GENETICS AND PLANT TAXONOMY

THE possibility that genetical experiments may be of direct service to plant taxonomists does not seem to be appreciated. Even among those systematic botanists who encourage such experiments, when done by geneticists for genetical purposes, there are few who consider it worth while to resort to genetical methods themselves. Yet the solution of such problems as the limits of species and phylogenetic relationships may often be assisted by the simplest methods of plant breeding, such as selection of biotypes followed by inbreeding and the crossing of biotypes.

The writer has been impressed with evidence thus secured which bears on the phylogenetic relationship between certain subspecies of Hemizonia. By inbreeding strains of one of these subspecies, forms were obtained in the third garden generation which closely resembled a distinct but related subspecies. The first would thus appear to be the older of the two subspecies in question, and this is in harmony with certain morphological differences between them. This appeals to the writer as an argument for keeping the two in one species, and the evidence from crossing supports this argument. They cross readily and are completely interfertile. The F_1 hybrid plants are intermediate and uniform in their characters, while the F_2 generation is also intermediate between the grandparental types but shows great variation in many characters. The two subspecies, therefore, must differ with respect to numerous genetic factors, but this does not necessarily remove them from the category of subspecies, while the evidence from inbreeding certainly favors such a classification.

But the service of genetics to taxonomy is not limited to the analysis of single species. Hybridization experiments involving several Linnaean species of Crepis have brought to light certain very suggestive facts bearing on their phylogeny. For example, two species supposed to be very closely related taxonomically, *C. capillaris* and *C. tectorum,* have, after repeated attempts, failed to produce hybrids that would grow beyond the cotyledon stage. On the other hand, both of these species cross readily with *C. setosa,* which is classified in a different section of the genus, and produce viable, partially fertile F_1 progeny. Such evidence as this has a direct bearing upon the phylogenetic relationships of the species concerned and must be taken into account eventually in the taxonomic treatment of the genus, if the taxonomic treatment is to be thorough and broadly useful. These are illustrative cases from the writer's own field of research; many other experiments with species hybrids have furnished data of comparable value in taxonomy. Most taxonomists may take exception to this on the ground that taxonomy recognizes as critical *only* morphological data. It must be admitted, however, that physiological similarity and dissimilarity has a bearing on phylogeny. Furthermore, when species crosses produce fertile offspring it is possible to study the inheritance of morphological characters in such hybrids.

Genetic analysis, as viewed by some botanists, must always be confined to the investigation of inheritance within single species. Thus in a recent important contribution to the science of taxonomy[1] the following statement is made: "genetic analysis can be of value taxonomically only in studying differentiation within the species itself." Here genetic analysis is considered as necessarily restricted to the experimental breeding of variads which differ only with respect to certain Mendelian factors. But genetics has been defined[2] as the science which seeks to account for the resemblances and the differences which are exhibited among organisms related by descent. One of the most significant developments in the science of genetics has been the extension of Mendelian concepts to include interspecific relationships. It may be helpful to quote here three conclusions[3] which are germane to the subject:

1. As a consequence of modern Mendelian developments, the Mendelian factors may be considered as making up a reaction system, the elements of which exhibit more or less specific relations to one another.

2. Strictly Mendelian results are to be expected only when the contrast is between factor differences within a common Mendelian reaction system as is ordinarily the case in varietal hybrids.

3. When distinct reaction systems are involved, as in species crosses, the phenomena must be viewed in the light of a contrast between systems rather than between specific factor differences, and the results obtained will depend upon the degree of mutual compatibility displayed between the specific elements of the two systems.

The above conclusions were reached as a result of actual genetic analysis of interspecific hybrids in the genus Nicotiana. The evidence thus secured is of significance in considering phylogeny in this genus, and phylogeny is recognized as the very basis of taxonomy in the above-mentioned taxonomic work.[4] The view of genetics and its very limited possibilities for service to taxonomy, as expressed by Hall and Clements, may be fairly representative of the views held by taxonomers generally, and the writer feels that it is time to call attention to the broadening

[1] Hall and Clements, "The Phylogenetic Method in Taxonomy," Carnegie Inst. Wash. Pub. No. 326, 1923, p. 10.

[2] Babcock and Clausen, "Genetics in Relation to Agriculture," N. Y., 1918.

