Mikulinsky, S. R.

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S. R. Mikulinsky (USSR)

HISTORY OF SCIENCE AND SOME PROBLEMS OF MODERN SCIENCE

ON SOME GENERAL TASKS OF THE HISTORY OF SCIENCE AS A SCIENCE

The importance of science in the modern world has greatly increased within the last twenty five years. Outstanding scientific discoveries always astonished people, served as starting point for the change of notions on the world and the man, for the alterations in outlook. But the present influence of science upon social life as a whole is definitely immeasurable. Science became an important transforming force.

As the influence of science upon all the spheres of production and social life increased, together with an enormous increase of the number of people engaged in scientific work, of the number of various scientific institutions, laboratories industrial research centers etc., (the USA, for example, spend in this field a considerable amount of 20 billion dollars a year), science itself became a complicated social phenomenon with certain regularities of its development. This evoked within the last decade great interest in the study of those regularities, in the principles of organization, planning and administration of scientific activity. All this favoured the uprise of a new scientific field — the theory of science, or the science of science (the term was offered by T. Kotarbiński already in 1927, but it became widely used only during the last years). Methods are being worked out of both qualitative and quantitative (by means of mathematics and statistics) analysis of the level and the pace of the progress in science, enabling to define the most promising branches and directions of investigation, and the most profitable forms of organization of science from the economic point of view.

Reviews of the theory of science which appeared obviously for the first time in the history of science are rather characteristic in this respect. They were organized in Hungary and Poland. The first issue of the Polish periodical: "Naukoznawstwo" (1965), is devoted to the problems of economical effects of scientific research.

In a number of countries, especially in the USA, problems of the theory of science and of the psychology of scientific and technological research are widely investigated. The object of these investigations is to study the evolution of the structure of science, of the correlation of theory and empirical data, of theory and method, to determine the regularities of the decline and uprise of scientific theories and the evolution of the methods of research. The new branch is also concerned with development of the formal apparatus of science, of the means and ways of argumentation, with conditions favouring the ultimate result of scientific work, with due selection of specialists, with organization of a scientist's work within a collective of investigators *etc.*

A number of these problems were discussed in works of Soviet authors. Here are some of them appearing within last years: B. M. Kedrov: *The Subject of Science and Interaction of Sciences.* 1963; B. M. Kedrov: *Classification of Sciences.* 1961; P. V. Kornin: *Hypothesis and Cognition of Reality.* 1962; V. A. Shtoff: *The Importance of Models in Cognition.* 1963; articles by N. E. Ovchinnikov in "Voprosy philosophii", 1964, No 2; G. M. Dobrov: *ibid.*, 1964, No 10; N. I. Rodny: *ibid.*, 1965, No 3.

The decisive factor of the development of science is to be found in the material conditions of social life, in the requirements of production and society. But the connection between the two is not always direct and unobtused. This is the reason for the actual importance (theoretical and practical) of the concrete and serious study of the interaction of science and society, or of the sociology of science as this direction of research is often called. Unlike a deal of other problems of the science of science this one is not new, and it has a long history, K. Marx and F. Engels being the first to discuss it, to approach it scientifically. Another example of this type of research is found in a well-known work by J. Bernal: *Science in History* (London 1954). No wonder that the problem attracts increasing numbers of scholars. Unprecedented possibilities of modern science, which becomes dangerous to the existence of civilisation, and perhaps to the very life on our planet if employed for destruction, together with the obvious dependence of scientific and technological progress on the proper organization of society, put forth the problems of social function of science, of scientists' responsibility in society, of the actual role of science and technology in society, of the influence of social and economic conditions upon the pace and orientation of scientific and technological progress, and so on.

This is the reason for increasing importance of the history of science as a science. We need detailed study of the concrete paths of scientific progress, we have to learn how this progress is actually achieved in science, we need to generalize the practical experience of scientific investigation, in short we need profound study of the history of science, to deal seriously with the mentioned problems of modern science. Thus we may achieve practical results and avoid abstract schemes, which are bound to appear, if the detailed concrete study of the history of science is missing. Such schemes are more or less narrow and cannot lead to practical progress.

