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SHALL WE LOSE OR KEEP OUR PLANT AND ANIMAL STOCKS

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GENETICISTS have learned to produce hereditary variations at will; they have succeeded in multiplying greatly the frequency with which mutations occur; but they have not yet brought under control the direction of these events. The future may well hold the secret of how to overcome the randomness of changes in the hereditary substratum of organisms, and we may thereby master the fashioning of plants and animals "according to plan." Until this time has arrived, however, we shall do well to keep in mind the words of William Bateson, "Variation leads; the breeder follows." The art of breeding, the art of producing new combinations of genes, rests entirely on the raw materials—the mutations—as they are provided by nature.

The uses to which new mutations and varied gene combinations may be put are manifold. Geneticists and biologists generally seek material which will aid in an analysis of development and evolution. Students of human and veterinary medicine are interested in those forms of life which are most likely to contribute to the understanding and control of disease. Breeders of livestock and of crop or ornamental plants search for types which will enhance the pleasures and profits to be derived from their stocks by heightened disease resistance, greater vigor, increased yields or particular esthetic values. The present war has dramatized the need of various industries for plant materials with specified qualities, many of which could not be obtained. Stocks which give specific and constant responses to drugs and other chemicals should have great potential value for manufacturers of pharmaceutical preparations and for assay and control laboratories. In short, for whatever purposes plants or animals are used by man, one may always expect that the value of particular types can be enhanced by improvements in their hereditary constitution. Moreover, in all fundamental work concerning animal and plant genetics, whether such investigations are concerned with the nature of the gene, linkage relations or other problems, it is of utmost importance that mutant stocks should be perpetuated for research purposes. The mutations which geneticists isolate and describe thus become at once the tools of theoretical and of applied biology, and the wise craftsman treasures his tools.

It is necessary to emphasize once again that these are tools which we can isolate and use in reshuffling the design of organisms, but which we can not create to order. This is a situation very different from that obtaining in other fields. All industrial developments are rooted in our knowledge concerning the physical and chemical nature of substances and the laws which govern their relations and interactions. This knowledge enables man to invent tools and machines and to synthesize all manner of new chemical compounds. Designs and patterns, models and formulae precede production, and these plans make it possible at any time to recreate the products of human invention. Steady and uninterrupted progress of industrial development is assured by the knowledge of raw materials and the blueprints of inventors which are handed on from generation to generation.

In contrast, the geneticist can not build with the knowledge of his predecessors unless he possesses also the necessary building stones, the mutants. Yet, all too frequently such mutants are allowed to become extinct. This is a common occurrence with research stocks after they have served the purposes of a particular investigator; it happens frequently with varieties of all kinds of plants which, with much labor and expense, had been collected in far-off countries, and with strains which had been isolated by breeders but had not given prospect of immediate returns.

Sooner or later many such extinct stocks will acquire renewed interest on account of fresh evidence. They will then be sought in vain. It is clearly impossible for the individual investigator or breeder or for any single laboratory to perpetuate stocks which are no longer used in their research program. The duty to do so rests with the groups which are interested in particular forms of animals or plants and with society at large.

This is a situation of long standing. More than 25 years ago the National Research Council was first approached to intervene with a specific program of stock maintenance. Nothing was done at that time. Later on, the maize and Drosophila-geneticists initiated group activities of their own and established stock centers from which every research worker now can be supplied, on short notice, with any particular mutation which he may need for his work.

The widespread use of maize and Drosophila in genetic research is accounted for by many advantages peculiar to these organisms, such as large size of the ear and the possibility of self- or cross-fertilization in corn, shortness of the life cycle in the fruit-fly, the great number of available mutants and relatively simple cytology of both. In the majority of other plants and animals the situation is less favorable, and this calls for even closer group cooperation and for more liberal financial support.

Hereditary variants of plants and animals belong to our most valuable natural resources. It is to be hoped that the protracted neglect of soil conservation will not be repeated in the biological domain. Only within recent years has it become acknowledged by all parties concerned that "to pass the soil on to succeeding generations as nearly unimpaired as possible is generally recognized as a worthy public purpose."[1] The basic consideration for soil conservation activities has been aptly formulated, as follows. "So far as agriculture is concerned, however, the case for saving all or most of the topsoil rests on the same principles as an accident or health insurance policy. Part of the soil may never be needed, but this is not certain. The premium required for protection against the uncertain hazards of the future should be paid, if it is not too large."[1] The purpose of such policies is to protect the interests of the immediate as well as those of the more remote future and "to be successful, an adequate soil-conservation program must serve the farmers' interest as well as the public interest."

