LYSENKO IS RIGHT

JAMES FYFE

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In this little book a botanist with 15 years' experience of agricultural plant breeding approaches the thorny questions of the Lysenko controversy and arrives at the conclusion that the position taken by Lysenko and his followers is scientifically sound and fruitful in practice.

He examines both the theory and practice of the Soviet biologists and sums up their leading conclusions. At the same time, he examines and criticises the theories of "orthodox" genetics.

A section is devoted to the rôle of the chromosomes in heredity, concerning which Mr. Fyfe has some new and important points to make, based on recent research.

Written in a clear and popular style, this book explains what the Soviet biological controversy is really all about.

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LYSENKO IS RIGHT

by

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M.Sc.

LONDON

LAWRENCE & WISHART

1950

MADE AND PRINTED IN GREAT BRITAIN
AT THE CHAPEL RIVER PRESS
ANDOVER, HANTS
11.50

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" It is not fit that Sciences, which belong to noble persons, should be communicated to the common and vulgar people, lest they grow proud, and contemn the wisedom of those to whom the charge of Government is committed; it is sufficient for them to learn the trade of their Fathers, and follow their profession, not aspiring to those improvements of mind, which appertain only to Princes and Rulers of the People."

Tupac Yupanqui, VIth Inca of Peru ; *Royal Commentaries* according to Garcilasso, Inca de la Vega

" Aims which are common to all natural science teaching in Soviet schools . . . are to help the development of a dialectical materialist view of the world, i.e. to show the children

(a) that the world around them really exists;
(b) that nature around us is in a state of constant motion, change and development (evolution—origin of plants, animals, man, etc.);
(c) that development, motion and change in nature take place according to definite laws, that there are no miracles in nature and that there is nothing supernatural;
(d) that man, knowing the laws of nature, can influence nature, and alter it for his own benefit."

K. E. Birkett ; *A Conference of Russian Teachers,* Soviet Studies 1950–1 : 319–327

" It is a strange and lamentable fact that, although the theory of evolution is admittedly one of the greatest achievements of science, yet to-day, nearly a century after the publication of Darwin's great work, evolution has still, in our western countries, not found its proper place in general education."

J. Huxley : *Soviet Genetics and World Science,* 1949

INTRODUCTION

Most biologists would agree with the observation by J. Huxley quoted opposite. The quotation from K. E. Birkett's objective description of the aims of Soviet education shows that the position is very different in the U.S.S.R. The VIth Inca of Peru, who did not need to practise the roundabout ways of speech of our modern rulers, stated simply and directly the reason for this difference. The theory of evolution is, of course, a very dangerous theory to " be communicated to the common and vulgar people." It is much safer, as the Catholic theorists know, to teach them that things are what they are because they contain " essential substances " which make them what they are.*

When, however, the common and vulgar people, realizing that they are the salt of the earth, take their destiny in their own hands, they quickly reject the great lie of " unchanging " nature and eagerly seize its very opposite, the scientific truth of evolution.

T. D. Lysenko and his colleagues in the Soviet Union, building on foundations laid by the great Russian plant breeder I. V. Michurin, have developed a theory of heredity called Michurinism. The controversy between this theory and the fairly widely accepted gene theory has shaken the world of biology and has aroused keen, even passionate interest in the widest circles.

* Since the above was written the Pope has issued the encyclical *Humani Generis*. " Some imprudently and indiscreetly hold," he says, " that evolution, which has not been fully proved even in the domain of natural science, explains the origin of all things, and audaciously support the monistic and pantheistic opinion that the world is in continual evolution."

It is true—and we must never forget it—that much of the rumpus about Michurinism has been stage-managed by the press, the radio and the "higher" theorists who serve the ruling, capitalist class. But they would have been less successful in staging this show if there had not been a real clash of views. When a people, like the British people, in whose education the theory of evolution "has not found its proper place," are confronted with the ideas of another people, in whose education the theory of evolution *has* found its proper place, then there are bound to be some difficulties and some misunderstandings. It is the purpose of this pamphlet to try to clear away some of these misunderstandings and to show that the Michurinist view of heredity is perfectly natural, reasonable, useful and, above all, true.

1

THE PROBLEM OF HEREDITY

The problem we are approaching, the problem of heredity, is a vast one and one of great antiquity. Ever since man has thought about himself and his surroundings, he has met with this universal property of living things. Civilization could not have emerged unless man had developed a sufficient understanding of heredity to succeed in domesticating plants and animals. To-day the problem of ensuring a more stable and ever-increasing production of food demands a deeper and more exact knowledge of heredity.

The popularizers of bourgeois biology often start their treatment of heredity with some such statement as " we may be certain that an acorn will develop into an oak, or a wheat grain into a wheat plant." Every forester and farmer knows, of course, that such statements are simply not true. We can be fairly certain that a wheat grain will not develop into anything else than a wheat plant, but the production of a wheat crop from grains of wheat is a skilled job and the farmer is never certain of its success until he has the crop threshed and in the granary.

This may seem like a quibble, or contemplating the obvious, but in fact there is a very important principle involved. If we express certainty that wheat grains will develop into wheat plants, we are taking for granted all those features of the soil, of the climate, of the numerous enemies of crops and, especially, of the cultivator's work and skill, which are just as decisive as the features of the wheat grains. We then slip into the easy way of thought that "like begets like," a way of thought which decides, if we adopt it as our starting point, what our views on heredity will be. Once adopted, this "easy" view, which is actually a begging of the question, also decides what methods we shall use to influence heredity and distorts our appreciation of their significance. This view leads us to consider the wheat grain in isolation and to seek in it something which makes it develop into a wheat plant.

The scholastic philosophers did this: they followed Aristotle and perfected the doctrine of essential substances. The "wheat-ness" of a wheat grain was its essential substance and possessing this particular substance meant that it would grow into a wheat plant. The English philosopher Hobbes in his *Leviathan* (1651) condemned this error by showing that the essential substances have merely the significance of the word *is*. As it is possible to construct a language which lacks the word *is* (e.g. the Russian language makes word order do the work of *is*), the essential substances have no basis in reality, regardless of whether we think of reality as material or spiritual—whether we are materialists or idealists.

The birth of modern science required a stubborn fight against the errors of the Schools. We may measure the success of that fight by noting that dunces are called after Duns Scotus, a famous scholastic philosopher. It is staggering, therefore, to find that the doctrine of essential substances has been revived in the 20th century in the guise of the gene theory of heredity.* This theory was developed by T. H. Morgan, building on the foundation laid by Mendel and is therefore called Mendel-Morganism. The general approach to heredity which looks for essential substances determining characters is called Weismannism, because it was Weismann who translated it into biological jargon in the 19th century, restating the scholastic attitude in more modern terms.

The problem of species exercised the scholastic philosophers unendingly. Their arguments induce giddiness in the reader as certainly as being spun round on a joy-wheel and I shall not attempt to reproduce them. It is enough to know that they approached the question as though species were fixed, unchanging, and that the members of a given species were recognized as of that species because of their substantial forms (the argument between Nominalist and Realist Schoolmen need not concern us).

To-day we are apt to take the title of Darwin's greatest work for granted, but that very title, *The Origin of Species,* signified a blow at the scholastic view from which it could never completely recover. Just as Newton completed the destruction of the scholastic view of the Universe, Darwin scientifically and irrefutably demolished the idea that the material causes of the differences between species are to be sought anywhere but

* Readers who are not familiar with the gene theory should not waste their time with the popular accounts written by non-geneticists. There are plenty of textbooks and popular accounts written by geneticists. Briefly, the gene theory maintains that there is a special substance of heredity and that it consists of particles, called genes, contained in the chromosomes. The genes are self-reproducing and it is supposed that heritable differences between individuals are determined by differences in their genes.

in their history. He showed that if we consider species in isolation from their environment and as unchanging, then we shall never understand them.

After 1851, the only way the scholastic view could re-establish itself in biology was by subterfuge, by pretending to be something else. The gene theory is one of its disguises, in which the essential substances appear as parts of chromosomes. The chromosomes are real and material enough, but the hypothetical genes are endowed with miraculous properties. The main property of a gene is to act as an " unmoved mover ": it determines the direction of development or change of other parts of the organism but its own direction of change is determined only by itself. The properties of a gene are therefore not to be explained in terms of its history and the gene itself is not subject to evolution in the way that every other part of an organism is. This or that gene may increase or decrease in number according to whether the characters it is supposed to determine favour or prejudice the chance of survival of the organism carrying it. It is even allowed, by the modern scholastics, that the environment may sometimes cause a gene to change but there must be no talk of any consistent relation between the cause of the change and the resultant change in the determinant properties of the gene.

It is here that we see most clearly that the gene theory is anti-scientific. This view that the direction of change of a gene is determined only by the gene itself (shortly called " randomness of mutation ") is not merely wrong, it is incapable of being proved or disproved.

A theory can be wrong and still be a scientific theory, but it must be possible to test it by experiment and observation. Now if we are told that the direction of change of a gene is at random with respect to the cause of the change, any experiment we can design to test the truth of the statement can lead to one of two results. If it fails to show a connection between cause and direction of change, the opponents of randomness can say that we looked for the wrong connection. If on the other hand we claim to have demonstrated a connection, the supporters of randomness can say that it is fortuitous, or more probably, that it is a result of selection.

We shall see later that there is another reason, inherent in the gene theory, why the randomness of mutation has never been tested experimentally. It is clear enough that while this view prevails, an important line of enquiry is blocked: in this sense, it is an anti-scientific theory.

The reader is probably wondering by now why I spared him the tortuousness of mediæval scholasticism, only to plague him with the modern version. Perhaps the sanity of Michurinism will be the more refreshing by contrast.

