THE FUNDAMENTAL PRINCIPLES OF MICHURIN GENETICS

By Professor I. E. Glushchenko

I.—INTRODUCTION

THE July-August Session of the Lenin All-Union Academy of Agricultural Sciences was one of the outstanding events in the scientific and ideological life of the Soviet people. That is why the proceedings of the Session excite the lively interest of all Soviet people.

This interest is understandable. Biological science is the foundation of agronomy, and it illuminates the way ahead for practical medicine. Only in the U.S.S.R., with dialectical materialism as the basis of the Marxist-Leninist world outlook, are all the conditions assured for the development of agronomical science. Thus it is not surprising that only in our country, thanks to the works of Timiryazev, Michurin, Williams, Lysenko, and other scientists, has agronomy developed from an empirical science to a profound theoretical science which now makes possible the correct and effective solution of practical problems of agriculture.

In his report, "The Situation in Biological Science," made at the July-August Session of the Academy, Academician Lysenko pointed out: "Agronomical science is concerned with living bodies—with plants, animals, and micro-organisms. Therefore, included in the theoretical basis of agronomy is the knowledge of biological laws. The more deeply biological science reveals the laws of life and development of animate bodies the more active is agronomical science."

It is interesting to note that two weeks before the session of the All-Union Academy of Agricultural Sciences, the Eighth International Genetics Congress completed its work after meeting for seven days in Stockholm, where over a hundred papers were read. Why did this Congress attract so little attention? Its organisers had intended to make the Congress a real event. Wasn't it important to know what the spokesmen of Weismanism were recommending; how they proposed to improve agricultural plants and domestic animals? What was there to report? Let us turn to the "Abstract Book" containing summaries of the papers. Among many summaries let us dwell on what was most "essential," on what engaged the minds of the Morganists. Here are some examples:—Linder's paper was entitled: "The Ability to Move One's Ears." The thesis of Romanus was: "Heredity of a Long Second Toe."

In the numerous series of papers on the genetics of man, the paper submitted by F. I. Seymour: "Artificial Insemination of Man," is of particular interest. Part of the summary of this paper reads: "Artificial insemination in human beings has been proved to be of great practical value, and the general acceptance and extending use of the procedures involved has led to the establishment of a new speciality. . . . (Page 121).

This new speciality practised by Seymour and others like him has, according to Seymour, provided an "invaluable measure which can be widely used to increase the birthrate, and therefore also marital happiness, and to decrease the incidence of divorce. When artificial insemination is practised in accordance with the principles of eugenics, the possibility of producing superior children is rendered actual. Hence, for the first time, positive eugenics becomes practicable." (Page 121).

And so the Eighth Genetics Congress, which shared the views of Seymour, admitted that (1) the principal work in the last ten years (the Seventh Genetics Congress took place in 1939) reduced itself to the study of problems such as human artificial insemination; and (2) up till now genetics had been completely divorced from practice, but now, as a result of intensified work in eugenics, it had come closer to "practice."

It is now clear why a full half-year before the Congress, its organisation committee resolved to "exclude from the plan of work of the Congress papers dealing with the application of genetics to plant and livestock breeding," and why at the Congress it was decided that "the content of papers on the genetics of man was not subject to any restrictions."

According to a report in the magazine "Nature" (1944, Vol. 153, June 24th), the English Genetics Society organised in April, 1944, in London, a discussion on "The Application of Genetics in Plant and Animal Breeding." Opening the meeting, Dr. Darlington, President of the Society, declared that "genetics" owes a debt to plant and animal breeding both for its foundation and its development. If the purpose of agriculture in the future is to be the highest production, genetics will have the opportunity of repaying this debt. The object of the symposium was to discuss whether genetics has the capacity to do so." Dr. Mather, the next speaker, asserted that "the progress of genetics has not yet led to the marked advance in plant and animal breeding which has been so confidently expected in the past. . . ." Dr. Walton said quite truly: "Livestock is improved as a direct result of better nurture. . . . By feeding animals individually, and successively raising the plane of nurture and by selecting these genotypes which respond, the breeder directs the evolution of superior strains. In the past, nutritional research and genetics have been carried out in isolation."

