WILD BARLEY HYBRIDS

III. *H. marinum* × *H. pusillum*

A. B. SCHOOLER*

PARENT AND HYBRID PLANTS
Figure 2

The parent lines *H. marinum* (No. 43), *H. marinum* (No. 56-39) and *H. pusillum* (No. 53) used in the present study are shown in *A*, *C*, and *E*. The allotetraploid plants obtained from crosses between *H. marinum* and *H. pusillum* are shown in *B* and *D*.

THIS PAPER completes a study of hybrids among three species of *Hordeum*, *H. marinum*, *H. pusillum*, and *H. compressum*[5,6]. Cultivated barley, *H. vulgare*, has been found to cross more readily with interspecific hybrids or allotetraploids (produced from interspecific hybrids) than with either

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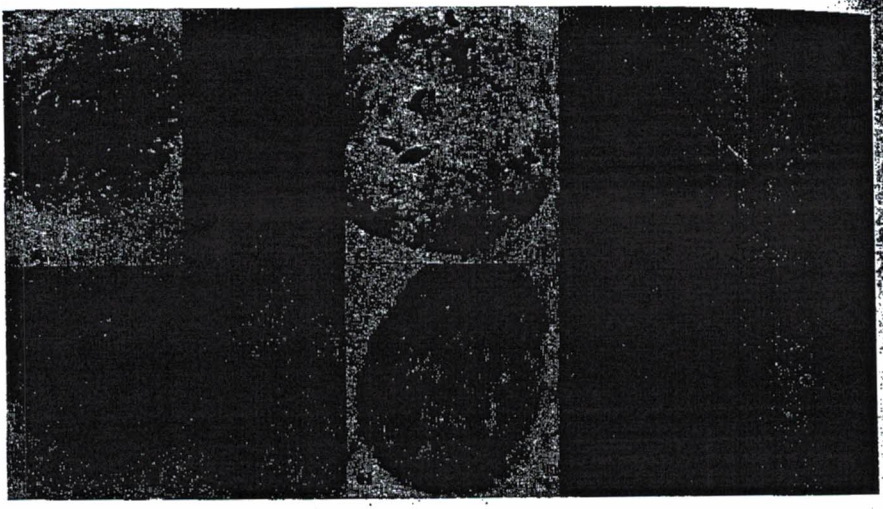


PARENTAL AND HYBRID CHROMOSOMAL BEHAVIOR

Figure 3

A and *B*—The meiotic process of the parental lines, *H. marinum* (No. 56-39) and *H. pusillum* (No. 53) showing seven pairs of chromosomes for each parent. *C* shows chromosome behavior of F_1 plants; *D*—sterile pollen of F_1 plants; *E* and *F*—F_2 diakinesis; *G*—F_2 metaphase; *H*—F_2 anaphase; *I*—F_2 tetrad; and *J*—fertile F_2 pollen.

parent of the hybrid. Several research workers [1-4], have reported on crossing studies among wild *Hordeum* species and other genera. One successful cross between *H. leporinum* × *H. vulgare* has been reported[5].

Materials and Methods

Two lines of *H. marinum* (No. 56-39 and 43) and one line of *H. pusillum* (No. 53) were obtained from Dr. G. A. Wiebe, U.S.D.A., Beltsville, Md. Each of the two lines of *H. marinum* were crossed with *H. pusillum* in the greenhouse during the spring of 1958. Several interspecific hybrids were treated with colchicine in an attempt to induce chromosome doubling. The colchicine treatment consisted of submerging the roots and crown of each plant in a 0.05 percent colchicine solution. Following this treatment, each plant was transferred to soil for further growth and development.

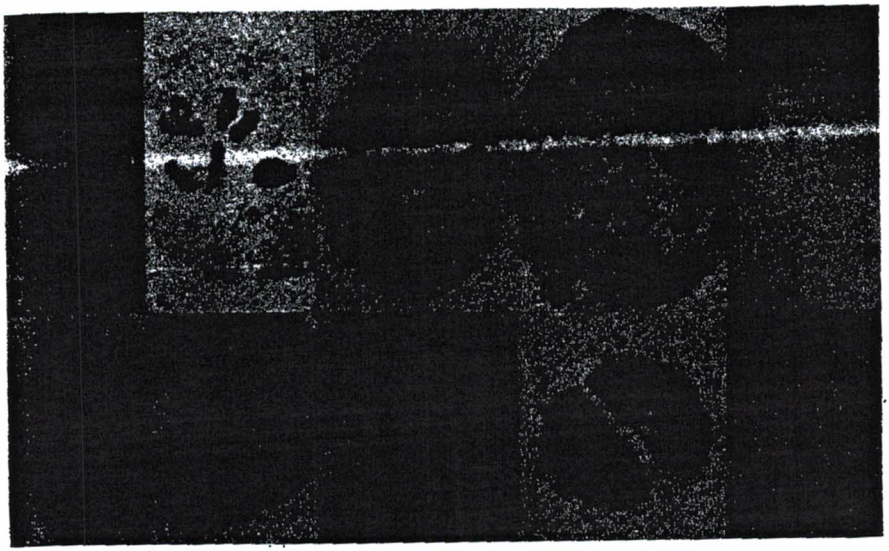
Cytological studies were conducted on pollen-mother-cells (PMC) to obtain information on chromosome numbers and behavior of both parents, the F_1 and F_2 plants. The potassium iodide technique was used for studying pollen grains. Normal pollen grains generally stain dark blue by this method.