Let us return to our wheat. Why does a farmer decide to grow wheat? Basically, because he knows, or hopes, that the soil and climate of his farm and the treatment which he is able to give it will be such as to enable his wheat seed to develop into a profitable crop. The question of profit, of course, introduces other factors than purely biological ones, but from the biological point of view, what the farmer has in mind is whether he can supply what wheat needs, whether he can fulfil its requirements. If not he will prefer to grow another crop: on light chalky soils he will prefer barley, or if his soil is light and more acid, oats or even rye. Having decided to grow wheat similar considerations determine his choice of species and variety. The English farmer whose land is not fertile enough for bread wheat (*Triticum vulgare*) will grow Rivett (*T. turgidum*). If the needs of crop rotation allow it, he will prefer to sow his wheat in the autumn, because this gives it the conditions for a heavier yield, especially a longer growing period than spring sowing: for autumn sowing he usually chooses a variety that needs to pass through a winter in the vegetative stage before it can complete its development to flowering and fruiting—a winter variety of wheat.

The first thing which the farmer must know about the hereditary properties of seed is its requirements for growth and development. Closely connected with this is the question of how it will react to various conditions. If the winter is open will it become winter-proud, will stormy weather before harvest lay it flat, will wet weather after harvest make it sprout in the stook? Heredity for the farmer is " the property of a living body to require definite conditions for its life, its development and to react definitely to various conditions " and this is T. D. Lysenko's definition of heredity (1946).

If an agriculturist is asked to venture an opinion on what the potential value of a new variety or strain or even species is likely to be, he will not ask " What genes has it? " but " What is its history? "

Commonsense and experience have taught that a variety which fulfils its needs for growth and development under conditions similar to ours is likely to do well here. In this way the experimenter with crops chooses the varieties he thinks worth testing in field experiments.

Naturally, he gets some surprises, because it is not always possible to know the relative importance of the different factors of soil, climate and disease, but there is no other way of making the first choice. Here again we see that the Michurinist view fits hand-in-glove with the approach of the practical worker, who in this case is working not as a farmer, but as an "improver."

The gene theorist on the other hand, because he takes genes as his starting point, is required to explain the correspondence between plant and environment. He does so in terms of selection: since the genes cannot change in an adaptive way, the only way the environment can direct the evolution of an organism is by selection of those genes which happen to occur and which produce characters favouring survival.

It is not at once obvious that this is a major defect of the gene theory. The necessary explanation comes readily to hand and over a surprisingly large field of human endeavour it makes little difference which view one holds. Had it been otherwise, the gene theory would never have survived, for it would have been too obvious that it contradicted experience.

There is no doubt that selection is an extremely powerful way of directing heredity. We know that it has been used successfully by man and there is no reason to doubt that it operates in Nature. But to assert that it is the *only* way of directing heredity is a different matter. A pragmatist would probably assert that the difference is a minor one but the theoretical difference which makes its appearance here leads to important errors.

Let us consider first the bearing of the gene theory on the significance of Darwin's great work. There is no need to impress on biologists the importance of this, but non-biologists will perhaps forgive the author if he reminds them that Darwin, by providing the great unifying principle of evolution, opened the era of modern biology. This was undoubtedly the mightiest achievement of bourgeois biology, ranking with Newton's, both of them a constant source of pride to English scientists.

Darwin's contemporaries, Darwin himself and historians all agree in considering Darwin's achievement to have been the irrefutable demonstration that species have an evolutionary history. The Mendel-Morganists differ. They claim that his achievement was to establish the theory of natural selection.

What purpose is served by this minority view? Nothing less than the reintroduction of that very scholasticism which Darwin drove out of biology. The hierarchical concept is revived, with the genes standing at the head, immune themselves from determinant effects, themselves determining the behaviour of everything below them. Any correspondence between such supernatural substances and the organism's environment could *only* be due to selection, hence the special Mendel-Morganist view of Darwin's achievement.

A general acceptance of this view by biologists would be disastrous for the development of biology. Fortunately, it has not yet won that acceptance. That same handful of English geneticists who have so unscrupulously slandered the Michurinist geneticists frequently complain of the neglect of Mendel-Morganist genetics in English Universities. (" It may well be said that biology as I have described it is not taught to-day in this country. That is true." C. D. Darlington, 1945.) In Cambridge University for example, though one would have some difficulty in naming a more distinguished Mendel-Morganist than the present Professor of Genetics (R. A. Fisher), his subject does not even rank as a half-subject for an honours degree.

Mendel-Morganists claim that their science of heredity influences every branch of biology, to say nothing of sociology. They mean that they would like it to do so. Before Mendel-Morganism can have the effect on biological sciences which its supporters want, it has to become so securely established that no biologist thinks of questioning its foundations. If anybody takes the trouble to examine those foundations, he is bound to observe their Aristotelian, scholastic features and to recognize them as unscientific. True, the Mendel-Morganists have considerable backing from the capitalist class, whose interests and outlook they reflect, and this gives them an influence on the course of biological research and teaching disproportionate to their theoretical influence. But scientists are rather apt to " contemn the wisedom of those to whom the charge of Government is committed " and are given to examining theories critically. Hence the Mendel-Morganists have always had to fight for the survival of their theory and since the bases of that theory are unscientific, the fight has not always been on scientific grounds. For example, Kammerer, in the 1920s, claimed to have demonstrated the inheritance of acquired characters: when he committed suicide, this was used to surround the whole subject of Lamarckism with an aura of disrepute. Rather similar tactics are being used to-day to discredit the Michurinists.

The fight against scholasticism in biology, so nobly begun by Darwin, is not yet won in all countries and in all fields of biology. The strongholds of scholasticism in biology are the related subjects heredity and embryology: its political strongholds are the imperialist countries, in which it faithfully serves the interests of the ruling class ("... science put heredity on a material basis—and with it the basis of class distinction ...." C. D. Darlington, 1947). The weaknesses of scholasticism are most clearly seen when science attempts its proper task, of increasing men's control over their environment, that is when science is put to work. Again, when the working class takes over political power, the political protectors of scholasticism can no longer help it and its position is further weakened. In the Soviet Union a working class government has put science to work on improving men's lot on a scale and at a pace which have never before been seen. It is not surprising therefore that it was in the Soviet Union that the decisive victory was won by science over scholasticism in the field of heredity. This is the historical significance of the triumph of Michurinism.

2

THE MICHURINIST VIEW OF HEREDITY

If we are to begin to understand the scientific significance of the triumph of Michurinism, we must of course have some grasp of what the Michurinist view of heredity is. Since, however, that view is already rather highly developed and is still developing very quickly, we can only hope to seize on the fundamentals.

The first thing to note in approaching Michurinism is its relation to practice. The experience of breeders and improvers of crops and stock gives rise to generalizations which express, often very briefly and even cryptically, empirical rules which breeders have found to give useful guidance. For example, the cereal breeders at Svalöf, the famous Swedish plant breeding station, find that the ability to endure a dense stand is an indispensable feature of a high yielding cereal variety. They therefore pay special attention in their selection work to the way different families respond to varying densities of plants. Again Michurin himself found that he had no success in acclimatizing fruits to northern Russian conditions unless he started from seed.

Generalizations like these do not add up to a scientific theory of heredity. By observation, experiment and logic, the scientist has to seek the more fundamental truths of which these practical generalizations are particular cases. But there is always a tendency for the development of any branch of science to be influenced by the discoveries it has already made, for these discoveries naturally make progress easier along those paths which they have opened up. This can lead to the problems stated by practice being ignored, while attention is concentrated on topics of more theoretical interest which appear capable of solution (known in the cant of scientists as "amusing problems"). The result is that a separation between theory and practice begins: if the separation persists the development of the particular branch of science is slowed down.

But this kind of drift can never lead to the complete stultification of a branch of science of its own accord; its appearance is a danger signal, but no more. This is partly because the requirements of practice keep forcing themselves on the attention of scientists and partly because the constant reference by scientists to experiment and observation tends so strongly to keep them close to the truth. The stultification of a science requires more than an absence of direct links between academic and practical work: it requires the acceptance by scientists of an anti-scientific theory, based in the ultimate analysis on the unknowable, the random, the irrational. The importance of the links between theory and practice is that they prevent the acceptance of such theories.

Some academic scientists, if they find it convenient to use the statistical concept of randomness, are only too ready to elevate that concept to the level of a principle. This is especially true to-day, when the days of the capitalist ruling class are numbered and all rational and historical justification for their existence has disappeared. In such a situation irrationalism becomes particularly fashionable. The practical worker, on the other hand, readily recognizes the concept of randomness as merely a convenient way of circumventing difficulties which he cannot, or does not wish to, cope with at the moment: he is quite used to working partly in the dark, because he cannot pick and choose his problems, but he knows perfectly well that any particular shadow will sooner or later be lit up by discovery.

On these grounds it is very important to note that the Michurinist study of heredity is closely linked with practice. It takes as its own starting point the experience, generalizations and principles of the famous Russian fruit breeder, I. V. Michurin, and its whole development has been interwoven with the development of Soviet agriculture on collective and state farms.

As a contrast we may quote a British professor of genetics, K. Mather (1942), on Mendel-Morganist genetics: " When Lysenko states that genetics has not contributed very much to the improvement of crops and stock, we must agree with him."

Michurin was not merely a very successful plant breeder in terms of producing successful varieties. He also enriched the practice and the literature of plant breeding with a number of practical rules for success, concerned for example with the choice of parents for crossing and the use of grafting to influence the outcome of crosses and the heredity of young seedlings. But he went further than this. In the course of more than 60 years' experience of fruit breeding he developed a very characteristic outlook on heredity, which has formed the basis of the Michurinist biology. This view was not characteristic of Michurin alone: it is a view shared to a large extent by many successful plant breeders. The American fruit breeder, Luther Burbank, although his breeding methods were very different from Michurin's, summed it up in the following words: "My own studies have led me to be assured that heredity is . . . the sum of all past environments . . . ." (Howard, 1945-46).

Although Michurin objected to being compared with Burbank, he would certainly have approved of the principle stated in this aphorism. The same principle is embodied in Michurin's oft-quoted motto: "We cannot wait for favours from nature; we must wrest them from her."

