HYBRIDIZATION OF PLANTS NATIVE TO CALIFORNIA AND BAJA CALIFORNIA IN THE GENUS *DIPLACUS*

DAVID S. VERITY

Mildred E. Mathias Botanical Garden
University of California
Los Angeles, California 90024-1606

Diplacus is a genus of about one dozen species or botanical varieties of small shrubs that are native to California and adjacent Baja California and Oregon. As members of the family Scrophulariaceae, they are close to *Mimulus*, but differ chiefly in their woody character. Known as "bush monkey-flower", they often attract attention by their abundant flowering on roadcuts or in recently burnt areas. With one exception the species are freely interfertile so that hybrids, both wild and from plants in cultivation, have long attracted the attention of horticulturists. Past workers have included Van Rensselaer (Santa Barbara Botanic Garden), McMinn (Mills College), Sexton (U.C. Davis) and Lenz (Rancho Santa Ana Botanical Garden). My work began in about 1965 and continued to 1980, with a great burst of activity during the final four years, being supported by a grant from the Elvenia J. Slosson University of California Endowment Fund for Ornamental Horticulture.

SPECIES AND VARIETIES USED IN THE PROGRAM

Diplacus longiflorus is the most common species in southern California. It is characterized by being densely pubescent, and has rather large pale orange flowers that, as in all species of the genus, are produced in pairs—one from the axil of each of the opposite leaves. It tolerates garden conditions as well as any of the others. D. l. var. *rutilus* is found in a few localities and has deep velvety red flowers. D. l. var. *calycinus* is more compact and has pale yellow flowers. It is found higher in the mountains (to 7,500 ft.) and, though not used, should provide cold hardiness to future workers. *D. aurantiacus* ssp. *australis* is similar to *D. longiflorus* but is glabrous and has slightly smaller flowers. It is found in parts of San Diego County and Baja California. With a similar distribution is *D. puniceus*, which has small red flowers and, on some of the offshore islands, grows the closely related *D. parviflorus*, which seems to be well adapted to cultivation. Two species which offer important characters to the hybrids are *D. grandiflorus*, with its extraordinarily large flowers (over 4 cm. across) and *D. clevelandii*, with its golden yellow flowers that have rounded lobes and red dots

in the throat. Hybrids with the latter species have reduced fertility which can be overcome in later generations.

METHODS USED IN BREEDING WORK

To make as rapid progress as conveniently possible, the plants were treated as annuals. Seed was sown in a greenhouse in October or November and, in most years, the seedlings (when about 2 in. tall) were moved bareroot directly into outside raised beds in February. These beds has been prepared by rototilling and fumigating with methyl bromide. The seedlings were watered and fertilized routinely until the end of June, by which time they were in full flower. When the plants were in bloom, it was often necessary to spray with malathion to control flower thrips which, if left uncontrolled, would cause the anthers to abort. Depending on the weather, the plants were watered about once every week or 10 days until the end of July, after which watering was greatly reduced.

Crosses were made, usually in mid-morning, by removing the selected pollen bearing flowers that had opened that morning and squeezing the anthers so that the pollen dropped directly onto the desired stigma. The stigmas of *Diplacus* and related genera are composed of two flattened lobes that close on contact. If they have been successfully pollinated, they remain closed, and, therefore, it is not necessary to emasculate the flower. If it were not for this characteristic, much time would have been necessary to emasculate and bag flowers, and the project would not have been possible. Each flower was tagged after pollination, and the resulting seed was collected in August and September. The pods open primarily with the fall rains, and seed collecting time is not critical. After all seed was collected, the plants were removed to make the beds ready for the following year.

GENETICALLY CONTROLLED CHARACTERISTICS

The objective of the breeding program was to develop a wide variety of plants that combined good growth habit with large well-displayed flowers in a broad spectrum of desirable colors. As the work proceeded, new traits were noted, some desirable and others not. New potentialities were revealed, particularly in bicolored flowers, that future workers can strive to reach. Some of the traits selected for are noted briefly below.

