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91. Problems of Collection, Maintenance and Evaluation of Wild Species of Cultivated Plants

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The introduction of seed samples of species of cultivated plants from their endemic habitats to other countries has been carried on in a primitive way since the earliest times. There is no country in which there are not cultivated species brought in from areas of their origin - often from far distant continents. It is well-known that the introduction of potato, maize, beans, and other species to Europe followed the discovery of the New World in about 1500 A.D. Botanical explorations and systematic studies up to this century have led to a deeper knowledge of the flora related to cultivated plants, but it is chiefly as a result of the Russian collecting expeditions in Eurasia, Asia and the New World (Regel, Vavilov) in the first quarter of the 20th century, followed by expeditions of other countries that a new period of research on the resources of wild and primitive species has been initiated.

In this article, questions related to the use of wild species as a source of genes for resistance to parasites and animal pests will be briefly considered. There are three chief problems:

(1) Collection
(2) Maintenance of collections, and
(3) The evaluation of collections.

1. Problems of collection

Until now, collections have been made by scientists who organized expeditions throughout the areas of origin of the wild species. They travelled to these areas during short periods and gathered seeds, tubers, etc. in places within the habitat which were easily accessible. Much of this material was bought in the markets of the indigenous populations. These expeditions have brought to light extremely interesting material for systematic, genetical,

cytogenetical and phytopathological (resistance) research. Nevertheless, these first expeditions were not able to collect representatives of the total variability of different species, as the points of collections by no means covered the total area of a given genus, and the places from which specimens were obtained were too scattered to allow a sufficiently comprehensive collection. It has been recognized that the reliable locating of gene centres depends chiefly on the density of the sites of collection.

Expeditions of short duration have another important drawback. It is well-known to specialists that the existence and time of appearance of plants of wild species in a certain locality during the growing season depend largely on the time of the rainy season and other factors. This applies particularly to the dry regions of the Andean countries. Thus it may well happen that in one year with an abnormal period of rainfall a certain species is not found in a place where it was located a year before.

In recent years scientists of those countries where gene centres are located have done successful work in the exploration of wild species. In South America Burkart, Cardenas, Ochoa, Parodi, Vargas and others have made very fine contributions and have been most helpful to various expeditions because of the fact that they live permanently in those regions. I should be mentioned that the very successful activity of Hawkes as a collector and systematist is due to a great extent to his long stay in Colombia.

The first conclusion to be drawn from the above observations is that the collection of wild species cannot be officiently done during the expeditions by scientists who go only for a short time to the areas of gene centres, but that plant collecting is a permanent task. Foreign scientists should work for at least two years in those areas in which they would like to collect, and national scientists of the countries involved should be given opportunities to co-operate intensively in collections.

There are other important aspects of plant collecting which make it an urgent matter to consider it as a permanent objective. Ecological studies within the regions and even in sites where

species and their sub-units occur cannot be made thoroughly without an adequate study of plant associations and climatic and edaphic conditions. It is a propitious moment to call attention to such fundamental studies, as we are commemorating the very important activity of Alexander von Humboldt in this domain a hundred years ago. It is clear that such studies would permit a more thorough knowledge of species and their varieties both from the general botanical standpoint, and also from that of plant breeding.

Closely connected with those studies are those on phytopathological conditions in regions and sites where certain genera, species and their sub-units occur. Wild species offer important gene resources for resistance to all kind of parasites. The selection for resistance in the natural habitat is of decisive importance for the evaluation of species and their components, as it is well-known that it is not a species as a whole which bears genes for resistance, but only single lines or families within it. Their detection in the endemic regions and sites will guarantee a much more effective evaluation than was possible when the discovery of resistant forms was largely accidental. In this connection, it should be realized that very often - if not generally - the habitat of the gene centre of species of cultivated plants is also the habitat of the parasites - fungous, bacterial, virus and animal - which affect their growth and health. There are definite biocoenoses of host plants and the organisms living on them. Though these relations must be studied in each case, the principles of such associations are convincing from the biological point of view. The chief parasites and pests of the potato, for example, (late blight, early blight, virus, scab, cancer, nematode), are to be found in the endemic habitat of potato species in South America, Mexico and other countries of Central America.

We can even formulate the hypothesis that the parasitic organisms have their "gene centres", the regions of most intensive specialization in common with species related to cultivated plants. This, of course, does not exclude the possibility that in countries remote from the gene centres, where the cultivation of certain species has begun, new parasites appear which are not known in the

original regions of these species. Nevertheless, the fact remeins that natural selection for resistance within the endemic area is of greatest importance, which explains the fact that the occurrence and frequency of genes for resistance is closely connected with the habitat of origin of a species.

Two contradictory phenomena must be considered. It is not the species as an entity which is resistant, as might be expected, if resistance is the outcome of natural selection. However, we must remember that wild species, in contrast to the cultivated ones, possess organs, e.g. the stolons in wild species of the potato, which enable them to escape from an annihilating epiphytic.

Further, we may find genes for resistance to parasites and pests which do not occur in the endemic area of a species, for example, the resistance to Colorado beetle in the Commersoniana group of Solanum. Nevertheless, for two reasons the "covariance" of species of origin or of related species of cultivated plants and their parasites - when compared - may be important:
(a) in plant collecting, selection for resistance should be done at the same time; (b) one might expect to find forms of wild species with "group resistance" to many physiological races, or another type of resistance which manifests itself independently from physiologic specialization ("field resistance", "incubation resistance", or "generalized type of resistance").

2. Problems of maintenance of collections

To those acquainted with the relevant problems, it is well-known that, when wild species are transferred to distant regions with very different light and temperature conditions, the maintenance of complete collections becomes very difficult, if not impossible. This is true for all species with pronounced photoperiodic, thermal and thermo-periodic reactions. As a result, many forms in a collection may be lost within a short time. On the other hand, it would be easy to maintain all the collected species and their sub-units at appropriate places within the gene centre, their original habitat.

3. Problems of evaluation of collections.

This should be done - as indicated by the above arguments - within the regions of origin of a genus. This evaluation should include systematic and genetical (cytogenetical) studies, as well as phytopathological studies and the search for resistance. This concentration of research in institutions located at appropriate places within the gene centres does not preclude the introduction of species and their sub-units to countries where they would be included as "gene stocks" in breeding programs, involving all those studies relating to the successful transfer of new desirable genes into varieties of cultivated plants.

Conclusion

Collection, maintenance and evaluation of wild species and primitive forms should be made the object of international co-operation. The three types of research noted are permanent objectives which can best be effected in institutes within the regions of the gene centres, where scientists from countries within those areas can co-operate with scientists of countries interested in the introduction of wild species and primitive forms as sources of valuable genes for resistance to parasites, climatic factors, and so on.

The best or at least a satisfactory form of international organization for such co-operation should be devised. Special consideration should be given to existing institutions. We call to your attention the Interamerican Institutes in Mexico, Colombia, Peru, Bolivia and elsewhere, organized and maintained by the Rockefeller Foundation. FAO, as the agricultural agency of the United Nations, could perhaps take the lead in organizing this important international co-operation.

The author had the opportunity to study these problems during a trip to Mexico, Peru, Bolivia and northwest Argentina in 1958. He is indepted for many valuable suggestions to Dr. John Niederhauser (Mexico), to Dr. M. Cardenas and other technicians of the countries visited, and to Dr.E.C. Stakman (St. Paul, Minnesota, U.S.A.). On the basis of 35 years of experience of research on the evaluation of wild species and primitive forms in breeding programs, the author feels justified in submitting these ideas for general discussion and as a basis for future planning.