[3] Goodspeed and Clausen, *Amer. Nat.,* 51 (1917), p. 99.

[4] Hall and Clements, *ibid.,* p. 5, *et seq.*

scope of the science of genetics and the greater possibilities which it offers.

One of the important factors contributing to progress in genetics has been the recognition of interdependence between genetics and cytology. It is only recently that the closer coordination of genetics and cytology has resulted in demonstrating that gross morphological variations may be caused by irregularities in chromosome distribution and that such irregularities may be induced in some instances by subjecting the plants to abnormally low temperatures. The hypothesis that new species with new chromosome numbers may originate through natural hybridization of existing species has been greatly strengthened by the results of recent coordinated efforts of the cytologist and the geneticist.

Regarding the allusion made by Hall and Clements[5] to Lotsy's proposed definition of a species, when they designate it as "the definition of the geneticists," so far as the writer is aware no other geneticist has proposed that gametic purity be used as a criterion for distinguishing species, and few other geneticists seem to have taken very seriously Lotsy's proposed revolutionary changes in taxonomic nomenclature. On the contrary, the general practise among geneticists is to use the specific names provided by taxonomists, and these in general are still based upon the concept of what is commonly referred to as a Linnaean species. It seems likely that most geneticists will heartily approve of the stand taken by Hall and Clements[6] in advocating the evolutionary criterion: "The evolutionary view of the species is that it is a definite phylogenetic stock, sprung from and related to similar stocks, and itself undergoing modification into a number of variads. As they have recently come from the same stock these variads are more closely related to each other than they are to those of any other species, and they represent a definite phylogenetic unit, the species, at the same time that they mark its further differentiation." It seems inevitable that the general adoption of this criterion along with the safeguards and helps of field studies and experiments, both ecological and genetical, will ultimately simplify the work of naming plants, and who more than the geneticists and plant breeders should welcome such a result?

Another aid to the recognition of interspecific relationships is found in cytology, particularly the study of the chromosomes. While this science may be looked upon as merely a phase of morphology, it is doubtful whether taxonomists recognize the promise that it holds as a means of aiding the solution of very perplexing problems in phylogeny. Thus when Hall and Clements[7] say that: "The only definite measure of the progress of evolution is the degree of morphological difference, and species necessarily share this morphological basis with other units," it is probable that they are speaking of the external morphological characters of the plant. At any rate, no reference is made by them to the characters of the chromosome group as of possible usefulness in taxonomy. This omission is doubtless justified from the viewpoint of most taxonomers on the ground that cytology is the work of specialists and is too time-consuming to be resorted to by systematists. Yet the methods of examining chromosome number and individuality in plants have been shortened and perfected in recent years, and these methods can be standardized for groups of plants so that cytological assistants could obtain dependable data on extensive series within a comparatively short time by working close to the living material. Furthermore, recent cytological investigations, especially those dealing with the series of chromosome numbers found in many plant genera, have demonstrated a definite relation between major plant groups and their chromosome groups. The chromosome group is, therefore, an indicator of phylogenetic relationship. It may seem beyond the possibility of realization in general taxonomy, but to the writer it appeals as highly desirable that certain groups at least of the higher plants should be chosen for critical investigations, combining all the means available in evolutionary taxonomy including chromosome studies and genetic analysis.

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[5] *Loc. cit.*, p. 9.

[6] *Loc. cit.*, p. 11.

[7] *Loc. cit.*, p. 11.

INVESTIGATIONS CONCERNING IMPORTED BIOLOGICAL STAINS

THE Commission on Standardization of Biological Stains has for some time been carrying on an investigation concerning domestic and imported stains. One article on the subject appeared in this journal which together with other activities of the commission has led to the impression that its members are prejudiced against imported stains. The present paper is prepared to show that any statements that may have been made are based upon sufficient evidence. Good stains and poor stains can be obtained from either domestic or foreign sources, and the principal reason why the commission has laid so much stress on the domestic articles is because of the ease with which we can cooperate with the domestic concerns in assisting them to improve their supplies.

There are certain definite objections to imported stains which apply in general to the whole supply. Some of these same objections may be raised in certain cases to American products, but they apply with particular force in the case of the foreign stains be-