

sults are preliminary, and that more time and study are needed if more conclusive results are to be established. Our thanks to Mr. Ron Liljedahl, who directs the horticulture program at Chabot College in Livermore, Ca., for his invaluable assistance, and the use of space at the College in which to conduct the tests. Our thanks also to our advisors, Mr. C. Baccus, Mr. S. Farwig, Mr. V. Girard; also to Mr. and Mrs. J. Robinette, and Dr. P. Fiedler.

To determine optimum planting depth, we tested six spp. from all three divisions: C. albus, C. Tolmiei, C. uniflorus; C. catalinae, C. venustus; and C. weedii. (These spp. were chosen because their ranges are relatively large, because they occupy distinctive habitats and climatic zones, and because all have been raised successfully as garden subjects by one or another grower.) Every effort was made to keep other variables, e.g., water, temperature, etc. constant, so as to accurately test one variable only, in this case the optimum planting depth for seed of Calochortus. Each sp. was planted in pots, with identical, sterilized media, at varying depths, viz., surface, $\frac{1}{4}$ ", $\frac{1}{2}$ ", 1", and 2" deep. The mix, modified from a successful media developed by Mr. C. Baccus, consisted in $\frac{2}{3}$ humus ($\frac{1}{4}$ bark, $\frac{1}{8}$ redwood compost, $\frac{1}{8}$ "orchid mix," mostly fine bark, $\frac{1}{4}$ potting mix, which includes sand, and $\frac{1}{4}$ mixed grade sand. The total sand in the mix was approximately $\frac{1}{3}$). This mix was used because it has a good track record, and combined drainage with water retention. The pots were watered twice a week until germination, and then once a week. As no known rules for watering could be drawn upon, we took the average annual precipitation during the growing season in their indigenous ranges for the spp. tested as our guide. This is higher than average for the southern spp. and lower than average for the northern. While this could skew the results, it seemed better to opt for a uniform watering schedule, especially as the use of pots is already a move away from indigenous conditions.

Horticulturalists use a rule of thumb for spp. whose optimum planting depth is unknown. It is to plant seed "2-3 times the smallest overall diameter" deep. While section Mariposa seeds are large on their flat face, about 3x4 mm, they are no larger in their "smallest overall diameter" than seeds of the other sections. In general, seeds of the genus Calochortus are about 1 mm in their "smallest overall diameter," and thus should be planted fairly shallowly, just under the surface.

The results of the test were that, for all spp.*, the $\frac{1}{4}$ " depth proved superior (*except for C. weedii, none of whose seed germinated in any of the tests. These tests will be repeated this fall for C. weedii from another seed source). All spp.* emerged at this planting depth, and did so well before some of the others. Interestingly, this held for small seed (sect. Calochortus) as much as for larger seed. Surface sown seeds germinated much later than those planted at $\frac{1}{4}$ ", in one case considerably so (2 mos.--C. albus). In two cases, surface sown seed failed to germinate (C. Tolmiei, C. Venustus). The late germination was consistent for the surface sown spp. which did germinate.

The $\frac{1}{2}$ " depth proved to be second best. Four of six spp. germinated at this depth, and three of these did so at roughly the same time as those planted at $\frac{1}{4}$ " (C. uniflorus and C. weedii did not germinate; C. Tolmiei germinated later at $\frac{1}{2}$ " than at $\frac{1}{4}$ " by $1\frac{1}{2}$ mos.). Only one sp., C. venustus, germinated at 1"; and only one at 2" (C. uniflorus).

This test is, at best, only tentative. A comprehensive test would require testing of all 6 spp. x 8 media x at least 4 watering schedules x the 5 depths=960 pots and about 15,000 seed (15/pot). This is well beyond the resources available to us (we did conduct media and watering tests separately, among others. These will be released in future volumes). Further, the tests are interrelated. It is difficult to conduct a planting depth test without knowing the optimum media and water schedule, and vice versa. Thus continued testing is required.

Nevertheless, it would seem that too deep or too shallow planting is ill-advised. The earlier germination of the seed planted at $\frac{1}{4}$ ", and to a lesser degree at $\frac{1}{2}$ ", may be vital for the success of the plant. Germination at too late a date may allow for insufficient time to grow and to form a tiny bulb, which can live over through the dormant period. This consideration may be more important in the wild, but it is not without application to Calochortus horticulture.

IV. The Horticultural History of Calochortus—4th Installment.

MacSelf, A.J., Bulb Gardening, N.Y.: Chas. Scribner's Sons, 1925. 1st ed. publ. in Unit. King.

"This genus richly deserves to occupy front rank among the choicest of bulbs for unheated greenhouses... In favored Southern (British) gardens Calochortus will succeed quite well out of doors, but in windy or otherwise unfavourable localities it is a pity to allow the beauty of the flowers to be marred by bad weather if any covering of glass is available to keep them clean and unbruised...