It is important to understand the difference between this view of the improvement of plants and the view dictated by the Mendel-Morganists. They maintain that the genes are the essential substances of heredity and that it is impossible to direct changes in their determinant properties. If it were possible, then genes capable of changing in an adaptive way would have an advantage in natural selection and would eliminate those incapable of adaptive changes. The lynch-pin of the Mendel-Morganist theory of evolution (neo-Darwinism) is "random mutation" and if this pin is withdrawn or tampered with, the whole artificial structure will tumble.

The Mendel-Morganists assure breeders, therefore, that all they can do to improve living organisms for man's use is to select existing genes and arrange them in suitable combinations. If the required genes are not available, the breeder must go on searching for them or wait until they happen to appear by "random mutation."

Now it is perfectly true that improvements can be, and in fact have been, brought about by these methods. The present author is himself engaged in them and would contest any attempt to underestimate their value. But he would also contest any attempt to assert that selection (following hybridization if necessary) is the *only* way to direct the heredity of living organisms. When the Mendel-Morganists so assert, they are trying to impose a limitation on the practical work of breeders. This limitation is harmful. It represents an inversion of Michurin's motto, which would become according to this view: "We cannot wrest favours from Nature: we must await them."

We can only extract the full value from Michurin's motto if we drop the scholastic notion of essential substances acting as unmoved movers (genes acting as self-determining determinants) and regard the heredity of an organism as the product of its history, including the history of its ancestors. We then see that anything that happens to living organisms has to be considered as possibly influencing their heredity. Our view of the problem of the improvement of heredity is correspondingly widened and a possibility is given of bringing theory and practice closer together.

In experimental science, to say that one understands a process, or can explain it, means that one can control it. The Mendel-Morganist assertion that mutation is a random process reflects in a distorted form a very important fact. The fact is that Mendel-Morganists do not understand mutation—they cannot see how to control its direction. Therefore they say, with sublime arrogance, "since *we* cannot control it, mutation is uncontrollable, random in direction." The odd thing is that they probably *can* control it but their gene theory has so blinded them that they cannot see the possibility.

Michurinists, on the other hand, inspired and pressed on by the practical problems of collective agriculture and the tremendous possibilities of applying science in the U.S.S.R., and guided by Michurin's work, refused to take " no " for an answer. They resolutely attacked the problem of directing hereditary changes and showed that it could be done. Which means that they deepened their understanding of heredity and its variability.

In approaching Michurinism first by considering its relation to practice, we have found the characteristic, special source of its strength. The demands of agricultural progress simply would not allow Michurinists to be put off by a polite fiction, a face-saving device whereby ignorance of changing heredity was glorified as a " principle " of randomness.

The peculiarly close relation between science and practice is responsible for the fact that in studying genetics in relation to practice we inevitably discover the most fundamental difference between Michurinism and Mendel-Morganism. We have not yet approached Michurinist theory and yet already we can see the difference in terms of practice. The Mendel-Morganists say " we cannot direct changes in heredity ": the Michurinists say " we can, and do." The " classical " genetics tries to impose a restriction on the practice of improving crops and stock : the materialist theory rejects the restriction. The academic geneticist could accept the restriction, for he can choose his problems accordingly : the practical scientist cannot accept it, for he must tackle those problems which are urgent and if one theory throws up its hands and says " this problem cannot be tackled " then he will try another theory. If that theory brings results, then he will adopt it.

The second thing to note in approaching Michurinism is that it is a very clear, fundamental, simple and definite biological theory. It stands in a very definite relationship to Mendel-Morganism—*one cannot believe both.*

This may seem too obvious to be worth stating, but it is in fact the point at which many biologists stick. They cannot see why a few Michurinist, or some-otherist, corrections cannot be added to or embodied in Mendel-Morganism, so as to put it on the right lines. There are even Mendel-Morganists who believe that the necessary corrections in their theory are being made. It is true that, being an unscientific theory, it can readily be "adjusted" to fit any new discoveries. In fact, however, Michurinism and Mendel-Morganism are irreconcilable and one of them must destroy the other.

That means that the adherents of one theory or the other must convince most biologists of its truth. It does not mean, as some Mendel-Morganists assert, that the adherents of one theory must destroy the adherents of the other. If we may judge by the way these men, taking the late Dr. Goebbels as a pattern, adapt their outbursts to the propagandist requirements of Anglo-American war plans, we must conclude that they regard an all-out military attack on the Soviet Union as the last hope of their theory.

The starting point of Michurinist theory is nothing hypothetical like genes, it is living, growing, changing, developing organisms, existing, as we know them, in a changing environment. Starting with the commonsense notion that one cannot conceive of an organism living except in an environment, Michurinism takes as axiomatic the connection between organism and environment. Unless we are dealing with an organism in a very peculiar (though familiar) condition like the dry dormant seeds of a crop or the spores of fungi and bacteria, we cannot break the connection between organism and environment. If we attempt to do so, the organism ceases to be an organism—in plain English, it dies.

We have already seen that anybody concerned with raising plants or animals, or with their improvement, is thoroughly familiar with the fact that the requirements of different species and varieties for growth and development are characteristically different. He is also familiar with the fact that different species and varieties respond in characteristic ways to different environmental conditions. These are the two main aspects of heredity for Michurinists.

For experimental scientists this view of heredity shows that it is possible to study heredity without performing breeding experiments. This is again an idea quite familiar to practical workers, but one which Mendel-Morganists grasp with difficulty, if at all. They distinguish the genotype and phenotype of an individual. As Dobzhansky puts it : " examination of the pedigree, or of the progeny, or both, is needed to study the genotype " while the phenotype, which is supposed to be produced by the genotype interacting with the environment, " changes continuously as the development proceeds and, in fact, never becomes fixed." The genotype is supposed to be fixed at fertilization and, barring accidents, does not change.

Let us test these two approaches to heredity by considering a typical practical case. There are many potato varieties, the pedigree of which is unknown and which are so sterile that one cannot breed from them. The whole stock of the variety, being produced by vegetative multiplication, is in a sense one individual. If Dobzhansky is right, we cannot study the genotype of such a variety. But of course by experiment and observation we can study its changing phenotype and discover regularities about it, such as a tendency to yield better on certain types of soil or in certain types of season, to bulk up early, or to mature late and so on. Of what, then, are these regularities a property, what causes them? They cannot be caused by the phenotype, because Dobzhansky says that the phenotype "never becomes fixed," while these responses to differing conditions *are* relatively constant and characteristic. On the other hand, we cannot study the genotype without knowledge of pedigree or progeny, so he says. Neither a Michurinist nor a practical agriculturist would hesitate to say that in such experiments we are studying the heredity of the potato variety. In spite of, or perhaps because of, his success in developing Mendel-Morganist theory, Dobzhansky is quite wrong. One *can* study the genotype without examining either pedigree or progeny.

The link between organism and environment is assimilation, the process whereby the organism selects and takes in parts of the environment and makes them parts of itself. The resulting growth and development depends in amount and in kind on what the particular individual received from its parents and on what it itself assimilates from the environment—this of course being strongly influenced by what is available. The result of the process of assimilation is that the organism builds itself *and its heredity.* This is the central feature of Michurinist biology. It is in fact what gives it the name Michurinism, for Michurin held firmly to this idea.

It depends on a particular view of the process of assimilation. According to Michurinism, when external conditions are assimilated, they become requirements.

> "*The alteration of requirements, that is of the heredity of a living body,* always reflects the specific effects of conditions of the external environment, provided that they are assimilated by it." (Lysenko 1946—his italics.)

Microbiologists are familiar with this idea. A strain of yeast assimilating sugar in the form of glucose requires glucose and cannot fulfil that requirement with another sugar, say melibiose. But it may be possible, by the Hobson's Choice method, to make it assimilate melibiose and thereafter it will require melibiose.

Now the heredity which is created in this way may not only determine the requirements of the individual itself. If it affects what is handed on to the offspring it affects the heredity of the offspring. Hence it is possible, by understanding and controlling assimilation, to direct changes in heredity.

An example will show more clearly what is meant by this.

If we take a sample of seed of a winter wheat and sow some of it in autumn and some, next to the first, in spring, then the first can flower and set seed in the summer, while the second cannot. A spring wheat could complete its development in either case provided it was not injured by a cold winter. Lysenko showed that the main, decisive difference between autumn and spring sowing for a winter wheat was a matter of temperature. The winter wheat has a cold requirement. This was discovered by finding out how to make a winter variety behave like a spring variety—how to vernalize it. The process of vernalizing winter wheat consists in giving the seed enough moisture and air to grow very slowly and keeping it at a temperature between 0°C and 10°C for a period of weeks; the exact minimum period needed depends on the variety and the conditions. The wheat can then fulfil its cold requirement while it has still grown so little that it can be sown in the ordinary way. When sown it will behave like a spring variety, with a similar risk of injury in the winter if autumn-sown, and with a similar capacity to complete its development if spring sown.

In passing, it is worth noting that this work was greeted with the now familiar incredulity of Mendel-Morganists when it was first reported. It is now accepted, with the comment "we knew this all the time."

By the time the work on vernalizing winter varieties of cereals had been accepted in the west, the Russian workers, mainly under Lysenko's lead, had gone further and shown that the development of higher plants proceeds by phases. The process of vernalization gave its name to the first phase. A spring wheat also has to pass through the vernalization phase, but can do so at higher temperatures than a winter wheat.

This gives us the clue as to how to transform the heredity of a winter wheat into that of a spring wheat. It must be made to accept, to "assimilate" higher temperatures than it normally requires. The exact conditions for completing normal vernalization are determined, then a trick is played. Instead of quite completing vernalization at a low temperature, a high temperature is given towards the end of the process. If the conditions can be specified and controlled exactly enough, the Michurinists claim, then the great majority of the seedlings will accept the new conditions. By repeating the process over two or three generations, progressively shortening the cold treatment, a winter wheat can be " trained " so as to lose its cold requirement.