The great majority of scholars dealing with the theory of science, with the "science of science" and with the organization of science (J. Bernal, T. Kotarbiński, Th. Kuhn, D. Price and others) proceed from the history of science and are still active in the field which enables them to solve actual problems of modern times. This is a characteristic fact. The same can be referred to studies of psychology of scientific and technological creativity which should answer the following questions: what is required from specialists engaged in creative work in the field of science, what sort of personal qualities and training must a specialist possess, what are the methods enabling to select specialists most fit for such activity, what are the conditions of scientific work and the means to increase its productivity, consequently, how to spend most effectively the allocations for scientific needs *etc.* These problems were for a long time approached through analysis of the history of science (*Cf.* for example H. Poincaré: *La création mathématique* 1906, or W. Ostwald: *Grosse Männer* 1906). After World War II the number of papers devoted to the subject increased greatly. R. B. Cattle, for instance, analysed biographies of 170 men of science and presented methods of elaborating psychological typology of scientists [1]. Statistical methods of analysis of scientific creation proceeding from biographies are being worked out. Practical manuals of organisation of science (W. B. Beveridge: *The Art of Scientific Investigation.* New York 1961; J. Barzunad, H. Graff: *The Modern Researches.* New York 1962) make wide use of it.

It is worth to note, that the recent times brought increased activity in the field of the history of science on the part of such eminent scientists as Bernal, De Broglie, Heisenberg, Born, Infeld and many others. The tendency, particularly strong in physics, made itself quite obvious at the XIth International Congress of the History of Science in Warsaw (August, 1965). The importance of the history of science in elaborating methods of modern science was emphasized in reports and speeches of J. Bernal and A. Mackay, S. Kulczyński, E. Olszewski, S. Malecki, R. Taton, B. M. Kedrov and others. (*Cf.* "Organon", No 2 1965).

Problems of logic in scientific research are proving quite important these years. This is to be explained by the rapid advance of science, the interaction of its various fields and wide usage of methods taken from different sciences in investigation of certain problems.

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[1] R. B. Cattle: *The Personality and Motivation of Research Scientist.* New York 1954.

Articles of Soviet authors published in recent collections of the Institute of Philosophy of the USSR Academy of Science: *Problems of Logic in Scientific Research* (1964) and *Formal Logic Methods of Scientific Research* (1964) are of considerable interest.

These problems also require the study of the history of science. It is often stated in papers on the theory and logic of science, that if a research-worker wants to achieve considerable advance in his field, he should quit its borders. The examples used are usually those of penetration of a chemist into physics, or a biologist into chemistry. Nowadays, attempts of a reverse kind are increasing in number, since biological data are employed in physics, chemistry and technology. It is senseless to deny the importance of mutual interaction of sciences, when methods of a group of sciences are fruitfully applied by another group to investigate various aspects of the same phenomenon.

A characteristic feature of the present period in the development of science concerns the study of the inherent elemental structure of various forms of matter which demands combination of methods from different sciences due to the fact, that a certain level of organization of matter puts a scientist in face of qualitatively new phenomena. Thus, at the molecular level of organic matter, a scientist deals with physics and chemistry of the animated world and not simply with well-known manifestation of life. Life becomes inseparable from physical properties and chemical structure of a given molecule. Here physics, chemistry and biology meet, not to supplement one another, remaining absolutely independent, but to form new sciences in the closest interpenetration. This corresponds to the change of the level of organization within the very object under study. At a certain elementary level of organization of matter, the forms of its movement lose strict demarcations and interpenetrate one another. This leads to new regularities, which cannot be restricted exclusively to the physical, chemical or biological form of movement of matter. But the approach is abstract, when the necessity to quit the borders of a certain science is stated as an irrevocable condition, independent of the level at which a given object is studied. The problem requires a positive historical analysis and knowledge of the history of science. It becomes clear that the abstract approach cannot be justified, when cases of such men as K. M. Baer, founder of scientific embryology, or V. O. Kovalevsky, who created evolutional paleontology, I. P. Pavlov and many other outstanding scholars are remembered.