These frank admissions by English geneticists must not be forgotten. They are very symptomatic of the failure of idealist geneticists to solve problems of practical importance. In view of the results of Mendel-Morganist genetics the July-August Session of the All-Union Academy of Agricultural Sciences, had grounds for the condemnation of modern Weismanism as a sterile trend.

The Academy unanimously recognised that Michurin's teaching is the basis of scientific biology, and that it alone offers man possibilities of changing animate nature and placing it at the service of our socialist society.

In the Soviet Union, where large-scale socialist agriculture is steadily becoming stronger and developing, the need for such a science is great. In its turn, science, by penetrating into practice, develops itself. Michurin wrote: ". . . the collective farm system by means of which the Communist Party is beginning to carry out the great task of renewing the land, will lead toiling mankind to real power over the forces of nature. The great future of all our natural science is on the collective and state farms." In our socialist society there is a unity of science and practice; they interact and enrich one another. This explains the keen interest of our people in the development of biological science. This explains the violent opposition with which the Morganists greeted the victory of the Michurinists. This also explains the joy and pride in Soviet science expressed by our friends abroad.

The victory of Michurin's materialist teaching over idealism and reaction in biology was not easily won. It was preceded by discussions lasting many years, by debates between Darwinists and anti-Darwinists, Michurinists and anti-Michurinists, between materialists and idealists. This victory was the outcome of continuous effort and hundreds of experiments by many scientific and practical workers all over the Soviet Union. In this struggle much is due to one man. Boldly and resolutely, with the passion and steadfastness so typical of him, Academician Lysenko exposed Weismanism. The difficulties were enormous but he advanced steadily, upholding materialist principles in biology, championing Michurinism.

II.—OBJECT OF INVESTIGATION

When the reader makes his first acquaintance with Lysenko's works, he is unable to decide immediately what the author is—physiologist, plant breeder, agrotechnician, geneticist, specialist in grain or industrial crops, sylviculturist, or entomologist. All these problems come within his scope.

But what is Lysenko after all?

Concretely, Lysenko is the creator of a new science. He is an agrobiologist. What then is agrobiology, what is its content? Here is the answer.

The basic problem of agrobiology is to reveal the causes for the actual phenomena which the plant or animal breeder must direct. Agrobiology may be defined as the science of general biological laws operating in agricultural production. To obtain the quantity of plants or animals needed in practice, it is essential for agrobiology to grasp the complex biological inter-connections, the laws of life and development of plants and animals. This is essential if the plants are to be provided with the necessary conditions and protected from common biological and climatic hazards. This is necessary to ensure the greatest possible benefit to mankind.

The starting point of agrobiology is the theory of the development of living organisms, or Darwinism. But agrobiology does not confine itself to the teachings of Darwin, for, as is known, Darwin was not concerned with the actual causes of variations in plants and animals, whereas agrobiology is principally interested in these causes. Without a knowledge of these causes, science at best is limited to classification and not to living creative work. The basis of agrobiology is Michurinist genetics, the science of heredity and its variability. Heredity, according to Lysenko's formulation, is that property of plants and animals which makes them require definite conditions for their life and react to these conditions in a definite way. When these requirements are known, man can create suitable conditions and receive from the plants and animals all that they can give. Agrobiology teaches that the requirements of a given organism are relatively limited ; they have their relative minimum and optimum. If the requirements of the plant are known, these minima and optima can be shifted to suit the needs of man. A distinct change in the normal requirements of an organism is possible only by acting on the organism with suitable conditions of life at definite stages of its development.

By what are winter and spring properties conditioned? Some geneticists —Mendelists—asserted that these characters are controlled by one hereditary particle, the gene, others said two genes, still others made the fate of winter properties dependent on many genes. In any case, it was claimed that winter and spring properties could never be controlled by man. This is a striking example of how reactionary genetics with its genic combinations, in practice enfeebles the experimenter. When it is known, for example, that winter wheat plants in the first period of their life require a definite complex of conditions, among which a low temperature is the leading factor, anyone can, like Lysenko, direct these requirements—he can vernalise winter plants, sow in the spring, and harvest a crop.