We shall see later that their own views on heredity, their gene theory, led Mendel-Morganists to misunderstand this work completely, but there is another important point which hampers an understanding of this achievement. Not many people are familiar with the behaviour of plants which have almost, but not quite, fulfilled their normal requirements for flowering. That behaviour can be most abnormal, even freakish. But because of the great amount of work which T. D. Lysenko and his pupils have done on the physiology of development, they were familiar with the idea that in passing from one stage to another a plant can be caught, so to speak, " on the hop," in a particularly unstable state in which it is easier to make it accept conditions which it would not normally accept.

Michurin claimed that the early stages of growth of a seedling also represents a sensitive stage of this sort and claimed that by grafting an older, more stable variety on to a young seedling it was possible to influence the heredity of the latter. His followers have demonstrated that he was right. They call the process graft-hybridization, following Darwin who also accepted the view that heredity could be changed by grafting.

Both the training of winter wheats into spring wheats and graft-hybridization illustrate the two main features of the Michurinist method of directing changes of heredity. The organism treated must be in a condition in which its heredity is unstable and while in this condition it must be induced to accept environmental conditions which it does not normally meet at that stage. Because they discovered the significance of both these features, the Michurinists succeeded where others had failed.

* * *

There are many other important theoretical aspects of Michurinism which cannot be described in the space available here. We must hope that they will become available in English translations for first hand study. But there is one aspect which must be treated briefly and that is the Michurinist view of the chromosomes. This is important because so many people are now familiar with chromosomes either at first or second-hand.

If we take a growing plant of maize and by suitable methods of preparation we examine under the microscope stained sections of its most rapidly growing parts, the tips of roots or the growing point of the shoot, we shall find that cells are being produced there. All stages of the process will be seen, whereby one cell gives rise to two and the nucleus of the parent cell gives rise to two nuclei, one for each daughter cell.

During this process of nuclear division the chromosomes become visible. There are usually in maize 20 of them and a careful study shows that there are 10 different kinds and two of each kind, i.e. there are

10 pairs of *homologous* chromosomes. The process of nuclear division involves an exact longitudinal splitting of these 20 thread-like bodies and an exact distribution of the halves to the daughter nuclei, so that the two daughter nuclei contain exactly the same 20 chromosomes as each other and as their parent nucleus had contained. This process is called *mitosis* and its main features are summed up in the statement that at each division of the nucleus there is one division of the chromosomes.

In the formation of sex cells, however, a different kind of division occurs, in which there are two divisions of the nucleus, but only one division of the chromosomes. This is called *meiosis* and, proceeding with a symmetry which is as exact as that of mitosis, it leads to the production of four nuclei, each having only one set of 10 chromosomes. The set of 10 is the haploid set, two of which make up the diploid set of 20, as actually happens when at fertilization the male nucleus fuses with the female nucleus. In meiosis there is an early stage where the pairs of similar chromosomes come together, lie close alongside each other in an exact linear correspondence and then divide. In the resulting four-thread stage crossing-over occurs, that is exchanges of material between non-sister threads.

All this elaborate and exact behaviour would have no survival value, would not survive, unless the double bodies we see in meiosis, made up of paired homologous chromosomes, have both a linear and a transverse structure. Not only are there 10 visibly different kinds of chromosomes, but each of the 10 has a characteristic structure, visible to a limited extent under the microscope. Moreover, when we consider the two members of a pair, they also must be slightly different; though this is not usually visible, it can be inferred from the occurrence of crossing-over which would be pointless (and would therefore not survive) if the material exchanged was identical.

Except that the number is not always 20, the very condensed account given above applies to most flowering plants. Amended to cover sex chromosomes, it would apply to most higher animals. The conclusion must be accepted that here are structures which are of fundamental importance in sexual reproduction, in growth and in development.

What, then, is the role of the chromosomes?

The Michurinist view of heredity gives the clue. There is no special, essential substance of heredity. Heredity is a property of all parts of a living organism, however minute those parts. The chromosomes have the property of heredity. But the central feature of chromosomes is that the reproduction of any chromosome, or even any part of a chromosome, is conditional upon the whole set of chromosomes being reproduced. It appears that the organization of nuclei and cells is such that different chromosomes, and different parts of chromosomes, facilitate each other's reproduction. The reproduction of a set of chromosomes does not depend on the requirements of every part of that set being fulfilled: if the requirements of enough parts are met, then—and only then—is the whole set reproduced. Unless something rather drastic has happened, the whole set of chromosomes is reproduced unchanged.

The significance of this organized behaviour of the chromosomes can be seen in the light of the Michurinist view of assimilation. According to this view, external factors, which the organism assimilates, become internal and set up a requirement for the same factors; this requirement becomes part of the heredity. It follows from this that the more a requirement is met, the more firmly that requirement becomes established as part of the heredity of the organism. For example, the colder the winters a winter cereal variety goes through, the more intense its cold requirement may become, or the more a strain of yeast is habituated to using a particular kind of sugar, the more does it require that kind of sugar, " as if increase of appetite had grown on what it fed on."

The process of intensification of requirements by assimilation—usually called adaptation—has a great survival value, but if unrestricted it has a corresponding danger. The environment in which an organism lives is subject to change and especially to repeated and rapid changes. In adapting itself to these changes, an organism will find it an advantage not to have to start from scratch every time. If it can maintain, within itself, alternative requirements, it will be in a much better position " to suffer the slings and arrows of outrageous fortune."

This, we may suggest, is the function of the chromosomes. Any other part of the organism, if it is to increase, requires its specific conditions: the parts of chromosomes can evade the most rigorous operation of this law. Being organized into chromosomes, and the chromosomes being organized in a nucleus, complete with nucleolus and nuclear membrane, it is possible for parts of chromosomes to be reproduced (i.e. to increase) without their specific requirements being fulfilled.

T. D. Lysenko (1949) puts it thus :—

> " The basic biological function of the nucleus, its chromosomes and other nuclear elements, both of the sexual and non-sexual cells, is precisely to create from different cells (nuclei) in the process of fertilization, one single, biologically contradictory body, and this constitutes the body's vitality."

The reason why a " biologically contradictory body " has vitality or vigour is simply that the environment in which it exists is constantly changing. An organism with highly specific requirements is very well placed if it grows in a very specialized environment. But an organism which has to endure " the thousand natural shocks that flesh is heir to " must, if it is to survive, be less specific in its requirements. It must have alternative requirements. These give it the ability to survive the shocks, an ability which we call vigour, which is in this sense the opposite of heredity. All breeders, of plants or animals, know that the inbreeding intensifies heredity but weakens vigour, while outbreeding does the opposite.

The student of heredity will readily see that this theory of chromosome function leads to an entirely different explanation of Mendelian phenomena than that given by the gene theory. He will also see that if he follows the matter further, then many puzzling features of chromosomes begin to appear perfectly natural. We cannot go into these here and now, but two things must be mentioned.

Firstly, there is the point, of general importance, that this materialist view of the chromosomes is radically opposed to the Mendel-Morganist view. The latter regards the chromosomes as the special substance of heredity: the former regards them as involved in an organized process, the most important outcome of which is not heredity, but vigour.

Secondly, the materialist view of the chromosomes leads to a different view of the process of chromosome mutation. Mutations are changes in the minute or grosser structure of chromosomes. In the vast majority of cases they affect only one of a pair of homologous chromosomes. But their most striking effects are seen when, after inbreeding, two altered chromosomes are brought together in the nuclei of one individual. On the Michurinist view this is quite understandable. The mutation is a change in heredity, resulting from the assimilation of some unusual external factor while the organism's heredity was unstable. The mutation represents, therefore, a specialized requirement and makes the organism better prepared to meet a persistence or repetition of the unusual circumstances which evoked it. If those circumstances do not persist or recur, the other, normal chromosome is still available to cope with the more normal conditions. But if we force the organism to inbreed and so produce offspring which lack the normal chromosome, then the results will be different, will usually be harmful and may even be disastrous, precisely because the requirements of the mutant chromosomes are unusual.

Now the Mendel-Morganists, because of the curious blinkering effect of their gene theory, regard the properties of the inbred offspring as the important feature of mutations. When the question is asked " are mutations adaptive? " they answer it with reference to the inbred offspring, not with reference to the individual in which the mutation occurred. It is not surprising that they answer it in the negative, for as everybody knows, inbreeding is for the most part a harmful and unnatural process.

It may also be mentioned that the Michurinist view of the chromosomes avoids a very awkward difficulty of the gene theory in relation to embryology. According to the gene theory, every cell of the body has the same genes. If the genes are determinants, how then can different tissues and organs arise?

3

MICHURINISM AND SOVIET AGRICULTURE

Before the Revolution, Russian agriculture was outstanding for its primitiveness. Yields of grain were no higher than those of the Canadian prairies, but required far more man-hours for their production. Only by the most terrible repression of the peasantry could Tsarist Russia maintain its export of wheat. Such agrarian " reforms " as the Tsarist government introduced after the unsuccessful 1905 revolution simply added to the burden of the poorer peasants. They then had to support the rich peasants (*kulaks*) as well as the feudal landowners. Readers of Tolstoy's novels will remember the helplessness of the landowners who realized that the introduction of English farming methods would increase the productivity of their estates. Under the prevailing political system, this simply could not be achieved. A large part of Michurin's life was spent under these conditions. If one admired nothing else about Michurin, one would be bound to admire his indomitable courage in persisting with his work in the face of official neglect and active discouragement.

To-day we see in operation a fifteen-year plan to change the aspect of the Russian steppes into something not unlike the English countryside. This plan, the Stalin Plan, is on a breathtaking scale involving the planting of millions of acres of shelter belts of trees, the construction of ponds and reservoirs, the introduction of complex crop rotations (*travopolye*), increase in livestock production and extension of mechanization. Its aim is to increase, and stabilize at a high level, the productivity of Soviet agriculture. Its scale makes the Groundnut Scheme look parochial, but unlike that ill-starred scheme, in the first year of operation its achievements exceeded those planned.