Results

Interspecific hybrids were obtained between two lines of *H. marinum* (No. 56-39 and 43) and *H. pusillum* (No. 53) by seed formation. The F_1 seeds were extremely shriveled because of abnormal endosperm formation but germinated and produced healthy, vigorous plants. These F_1 plants were sterile, as illustrated by the staining reaction of the pollen grains (Figures 3*D* and 4*E*).

Certain of the hybrid plants were treated with colchicine by submerging the roots and crowns in a 0.05 percent solution of colchicine. A few of the colchicine treated plants produced seed. Several seeds from each cross were planted in six-inch pots. The resulting F_2 plants were examined cytologically and for plant type.

The F_2 plants from these crosses were



CHROMOSOMES OF INTERSPECIFIC HYBRIDS

Figure 4

A and *B* show the chromosomes of parent lines *H. pusillum* (No. 53) and *H. marinum* (No. 43). *C* and *D* shows the chromosome behavior of F_1 plants; *E*—sterile F_1 pollen; *F*—F_2 diakinesis; *G*—F_2 metaphase; *H*—F_2 anaphase, showing fragment; *I*—F_2 tetrad; and *J*—fertile F_2 pollen grains.

definitely taller than either parent (Figure 2) and also produced larger spikes and seeds. The F_2 (allotetraploid) plants were morphologically similar to the primary interspecific hybrid, or F_1. However, the F_2 plants were highly fertile, and produced pollen grains that stained dark blue (Figures 3*J* and 4*J*).

The meiotic process appeared normal for the parents, and each parent contained seven pairs of chromosomes (Figures 3*A* and *B*, 4*A* and *B*).

The hybrid plants contained 14 chromosomes. In this cross, seven chromosomes were apparently contributed by each parent. The hybrid plants produced a high frequency of univalent chromosomes as illustrated in Figures 3*C*, 4*C* and *D*. Such failure of chromosome pairing during diakinesis can often be expected with interspecific hybrids, and could account for the complete absence of fertility exhibited by the F_1 plants (Figures 3*D* and 4*E*).

The F_2 plants, obtained through seed formation on F_1 plants after colchicine treatment, showed nearly normal pairing and disjunction of chromosomes during the meiotic process, and were highly fertile. These results suggest that pairing in the F_2 plants was between parental chromosomes of like origin (Figures 3*E*, *F* and 4*F*). The meiotic processes following diakinesis also appeared to be quite regular as shown in Figures 3*G*, *H*, *I*, and 4*G*, *H*, *I*. A few chromosome fragments were observed at anaphase during the process of meiosis, but were less frequent as compared with the interspecific hybrids of *H. marinum* × *H. compressum*. The F_2 and F_3 progenies of the crosses between *H. marinum* and *H. pusillum* have not shown any segregation of morphological characteristics.

Discussion

Interspecific hybrids between two lines of *H. marinum* and *H. pusillum* were produced. Cytological examinations on PMC's of the F_1 plants revealed a low frequency of chromosome pairing

during the meiotic process. Subsequently, abnormal pollen grains were produced. These results provide evidence that hybrid plants were obtained. The almost complete absence of chromosome pairing observed on PMC's of the interspecific hybrid can be explained on the basis of the non-homology of parental chromosomes.

Allotetraploid plants were produced from interspecific hybrids of *H. marinum* and *H. pusillum* through the use of colchicine. These results were indicated by the observations that the F_2 plants: (a) contained 14 pairs of chromosomes which appeared to behave normally during meiosis, (b) produced normal pollen, and (c) were highly fertile. The diploid type of chromosome pairing and absence of segregation in the F_2 and F_3 progenies are supporting evidence that allotetraploids were produced. If the parental chromosomes were doubled by the use of colchicine, each pair of chromosomes would comprise homologues, and segregation for characters differentiating the parental species would not be expected.

Summary

Allotetraploid plants were produced following colchicine treatment of sterile, interspecific F_1 hybrid plants following crosses between two lines of *H. marinum* with *H. pusillum*. The allotetraploid plants are highly fertile.

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