When the nature of the phases of vernalisation are revealed, it becomes possible not only to direct the development of one generation of plants but also to fix the variations obtained in the offspring. If, for example, the vernalisation phase for the winter wheat variety Cooperator at a temperature of 0° to 5° takes 40 days, it is also possible at a temperature of 10° to 15°, but it will require a much longer period. It is evident that by vernalising this wheat in a series of generations at a temperature of 10° to 15° its normal requirements can be shifted in such a way that the wheat will "forget," as it were, its old path of development. Its requirement norm will become, not cold, but warmth. In his experiments on the wheat variety Cooperator, Lysenko showed for the first time that by means of vernalisation, a winter culture changes its hereditary basis and turns into a hereditarily spring culture. This was an outstanding achievement of the new Michurinist genetics.

III.—METHOD OF INVESTIGATION

Modern biology has accumulated mounds of facts. However, according to Academician V. Williams: "It is not always possible to understand the essence behind these mounds of figures, charts, and tables. It has already become a commonplace to say that in modern science, generalisation lags behind the accumulation of facts. Most contemporary scientists cover up an inability to think and reason dialectically with a mass of observations and facts, with masses of figures and tables. For science, the latter are as necessary as air, but by themselves they still do not make a science. These are the stones which we use in building the splendid edifice of science. Indeed, as science continues to expand in breadth and depth, and becomes enriched with ideas and laws, it becomes increasingly difficult for the scientist to confine himself to observations and experiments. Frequently, instead of posing the problem, finding out what is essential and finding the correct answer, we get collections or classifications of ill-digested facts."

V. P. Williams rightly asserts that Lysenko is not merely a fact finder. He knows the value of a fact or observation, but to him a fact is important only as a link in the general system of ideas. In studying the phenomena of nature, Lysenko arranges the facts he and his collaborators have discovered in their proper places; in other words, he finds the inter-relations of biological phenomena. These relations, which constantly develop, are numerous and complex. To approach the phenomena of nature dialectically, to reveal their concrete causal relations, to verify one's prognosis by practice and experiment—this is what is most important in order correctly to pose a problem and give a concise, quick, and correct solution. Such is T. D. Lysenko's method of work.

IV.—SCIENTIFIC PRINCIPLES

The most important scientific principles in the works of Academician Lysenko are enumerated below:—

1. The unity between the organism and its conditions of life.
2. Metabolism is the basis of the unity of the internal and the external.
3. Heredity is the effect of the concentration of environmental influences assimilated by organisms in a series of preceding generations.
4. Without the possibility of the inheritance of variations acquired by the organism in the process of its life, there can be no evolution.
5. A decisive change in the norms and types of metabolism is the reason for the change in selectivity, the reason for variation.
6. The life processes of plants differ qualitatively from one another.
7. The process of fertilisation is a process of mutual assimilative activity of the reproductive cells.

8. Only through the conditions of life is it possible to direct the heredity of plants and animals.

Let us examine these principles in more detail.

The Unity of the Organism and Conditions of Life

Animate and inanimate bodies have certain relations to their environment. However, the inter-relations between organisms and their environent are fundamentally different from the inter-relations of non-living bodies to the same environment, says Lysenko. The basic difference is that the interaction of inanimate bodies and the environment is not a condition for their preservation but, on the contrary, is a condition for their destruction.

The more completely an inanimate body is isolated from the influence of the environment, the longer it remains unchanged. A living organism, on the contrary, isolated from the conditions of the environment, ceases to be an organism, for the living is inseparably connected with the environment, with the conditions of a continuous metabolism. Hence, for living bodies inter-relation with the environment is an essential condition of their existence, nutrition, and development—i.e., the formation of the hereditary properties of the organisms. An exposition of the laws of the inter-relations of organisms to the environment is the basic content of the work of agrobiologists. The more deeply science understands the interaction of organisms and the conditions of the environment, the more effectively will experimenters be able to direct the development of organisms.