There are many other problems in which the study of the history of science is essential.

The history of science and technology, as a reverberation of social and historical practice, is a part of the general history of the productive forces and culture. Thus the historical progress of society, as a regular process in which modes of production are replaced, cannot be examined in detail when the analysis of scientific and technological advance is dropped. The history of science is a reverberation of the history of human cognition; it is therefore directly connected with the history of philosophy, *e.g.* the history of development of the materialistic, scientific outlook.

The history of science is one of the most important means enabling us to reveal the regularities of cognition as a whole. This idea was underlined many times by Lenin. He wrote that the history of zoopsychology, linguistics, psychology and physiology of senses constitute "the fields of knowledge from which the theory of cognition and dialectics must arise".

The increasing differentiation and specialization in science, which are natural processes resulting from the need for more profound knowledge of objects and phenomena, can blur the perspective. This is why true and concise information on the principal stages in the development of parallel fields and directions of scientific investigation, as well as of science as a whole, becomes necessary. It is hard to overrate the importance of the history of science in this aspect.

Last, not the least, the constantly growing stream of information renders it increasingly difficult to grasp not only the whole of the facts collected by science in previous periods, but also the facts and data revealed in the present day scientific literature. Valuable data are often conserved in libraries. This is convincingly shown in a paper by D. Price ("Science" 1965, vol. 149, pp. 510-515), who suggested special methods of registration and statistical analysis of the distribution in time of the number of references mentioning previous publications. To reveal these valuable time-proved data and ideas, and to bring them back to science is one of the tasks of the history of science. There is another aspect of this task. To achieve successful advance, science has to liberate itself systematically from hypotheses and theories which are decrepit or proved false. Experiment and practice are naturally the main criteria in this respect. But constant profound analysis of the factual material of science is also essential. It may undoubtedly help to avoid a lot of errors, of excessive passions, followed as a rule by no less excessive disappointments. On the other hand, it enables to break away the notions which proved false when tested by facts. It has always been fruitful to confront in a creative manner new ideas with the data of the previous experience and achievements of the predecessors. A nihilistic attitude towards the past of science is as harmful and dangerous as dogmatism in scientific matters.

It is impossible to discuss in detail all the tasks mentioned above within an article. Thus we must restrict the paper to two problems:

what are the ways of cognition of regularities in scientific progress, and what is the correlation between history and modern times; we take biology as illustration.

REGULARITIES IN SCIENTIFIC PROGRESS MUST BE REVEALED BY MEANS OF STUDY OF THE EVOLUTION IN METHODS OF RESEARCH

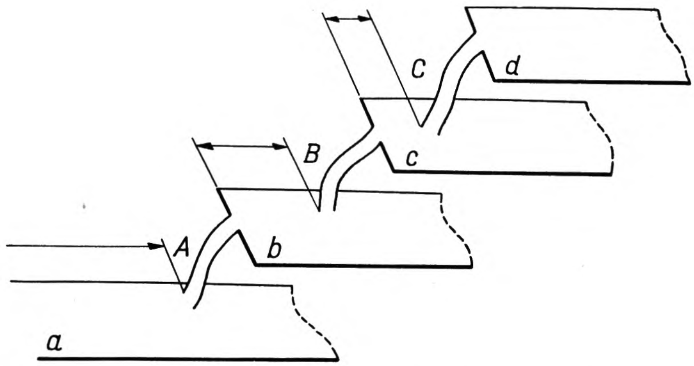
Science at all stages of its development was closely connected with conditions of social life and influenced by economic and political aspects of the epoch as well as by prevailing ideological and philosophical ideas. The history of science, however, is not a record of subjective motives of its workers. Scientists should be first of all concerned with the study of facts, of objective reality. This means, that the history of science is not completed at the stage of analysis of philosophical concepts and ideological conflicts in science; it should first and foremost reveal all the successive stages of the increasingly profound cognition of the phenomena and laws of nature.

