EFFECTS OF HYBRIDIZATION BETWEEN DIVERGENT TYPES OF BIG BLUESTEM, *ANDROPOGON GERARDI* VITMAN, AND SAND BLUESTEM, *ANDROPOGON HALLII* HACK.

by

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INTRODUCTION

The genus *Andropogon* has long been recognized as important in the American grassland flora. Big bluestem, *A. gerardi* Vitman, is an important component in the North American tall grass prairie formation; while sand bluestem, *A. hallii* Hack., is dominant in the sandy soils farther west. Other species are present in the southern and eastern part of the United States. The genus is cosmopolitan as it is also found in Central and South America, Europe, Asia, Australia and Africa. The group as a whole is characterized by warm-season bunch grasses of tropical and subtropical affinity, some members of which are important range and pasture plants. Even the Old World andropogons which have been introduced into the Western Hemisphere have created interest. However, *A. gerardi* and *A. hallii* appear morphologically and cytologically much more closely related to each other than to any other known species.

The need for a better understanding of the interspecific relationship of *A. gerardi* and *A. hallii*, as related to the improvement of strains and varieties for propagation, has instigated this study. Investigations on breeding behavior and hybridization of selected types of these two species were started

in 1953 and continued through the growing season of 1956 at the Nebraska Agricultural Experiment Station, Lincoln, Nebraska. The effects of hybridization, inbreeding and outcrossing in the F_1 and F_2 generations of clones selected from different regions were evaluated. The results of this study are described and discussed in relation to natural hybridization and the value of such hybrids in an improvement program.

REVIEW OF LITERATURE

There are numerous references in the literature reporting studies of intergeneric and interspecific hybridization as well as interspecific and intraspecific variation. However, the word "hybrid" has come to have a very broad meaning. It is quite common to call the progeny of two plants which differ by only one gene pair, a hybrid. On the other hand, another term, "introgressive hybridization," as used by Anderson (3), refers to the transfer of germ plasm from one species to another by means of hybridization. This terminology is also in common use.

An attempt has also been made to define the term "species." Some biologists and geneticists considered the Linnean species concept as being based upon the supposition that species are separate entities unable to cross or at least unable to produce hybrids with a high degree of fertility. It is apparent that most workers consider that each species is composed of a number of individuals so much alike that it may reasonably be assumed that they have arisen from a common ancestor.

Babcock (5) in his review of the Linnean species, sometimes found bulky systems belonging to one species, which might be expediently subdivided into categories or subspecies. Sometimes, on the contrary, a Linnean species represented a very limited and comparatively small system.

In their early work, Clausen, Keck and Hiesey (12) indicate that the species concept is an abstraction. Their ecospecies correspond to, but are not always identical with, the taxonomic

species. To a limited extent, ecospecies can exchange genes. If crossed, their hybrids are partially sterile, or the second generation offspring are weak. With strong competition these plants have a small chance of survival. A small percentage of the total offspring may be vigorous and fertile but tend to be absorbed eventually into one or the other of the parental species. The genetic barriers between ecospecies or species are often produced by differences in numbers of chromosomes.

If there is no genetic but only geographic or ecologic isolation, Clausen, Keck and Hiesey (12) consider the units as ecotypes of one ecospecies. They parallel, but are not always identical with, the geographic subspecies. Ecotypes of one ecospecies may occupy a series of different habitats as do ecospecies. The only difference between the two units is the lack of a genetic barrier between ecotypes. Ecotypes differ by many genes, hybridize freely where they meet, but at a distance from the point of contact they may be quite pure.

In the light of evidence from cytology and genetics, Babcock (5) formulated some essential ideas on the subject of the species concept. He stated that subspecific groups often occupy different geographic areas; and that these groups differ more from one another in structure and interfertility or both than do the individuals within the groups, but that these subspecific groups are sometimes still connected with one another by intergrading forms. He considers this to be the necessary result of genetic variability within the species plus the influence of environmental variability, isolation, and natural selection.

In a later report of Babcock (6), which included 195 interspecific hybrid combinations in which 55 different species of Crepis were involved, important features were observed to be most striking. He found 93 percent of the intrasectional combinations produced hybrids, and 27.5 percent of these hybrids were vigorous with medium to high fertility, while only 60 percent of the intersectional combinations produced hybrids, and not one of these was both vigorous and of medium or high fertility. Although crossability alone is of little value as an index of relationship, he considered the difference between these intra- and intersectional crosses very striking and that some degree of significance must be inferred from the crossability of the parents, and the hybrid vigor and fertility of the progeny. His hybridization evidence indicated that the species included in one section are more closely related to one another than to the members of other sections. In short, his sections are groups of related species.

Dobzhansky (14) proposed to define species, not as static units, but as stages of the evolutionary process, "at which the once actually or potentially interbreeding array of forms becomes segregated into two or more separate arrays which are physiologically incapable of interbreeding."

The species, according to Hatch (18), is the concept that the taxonomist develops on the basis of his data, but with the important qualification that it is subject to modification as more data accumulate or as those data available are better understood.

Bateson (7) expresses most concisely that species are more definite entities than all other groups. He states that species cannot be strictly defined, but that they have properties which varieties have not.

The work of Harland (17) has shown that stable complexes of interrelated genes are built up within each species. When such species are crossed, the "genetic balance" is disrupted in the F_2 generation, giving a maze of abnormal and unbalanced types.

Observations on artificial hybrids of *Elymus triticoides* x *E. condensatus*, *Agropyron Parishii* x *E. condensatus* and *E. glaucus* x *E. condensatus* have led Stebbins and Walters (28) to conclude that the present system of classification is far from satisfactory as a means of portraying the natural relationship between certain species. Cytological evidence, when integrated with external morphology, gave them a much clearer insight into the true relationship among species. Although the present system is an entirely artificial one, they have not presented evidence for the construction of a new one.

The morphological characteristics of two genera of grasses, namely, *Festuca* and *Lolium*, as reviewed by Stebbins (27), led him to conclude that some of the species of different genera differ from each other no more than do different species belonging to the same genus in the Gramineae family.

The conclusion of a number of studies, especially those of Wiegand (30), Anderson and Hubricht (4), Riley (22), Anderson (2), and Heiser (19), is that introgressive hybridization has been

observed most frequently in localities which have had interference by man. It was concluded by Anderson (2) and Anderson and Hubricht (4) that two species which differ in their habitat requirements, will produce a first generation hybrid adjusted to a uniform, intermediate environment. The second generation, however, consists of individuals each of which requires its own peculiar habitat for optimum development. They concluded that hybrid swarms can be found in places where man has greatly altered natural conditions.

The work of Clausen, Keck and Hiesey (13) indicates that they are fully aware of the variability of species. Both geographically and ecologically isolated races of a species are developed through the interaction of many genes in a balanced system in harmony with their environment. They indicate that differences between natural races are quite apparent and that when crossings occur between contrasting geographic or ecologic races, the number of new forms may far exceed that in the wild population of the species. These facts are believed to be of importance in furnishing information for those engaged in plant breeding.

In central Tennessee, Rollins (23) has observed numerous hybrid populations of Lesquerella densipila x L. lescurii which are apparently completely fertile and capable of survival without back-crossing to either parent. Thus the importance of inter-specific hybridization is seen in providing a wide range of genetic material upon which natural selection can operate and give rise to new forms of plants.

A study in Europe by Turrill (29) of the genus Ajuga indicated a close morphological relationship of the two species