The Basic Unity of the Organisms and the Conditions of the Environment is Metabolism

The organism and the conditions of its life are in constant and indissoluble unity. Only in this way can and must the agrobiologist understand the problem of the unity of the internal and the external. It should be stressed that by *external* is meant what is assimilated by the living body and, by *internal,* that which assimilates—i.e., the living body itself. According to Lysenko, external factors which have been incorporated or assimilated by the living body, become part of this living body, and for their growth and development now require new food and environmental conditions. A living body consists, so to speak, of separate elements of the environment which have become elements of the living body. For the growth of the separate elements and the development of the characters of the living body, the same conditions of the environment as had been assimilated by the organism in preceding generations, are required.

By means of controlling the conditions of life, new conditions of the environment may be incorporated in the living body and other elements excluded. For example, the process of vernalisation of spring cereals does not require low-temperature conditions. The vernalisation of spring cereals takes place easily under normal spring and summer field temperatures. If the vernalisation of spring cereals is conducted over a long period at low-temperature conditions, then in several generations the spring nature of wheat becomes a winter nature which will now require not a higher but a lower temperature during the vernalisation phase. This example illustrates how new external conditions are incorporated in the living body, and how the offspring of experimental plants develop new requirements.

From what has been said, there follow two conclusions :—

1. Changes of requirements—i.e., the heredity of the living body, always correspond to the influence of the conditions of the environment, if these conditions are assimilated by the living body.

2. The basic unity of the organism and the environment is always metabolism.

Heredity is the Effect of Concentration of the Action of the Environment Assimilated by the Organism in a Series of Preceding Generations

As is known, Weisman geneticists understand by heredity the reproduction by the organism of its kind. This idea offers little to real knowledge of the phenomen of heredity. Proceeding from this definition, idealist genetics studies heredity by methods which do not show the essence of the phenomena of heredity. In reality, the Weismanists, according to Lysenko, study the final differences between organisms with different heredity, and not the phenomena, the process, of heredity. The method of the Weisman idealist genetics is to take two organisms with different heredity and by crossing, mix this heredity. From the varied offspring obtained they expect to learn about the heredity of the organisms under investigation. By this method of investigation it is possible to learn only how many of the offspring resemble one or the other parent. Experiments of this type give no answer to the question: In what does the essence of heredity of one or the other parent consist?

Lysenko gives a different definition of the phenomenon of heredity. By heredity, as explained above, he understands the property of the living body to require definite conditions for its life and development, and to react to these conditions in a definite way; in other words, heredity is the effect of the concentration of the influence of the environment assimilated by the organism in a series of preceding generations.

In order to study the heredity of an organism, there is no need to cross it with the representative of another different heredity. The study of heredity aims at determining the relations of a specific organism to the conditions of the environment. After crossing, one obtains offspring with a different heredity, and not the heredity which was originally to be studied. In the study of heredity, cross-breedings are necessary only when one wants to determine the strength and stability of one heredity as compared with another, or in order to "shake" heredity—i.e., to make it unstable and pliant to conditions of development. Only by the study of the requirements of an organism and its relations to the conditions of the environment is it possible to direct the life and development of a given organism. Only on the basis of such knowledge is it possible to direct the change of the heredity of organisms.

The Possibility and Necessity of the Inheritance of Variations Acquired by the Organism in the Process of its Life

As is known, the Weismanists speculatively split the organism into "hereditary substance" and "nutrient substance," and speak of the former as eternal, as never emerging but only multiplying. This mythical "hereditary substance" is deprived of the possibility of developing, changing, or producing new forms—i.e., of becoming transformed under the influence of its carrier—the living body, and its conditions of life.

From this conception of the Weismanists it follows that new tendencies and modifications acquired by the organism in definite conditions of its development cannot be inherited and are not included in evolution. The leader of Mendelian genetics, T. G. Morgan, regrets that as yet "it is not as well-known as it should be that new works on genetics have inflicted a decisive blow to the old teachings of the heredity of acquired characters."