The history of biology must reverberate successively increasing knowledge of animated nature and its development, of the laws of biological phenomena and means to control them, in order to muster the processes in organisms and transformations of organic forms for the benefit of man. It must simultaneously reveal the dependence of the level of knowledge and the character of scientific approach on material and intellectual conditions of social life as a whole in each historical epoch.

Hence it follows, first, that although the history of biology as a science deals with ways of cognition of biological objects and not directly with those objects themselves, and although its methods are different from those employed in biological research, it is nevertheless directly connected with biology proper. It is a means to solve methodological problems of biology, to elaborate and advance its theoretical foundations. Second, it follows, that the most important task of historical study is not to present quotations taken from past epochs, which owing to their uncertainty might be taken as anticipations of certain modern points of view, picturing their authors as predecessors of prominent men of modern science, but to reveal the concrete facts which favoured the progress of cognition of the biological world and which were beneficient to the advance of biology as a science.

This can be done, we think, by means of a concrete analysis of the part played by evolution in the methods of research which marked the progress of biology; by a study of connections between science and practice, of interaction between different branches of a given science and other sciences; by revealing the correlation between theory an experiment or observation; by showing the importance of general methods in choosing the right direction of research and theoretical generalization of the acquired data.

If we try to express the general trend in the progress of science in a figure, it will probably remind a well-known scheme suggested by A. N. Sewerzov (*Cf.* A. Sewerzov: *Morphologische Gesetzmässigkeit der Evolution.* Jena 1931). Of course, there is only a graphic likeness.



Planes a, b, c, d, *etc.*, reveal certain levels of the development of a science. When definite methods of research are elaborated within this science and when a theory is created which collects, generalizes or systematizes available facts, then these methods together with this theory are soon to be employed to study new objects, as the data are practically used in various branches of science and practice. The theory and methods of research prevailing today are comparatively steady, universally recognized. As new data are gathered within a certain segment of the plane a new direction appears, mostly as a consequence of revealing new facts which do not correspond to existing theory. A leap, a transition to the study of phenomena in a new aspect takes place. These are, to coin the term, aramorphoses in the progress of science, the decisive points in its history, when the study passes on to a new plane, a new level. The study of new objects by means of old methods and theories is simultaneously going on, the sphere of their application, including practical use, becomes wider. Historians of science should pay principal attention to the conditions causing these leaps, aramorphoses, transitions towards a new level, and also to the time and place of their appearance, that is to say the period in question in the development of a given science.

This is undoubtedly only a scheme, which cannot reveal the whole process of differentiation and integration of new sciences. But it enables to show in an obvious way, that the progress of a science shortens step by step the way to a higher level. For instance the pace of scientific progress increases leaving the study of a phenomenon at the old level, which means as a rule, the extension in the sphere of application of older methods or theories. Owing to this, new data are accumulated and new possibilities of their practical application become revealed. The scheme is especially important as directing attention to the "point" of differentiation of a principally new method of research, that is to say, to the discovery of a horizon.

