MARIPOSA
VOL. IX, #3
EDITORS: H.P. MCDONALD
AND K. STOKKINK
PUBLISHED QUARTERLY AT
P.O. BOX 2768
BERKELEY, CA 94702-0768

MARIPOSA

THE *CALOCHORTUS* SOCIETY
NEWSLETTER

JANUARY, 1998

ADVISORS: C. BACCUS
AND B. NESS

I. Announcements

1. When *Calochortus tiburonensis* was first discovered, it was speculated that the species combined characteristics of several sections, in that the flower resembled *C. tolmiei* and the capsule section Mariposa capsules. Having seen and examined this species at length, I have come to the conclusion that this reasoning is incorrect and that *C. tiburonensis* is a clear cut section Cyclobothra species. Its fibrous-reticulate bulb coat and upright capsules match Ownbey's specification of the defining characteristics of that section precisely. It resembles *C. tolmiei* no more than *C. weedii* and differs from the former in the same respects, *viz* the bulb coat, capsule and seed features, the later blooming habit, the larger less hirsute inflorescence, unbranched stems, etc. The capsule is thicker in the middle than the other California Cyclobothras, but no more so than many of the Mexican Cyclobothras. The unusually northern range is exceptional, but such isolated stands of rare endemics from the rest of the species or section is common in *Calochortus*, e.g. in *C. westoni*, *C. splendens*, *C. macrocarpus*, *C. ghiesbreghtii*, to mention only the most prominent. Indeed, such isolation may be the condition of speciation, as Ownbey noted in the case of *C. minimus* and *C. nudus*. *Calochortus tiburonensis* also divides within the bulb coat like the other California Cyclobothras, a feature noted over a century ago as characteristic of this subsection by Purdy. In sum, *Calochortus tiburonensis* is best judged as belonging to the California Cyclobothras, albeit with interesting specific differences.

2. Calochortus and fires: Many have noted the tendency of Calochortus to bloom in profusion after a fire. Marjorie Schmitt wrote about this in her book on Native Plant horticulture and Mr. G. Burleigh has seen magnificent stands of Mariposas in Southern California after chapparal fires. Mr. L. Corbett-Grant has speculated that smoke from fires might be used to "get stubborn bulbs to flower." He adds that, "horticulturists on the Scilley Islands have for years been using smoke from hay to activate the early flowering of *Narcissus* species." He cites an article from South Africa, in *Veld and Flora*, Sept. 1994, which argues that it is the smoke, and not the nutrients released from charred plants which causes the unusual blooming. However, ashes from fires have been used for centuries as fertilizer, reflected in the name 'potash'--pot ash. It may be this additional fertilization which causes the profuse blooming.

II. Trips will return next issue.

III. Horticulture:

Germination Tests, 23rd Installment: In-Ground Tests.
Report on the outcome of trial growing tests conducted on *Calochortus*.
The in-ground tests faced a number of hurdles which delayed and probably distorted the results. When first begun, they were set up in Livermore at Las Positas College. Unfortunately, "groundskeepers" were given a key to the restricted area where the plants were grown and stomped all over the area where the trials had been set up. As this skewered the results, I decided to do the tests again at my house, where the plants would be kept away from the feet of well-meaning nincompoops. When we moved to Berkeley, I set up the tests on the side of the lot, next to a neighbors fence. Unfortunately, this did not protect the experiments completely; the shade growers' section was deluged by a tenant's wash water and had to be done over. A factor influencing the outcome was that the soil on my lot is a tough adobe clay, rather than a nice loam. When mixing it with the various amendments to determine the best mix, it proved difficult to break down the clods completely. Further, some Calochorti do not do well in clay and thus a test utilizing clay soil would

not result in completely accurate results for such species. Also, clay soil tends to hold water to a greater degree than other soils and thus to be a poor medium for species from drier areas, if the tests are conducted in a normally rainy area. In sum, the tests were practically useless for testing the desert species and, for that matter, all but species which normally grow in clay or at least are adaptable enough to tolerate it. While the species selected to be tested were chosen with some care, it proved impossible to achieve anything like scientific results, given the initial soil type and the exceptionally heavy rainfall of both 1995 and 1997. More accurate results would require a drier, somewhat cooler climate, like that of Livermore, but with a better soil type than the even more unworkable adobe of that city.

In the next issue, the various species used for the test and also the various amendments to the soil will be listed. Then the outcome of the trials will be given, for what they are worth.

IV. The Horticultural History of Calochortus

[Second installment of the article by Claude Barr, "Calochortus, Sensational Native American Tulips"}

"In the difficult environment of my garden on the South Dakota plains, the superhardy species have proven their true worth. Here a basically heavy soil, often a shortage of moisture in the growing time, occasional deep wetting in the dormant and rapidly fluctuating and extreme temperatures have provided a natural laboratory for observing various limits of adaptability. Yet here has been met an encouraging success in growing nearly all the kinds [including] a number of rare ones...