"...Unlike the rest of the tribe these smaller kinds which produce drooping globular blossoms prefer shade, or at any rate partial shade, but the other sections cannot have too much sun...

"Three good bulbs in a 5-inch pot will make a good show. A light, sandy loam, some peat and leaf-mould in equal proportions and a good addition of silver sand will make a suitable compost. Pots should be very well-drained, and the bulbs should be potted in October, started in a frame, removed to a sunny position (except the Globe varieties) as soon as growth appears, and thenceforward be kept liberally watered until flowering has finished, when they should be thoroughly ripened and well roasted in the sun. In October shake out, separate the offsets, which should be grown on in pans, and repot the large bulbs as before. Feeding with liquid manure during growth is permissible but must be done with cautious moderation."

This selection, which brings us into the twenties, again reflects British experience in growing Calochorti (cf. Mariposa I,4). Only California spp. are mentioned in the rest of the text (edited out; Carl Purdy as the source of the bulbs?). Yet the best spp. for cold climates like that of the Un. Kingdom are mostly from outside California. The author seems almost to be quoting the Sanders selection (Mariposa I,4) in part of his treatment: the first such derivative approach of many that I have come across. "Ripened" means, presumably, dried out during dormancy. A five inch pot is too small for section Mariposa. The use of an unheated greenhouse may be suitable for cold climates, but not warm ones: the bulbs require some chilling (with a few exceptions) to do well. The soil mix sounds reasonably good if inexact.

V. Conservation: the California Native Plant Society Inventory

The Cal. Native Plant Society has for several years published an Inventory of Rare and Endangered Vascular Plants of California. This volume has provided a valuable source for information on the shrinking ranges of many native Cal. spp., the many threats to their survival from development, ground water pumping, grazing, etc., and a ranking system which separates various categories of endangerment, from possible threats to immediate.

The 1988 ed. of the Inventory lists 23 spp. or varieties of Calochortus. Of these, 1 is presumed extinct, 2 are considered to have taxonomic validity problems, 2 are considered but rejected as "too common." Of the remaining 18, three are listed by the State of California as rare and endangered. An additional eight are considered rare and endangered by the CNPS, but, for various reasons, have not yet been listed by the State. The other seven are on the "watch list." This last contains plants which are not yet rare or endangered, but could become so given present trends.

The CNPS should be applauded for its work in collecting information on these plants, for its publishing and publicizing threats to various spp., and for its efforts at conservation. No other organization has come close

to the CNPS at documenting the assault on California Flora, and to its attempt to halt and reverse the decline of the native biosphere. As far as it goes, the Calochorti listing in the Inventory is well-considered. Nevertheless, the list is incomplete. There are many spp. and var. of Calochortus which are not in the Inventory which are either intrinsically rare or have become so due to human encroachment.

A species is intrinsically rare if its original (known) range is confined to one or a few small areas. For example, C. panamintensis (C. Nuttallii var. panamintensis) is confined to two small stands in the Panamint Mts. of SE California. This is a confined habitat indeed: one area of one county of one state. By contrast, the range of C. nuttallii var. nuttallii, the species proper, extends across parts of ten or more states. C. panamintensis is not listed in the Inventory. Other spp. or varieties which are intrinsically rare but not listed are C. clavatus var. gracilis, C. weedii var. intermedius, C. coeruleus var. fimbriatus, and C. elegans var. nanus.

Two others are rare due to the extensive expansion of human settlements into their original range. C. plummerae was listed as "common" 100 years ago (Parrish), but is now quite reduced. Unfortunately, its habitat lies in areas attractive to Los Angeles developers. Perhaps two-thirds of its known stands have been eliminated for housing. A similar fate has befallen the enchanting variety of C. weedii, var. vestus in Santa Barbara and Ventura Counties. While this variety, which some consider a separate sp., was never common, it is now much reduced due to human expansion.

VI. Species This Issue: C. eurycarpus

Range: From E Oregon through Idaho to W Montana and NW Wyoming. Disjunct population in NE Nevada.

Botany: C. eurycarpus is the most widespread of the "Nitidi" subsection of section (eu)calochortus. The flowers of this section are upright, as in the "Nudi" subsection, which differentiates them from the fairy lanterns. Unlike most of the nudi, however, the seed capsules of the Nitidi tend to remain upright.

C. eurycarpus, from An Illustrated Flora of the Pacific States, by Leroy Abrams, Ph.D., Stanford Univ. Press, 1923, p. 439.



23. Calochortus eurycarpus S. Wats.
Big-pod Mariposa. Fig. 1079.

Calochortus eurycarpus S. Wats. Bot. King Exp. 345 (1871).