Possibly different terms may be offered to describe the ways expressed in our scheme (see figure above) by planes a, b, c, d, *etc.*, and the lines of ascent expressed by sections A, B, C, *etc*. The ways expressed by planes a_1 b_1 c_1 d_1 embody, we think, the stage in the development of science called by Th. Kuhn in *The Structure of Scientific Revolutions* (Chicago 1963) the paradigms of science, or the normalized development of science; those expressed by the lines of ascent A_1 B_1 C_1 — can be called scientific revolutions. Possibly, the terms "intensive" and "extensive" development of science could be correspondingly applied here; They were suggested by N. F. Ovchinnikov ("Voprosy philosophii" 1965, No 2). In the last instance it is essential to point out, that if the development of a science, for a considerable period of time, or taken as a whole, is considered (that is to say, if the aspect is not restricted to a certain time-period), then one can state, that there are no siences developing only intensively or only extensively. This is, however, the case of determination, not the case of terminology. The main task is to define the conditions in which the transition from a paradigm to a revolution occurs, *i.e.* from extensive to intensive development. It is also essential to study for how long old methods of research can be productive when science or some of its fields have passed on to a higher level. The question is not only theoretical, since we are concerned here with problems of planning in science, with those of its application in practice and of the selection of specialists which are all of immense practical importance.

The rise of new methods and theories generalising accumulated facts must be considered most attentively. We can see in all the biological sciences, that application of a new method or a new theory has always been an immediate condition of transition to a higher level. The introduction of the microscope enabled to discover a new world of beings. The next step was the discovery of the method of coloured preparates and of serial sections which led to colouring and observation when alive, and finally, to electronic microscopy, which was an essentially new method. All those methods were successive steps in the development of knowledge on microorganisms and on microscopic and ultramicroscopic structures in organisms. Parallely the older methods were wider applied to study new objects. The same may be said, for example, of animal embryology. The foundations of embryology as a science were laid by K. F. Wolf in his theories of epigenesis and conception. Embriology reached a new level owing to H. Pander and K. Baer's discovery of germ layers and to K. Baer's detailed study of the development of a large embryo, when he proved that the development occurs in differentiation of simpler layers. These were premises of comparative embryology, and then the comparative and evolutional stages in embryology were reached owing mostly to the application of the evolutional principle in embriology by A. O. Kovalevsky and I. I. Mechnickov. A number of embryologists, however, continued to employ the method of K. Baer applying it to study new objects.

The introduction of the experimental method and, recently, of the method of marked atoms revolutionized embryology. K. A. Timiriasev said, that physiology is greatly indebted to physical and chemical methods of investigation applied to the phenomena of life. One could also mention the importance of I. P. Pavlov's method of conditioned reflexes for physiology.

During the forties, data on biochemical foundations of life started to accumulate at great speed. Science began to penetrate a new field of chemical and physical processes in organisms at the molecular level. New branches, such as biochemistry, biophysics, radiobiology joining biology, chemistry and physics achieved great progress. An absolutely new field of molecular biology emerged to combine methods and data of chemistry, physics and biology, to interpret the foundations of biological phenomena as a result of interaction of molecules, and to reveal biological functions of molecules of various chemically active substances, as well as the way in which their functions are performed.

The progress in study of the phenomena of life at subcellular and molecular levels by means of physical and chemical methods caused rapid differentiation of sciences, both former and comparatively recent. New branches and directions were formed, such as biochemical embryology, seeking to reveal chemical foundations of the regulation of growth, differentiation and development of organisms at embryonic stages, biochemical and radioactive genetics, radioecology, and so forth.

All these new processes which marked the progress of biology within the two recent decades are closely connected with the application of new methods of research revolutionizing biology. A number of these new methods and devices were borrowed from other sciences, chemistry and physics first of all. Ultramicroscopy, X-ray analysis, marked atoms *etc.*, showed that cellular formations regarded formerly structurless colloids possess in fact strictly structural organization which accomplishes the extremely agreed functionning of all the elements of a cell.

Attempts to introduce mathematics and cybernetics into biology, to build models of biological phenomena grow more numerous. The connections between biology and technology greatly increase. This is to be explained by the mutual benefit from such connections. Technological means are employed in biological research and biological evidence is applied in technology to build new types of automatic devices and systems of control. This is the starting ground for a new science — bionics.