According to Morgan, the theory of change of the hereditary properties of the organism in correspondence to changes in its conditions of life is a "harmful superstition." Proceeding from these positions, the Morganists (for example, Filippchenko) said to our practical workers such things as this: "Let us assume that somewhere a high-quality variety of wheat is developed. It is acquired by a seed-growing establishment, sown on its field, and these seeds are passed on. Some of these seeds come from good plants; others, on the contrary, from bad, feeble plants; but this circumstance—we are well aware—has no significance as the offspring of both one and the other will be the same. . . ." Similar views are expressed about the breeding of animals. Yet many centuries of human practice in creating new forms of plants and animals bear striking witness to the fact that evolution takes place only because the inheritance of characters and properties acquired by the organism in the course of its individual life is possible.

The possibility of the inheritance of characters is confirmed everywhere. And if the man of science is guided by this extremely important principle he can accomplish marvels. All the works of Academician Lysenko and his collaborators on changing the nature of plants by means of training in changed conditions of life, on vegetative hybridisation, &c., are striking proof of the fact that assimilated external conditions become internal processes of development. From this Lysenko draws the conclusion that the development of every organism sets its imprint on the development of succeeding generations—i.e., that the inheritance of properties acquired by the organism in the process of its development is not only possible but necessary.

Disruption of the Norms of Metabolism is the Reason for the Disruptions of Selectivity, the Reason for Variations

Lysenko teaches that every organism and also every process taking place in the organism has the ability of selecting the conditions of life, conditions which insure normality of a given character or property. The organism, as a result of this selection property which is developed during evolution, possesses the ability to select from the environment the conditions it requires. When the organism obtains from the environment conditions corresponding to its nature, its development proceeds according to its previous heredity. If the organism does not receive the conditions it requires, and is forced to assimilate conditions that do not correspond to its nature, it is compelled to change; and in this case the organism as a whole (or separate parts of it) will differ from the preceding generation. If the modified part of the organism is the point of departure in the new generation, then the latter will already differ in its requirements, in its nature, from its predecessors. The differences in these generations can be demonstrated experimentally.

Thus, the reason for variation in the nature of the living body, according to Lysenko's teaching, is the variation of the normal type of assimilation, the normal type of metabolism.

The Life Processes of Plants are Qualitatively Different

Lysenko has enriched science with a general biological theory of the phasic development of plants, an outstanding achievement of Michurin biology. This theory revealed for the first time the internal essence of life processes and their qualitative differences.

"A plant requires for its development," writes Academician Lysenko, "a definite complex of factors among which, in addition to mineral food, are included temperature, light, moisture, a certain period of daylight, or night, &c. If all, or even a part of the enumerated conditions do not correspond to the nature of the development of the given plants, they will not yield a good crop. That is why not infrequently it can be observed that some plants grow quite well, but are late in flowering and bearing fruit, or even do not flower or bear fruit at all."

Clearly different plants require different conditions for their development. The climatic conditions which, for example, are required for winter rye are unsuitable for plants like cotton. Plants throughout their life, from the sowing of the seed up to the ripening of new seed, require differing external conditions. As has already been pointed out, our winter cereals at the beginning of their development invariably require low temperatures, but after being subjected to qualitative changes called vernalisation, at the end of their development they require higher temperatures.

Lysenko says "The change in requirements, made by the developing plant on the conditions of the environment, shows that the development of an annual seed plant, from the sprouting of the seed until the ripening of the new seed, is not of the same type of quality throughout."

On the basis of this, Lysenko reaches the conclusion that the development of the plant consists of separate stages or qualitatively different phases. For these different phases of development of the plant, different conditions are required. Phases are necessary stages in the development of every plant, and a given organ or character can develop only at a definite phase. However, one should under no circumstances draw the conclusion that different phases denote the formation of different organs and parts of plants. Phases are only qualitative turning points in the development of the organs, without which the formation of separate organs is impossible. Phasic changes always take place in the growing points of the plant stalk by division of cells and the transmission of qualitative changes to the daughter cells, which, in their turn are also subject to variations. It follows that the plant is qualitatively different throughout the length of its stalk, the lower part is phasically the youngest—the top, though young in age, is phasically old. Phases follow each other with strict regularity and are irreversible, just as all development is irreversible. Under no circumstances can a plant skip any of the phases. There are several phases of development in annual agricultural plants. Two of them have been studied in detail (1) vernalisation, the stage for example, when cultivated grains require low temperatures; (2) the photo phase—a definite stage throughout which the plant requires a definite period of *daylight* in the case of wheat, barley, oats, or *darkness* in the case of soya bean, millet.