"My first effort, with a mixed lot of the vaunted gaudy Californians, was as fruitless as anyone may expect who plants them wholly without understanding. There followed a splendid performance by one of the local kinds, the lovely *C. nuttallii*..

"Bulbs for a good size planting were purchased and put into the ground in October, the soil of the garden being lightened by the addition of sand and gravel to a depth of six inches. Taking on faith an impression as to hardiness, no protection was given...The winter was mild, with light snowfall...Spring gave no superabundance of wet...and a dozen kinds, Californians and others, gave thrilling bloom...two or three kinds did not bloom at all, possibly from too little moisture, [and] that *C. plummerae* and *C. catalinae* [were] too tender...[but] have since performed faithfully...given full protection from cold.

"So began an extensive series of experiments, testing many types of soil, varying the planting depth, improving subdrainage, increasing or lessening shade, seeking the right moisture for the growing period. All the Californians had been given their then-accustomed blanket of 12" of hay at the first serious onslaught of winter...[except] *C. vestae*..one of the hardier...The cold wave held for a month... *C. vestae* failed utterly...From that I quite lost interest in cold tests and so I do not know exactly how much some of the Coast Range bulbs will bear.

"Circumstantially, side by side with *C. vestae* through that...trial stood *C. macrocarpus, C. lyallii, C. apiculatus, C. gunnisoni, C. nuttallii*..and other cold-climate kinds and 40°F below impressed them not at all. They came through to a bulb.

"...Outside the growing season, early March to mid-July, here, the soil may be as dry as ground can become in this dustbowl climate, even for the Californians accustomed to their winter rains; a dry dormant bulb is a safe one. There has been no opportunity in many years to observe the effect of a continuously wet summer and fall, but occasional soaking rains are not fatal when soil texture and drainage provide quick dissipation of the excess.Planting may be done as late before winter sets in as convenient. Four inches to the base of the bulb is a good depth...they grow well at two and a half inches apart...Bulbs that have remained dry...[to] early March bloom freely if they receive moisture at that time or as soon as the ground is frost free.

"...From the first activity of the tips beneath the soil until blossom buds are in evidence is a touchy time and moderate moisture is the safe rule. For the less hardy kinds it is well to have lath frames, burlap pads, perhaps hay, at hand until frosts are surely past. They want plenty of water from the appearance of the buds until just before flowering time; then, preferably drought...At this time or with little delay a thorough drying out serves perfect ripening. In a congenial environment, the bulbs continue for many years."[Continued next issue]

V. Conservation: Report on *Calochortus plummerae*

Calochortus plummerae was described as "common" by the Southern California botanist Parrish a century ago. Since that time the species' range has been in steady retreat as subdivisions and freeways gobble up more and more of its habitat. This consists for the most part of low altitude chapparal slopes, often with sandstone as the parent material. Unfortunately, this habitat provides lovely views and so is very often desirable as a housing site.

The species is almost confined to Los Angeles, San Bernardino and Riverside counties, in the Transverse and N. Peninsular Ranges. In Los Angeles County, the species is still fairly abundant, particularly in the Western Santa Monicas and the flood plains of the San Gabriels, but the lower lying stands have been wiped out, e.g. most of those in Claremont. In San Bernardino County, there are only isolated stands left as development has eliminated many of the formerly abundant stands. The species was never common in Riverside County, but its known stands still persist there and are probably safe for the immediate future.

Our many population surveys over the years, in dry and wet years, leads us to believe that the plant is down to about 1000 to 1500 plants in the wild in known stands. True, there are acres of chapparal in S. California which might contain more plants. Yet this area has been fairly extensively botanized, and it is unlikely such a showy plant would be overlooked very often.

The plant should be listed as rare and endangered and we have taken steps to do so. A further problem is genetic isolation of existing stands from one another as their numbers decrease. Unfortunately, political tampering with the Rare and Endangered Species Law by plutocrats may condemn this lovely species to slow extinction.

VI. Botany

[Part Two of the article on *Calochortus* phylogeny by Tom Patterson]

P. II- Genetic Approaches to Phylogeny Reconstruction

As was discussed in Part I, the main objective of my thesis is to generate an evolutionary tree, or phylogeny, of *Calochortus*. Traditionally, botanists have utilized morphological data such as shape of the petals and sepals, existence of hairs, leaf characteristics, etc. to reconstruct phylogenies. Plants, however, are notorious for exhibiting extreme and very rapid morphological changes, even in floral traits which, historically, were believed to evolve very slowly. Although this dynamic evolution makes plants great subjects for evolutionary studies, it also, ironically, acts to blur the phylogenetic information contained in morphological data. Luckily, there appears to be another, potentially better way to construct phylogenies: through the examination of DNA [dioxy-ribonucleic acid, the basic chemical of life-ed.].