The decisive factor in achieving this amazing transformation from a most backward to a most advanced agriculture has been the agrarian policy of the Soviet Government. The leading part in shaping that policy has been played by J. V. Stalin.

We can recognize three main stages in the historic process of changing Russian agriculture. First, the Revolution, won by an alliance of workers and peasants, freed the peasants from their intolerable burden of economic parasites. Second, the development of large state farms and the sweeping success of voluntary collectivization of peasant holdings created large-scale mechanized agriculture. Third, the emergence of a new kind of peasant; not only did the new, Soviet peasants lack the traditional peasant conservatism, not only did they eagerly accept the achievements of agricultural science, but they produced their own innovators.

Under collectivization, science and practice came to meet each other. The scientists went out to the farms and the farmers became scientists. As has already been mentioned, this had profound effects on biology. Under these conditions Mendel-Morganism, with its restrictions and polite fictions was bound to lose ground, Michurinism with its greater freedom and more realist approach was bound to win. In the domain of agricultural research there developed a sharp, even bitter, unrelenting struggle between the two biological theories. Firmly supported by practical research workers and farmer-innovators, Michurinism won that fight. The leading state organization of agricultural research (the V. I. Lenin All-Union Academy of Agricultural Sciences) came under Michurinist leadership, with T. D. Lysenko as President.

The struggle was between two radically different approaches to nature and therefore it involved philosophical issues. It was also a struggle for the control and direction of official research facilities, therefore it involved state and administrative issues. And, of course, as a struggle between two theories of heredity, it involved scientific issues. But the solid foundation of the Michurinist victory in agricultural research was laid by its successes on the farms.

The attitude to these practical successes, of the few Mendel-Morganists who have volunteered as propagandists in the anti-Soviet cold war, is very illuminating. They do not deny them. In a half-hearted way they may try to belittle them but for the most part they seek to dismiss them as irrelevant. In some cases this may mean that their knowledge of agriculture is not deep enough for them to tell a bee from a bull's foot, as the saying goes. But this is not the main reason. For propagandist purposes, they have to present a false picture of a theory imposed on an unwilling, oppressed people by a tyrannical government. Therefore the main source of strength of that theory has to be hidden.

There is not enough space available to do more than list some of the practical successes of Michurinist biology—the introduction of vernalization on millions of hectares, intra-varietal crossing, changes in the organization of seed production, the breeding of new varieties of crops by Michurinist methods, supplementary pollination, transformation of millet from a poverty crop to a high-yielding crop. These are some of the achievements with agricultural crops. In horticulture equally striking successes have been registered from the Arctic to the sub-tropics.

There is a general feature of these successes which must be grasped if the full significance of Michurinism is to be understood. They are successes of a special kind. In their development and application scientists and farmers work hand in hand, each understanding the other's work, because the underlying theory is comprehensible to both. This is in striking contrast with Mendel-Morganism. A schoolboy can learn the simple rules of Mendelian inheritance, but when it comes to applying them to practical problems there are so many reservations and complications that not only the ordinary farmer gives up the struggle, but the outstanding farmer too. The result is that Mendel-Morganism, even if taken at its own valuation, plays its part in the improvement of agriculture only through the work of specialists.

A good example of this is hybrid maize, which has swept the board in the Corn Belt of the United States and increased maize yields by 15 or 20 per cent. The farmers in the Corn Belt are now completely excluded from the improvement of maize, which is henceforward entirely in the hands of research stations and larger seed firms.

The case of hybrid maize is instructive in another respect. We have seen that the Mendel-Morganist propagandists affect a lofty contempt for practical successes when they are achieved by Michurinism. But they are quite ready to claim hybrid maize as an achievement of their theory, to rebut the charge of sterility. What is Professor R. A. Fisher's verdict?

> "It is characteristic of the great work of maize improvement that it is very largely empirical, and without any distinct or satisfying analytic basis. Abundant enterprise and strong public support are its mainsprings; theoretical ideas have, on the whole, been insufficient to explain what has been achieved."

It is this inadequacy of Mendel-Morganism in practice which will be its downfall even in capitalist countries. Its general tendency to lag behind the practical work of improvement of crops and stock becomes characteristically conspicuous when it is a question of cross-breeding organisms. In the Soviet Union, if specialist plant and animal breeders had felt that Mendel-Morganism was a firm theoretical basis for their work, the victory of Michurinism in agricultural research would not have been won.

The importance which Michurinism attaches to the environment, as the source of those forces which mould heredity, makes it possible to integrate the work of crop and stock improvement with the other branches of science bearing on agriculture—plant physiology, soil science, ecology, climatology: the result is a new branch of science—agrobiology.

The co-ordinated application of improvement on many fronts is a special feature of Soviet planning. It has had much to do with their rapid advance in the industrial field. We are now seeing, in the Stalin Plan, the application of these methods in agriculture. The results will demonstrate in practice the falsity of the law of diminishing returns, to say nothing of the pessimistic Malthusian perversions which have reappeared recently in America and England. The developing science of Michurinist agrobiology is particularly well fitted to play its part in this work. In the course of the work the distinction between mental and manual labour will be still further reduced.

4

MICHURINISM AND POLITICS

In the preceding section we have seen that the source of the invincible strength of Michurinist theory in the battle of ideas was its usefulness to practical research and innovation in agriculture and its comprehensibility. Because it deals with living organisms as we actually meet them, and not with remote unknowable abstractions, it is equally well suited for theoretical and practical work; it therefore joins theory and practice in an organic whole. This makes Michurinism an invaluable theory under any political system, but under a Soviet system it has an added significance.

Though the Soviet Union as a whole is still in the socialist stage of society, the features of a higher stage are already emerging. This new stage is communism. The difference between these two stages is summed up in the well-known slogans: socialism—" from each according to his ability, to each according to his work "; communism—" from each according to his ability, to each according to his needs."

It is obvious that the transition from socialism to communism demands a great all-round increase in productivity. But it is equally obvious that increased productivity alone is not enough. Capitalism can and does increase productivity per man and, in agriculture, per acre: the result is economic crises, unemployment and war. The reformers of capitalism seek to avoid this by introducing a " planned economy ": if successful this accelerates the increase in productivity but still can only intensify the crises. The new feature, which makes its appearance only after a socialist revolution, in which the workers assume power and become the ruling class, is that the increase in productivity benefits the workers. This leads to an entirely different attitude to work, which is no longer seen as the curse of Adam but as the source of all benefits. The mechanic is still a mechanic, but not a "mere mechanic," the peasant is still a peasant but not a "rude peasant." This is the beginning of the process of raising the dignity of labour and of wiping out the distinction between manual and mental work. The result of this process is communist society, in which every man and woman has reason to be proud of their contribution to the general good. What particularly concerns us, in studying Michurinism, is that in the building of communism everybody can take part in the *increase* of productivity.

Socialism is bound to defeat capitalism and communism is bound to emerge from socialism, but this great historical process is not automatic. It proceeds through the conscious activity of people, working people, guided by the theory of Marxism. Communist Parties are organizations of politically conscious working people engaged in the struggle for socialism and communism.

In the building of communism out of socialism, the Communist Party of the Soviet Union has its particular part to play. It has to provide leadership of a special kind. Its members have, in the course of their daily work—as engineers, agronomists, tractor drivers, stockmen or whatever they are—to strengthen the new, emerging features of communism and to combat the old, dying features of capitalism. The process which they lead is not unconscious, but equally it is not artificial: it is the natural line of development of socialist society. Nor are communists a "super-élite," governing society but not themselves engaged in its mundane activities.

This last point is worth more than casual attention. There is a very close parallel between the idea of genes in biology and the political idea of an élite, a "chosen" ruling class. And it is characteristic of the propagandists of Mendel-Morganism that they fall into both errors simultaneously. The two errors have a common origin—contempt of labour.

In a society where success is measured by the number of people whose labour one can control and in which money is sought as a means to power, labour is too often seen in an entirely wrong light. Labour is seen as an activity for "the common and vulgar people," not for "noble persons . . . to whom the charge of Government is committed." This return by the bourgeoisie to ideas of an earlier epoch is in itself an interesting feature of the general crisis of capitalism, but for the biologist its most fascinating aspect is the way it has been incorporated in Mendel-Morganism. The genes are an image of the ruling class as it sees itself.

It is a very human failing to see a mote in our brother's eye and miss the beam in our own. Any sixth form schoolboy can correctly explain that Greek science came to an end because it developed in a slave society in which manual labour was held in contempt. But even eminent biologists in capitalist countries cannot see that their own science stands in danger of the same fate and for the same reason.

The converse is also true. A science which recognizes labour as the ultimate source of all progress can never end in sterility and must come closer to the truth. This is a very important principle for everybody who is interested in technical and scientific progress, especially to-day when the world is divided between socialism and capitalism. In the socialist half the restrictive and distorting ideas of a dying ruling class are disappearing and a truer science is emerging. A close study of that science may not be the highroad to official honours and power, but it is a most valuable guide to a deeper understanding of nature and of man.

In the light of these considerations it is clear that the Communist Party of the Soviet Union would be failing in its duty if it had not taken a close interest in the fight between Michurinism and Mendel-Morganism. But it would have fallen into an even worse error if it had taken on itself the task of deciding between them and arbitrarily imposing its choice on Soviet biologists and agriculturists. To do this would defeat the main aim of the Communist Party—the building of communism. This aim imposes an imperative necessity—the agriculturists and biologists must decide for themselves. In making their own decision they strengthened their theory and themselves: the imposition of a decision "from above" would have weakened both the biologists and their theory.

Communists in the Soviet Union have been involved in the struggle between Michurinism and Mendel-Morganism, on both sides. So far as the writer is aware, no communist Soviet biologist (and probably no non-communist) has declared himself a supporter of

Mendel-Morganism, but some have failed to see that the conflict was irreconcilable and have therefore adopted a position which in fact, though not necessarily in intention, supported Mendel-Morganism. This was the position of the present writer in 1947; it may interest biologists to learn that a major factor in changing his ideas was the necessity, arising from plant breeding work, of examining closely the current Mendel-Morganist theories of hybrid vigour.