These statements can be applied directly to the problems of preserving and maintaining stocks of plants and animals. We must look forward to the day when, to speak with Henry A. Wallace, "humanity will take as great an interest in the creation of superior forms of life as it has taken in past years in the perfection of superior forms of machinery," and if we are to be ready on that day to begin creative work on a large scale we must husband our resources now. It will be impossible, of course, to preserve each mutant and to maintain every strain and variety of all plants and animals. What deserves to be preserved must be decided by those who are in the best position to judge. But it is certainly in the interest of society that any stock should be propa-

[1] U.S.D.A. Yearbook of Agriculture, 1938.

gated which might have future value for science, agriculture or industry.

From a practical point of view the development of hybrid corn is probably the greatest contribution which genetics has made to agriculture. The production of hybrid seed involves the maintenance of many stocks which by themselves would be of relatively little value. They are preserved because it is profitable to do so. There is no doubt, however, that many stocks which in the past have been allowed to become extinct or which, in the absence of facilities for maintenance, will disappear in the future, might easily be of importance comparable to the maize stocks which are used in producing hybrid corn. It can not be emphasized too strongly that the future usefulness of many stocks and mutants can not be foreseen. The introduction of plant and animal species into regions in which they have not been cultivated previously, the widespread occurrence of infectious diseases with the consequent need of finding or creating resistant stocks, and other conditions may at any time focus the breeder's interest on types which, until then, had not been considered profitable. Post-war conditions will almost certainly create a demand for new kinds and varieties of plants and animals for agricultural and industrial use. Provisions which anticipate these and subsequent requirements should be made now.

Certain needs are with us already, however, which call for the creative ingenuity of geneticists. The accuracy and reliability of much of the work of physiologists, pharmacologists and experimental pathologists depends largely on the uniformity of response of their experimental animals to particular conditions. Few investigators will seriously defend the proposition that alley cats are proper material for quantitative tests, that dogs from city pounds are ideal experimental animals or that one rabbit equals another irrespective of its genetic constitution. Yet, the majority of university, industrial and government laboratories everywhere proceed as if genetic uniformity were of no consequence in their experiments or assays. It is the duty of geneticists to underscore the dangers of such an attitude. It is their duty also, of course, to provide the proper stocks, but the initiation of such necessarily costly undertakings must presumably wait until sufficient interest has been aroused to provide for a sound financial basis.

Some years ago the National Research Council created a "Committee on the Maintenance of Pure Genetic Strains," recently renamed "Committee on Plant and Animal Stocks," of which the writer has the honor to be chairman. The problems which have been discussed in the preceding paragraphs are of great concern to this committee and any information which has a bearing on these problems will help the committee in its work.

DISEASE OF THE HEART. II

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What has now been passed in review concerns the several structural elements of the heart—its muscle, its vascular systems, its inner and outer coverings, its valves, its nerves and ganglia. It seems odd that the first recognizable description of a disease of the heart, made by Morgagni, should depend on the last of its structural elements to be discovered—heart block depending on the severance of the auriculo-ventricular conducting system. This first discovery came late. Dates are in fact not uninteresting. Morgagni (1682–1771) was born when Newton (1642–1727) was forty years old. Newton lived on till eighty-five. Morgagni's observation, clearly, was not based on knowledge of the existence of this system, which was not described until 1903. What he observed was slowness of the pulse and attacks of epilepsy.

But that was nevertheless the first statement about a cardiac disease which is still identifiable. Next in the order of the time came suggestions about the meaning of rheumatic fever. Pitcairn began to talk about the possibility of such a relation to disease of the cardiac valves in 1788. Wells, a native of South Carolina, a loyalist who returned to England, made record of this belief of Pitcairn's in 1812, though Baillie referred to Pitcairn's teaching even earlier, in 1797. That was a year after Jenner published his book on vaccination against smallpox. In all probability it was not until 1832, however, when James Hope specified "inflammation of the internal membrane of the heart, resulting from carditis, pericarditis—especially rheumatic—from fever or from any other cause" that the influence of rheumatic fever upon the valves of the heart was put forward in clear anatomical terms. Even if Pitcairn knew that rheumatic fever affected the heart, he had not the means of ascertaining that relation clinically. To do this required that genial device introduced by Laennec in 1819. With his stethescope one could hear what was going on. It does not matter that Laennec did not identify correctly the valves which account respectively for the first and second sounds, nor had