DNA analysis allows scientists to "tap into" the very essence or fabric of phylogeny. Or, as the venerable paleontologist George G. Simpson put it in 1945, "the stream of heredity [DNA] makes phylogeny; in a sense, it is phylogeny. Complete genetic analysis would provide the most priceless data for mapping of this stream." recent advances in molecular biology have made genetic analysis readily available to scientists in a wide range of fields, including phylogenetics. As a result, Simpson's dream of "mapping the heredity stream" is close at hand.

Two major developments acting to revolutionize genetic analysis have exploded the top off the field of phylogenetics in recent years. The first was the invention of the polymerase chain reaction (PCR). PCR is a laboratory technique that utilizes an enzyme extracted from bacteria living in the hot springs of Yellowstone National Park to copy or "amplify" pieces of DNA. Interestingly, the discoverer of PCR, Kary Mullis, thought of the concept while driving his motorcycle down the Pacific Coast Highway in California late one evening. Mullis knew immediately the significance of his invention and proclaimed that it would change the world. He was right--in 1993 he won the Nobel prize in chemistry. What makes PCR revolutionary is that it allows scientists to rapidly make millions upon millions of copies of DNA from very small initial quantities and it allows them to focus on, or isolate, particular regions of DNA, like a specific gene, even when that region constitutes a very small portion of the total DNA in a cell.

The second major development was the advent of DNA sequencing. This process allows scientists to take the amplified regions of DNA produced from PCR and literally "decode" the genetic message. Sequencing is under major use at the present time in a wide range of fields, including the Human Genome Project. While the ends for many sequencing projects are to determine the genetic code, phylogeneticists are not primarily interested in what the DNA says *per se*, but rather how the code differs among species or groups of species under study. When a change or mutation occurs in the DNA of a particular species it will be passed on to each of its descendants. Species which have a common ancestor (i.e. descended from the same parental species), then, can easily be identified via sequencing that particular stretch of DNA (i.e. they will all possess the same inherited mutation). If a mutation occurs in some of the newly formed daughter species and they in turn branch to create new species, the new daughter species will have both the new mutation as well as the more inclusive mutation that was passed on from their parent's parent. By identifying more and less inclusive mutations and putting species into more and less inclusive groups accordingly, the branching patterns of the evolutionary tree can eventually be ascertained .

What are the benefits of using DNA to reconstruct phylogenies? The examination of the genetic code, by yielding direct access to the "hereditary stream," reveal;s an uncorrupted view of phylogeny. As a result, genetic analysis can wade through much of the "noise" that can be associated with traditional sources of data. This is one of the main reasons I will be using DNA sequencing as the primary method for data generation on my study of *Calochortus*. Nevertheless, genetic analysis has several other advantages over traditional methods for phylogeny reconstruction.

First, genetic analysis is generally more objective than traditional methods. When using morphological data, for example, it can be difficult to know which characters are 'good' (i.e. are phylogenetically informative) and which are not. In some plant groups, flower characteristics are very indicative of species relationships; in other groups, leaf shape is very important and in others, perhaps neither--or both--types of characters are useful. These difficulties can often make choosing characters for phylogenetic studies highly subjective and as a result virtually impossible to replicate by other scientists. Although DNA analysis is not completely objective, there are no *a priori* 'good' or 'bad' mutations in a DNA sequence and re-sequencing will verify a mutation's existence to any interested researcher.

Second, genetic data sets tend to be much larger than traditional data sets, offering many more characters for phylogenetic analysis. Compared with the average study based on morphology, genetic data sets tend to be 5 to 500 times greater. As sequencing technology improves, which is constantly happening, this gap will only widen in the future. Finally genetic data can unequivocally elucidate hybridization in plants. Hybridization is often portrayed as the scourge of plant phylogenetics because it has been very difficult to prove and when not known to have occurred can wreak havoc on attempts to reconstruct phylogenies. Now, by examining two or more DNA segments (as long as they are independently segregating), hybridization can easily be spotted. Conflicting phylogenetic patterns derived from two or more (independently segregating) regions of DNA represents good evidence that hybridization has occurred. However, a lack of conflict does not, unequivocally rule out the possibility that hybridization could have occurred, although it makes it less likely.

I should point out that there are potential problems associated with genetic analysis when applied to phylogenetic studies. First, most sequencing studies, although often containing vast quantities of data, include, in fact, only a small portion of the total DNA represented in a species. Thus we are utilizing just a sample of the total "stream of heredity." The evolutionary trees that are generated, therefore, are a representation of, rather than the true phylogeny. There are several other potential problems, but these--such as gene duplications, introgression, inappropriate evolutionary rate of DNA sequence for the level of phylogenetic question at hand, etc.--are too technical for this article. Suffice it to say that, as opposed to the situation with many traditional methods, precautionary measures can be taken to identify and alleviate most of these problems. **[All pictures on page 5 by H. P. McDonald.]**

C. venustus