As the aim of building communism forbade any imposition of Michurinism, the chief tactic which Soviet communists used was the stimulation of controversy. This open controversy inevitably resulted in the victory of Michurinism, for as already mentioned, Mendel-Morganism cannot survive a thorough scientific examination. Mendel-Morganists are much happier when controversy is suppressed or confined within the framework of their own theory.

The part played by vigorous controversy in settling the course of biological science in the Soviet Union is a particular case of the operation of criticism and self-criticism. The late A. A. Zhdanov regarded criticism and self-criticism as the main force behind the evolution of socialism into communism. The charge that the Soviet Government has tried to suppress controversy and impose its own views is a particularly stupid one. A glance at the facts refutes it. It would be a little more difficult to answer an accusation that they stimulate controversy for its own sake. This accusation is unlikely to be made, for it does not fit the false propagandist picture of Soviet Communism as the enemy of freedom.

In his article " Concerning Marxism in Linguistics " in *Pravda,* 1950, J. V. Stalin wrote :—

" It is generally recognized that no science can develop and flourish without a battle of opinions, without freedom of criticism." Referring to the activities of the " disciples " of N. Y. Marr, he goes on :

> " But this generally recognized rule was ignored and flouted in the most unceremonious fashion. There arose a close group of infallible leaders, who, having secured themselves against any possible criticism, became a law unto themselves and did whatever they pleased."

Stalin then refers to a particular example of this and states his attitude to it. " If I were not convinced of the integrity of Comrade Meshchaninov and the other linguistic leaders, I would say that such conduct is tantamount to sabotage." To use a favourite phrase of Stalin's, " that is clear, one would think."

Even in a polyglot country like the U.S.S.R., the ordinary people are not continually making use of the science of linguistics. In this science it was, therefore, possible for a clique to suppress criticism for a time. The same appeared to be true for a time in the field of musical composition. But it is not true of biology. Very nearly half of the Soviet people still work in agriculture and have set themselves the aim of improving agricultural output by their own efforts. Consequently any attempt to ignore or suppress controversy was bound to fail. It could only make the controversy all the sharper.

The last stronghold of Mendel-Morganism in the Soviet Union was the Universities. This is what we might expect, for universities often tend to be somewhat remote from everyday life and work. The survival of Mendel-Morganism in universities, after it had been discarded by agriculturists, created a position where a theory was being taught which the students would have to unlearn when they went out to their jobs—a theory which practically everybody outside the universities, and not a few inside them, believed to be false. The now famous session of the Lenin Academy in August, 1948, brought this position into the open and, especially, to the attention of the Academy of Sciences of the U.S.S.R. The latter body met, discussed the matter thoroughly and decided to change the position, in favour of Michurinism. It was its job to decide one way or the other and it decided.

The whole historical process of the victory of Michurinist biology started with the aid given by the new Soviet Government to Michurin himself, immediately after the Revolution. It ended in 1948, some 30 years later. From start to finish it was essentially a democratic process, in which the important decisions were made by biologists and agriculturists themselves. The Communist Party played its part, but not as a body standing apart, directing from above, but mainly by communist biologists and agriculturists taking part in the struggle alongside and hand-in-hand with their non-party colleagues. T. D. Lysenko is, of course, the outstanding example of these non-party workers.

The Mendel-Morganist propagandists like J. Huxley and C. D. Darlington who denounce this process as the "intervention of political bodies in biology" are really denouncing democracy. "Democracy is a fine thing," these propagandists are in fact saying, "but not in biology. *We* look after biology."

Coming nearer home, we can observe the same divergence of views opening up in capitalist countries. The universities teach a more and more abstract biology. Graduates are turned out who know less and less about plants and animals, more and more about genes, enzymes, quanta, clines, variances, hormones, etc., etc. They are fairly well equipped to teach other students about genes, enzymes, etc., but not to cope with practical problems. Their real education begins only after they graduate.

The resulting gap between theory and practice is perhaps seen most clearly in stock breeding. Mendel-Morganism is a dead letter as far as the best English stock-breeders are concerned, yet they will stand comparison with any in the world. The close parallel between the methods and achievements of English and Soviet stock-breeders suggests that the English breeders would take to Michurinism as readily as their Soviet counterparts if they got the chance. The same is true in almost all fields of human work and the resulting community of outlook would be a most powerful influence for peace.

It would also be the end of Mendel-Morganism. This is the basic reason why a handful of Mendel-Morganists in Britain and in America have set themselves the task of fomenting hatred of everything Soviet. In their determination to maintain their own positions they have thrown aside respect for truth, for science and for humanity. It matters nothing to them that a substantial part (radiation genetics) of their own science has been enlisted for atomic warfare, so that the atom-maniacs can work their vengeance not only on the people who have the courage to oppose them, but also on their children and their children's children.

But they have over-reached themselves. Their propaganda has so sickened their colleagues as actually to strengthen the appeal of Michurinism. True, they have succeeded momentarily in repressing scientific discussion and controversy about Michurinism; this is a sign of the sickness of biology in capitalist countries. Given peace, the sickness will pass away.

In the colonial and semi-colonial countries of the capitalist world, the seamy side of imperialism is better known. Where a native intelligentsia is arising it is turning away from imperialist ideology. One of the signs of this healthier trend is the closer attention their agriculturists pay to Michurinism.

5

MICHURINISM AND PHILOSOPHY

Many biologists, including some who feel the appeal of Michurinism, have been misled into thinking that Michurinism is an offshoot of Marxism. This leads to a more or less clearly expressed opinion that accepting Michurinism means accepting Marxism. This is not true. Michurinism is an experimental science and its theories and hypotheses are to be checked by appeal to experiment and observation and tested in practice.

Nevertheless, philosophy, both in the sense of a theory of knowledge and in the sense of a world-outlook does play an important role in the controversy. This is because Mendel-Morganism, the other protagonist in the controversy, has its concealed basis in a dead, mediæval philosophy. That particular philosophy, scholasticism, is dead in the sense that it is no longer capable of development. It still has an influence on biological science, the influence of a dead weight, a useless and even harmful top-hamper of ideas which will have to be discarded completely before biologists can achieve anything like the freedom enjoyed by their colleagues in the physical sciences. It will not be discarded until biologists become aware of its existence. This requires that biologists should pay some attention to philosophy.

It is a striking historical fact that a great many biologists are not prepared to think about philosophy. The result is that they are left without any defence against the decadent outlook of a dying ruling class. A full examination of the reasons for this contempt of philosophy lies outside the scope of this pamphlet. Briefly, we may put it thus: Marxism is the only philosophy which makes any strong appeal to biologists, but when they turn towards it they meet a barrage of propaganda from the press and other ephemeral publications and of misrepresentation in the more serious "official" works on philosophy. Many fail to break through this barrage and as the other philosophies seem to be involved in arguments which do not concern biologists, they decide to do without philosophy altogether. The paradoxical position is reached that many young biologists work for three years to get the degree of Doctor of Philosophy and, having got it, would feel insulted if anybody called them a philosopher.

The reaction of most biologists to Mendel-Morganism seems to be that they feel something is wrong, but cannot quite put their finger on it. Mendel-Morganism and its genes are regarded as something to be kept out of sight, in a special compartment. If they are referred to, it is with a special expression, not unlike that worn when referring to religion.

The reluctance to accept Mendel-Morganism is a healthy sign, but the inability or unwillingness to examine its unscientific basis is not. Because Mendel-Morganism still holds sway in the study of heredity in our Universities, our biology is suffering a grave handicap. No biologist can afford to ignore heredity and evolution.

While almost any philosophy worthy of the name could expose the fallacies of Mendel-Morganism, it was left for Marxism to do so. The main line of propaganda against Marxism is that it is a restriction of one's personal and intellectual freedom. This example of the work of Marxists shows that the very opposite is true: Marxism has removed a restriction on the freedom of thought of biologists.

In developing their science, Michurinists make great use of Marxist philosophy. They direct their attention to processes of change and development, refuse to consider parts or processes in isolation from each other, seek the contradictions which provide the driving force of evolution and development. They use Marxism as a theory of knowledge to guide them in building their theory of biology. But the acid test of their theory of biology is not whether it is consistent with Marxism, but whether it is consistent with nature.

Being guided by Marxism, Michurinists may also take pride in the fact that their work assists in the development of Marxism, which is not, as its opponents would like us to believe, an ossified dogma, but a living, developing philosophy. Like science, Marxism grows and develops by being put to work. The only way to develop an understanding of Marxism is to use it. This principle can be verified by noting the howlers perpetrated by those Mendel-Morganists who have ventured to discuss this aspect of Michurinism.

Let us first of all put the jewel quoted from C. D. Darlington on p. 10 back into its setting:—

> "To Marx, heredity was not part of the materialist interpretation because it was immaterial. When science put heredity on a material basis—and with it the basis of class distinction—Marxism was already petrified. We can see therefore how fatal an uncontrolled development of science might be to a political system ostensibly

founded on science. To use the Marxist phrase, we can see how the internal contradiction developed in political Marxism."

Note the pretended familiarity with Marxism in the last sentence and then recall that according to Marxism the certain effect of an internal contradiction is not petrifaction but development. Look at the first sentence: recall that Marx refused to separate even thought from matter that thinks. How on earth then could he regard heredity as part of anything but "the materialist interpretation," especially when he would not admit any other interpretation? The "material basis" of heredity for C. D. Darlington means genes, which are about as material as the soul. The suggestion that the genes, not such mundane matters as wealth and brute force, are the basis of class distinction is not merely absurd, it is absurd in a characteristic, Mendel-Morganist way. The operation of biological inheritance in human society is closely interwoven with the operation of other kinds of inheritance. But to recognize this would spoil the formal elegance of Mendel-Morganism and so it must be ignored. Finally we have the easy but completely fallacious assumption that there could be an "uncontrolled development of science."