What has the discovery of these phases yielded practically, beside an understanding of the development of plants? First, on the basis of the study of phasic development, methods have been worked out for the vernalisation of cereals (in particular spring cereals), which make it possible to sow seeds that have already been biologically treated. Secondly, the discovery of the two phases has made it possible to solve in an entirely new way the very important question of the selection of the parents in breeding new varieties of agricultural plants. Thirdly, the principle of phasic development is the foundation on which Michurin genetics is developing. The creation of this theory has rendered it possible to understand when, how, and with what conditions, plants should be influenced in order to produce corresponding variations and to reinforce these variations in the offspring—i.e., it has made it possible not only to direct qualitatively different processes in individual development, but also to proceed to directing qualitatively different processes in historical development.

The Process of Fertilisation is a Process of the Mutual Assimilative Activity of the Reproductive Cells

Experimental work on vegetative hybridisation strikingly demonstrates that variations in the nature of metabolism in body tissues lead to changes in the reproductive cells. These phenomena served as the basis for the following statement by Darwin: ". . . I believe everyone will agree that the above-mentioned cases (cases when vegetative hybrids were obtained), teach us an extremely important physiological fact: those elements which go towards creating a new being are not invariably formed in the male and female organs. They are to be found in the cell-tissue, and their state is such that they can unite without the assistance of the sex organs and by this means yield the beginning of a new bud which assumes the characters of both parent forms." These facts are so important, declared Darwin, that sooner or later they will force physiologists to change their views on sex reproduction.

If vegetative and sex hybridisation are phenomena of the same order, it follows that they must both have a common foundation. This common foundation, according to Lysenko, consists in the fact that both in vegetative and sex hybridisation similar processes occur—metabolism, mutual assimilative activity, &c., as a result of which a hybrid organism is developed.

Fertilisation, just like any other process in the living organism, is subject to the laws of assimilation. Depending on which of the sex cells has a greater power of assimilation, there will develop a hybrid embryo with a certain degree of deviation towards the nature of this particular sex cell. If the power of assimilation of the sex cells is equal, the result is a new cell (or zygote) yielding an organism in which maternal and paternal properties are about equally distributed.

On the basis of this principle, it is possible to facilitate the shaping of the nature of hybrid embryos with large or small deviations toward the maternal or paternal forms. That is precisely how I. V. Michurin proceeded in his selection work. To bring out the maternal properties in hybrids, Michurin suggests taking the pollen from a young plant that has flowered for the first time and has still not completed its formation. The buds of the other plant to which it is desirable to impart only particular properties of the first parent, should be chosen from an old tree that has repeatedly borne fruit and from those of its branches which ensure the best supply of food. By this means, Michurin created the conditions for the predominance of particular desirable maternal properties in the progeny. He often advises choosing forms for crossing which are widely separated in the conditions of their origin. On this principle rests the suggestion that parent forms should not be from the same locality, but from geographically distant places, so that the external conditions might be foreign to the same degree, to the development of the properties of both parents. From these hybrid seeds, with skilful training of the plants it is easier to create a variety with good qualities of fruit and necessary resistance to frost. Michurin genetics teaches and shows very strikingly that the sex process of plants can be directed if one is guided by the principle that its basis is the process of metabolism—the process of assimilation.

Only Through the Conditions of Life is it Possible to Direct the Heredity of Plants and Animals

The idealist trend in genetics, which denies the role of external conditions in shaping the life of organisms, maintains that it is impossible to direct the evolutionary process. Variations of hereditary properties are realised only by accidental variations (mutations) of the genes in nature, or by applying very powerful agents (X-rays, colchicine, &c.) experimentally. Acting on the living body with a selection of factors not required in the normal development of the organism, these investigators obtain accidental, non-directed, and as a rule, harmful variations which are destructive to the organism.