Color. As described by Van Rensselaer (1), a great diversity of flower colors beyond anything seen in the wild is soon revealed in second generation crosses. Attempts to stabilize some of these colors so that they come true from seed was successful in some

instances, while others await future work. Pure white flowers were obtained by combining traits from several near-white wild mutant individuals. An F_2 population from a cross between *D. parviflorus* and a near-white mutant of *D. longiflorus* yielded the whole range of colors seen, but not all of the more subtle shades. Included in this was a yellow that was as intense as that found in *D. clevelandii*.

Flower size. The large size of the *D. grandiflorus* flower can be recovered in a few generations, and some progenies had flowers that were seemingly larger than those in wild plants, but actual measurements were not made.

Width of petal lobes. Two species, *D. parviflorus* and *D. clevelandii*, have broad petal lobes, a characteristic considered desirable.

Margin of petal lobes. *D. longiflorus* and *D. aurantiacus* ssp. *australis* have irregular petal margins, while those of *D. clevelandii* and *D. parviflorus* are entire. In this project selection was generally for entire margins, but some very interesting flowers with irregular margins appeared. *D. grandiflorus* has each petal lobe deeply divided into two narrow segments, a character that was selected against, but could be used to develop interesting flowers.

Throat openness. The throat of *D. clevelandii* is strongly constricted within the tube, a character considered undesirable.

Flower color fading. Some red colors fade strongly in one or two days, while others do not, but no studies that I know of have been made on *Diplacus* pigments. Interesting multicolored effects can be seen on a plant with fading colors.

Nectar guide size and color. At the bottom of the throat there is usually a pair of nectar guides, which varies in width and in color from yellow to dark orange. *D. clevelandii* has a nectar guide composed of red spots, and it may be possible to develop broad red nectar guides.

Color around mouth of throat. An irregular area around the throat entrance may be colored differently from the rest of the petal. There are two patterns that are apparently genetically separately controlled—one that is diffuse and another that is very abrupt. The color of this area may be red, yellow, orange, or white. Through the manipulation of these traits, exceptionally interesting flowers can be developed.

Added flowers. Normally there is a single flower at each leaf axil. Plants have appeared that have a second or even third flower beneath the normal one, these additional flowers opening several days after the original one. This character appears only during periods when the plants are growing and blooming vigorously. By breeding from these plants, the percentages of such individuals in the progenies has been increased, but the inheritance mechanism of this character seems to be very complex.

Short internodes. The internode length varies considerably, and by selecting from individuals with very short internodes, extremely compact plants have been developed that should be useful for bedding purposes.

STATUS OF THE BREEDING PROGRAM IN 1980

At the end of the Slosson grant period in 1980, it became necessary to devote the botanical garden space to other purposes, and bed space in another part of campus was soon to be obliterated by new buildings. At this time significant results had been achieved that are briefly described below:

1. True breeding strains with large flowers in colors of red, orchid, and white had been developed.
2. Sterility barriers of the yellow strains derived from *D. clevelandii* had been overcome, and progenies with a high percentage of large yellow-flowered individuals were obtained, although some orange-flowered plants were still present.
3. True breeding strains with very small compact plants in several colors were developed.
4. Plants that have large white flowers with yellow or orange nectar guides and yellow or orange rings around the throat had been developed, although the strains were not true.
5. Plants that have large white or yellow flowers and red rings in the throat had also appeared.
6. An unusual new clear pink color was developed in a number of plants.
7. Crosses between color strains were yielding a broad diversity of color shades and combinations.

FUTURE WORK

Although time and space do not permit me to continue with this project, work on *Diplacus* breeding, selection, and propagation is continuing both by Mike Evans at Tree of Life Nursery in San Juan Capistrano and by Steve Morgan at the Botanical Garden, University of California, Riverside. Seed stored in the refrigerator since 1980 was planted in 1988 and 1989 and germination was excellent. At Riverside current work is concentrated on selfing plants to concentrate desirable characteristics, propagation, and irrigation regimes. At Tree of Life Nursery, clones have been selected, named, and are being propagated for sale. Future workers should go back to the species to develop such characteristics as increased longevity in the garden, drought and cold tolerance, and additional flower characters and colors.

LITERATURE CITED

1. Van Rensselaer, Maunsell 1944 *Diplacus* for gardens and roadside *Jour. Calif, Hort. Soc.* 5:138-143