest and most permanent manner possible into the system of scientific investigation and becomes an essential component of it, the "dubious philosophy" can no longer exert its disarming effect, and the age-old rupture between philosophy and science will be healed. "It is only when natural science and historical science absorb dialectics, it is only then that the whole philosophical stockpile—except for the pure philosophy of thought—will become superfluous and will disappear in positive science" [27].

In this connection Engel's assessment of his own work is particularly important: "It may be," he wrote, "that progress in theoretical science will make my work, in part or in whole, superfluous, for the revolution to which theoretical science is being forced by the simple necessity of systematizing the accumulated mass of purely empirical discoveries, must lead even the most convinced empiricist to the realization of the dialectical character of natural processes" [28]. Of course, Engels' works will remain forever in the storehouse of human thought and will be a source for the interpretation of materialistic dialectics. It is remarkable that, in the words of Engels cited above, the dialectical essence of his thinking could not be expressed more clearly. The words cited above are also remarkable because they show the whole greatness of Engels, his modesty as a true scientist and great man. Engels devoted all his last years to his work on the second and third volumes of Marx's "Das Kapital," which were still incomplete when Marx died. He undertook this task at a time when all the necessary preparatory work for the writing of his fundamental book on the dialectics of nature and science, which, by its very nature, must have been just as important to science as Marx's "Das Kapital" was for political economy, had been completed. However, recognizing the exceptional importance of Marx's work for history and for mankind in the future, he bowed to Marx's genius and to the memory of his friend. Engels devoted the last part of his life—more than ten years of really hard work—entirely to "Das Kapital." It was Lenin who said: "These two volumes of 'Das Kapital' are the work of two people: Marx and Engels." "The Austrian social democrat, Adler, rightly observed that by the publication of volumes 2 and 3 of 'Das Kapital' Engels erected a magnificent memorial to his friend and genius, on which his own name is unwittingly inscribed in uneffaceable characters" [29].

Engels' whole life is a shining example of unflagging service to mankind in the name of high ideals, in the name of the glorious future to which the path was shown by Marx and himself. This is a wonderful example of true freedom as a recognized necessity.

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