J. Huxley's understanding of Marxism is on about the same level as this, but unfortunately he lacks C. D. Darlington's special gift of compressing his errors. In this extract from his book *Soviet Genetics* he puts his foot in it with more than his usual grace.

"It has puzzled many observers to note that, in the genetics controversy, the official Soviet scientists have abandoned one element in orthodox Marxism, namely *the principle that advance is effected through the reconciliation of opposites . . . .*" (my italics, J. F.).

Huxley may have invented this " principle " himself or copied it from some hack compendium, but whichever it was, it has nothing to do with Marxism. It is the *irreconcilable* struggle of opposites which is the driving force of development.

As Michurinism develops, it will doubtless raise many finer problems of philosophical interest. Even in its present, youthful form it presents a rich field for students of philosophy. Such points will not be pursued in this pamphlet. It is much better to keep clearly in our minds the simple, but supremely important fact, that Mendel-Morganism is basically scholastic while Michurinism has shown how to avoid scholasticism in biology. Mendel-Morganism therefore reverses the general trend of modern biology; it puts the clock back. Michurinism continues the healthy development of modern biology; the future belongs to the Michurinists.

6

MICHURINISM AND US

In the preceding parts of this pamphlet, an attempt has been made to set out the issues involved in the genetics controversy. It is to be hoped that the reader has been able to catch some of the excitement of those issues and the way they were fought out. But the controversy is more than an interesting or exciting tussle. It is part of the tremendous struggle which is shaking the whole world to-day. That struggle is between the forces of progress and the forces of reaction. The word progress is used here in the sense in which one speaks, for example, of a progressive farmer; we do not mean that he votes Labour or believes in proportional representation, but that he is continually improving his farming.

A progressive farm can be a lesson in world history. Satisfying work, which makes the farmer think about and improve his methods, leads to increasing output per acre and per man. Continued progress not only gives increasing satisfaction with a good job well done, but also gives more leisure for recreation and culture. But there is a snag. Capitalist crises, which hit agriculture first, stop and then reverse the process. Productivity per acre goes down and productivity per man can only be increased at the expense of leisure.

Neither in agriculture nor in industry can practical men be persuaded that limits of progress are already in sight. They know too well how many problems remain to be solved. They know, too, that those problems can be solved and will in their turn generate new problems, new possibilities of advance. Their outlook is therefore essentially optimistic. When the modern Malthusians come along and announce that the world's population is increasing too fast to be fed (as if all people do for food is to sit with their mouths open waiting for it to drop in), the practical agriculturist is apt to reply in very short words, often Anglo-Saxon words. Any particular Malthusian, or any kind of misanthropic prophet, is soon discredited. Why, then, are they so thick on the ground to-day? Surely it is because they pretend to give some sort of scientific justification for the obvious failure of capitalism.

V. Gordon Childe has put forward a view of man's history as a series of revolutionary advances in productivity. It is difficult to avoid the conclusion that the world now stands on the threshold of another such advance. The few people —" they toil not, neither do they spin "—whose interests are vested in the dying order, are the forces of reaction. It is in their interest to announce that this or that problem is insoluble, that this or that process is random and therefore uncontrollable.

Now this is exactly the assertion that Mendel-Morganism makes about the direction of hereditary changes. Whatever the intention of its adherents, the theory in fact serves the interests of the forces of reaction. It is not surprising, therefore, that the daily press—and the high- and middle-brow reviews, which those forces control—came out so emphatically on the side of Mendel-Morganism. Nor is it surprising that in the farming and horticultural journals there is support for Michurinism.

When we approach the controversy in this way, we see that its outcome affects every one of us. We see that the victory of the more fertile, more productive, less restrictive side is an issue which we must not only hope for, but must work for.

How can we do this?

The first thing is to get our bearings. The controversy is not about some abstract issue like whether probability is objective or subjective: it is about our daily bread. It is an engagement in the ceaseless struggle between progress and reaction. Therefore we cannot expect to have it explained "impartially" by somebody standing outside it. There is nobody who stands outside it. And if anybody claims that he is disinterested in it and that his account is impartial, we must suspect either his honesty or his competence.

Once one has realized the depth and importance of the basic issues of the two sides in the genetic controversy, it is easy to understand why the controversy rages so furiously. In particular the terms like "clerical," "scholastic" and "reactionary" used by the Michurinists about Mendel-Morganism are seen not as mere abuse, but as critically descriptive terms used in an exact sense. For example, it was no accident that Mendel was a Catholic priest, trained for the church. On the contrary, his training in Thomist philosophy must have determined his interpretation of his data—to say nothing of his sophistication of the data. It was no accident that his attempt in 1865 to re-introduce scholasticism into biology should fail. Biology was just awakening to the possibilities opened by Darwin's expulsion of scholasticism. Mendelism had more success in 1900, a date which also marks the ascendance of monopoly capitalism (imperialism in Hobson's and in Lenin's sense). The *entrepreneur* who built his enterprise on his own knowledge of the work it did was superseded by the finance capitalist. There is more than an accident of chronology here.

The first thing, then, that we can see about the genetics controversy is that it is one aspect of an unceasing, irreconcilable struggle between progress and reaction. Practical improvers will always struggle against restrictive ideas handed down to them from on high. Capitalists in XVIIth century England struggled against the restrictions of feudalism and ultimately fought and defeated them. The issues in the genetics controversy are not to be settled by military struggle, but neither are they to be settled without a struggle.

In approaching that struggle, we have to decide on which side we stand and evaluate the contributions of both sides accordingly. Until this has been done it is extremely difficult to approach the factual and experimental results in anything like a scientific spirit. Again, this can be verified by studying Mendel-Morganist propaganda. We find quite distinguished scientists making blunders which would disgrace a schoolboy.

Let us take the case of training winter wheats to change their heredity to that of a spring wheat. We saw on p. 22 that the central feature of the treatment was the change of conditions near the end of the vernalization phase. C. D. Darlington's (1947) version of this is:—" He (Lysenko) can vernalize his wheat once and all succeeding generations will be born ready vernalized." This has the merit of brevity: it compresses two errors into one short sentence. The greater error is the omission of anything to distinguish ordinary vernalization from " training." According to Lysenko, he could " vernalize his wheat " until the crack of doom and its offspring would still need vernalizing. The minor error is that Lysenko does not claim to bring about the change in one generation.

On the same question the American geneticist T. M. Sonneborn (1950) goes to more trouble to demonstrate his failure to understand either the principle or the technique. On the principle, he states the Michurinist (save the mark) position thus:

> " When the traits of a plant are modified by subjection to a particular environmental treatment and, after several generations of treatment, plants show the new traits *without requiring the environmental treatment,* it is concluded that the effects of the treatment have become hereditary " (my italics, J. F.).

As the whole point of Michurinist control of hereditary changes is to make the plant *require* the environmental treatment, Sonneborn's exposition can hardly be called brilliant. In case anybody is left in any doubt about whether Sonneborn has inverted the Michurinist statement, here is his account of the training of winter wheat into spring wheat:

> " Lysenko claims that, after a few generations in which vernalization treatment was applied to winter wheat, he ended up with wheats that did not require the vernalization treatment. He maintains this evidence demonstrates that the effects of the vernalization treatment have become inherited, winter wheat being transformed into spring wheat."

This is from his address as retiring President of the

American Society of Naturalists, delivered on December 30th, 1949: it would have been more appropriate to Hogmanay.

J. Huxley confesses that he does not understand the principle (he actually says that the reason is "not apparent to western geneticists," but this is an unnecessary slur on his colleagues) and goes on to assert quite definitely that the results observed are due to selection. "No data," he says (p. 72 *op. cit.*) "are available as to the variability in behaviour of the strains when untreated." In fact V. N. Stoletov had shown quite adequately in 1948 that selection of the occasional late ears produced by spring-sown winter wheats does not lead to the production of a spring variety. This is also evidence against the explanation which Huxley attributes to E. Ashby, according to which the effect is a result of partial vernalization of seed ripening in a late ear.

There is no need to assume that these distinguished gentlemen are "whited sepulchres." They are simply blinded by prejudice. In the notorious B.B.C. broadcast by J. B. S. Haldane, C. D. Darlington, S. C. Harland and R. A. Fisher, it was Haldane who was prepared to examine the evidence, while at the other extreme was R. A. Fisher who realized exactly what was wanted and supplied it. He made no attempt whatever to examine any experimental data but produced this: "The reward he (Lysenko) is so eagerly grasping is power, power for himself, power to threaten, power to torture, power to kill."

It is quite easy to see why that sort of rubbish should influence most people in favour of Michurinism, yet there is a logic behind it which compels a curious, reluctant admiration. After all, if one supposes that Michurinism has in any way been imposed on Russian agriculturists and biologists by a tyranny, one might as well go the whole hog. And equally, if one wants to pretend that science should stand apart from these mundane matters, one might as well ignore the scientific aspect of the controversy altogether. This is the point J. Huxley keeps trying to make, when he insists that the scientific issue is not the main one, though he cannot bring himself to ignore it.

The truth is, of course, that science and progress are inseparable. If the attempt is made to separate them, science suffers to the measure that the attempt succeeds.

If we want to avoid falling into the same sort of errors as those just illustrated, we have to make a different approach to the Michurinists. We have first to understand that they are trying to restore and strengthen the connection between biological science and technical progress. Secondly, we have to make ourselves more familiar with the experiments they do, so that their generalizations become more concrete, less abstract in their meaning for us. If we try to understand their generalizations in terms of experiments arranged so that chromosome variation is the decisive factor, we are trying to fit them to the wrong context. This was another error the present writer made in 1947.