Calochortus nitidus eurycarpus Hemmerson, Bull. Torrey Club 27: 256 (1900).

Stem erect, stiff 25-45 cm high. Leaves 1-2 flowered; sepals ovate-lanceolate, long acuminate, usually exceeding the petals; petals white to lavender, with a conspicuous orbicular indigo spot in the middle, 25-45 mm. long; sparsely long-villous around the small round gland, this covered with short yellow hairs completely concealing the narrow scale at the base; filaments dilated below, 10 mm. long; anthers oblong 6-8 mm. long; capsule elliptic, 20-25 mm. long, broadly winged, abruptly rounded at apex to the short beak.

Open meadows, of the Canadian Zone, Blue Mountains, eastern Oregon, to Montana and northern Nevada. Type locality: "East Humboldt Mountains, Nevada, 7,000-9,500 feet altitude."

The Nitidi have hairier petals than the nude star tulips, but not so hairy as the pussy ears. They tend to be larger than the spp. in the other subsections.

C. eurycarpus differs from the other nitidi in a variety of characters. Unlike C. longebarbatus, it is not bulbiferous. (Purdy alone claims it is, but there is no herbarium record of a bulbiferous plant, and I have yet to see any evidence in the field of leaf-axil offsets, as opposed to bulb division.) C. nitidus is tetraploid while C. eurycarpus is diploid, with

a haploid chromosome count of 10. From C. Greenei and C. Howellii it differs in range, color, and in the shape of the gland. Finally, C. persistens, alone of the Nitidi, has nodding seed capsules, while the others, including C. eurycarpus, have upright capsules. (Ownbey classifies C. lyalli as a Nitidi, but is inconsistent in his criteria for doing so. While C. lyalli is difficult to classify, it is far closer to the pussy ears than to the larger Nitidi.)

The botanical literature has differed on whether the sepals of C. eurycarpus are longer than the petals or vice versa. Purdy (1901) and Abrams claim that they are, but Ownbey states that the sepals are "usually much shorter than the petals" (1940). Field observation tends to bear out Ownbey on this point, but the sp. has an extensive enough range that there are undoubtedly individual specimens with longer sepals. The flowers are usually white with a purple blotch in the center of the petal, and yellowish hairs surrounding the gland near the base of the petal. In NE Oregon, where it is numerous, there are lilac and purple flowers as well. Purdy mentions a yellow form at Yellowstone, Wy. Purdy and Abrams describe the gland as round, while Ownbey describes it as "triangular-lunate."

HISTORY: The name of the sp. has undergone bewildering changes, making one wonder what plant various botanists are talking about. Purdy and Ownbey (1940) call the plant C. nitidus. Watson, Abrams and the later Ownbey (Vascular Plants of the Pacific Northwest 1969) call it C. eurycarpus. C. nitidus is another sp., but in some of the literature, the author is actually discussing C. eurycarpus when speaking of C. nitidus. The sp. was first described, apparently, by the well regarded botanist S. Watson (1871), and not D. Douglas, as Ownbey first thought. Beside the confusion with C. nitidus, the sp. has been labelled C. parviflorus, C. umbellatus, and C. euumbellatus by different observers. This plethora of names identifies a sp. which is difficult to confuse with any other in the field.

HORTICULTURE: In the wild, C. eurycarpus grows in high mountain meadows (e.g. 4800' in NE Oregon). I have seen it both in part shade and, more rarely, in full sun, but it tends to grow near low shrubs in the sunny locales, so it probably gets some shade there. It grows among low grasses, which may help to shade the lower portions of the plant, as well as provide mulch and compost. Rainfall varies from 10-30"/yr. Much is in the form of snow, and snowmelt probably triggers seedling germination in the spring. However, this sp. does get summer rains. C. eurycarpus is hardy to -30°F (-34°C) in its wild range, but may be hardier yet in cultivation, with snow cover, or other protection. It blooms late spring to early summer, and probably has a short growing season.

In mild winter or hot summer climates C. eurycarpus would be difficult to grow, as it prefers cold winters and mild summers. It should be suited to the No. and E. U.S., however, as well as similar cold winter climates. It is quite hardy, and tolerates some summer water. Cold climate growers can place the seeds in a one-gallon or larger pot, and set it out in winter with snow on top. They may be able to grow it in the ground as well. Heavy soils should be modified with sand and pine leaf-mold in equal proportions (up to 50%. There are records of its being grown in heavy clay-loam, but in a dry climate-Krukeberg, 1982n). In warmer climates, the seeds should be cold stratified in moist vermiculite for 6-10 weeks and then transplanted. I have had some success in pots with the U.C. mix of ½ sand ½ peat moss, and a small amount of low nitrogen, complete bulb fertilizer. Water once a week--less later in the season. The pots should be kept as dry as possible during dormancy.