New methods of research borrowed by biology from physics and chemistry, and later on from mathematics and cybernetics being applied, a number of new methodological and philosophical aspects emerge. We now have to deal with a great many problems. They concern the qualitative characteristic of biological phenomena: we must define possible limits of their physical and chemical interpretation, the role of models in revealing the essence of biological processes, the correlation of physical and chemical methods on the one hand, and peculiarly biological methods on the other. Thus, there is a problem of correlation between the experimental and the historical approach to phenomena, provided that the latter approach was first to form biology as science proper. The correlation of different levels of organization of animated matter, the cognitive meaning of functional determination of life must also be revealed.

Here we meet a phenomenon, which probably constitutes a characteristic feature of the modern period of the development of science. Now, as perhaps never before, we witness the closest interpenetration of methodological problems from different sciences, which should be solved to provide advance of a given science. This can be done exclusively by way of investigation, in a given science or in parallel sciences, of more general, philosophical problems, which require peculiar cognitive means to be solved. These problems include the unreducibility of various forms of material movement which becomes extremely actual again, the necessity to overcome the mechanic outlook and the elaboration of a logical apparatus of science, of its general methods and of the logic of scientific research *etc.*

This leads to the increasing comprehension of the need for a union of science and philosophy on the one hand, and to an apprehension of the erroneous substitution of abstract philosophical discourse for scientific approach to concrete problems on the other. This discourse leads to vain attempts at restoring philosophy of nature, which cannot be of any use either to science or to philosophy.

The achievements of biochemistry and those of other recent branches and directions in biology are no doubt brilliant and exciting. But certain biologists, especially neophytes are so enthusiastic about them, that a tendency emerged to deny the leading role of evolutionary doctrine in biology. Such men are apt to argue, that the mentioned doctrine ceased to be the decisive factor of the future of biology as a science. We consider this position erroneous.

There exists a more or less overt tendency to claim, that the evolutional doctrine as a general biological theory can be substituted by the theory of integrative levels, *e.g.*, by the theory of levels of organization. Certain biologists seem to consider, that the approach to organization, regarding it as the result of development proceeding from evolution is incorrect.

Matter is undoubtedly characterized by a certain level of organization, a certain structure. This refers not only to animated matter; we can claim that organization is contained in the very basis of matter. Everything we know of matter shows that there is no matter outside certain structures, certain organization. But we find, that to separate organization from matter, its structure from its development, and to regard these structures and this organization as philosophically independent essences is as erroneous as to separate matter from movement. It is also incorrect to underestimate the peculiarities of the laws of development at various levels of organization.

Regularities, peculiar to animated matter, are revealed in a specific form in plants and animals, in lower and higher plants, lower and higher animals, in unicellular beings and still more obviously at the cellular, subcellular and molecular levels. At each level, the organism appears as a certain structure with definite peculiarities. Biocenosis, biogeocenosis and biosphere as a whole are complex systems at different levels with specific regularities of existence. This problem remains unsolved in biology and it opens, we think, an important field for the theory of levels of organization in the future. But research-work in this direction can be successful only under the condition of a historical approach to phenomena.

Scientists professing, that it is impossible to understand the organization of an animal proceeding from its development, are not conscious of their contradiction with Darwin's greatest achievement: his explanation of relative expediency in the organic world. Moreover, they undermine the very reasonable foundation of the theory of levels of organization which is being formed. If various levels of organization cannot be understood and explained proceeding from their development, they cease to be l e v e l s of organization. Each of them becomes a thing in itself, and the theory gets consequently deprived of its general biological meaning.

Meanwhile, there are cases in which the so-called elaboration of the most up-to-date methods in biology becomes in fact an attempt to form some particular biological methods, descriptive, comparative, experimental, methods of modelling *etc.*; *e.g.*, to form a method which holds good for separate branches of biology, such as paleontology or phylogeny only. It is sometimes stated, that the historical method can be successfully applied only in definite, often limited borders, that it deals, as a rule, with materials of simple observation. Its limitations are, for this group of scientists, in its demand for a wide basis of facts, as if any method could be productively employed to reach wide generalizations when a solid knowledge of facts is missing. They argue, that the historical method can bring satisfactory results only in combination with other methods, especially experimental ones, but they do not seem to notice, that the same is still more true for all other methods, including the experimental ones, because facts in themselves, even thrice proved, are insufficient to form science.