T. D. Lysenko's views on colchicine are instructive in this respect. Criticizing the drastic chemical and physical methods used by Mendel-Morganists to induce hereditary changes in living organisms, he says: " By treating plants with a very powerful poison, colchicine, and other torturing applications they mutilate plants" (quoted from Huxley, *op. cit.*). The point of this criticism is that such methods are on a par with trying to repair a watch by banging it on the floor, or with smashing the triangle in snooker. Success in either case is a fluke. It is not, as we have seen, surprising that Huxley should miss the point. It is, however, rather surprising that he should quote it as an " example of Lysenko's scientific illiteracy," on the grounds that treatment with colchicine " in no way prevents the plant from exercising any of its normal functions." Anybody who has either used colchicine, or read even the few basic papers about it, knows that Lysenko is perfectly right in calling it a powerful poison and in saying that it mutilates plants. If anybody's illiteracy has been demonstrated here, it is not Lysenko's.

Two other cases may be quoted to show both the usefulness and fertility of Michurinist principles and how easy it is to miss the point if we keep to the scholastic mode of thought imposed by Mendel-Morganism.

T. D. Lysenko insists that sexual fertilization is a process of assimilation. Mendel-Morganists on the other hand are so hypnotized by their view of chromosomes as the special material of heredity that they insist that, genetically, the fusion of the male and female nuclei is the essence of fertilization. Yet Lysenko's view is a very profitable one to keep in mind when investigating pollination in the flowering plants. It may also throw an entirely new light on some puzzling aspects of the inheritance of blood groups and " individual " antigens in animals.

The other example is Lysenko's view that members of the same species do not compete with each other, but on the contrary, provide each other with mutual aid; members of different species may compete with or assist each other. Mendel-Morganists, such as J. Huxley, strenuously deny this. A farmer on the other hand will recognize it as a general statement embracing his rule that the best defence against weeds is a good crop. Individual plants of wheat, for example, are helpless against weeds: crowded together, they can suppress the weeds and yield a good crop. The aim of the forester, to get the canopy of tree tops closed as quickly as possible, is another special case. Lysenko, by a penetrating, though simple, analysis induced the general principle of mutual aid within a species, and not only devised new methods of applying it in agriculture and forestry but exposed the fallacy of the Malthusianism in Darwin's selection theory. This is a particularly clear instance of the solution of practical problems bringing a basic theoretical advance.

One reason why some Mendel-Morganists have failed to understand mutual aid within a species is that they keep their knowledge in separate pigeon holes and strictly observe the rule that only one pigeon hole must be open at any time. If this view was presented to them to be filed under "ecology" they would probably see its reasonableness. But when it comes with two labels, "ecology" *and* "evolution," they are lost.

If we can do these two things (recognize the position of the two sides in relation to our own: understand what the Michurinists are saying, not merely what we think they might be talking about) then we shall be in a position to begin to use Michurinism. Only then shall we grasp its principles firmly.

By " using Michurinism " is meant applying it to our own problems. The repetition of Russian experiments is a laudable and desirable activity. In the writer's opinion, however, we are likely to travel further and faster if we apply Michurinism in fields with which we are ourselves familiar. No doubt we shall make mistakes, but even this is better than pretending infallibility. The explanation of the function of the chromosomes given earlier (pp. 23-29) is an attempt to do this; the central clue is given by Lysenko. If the explanation is correct, it enables us to go forward from the position reached by Mendelian experimental work, discarding scholastic interpretations and misdirections.

For example, a problem which Mendel-Morganism has completely failed to solve is this: if we have two true-breeding lines how can we predict the performance of a hybrid between them? The solution of this problem is basic to the breeding of cross-breeding plants and animals and to the practical utilization of mutations. We may simplify the problem and concentrate on the case in which the two lines behave as though their differences (as displayed in a common environment) depended on a difference at one place in a pair of chromosomes—a single Mendelian difference. But even then all the Mendel-Morganists can say is that the performance of the hybrid is due to a specific, unpredictable reaction between the two factors it has received from its two parents. If, however, we consider the chromosomes in the way suggested earlier, we have a clue which leads to experimental study of the problem. Our attention is directed to the environmental conditions which the two parent lines require. These are the alternative requirements of the hybrid. If we are dealing with a normal line and a " mutant " line then the important information we need is not what the mutant line does under normal conditions, but what conditions make it behave more normally. Investigations along these lines might actually show that the direction of mutations is not only controllable, but has in fact been unwittingly controlled by Mendel-Morganists themselves.

Turning to more severely practical problems, the question of crop varieties may be raised. Here we are immediately faced with the question of defining an agricultural variety. This can be approached in two ways. We may ask how to recognize it, which is a relatively secondary matter or we may ask how it evolved, which is the primary consideration. The first approach leads to a definition of a variety in terms of what it looks like, which is again a secondary matter. It is an easy step from this to come to regard a variety as something static and unchanging and to set up the maintenance of varietal purity as an end in itself. The Michurinist's view is that a variety is a product of human activity and that the important thing about it is the job it is capable of doing. Consequently they are less concerned with maintaining the varietal purity of seed supplies than with improving them.

A seedsman once remarked to the present writer that " all this restriction of varieties and certification of seed crops is taking the fun out of the seed trade." By " fun " he meant trying to produce and sell better seeds than his rivals. Without necessarily regarding the seed trade as a philanthropic institution, one can have much sympathy with his view. The increasingly bureaucratic ordering of our lives is a result of our domination by monopoly capitalism. The result is the sapping of local and individual initiative. The opposite tendency, the encouragement of initiative, is seen in the Soviet Union and is well illustrated even in this rather small but important sector of agriculture. Collective and state farms are urged by the Michurinists to give attention to the improvement of their own seed supplies.

The same attitude is seen in the field of stockbreeding. Like the best English stockbreeders, the Michurinists refuse to separate feeding and management from hereditary improvement.

7

MICHURINISM AND THE FUTURE

If we could believe the Mendel-Morganist propagandists we should have to believe that Michurinism has no future. According to them, Soviet scientists—biologists and agriculturists—have been ordered to believe Michurinism and to revise their work accordingly, or else . . . . It is obvious that if this were true, there could be no development of Michurinism : on the contrary, it could only ossify into a rigid dogma. If we accept this view, we also have to accept the view that the Soviet Union is governed by half-wits who cannot foresee the disastrous consequences of their own dictatorial policy.

Unfortunately for the Mendel-Morganists, their view can be tested by reference to facts. The facts show that Michurinism is developing extremely rapidly, while Mendel-Morganism is not developing at all. Comparison of the reports of the 1939 and 1948 International Congresses of Genetics will show the stagnation of Mendel-Morganism. The student who was up-to-date in Mendel-Morganist genetics in 1939 would, in all important aspects, be up-to-date to-day.

The question naturally arises, will Michurinism follow the same course as Mendelism, which has worked itself out in about fifty years? Predicting the development of a science is always a very risky business, but all the indications are that the development of Michurinism will be very different. There are three main reasons for this. Firstly, Michurinism has developed out of practice, and shows every sign of maintaining its close connections with practice. This means that it will be constantly stimulated by the problems arising as agricultural technique develops. Secondly, Michurinism arose and develops in a socialist country, in which the importance of criticism is fully realized. This means that even if the Michurinists wanted to suppress criticism of their theories, they would never succeed in doing so. In fact they show no signs of repeating this mistake of their Mendel-Morganist opponents. Thirdly, Michurinism is a scientific theory. This means that, unlike Mendel-Morganism, it does not embody ideas which will ultimately stop its development.

Another question of great importance for the future of Michurinism is this: could scholastic ideas be implanted into Michurinism, as the Mendel-Morganists seek to implant them in Darwinism? If Michurinism were a purely academic pursuit, there is no doubt that this would be possible. All Michurinist experiments—and indeed any conceivable experiment—could be interpreted in terms of unmoved movers or self-determining determinants. One has merely to postulate enough kinds or enough properties of those already incorporated in the theory. But a theory which develops in this way can only tail further and further behind practice, ultimately coming to a standstill. Conversely, a theory which maintains the closest connection with practice is most unlikely to follow this course. There is plenty of evidence that the Michurinists are determined to resist any such attempt to introduce scholastic ideas into their theory, hence their distrust of viruses and hormones as "easy" explanations of the phenomena with which they deal.

It seems very probable that the next big step in biology will be the development and testing of hypotheses which put substances of great and specific activity (enzymes, hormones, viruses and even chromosomes) in their proper perspective. This will only be possible when, and to the extent that, scholasticism is expelled from biology.

The material prerequisites for the completion of the victory of scientific biology over scholasticism can be stated fairly exactly. They are the same as those required for putting science to work. The first is peace. The second is the general recognition that increasing the fruits of the earth is a wholly desirable pursuit. The third is the realization by biological scientists that if practical agriculturists often look sideways at the theories offered them, it may sometimes be the theory that is wrong. Lastly, agriculturists will have to learn the difficult lesson that theory is necessary. On these bases could be constructed a union of theory and practice, helpful to both and inimical to scholasticism. If this is not possible under capitalism, so much the worse for capitalism.

REFERENCES

V. G. Childe (1941). *Man Makes Himself,* Watts & Co. (Thinkers Library), London, pp. XIII & 242.

C. D. Darlington (1945). Nature (London) *161*: 872.

C. D. Darlington (1947). The XIXth Century and After (September issue).

Th. Dobzhansky (1950). Science *111*: 165.

R. A. Fisher (1949). British Science News *1* (10): 2.

J. Fyfe (1947). Modern Quarterly *2*: 347

W. L. Howard. (1945/6). *Luther Burbank—a victim of hero worship,* Chronica Botanica *9*: 383.

J. Huxley (1949). *Soviet genetics and world science—Lysenko and the meaning of heredity.* Chatto & Windus, London, pp. X & 245.

T. D. Lysenko (1946). *Heredity and its variability* (English translation by Th. Dobzhansky), King's Crown Press, New York, pp. v & 65.

T. D. Lysenko (1949). Address on the problems of breeding collective farm livestock.

K. Mather (1942). Nature (London) *149*: 427.

T. M. Sonneborn (1950). Science *111*: 529.

V. N. Stoletov (1948). Trudy Inst. Genetiki No. 16: 38.

To be published in **1951**

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