Viable Hybrids from Matings of Chard with Beta Procumbens and B. Webbiana[1]

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The three viny species of *Beta*—*B. palellaris* Moq., *B. procumbens* Chr. Sm., and *B. webbiana* Moq. (Figure 1)—possess certain very desirable char-acters which are not known to occur in the sugar beet, *B. vulgaris* L. (1, 2) [3]. Attemps to transfer these characters to sugar beet have failed consistently, the F_1 hybrids ordinarily dying while very small seedlings. Stewart reported obtaining a single F_1 plant—sugar beet x *B. procumbens*—which produced fairly vigorous growth and from which the first and second backcross gen-erations were obtained, the sugar beet serving as the recurring parent (2) . However, the plants of the second backcross generation died while relatively small, without producing seed, bringing the series to a disappointing end.

At Fort Collins, Colorado, in 1945, chard (sometimes designated as *B. vulgaris* var. cicla (L,.) Moq.) was included in a series of matings between *B. vulgaris* and the three species of the section *Patellares* in the hope that it would be more compatible with the wild material than sugar beet had proved to be. A single flowering plant of the chard variety, Fordhook Giant, was pollinated liberally with a mixture of pollen from the three wild species. Three individual sugar beet plants were similarly pollinated. Seed harvested from the chard plant and from each of the sugar beets produced abundant F_1 seedlings which were distinctly different from the chard and sugar beet selfs.

As usual, none of the hybrids having sugar beet as a parent survived beyond the early seedling stage. However, a small percentage of those from the chard cross did survive and eventually grew to a height of several feet. Young F_1 seedlings representative of the outcome of the four hybrid-izations are depicted in Figure 2. Chard hybrids at a later stage are shown in Figure 3. All of the chard hybrids appeared to be pollen sterile, but several produced seeds, similar to those described by Stewart (2) , following pollination by *B. vulgaris.* Several seedlings representing the first backcross were obtained from those seeds. In general they were extrmely weak, most of them died while very small, and no concrete results were obtained.

Although the 1945 trial failed to produce tangible results, it stimulated interest in this approach to the problem. Subsequently, attempts were made to repeat the process, using *B. patellaris,* alone, as the pollinator. Chard material used as the included plants thought to be tetraploid as well as the ordinary diploid type. All these attempts failed to produce healthy F_1 hybrids.

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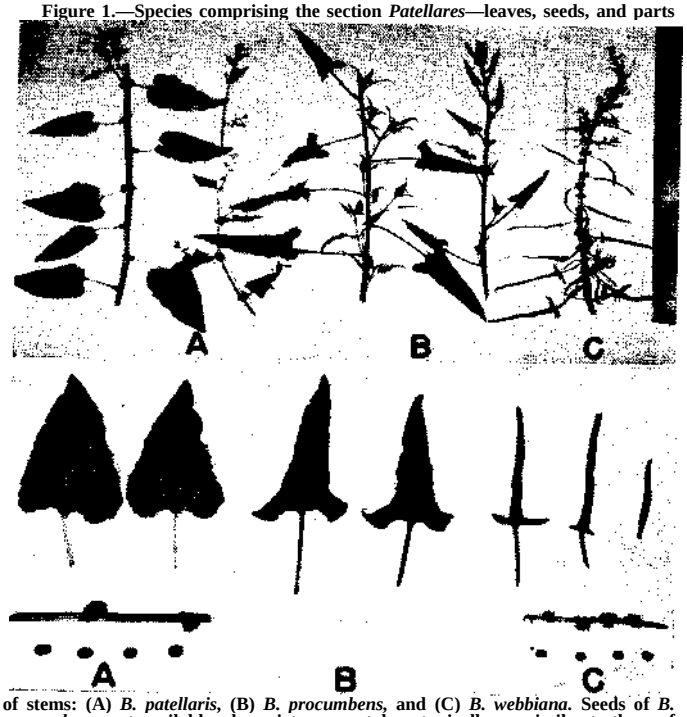
[3] Numbers in parentheses refer to literature cited.

Figure 1.—Species comprising the section *Patellares*—leaves, seeds, and parts



of stems: (A) *B. patellaris,* (B) *B. procumbens,* and (C) *B. webbiana.* Seeds of *B. procumbens,* not available when picture was taken, typically are similar to those of *B. webbiana.* Seeds of all three species are hard-walled and monogerm.

In the spring of 1953 eight matings of chard with *B. procumbens* and fifteen matings with *B. webbiana* were attempted. The same variety of chard was used as in 1945. For each mating, branches of a single chard plant and branches of one or more plants of one of the wild species were enclosed in a bag and allowed to interpollinate. The seed lots harvested from the respective chard individuals were planted in the greenhouse on August 19, 1953. Seedling emergence was practically complete by September 2, and counts made on that date (Table 1) showed that F_1 plants had been obtained from 21 of the 23 attempted matings, the total number amounting to approximately 1,035.