All the above mentioned views underrate the evolutional theory as the theoretical basis of biology and they seem to be unfair to the historical method explaining phenomena of organic life. The historical method becomes, however, extremely essential in mastering the new nature of a given phenomenon, in explaining its relation to other phenomena and processes, as well as its place and meaning in life activity of organism, solely by means of revealing its origin and the stages of its development. This is still more true owing to the biological application of methods borrowed from parallel sciences, and to the penetration into new fields of research. By the way, the historical method alone could lead to the concept of organism as a peculiar dynamic unity and protect biology from the mechanistic outlook. Rational contents and meaning of the theory of levels or organization consists in its insistence upon the necessity of historical approach to biological phenomena, and upon consideration of the concrete appearance of the phenomenon at different stages of development of the organic world.

We could quote a great deal of instances from the history of biology proving, that it turned harmful to ignore the principle of development. Remember, for example, the experience of the mechanics of development.

We think, that many difficulties in classical genetics, especially at its early stage, are to a great extent connected with treating separate facts as absolute, and probably, the attempts at solving the problem of heredity outside the historical approach to this phenomenon.

The great progress of biochemistry makes it essential to reveal the application of evolutionary doctrine in biochemical research, on one hand, and to understand biochemical foundations of evolution on the other. Certainly, the two tasks are in close connection and require further improvement of evolutionary theory, taking into account the newest achievements of science. It is noteworthy, that biochemists themselves become aware of the importance of this task; an example can be found in Ch. B. Anfinsen's book: *The Molecular Basis of Evolution* (1935) which, to quote the words of this American scientist, was written "to arouse interest in regard of evolution, that central problem of the whole biology".

Speaking of influence of new methods on the development of science, we imply as well the interaction of various branches of a science or of whole sciences, for this is in fact a peculiar form of application of a new method of research. Analysing the importance of the interaction of sciences in the history of biology, we should not forget that it is something more than interaction of biology, physics and chemistry. The evolutionary theory presented a creative synthesis of the data of practice and those of a great number of fields of knowledge, including data of zoogeography and phytogeography, embriology, ecology, systematics, paleontology, geology. As a matter of course, it is hard to understand in this connection, why one of the directions of contemporary evolutionary doctrine, often opposed to Darwin's teaching, is called "the synthetic theory of evolution".

The complex study of the problem, making use of data from various branches of biology, was one of the conditions which secured a good deal of its achievements.

THE HISTORY OF SCIENCE AND MODERN TIMES

An eminent paper by René Taton: *L'histoire des sciences et la science actuelle* ("Organon", No 2, 1965, pp. 213—225) concerns various general aspects of the problem. We would like to dwell on its separate manifestations, mainly on the principal importance of the history of science for modern science.

We have already mentioned the extreme importance of theory as one of the basic facts ensuring transition to a higher level of cognition at which a more profound essence is revealed. It is, perhaps, most evident in biology, where Darwinism caused decisive changes literally in all its branches and in the whole thinking of its research workers. We should only emphasize, that it is the history of science which has to face, as its most essential task, the study of the origin, structure and development of scientific theory; it is the history of science, which possesses means to solve this task.

The most actual problems here are the correlation of empirical data and theory, the connection between general methods and scientific theory, and finally, the connection between theory and practice.

The history of science must reveal numerous concrete forms of the influence of practice upon the origins and development of scientific theory and the reverse influence of the theory upon practice.