Academician Lysenko teaches that it is necessary to draw a strict demarcation line between accidental factors influencing the organism and the "normal" influences of the conditions of life. The former leads man to "treasure hunting," the latter enable man to direct evolution. Any change of heredity which employs the conditions of life, is a compulsory non-accidental change, as it results from a departure from the normal metabolism of the organism. Numerous experiments show that after the disruption of the norm, the new heredity is not reinforced at once. In the overwhelming majority of cases there are obtained organisms with a plastic nature, a state which Michurin calls "de-stabilised."

According to Lysenko's definition, "plant organisms with a 'de-stabilised' nature are those in which their conservatism is destroyed, their selectivity weakened in relation to the conditions of the environment. In such plants, instead of a conservative heredity there is preserved, or newly appears, only the tendency to give a slight preference to certain conditions over others.

The plant organism can be put in a de-stabilised condition by three methods: (1) by grafting plants with different heredity; (2) by acting on the organism through the conditions of the environment at moments in certain processes of development through which the organism passes; (3) by means of cross-breeding—in particular, cross-breeding of forms sharply differing in their place of habitation or origin.

Plastic plant forms with an unsettled heredity must be further cultivated in those conditions which will develop and reinforce the adaptability of a given organism. Guided by these basic principles, Lysenko is successfully conducting his experimental work for the welfare of our country and its science.

V.—RESULTS

Lysenko has in 25 years of scientific activity armed agricultural practice with an advanced theory which has borne splendid fruit every year. The discovery of the law of phasic development of plants has rendered it possible to introduce in practice a widely-known agronomical method—the vernalisation of a number of agricultural crops. The theory of the selection of parent forms in the hybridisation of plants has provided the plant breeder with a weapon with which he can create varieties according to plan in a comparatively short period. The teachings of Academician Lysenko on the unity of the organism and the conditions of its life made it possible to recommend for large-scale production the summer sowing of the potato. For example, by transforming the nature of plants, Lysenko and his followers were able to obtain spring forms from winter forms and, what is especially important, winter from spring forms. These changed forms are already being produced on a large scale.

At the present time it is curious to speak of what modern Weismanists have taught—that is, that inbreeding is a stumbling block in the breeding of plants and animals. Anyone who wishes to create new and useful forms of plants and animal breeds must use both intravarietal and intervarietal crossing of plants (including self-fertilising plants) as well as intercross breeding of animals. All this must be combined with good conditions of training.

In the estimation of the moving forces of evolution, for a long time the opinion prevailed that intraspecies competition is the basis of the formation of the species. Lysenko showed that this assertion has no foundation, and that in nature as well as in experiment these facts are absent. "Facts" occasionally cited are the usual fictions.

In nature everything develops on the basis of contradictions. Academician Lysenko has shown experimentally that intraspecies relations—i.e., the relations of the organisms of one species to each other, represent the ordinary type of contradictions which cause the species to flourish. Between organisms of one species there is not and cannot be competition leading to a "struggle for existence" with one another. Only interspecies relations are built on antagonistic contradictions—contradictions which quite often lead, on the one hand, to the direct destruction of the representatives of one or the other antagonistic side, and, on the other hand, lead to the modification and perfection of the respective organs and characters of plants and animals that survive in the struggle. In relations between different species, side by side with antagonistic contradictions one finds mutual help and community of life, which is not so within a particular species.

This theory of species relations enabled Lysenko to propose to agriculturists the excellent method of hill-planting for kok-saghyz, and to suggest new ways of planting forests, &c. Another outstanding contribution to the theory of evolution is Lysenko's teaching on the origin of species by means of leaps. Species do not arise gradually but suddenly, by leaps, on the basis of preceding, gradual quantitative changes. Academician Lysenko's elaboration of an extremely important section of the teachings of I. V. Michurin, the science of mentors, clearly shows how scholastic is the so-called chromosome theory of heredity preached by the Mendel-Morganists. The works of Lysenko and his pupils on vegetative hybridisation enabled the Michurinists to draw some extremely important conclusions. These are: (1) Heredity belongs not only to the chromosomes, but also to any particle of the living body; (2) the inheritance of characters acquired by the organism in the process of its life is not only possible, but inevitable.

Such is the scientific path, such are the scientific principles and achievements of Michurin biology, the chief exponent of which is Academician Trofim Lysenko.