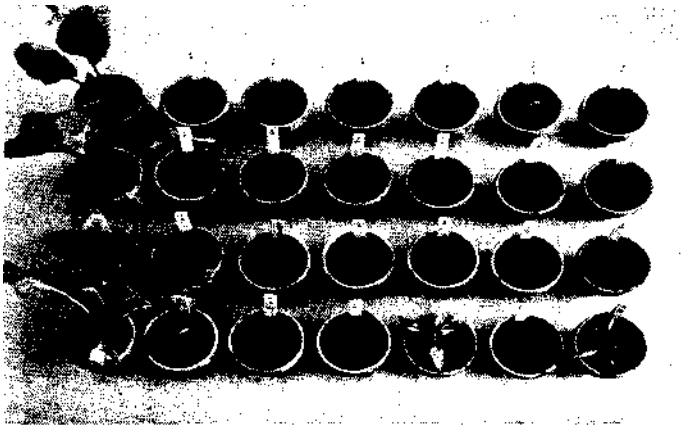


Figure 2.—F_1 seedlings from four crosses, *B. vulgaris* ♀ x species of the section *Patellares*. The upper three rows represent, respectively, three crosses having sugar beet as the ♀ parent. A sugar beet plant occurs at the left in each of those rows. The bottom row represents hybrids having chard as the ♀ parent; chard plant shown at left. The picture was taken November 29, 1945, 2 months after planting. The pots originally contained one plant each, but many of the hybrids had died before the picture was taken. Note that the only hybrids showing promise of survival are from the chard cross.

Table 1.—F_1 Hybrids Obtained from 23 Attempted Matings of Chard with 2 Species of the Section *Patellares*.[1]

	Chard ♀ x *B. procumbens*	Chard ♀ x *B. webbiana*	Total
Total No. of crosses attempted	8	15	23
F_1 seedlings emerged on or before 9/2/53:			
No. of crosses	7	14	21
No. of plants (approx.)	445	590	1,035
Healthy appearing F_1 seedlings at least 6 inches high, 1/18/54:			
No. of crosses	3	2	5
Total No. of plants	6	19	25
No. of plants flowering	1	5	6

[1] Data obtained from a partial planting of seed, August 19, 1953.

The hybrids were readily distinguishable from the chard selfs, which were discarded. As in the 1945 trial, most of the F_1 seedlings were unthrifty and died early. A small percentage of those obtained from several matings survived the lethal stage and appeared quite healthy 5 months after planting (Table 1 and Figure 4). Considerable variation was observed both in vigor and in foliage type, among these plants—even among those having

the same species as the ♂ parent. As indicated in Figures 1 and 4 the hybrids were distinctly different from either parent but tended to resemble the wild type more closely. The few which were flowering on January 18, 1954, appeared to be pollen sterile. It is interesting to note the similarity between these hybrids (Figure 4) and those obtained from the 1945 trial (Figure 3). This observation and the failure to obtain viable hybrids when *B. patellaris* was used as the only source of wild pollen indicate that this species was not a parent of any of the healthy hybrids obtained in 1945.

Figure 3.—F_1 hybrids, chard ♀ x the section *Patellares*, February 26, 1946, five months after planting. The specimen at the left was approximately 2 feet high when the picture was taken; the others were about 6 inches high.

The counts made on January 18, 1954, (Table 1) show a total of 25 F_1 plants, at least 6 inches high, classed as healthy on that date. Three different matings of chard x *B. procumbens* and two of chard x *B. webbiana* were represented among those 25 plants. Sixteen of the twenty-five were more than 1 foot high and six were flowering.

Many problems must be solved if desirable characters of the section *Patellares* are to be utilized for genetic improvement of the sugar beet. In the past the first problem—the lethal condition of the F_1 seedlings—has essentially precluded research on all others. The results reported in this paper apparently offer a means of bypassing the first serious obstacle, thus opening the way for vigorous attack on some of the others. Chard is closely related to sugar beet, crosses readily with it, and the hybrids are vigorous and fertile. Consequently, if desirable genes could be transferred successfully from the section *Patellares* to chard, presumably those genes then could be passed on to sugar beet.

Summary

Successful outcome of hybridization in 1945 and again in 1953, between chard as female parent and *Beta procumbens* and *B. webbiana* as

Figure 4.—A chard plant, at left, and F_1 hybrids representing four different matings, chard ♀ x species of the section *Patellares*. The two hybrids at the right are chard x *B. procumbens;* the other two are chard x *B. webbiana.* The picture was taken January 15, 1954, approximately 5 months after planting.

pollen sources, is reported. In the more recent work, a total of 28 attempted matings gave rise to approximately 445 and 590 F_1 plants from *B. procumbens* and *B. webbiana,* respectively. Six plants of the first group and 19 of the second were classed as healthy in January, 1954, at the age of 5 months. One plant of chard x *B. procumbens* and 5 of chard x *B. webbiana* were in flower at that time. Hybridizations with chard may afford a technique for transfer of genes from these wild species to sugar beet.

Literature Cited

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NOTE—Soon after the above article had been prepared, the roots of seedlings which had been grown for three months in soil infested with sugar beet nematode (*Heterodera schachtii* Schmidt) were washed and examined microscopically. Specimens of the female nematode were found on 29 or 30 sugar beet plants examined and on all of the 7 chard plants in the test, but were not found on any of the F_1 hybrids—chard x *B. procumbens* (2 plants) and chard x *B. webbiana* (4 plants). Most of the hybrids were small, and the results cannot be considered as conclusive, but they do suggest that the high degree of nematode resistance, known to be a characteristic of the 2 wild species, was transmitted to the hybrids.