Science emerged from generalization of practice. Its mission is to meet requirements of practice in which it finds the principal foundations of its development. In modern society science is increasingly becoming an immediate productive force; the degree of its influence upon practice is a measure of its achievements. But we must not oversimplify the problem. Starting his research, the scientist does not always foresee its practical meaning, and inversely, research done especially to serve some practical end is not always the most influential in regard to practice. It was hardly possible, that during the thirties anybody could foresee, even in a remote measure, the scale of practical after-effects of research in the field of nuclear physics, which seemed so obviously theoretical; it is no less doubtful, that anyone is aware of the possible after-effects of some present-day particular theoretical studies, say, in the fields of genetics, biochemistry or microbiology. Studies which seemed absolutely deprived of practical importance, as for example, investigations on the orientation of insects in flight, or on the frog's eye, served to create gyroscopes and electronic "eyes" watching an object in motion.

Sciences, such as zoogeography, phytogeography, geobotany, systematics and a number of other ones, in which theoretical problems have no immediate concern with the task of the reconstruction of organisms, or such as paleonthology which is not concerned at all with living organisms, contributed and are still contributing a great deal to the practice and general progress of Darwinism, owing to their role in revealing the laws of existence of organic forms.

Science will not be able to meet the demands of production, if it is solely restricted to the immediate tasks of the present-day practice: such a restriction would to a great extent hinder the advance of all the spheres of production. Considerable scientific and technological progress will occur only under large experimenting in various branches and directions. A number of such investigations might have importance exclusively for science proper, enriching its cognitive power. But although they do not influence practice directly, they might be of a great help to it, due to their importance for science proper.

Thus, when we speak of concrete research and not of science in general, the immediate practical orientation of the former is not by far the most important thing. We must discover, how research favours the knowledge of the laws of nature, rendering it more profound and wide. This knowledge is always bound to be applied in some form for the needs of social production, if there is no hindrance on the part of social conditions of society and of its technological abilities at a given moment.

When we deal with the history of science, especially with its recent periods, there appears, we think, another problem. There were many instances in the history of science, when opposite, struggling theories were in fact explaining different aspects of the same phenomenon. A classic example concerns the struggle between the corpuscular and wave theories of light. A similar case in biology concerns the contest of the theories of humoral and nerval regulation. The conflict of those theories was sometimes sharp and dramatic. These instances are no exceptions. They are natural consequences of the multitude, of the inexhaustible character of phenomena of nature, and especially of the human cognition, arising by means of relative truths to successively higher orders. Thus, a historian facing similar situations in modern science must not forget, that the problem is solved by further investigation and finally by practice itself, and that he is here not to utter a verdict, but to devote himself to the most careful and objective study of the relation of a given theory to practice. Such a study must take into account contradictory interpretations of the same phenomenon, arising when various methods are applied to solve the problem, often indicating unsolved problems and the necessity for further research. Thus, the historian is able to help modern science in its moot points only by revealing the origin of all the competing theories and the ammount of facts on which they are based.

Each essentially new discovery in science leads as a rule to new perception of previously discovered facts and theories.

V. I. Vernadsky said, that a paper on the history of science proceeding from the up-to-date progressive theory, should reveal and demonstrate new aspects in old facts and ideas.

It is extremely essential for the cognition of regularities of the development of science, of those of scientific advance and of logic of scientific research, to reveal in the history of science the "moment" of uprise of an essentially new method of investigation in its very "embryo". It is quite important to study exhaustively and to describe in a trustworthy way all the circumstances of its uprise and establishment. Here, we think, is the principal importance of the history of science for modern science, since this enables to elaborate methods of scientific cognition.

The prestige of the history of science will grow among men of science depending on their awareness of its practical importance for their studies. But this would become impossible, if research workers in the history of science regarded their field as a storage of facts and ideas, and considered themselves as caretakers of this storage, brought to sort the materials and describe them in good fashion. The history of science should answer first of all how and why something is achieved by science in a given period; what is achieved is its secondary (in the sense of the complete answer) task to fulfill.