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agave

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Cover: *Agave parryi* **var.** *huachucensis,* **six miles southeast of Sonoita, Arizona, on the road to Canelo, grama grassland, elevation c. 1,500m (5,000 ft.), June 17, 1968. Photo by Howard Scott Gentry.**

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Agave chiapensis *in native habitat near San Cristobel de las Casas, Chiapas, Mexico. Photo by Howard Scott Gentry.*

THE MANY KINDS OF SPECIES IN AGAVE

by Howard Scott Gentry, Ph.D.

In the early part of this century, one learned in general biology classes that species were groups of organisms reproducing themselves within limits of variability and environment. This concept can be stated in various ways, with different terms, but the basic idea remains that individuals, families and populations do go on reproducing generation after generation and have done so longer than anyone can rightly know. We also have learned that there are many kinds of species: those that undergo asexual reproduction, where a one-celled organism simply divides and becomes two one-celled organisms; and sexual species, where two generative cells unite to form a new organism. Agaves are quite sexy.

Names and Classification of Species

The Linnaean species was a pretty definite concept, with each species regarded as a fixed entity distinct from every other species, more or less as it was created in the beginning. Linnaeus's binomial system, based on flower morphology, gave us a grasp of relationships. Later, the international rules of botanical nomenclature stabilized plant names and further established Botany as a science. However, our system of names is not altogether a system of logical classification. To think that the nomenclatural type of a genus or of a species is typical of the genus or species may be quite erroneous. The type and type specimens serve only to establish the *first name* assigned to it with legitimate descriptive publication, which may or may not have been adequate; this is commonly called a diagnosis and is in Latin. We are directed to follow the rules in using names; this frequently causes confusion and frustration. A case in point is the well-known "sugar-bush," *Protea mellifera*, which was suddenly changed to *Protea repens* when a research botanist found that *P. repens* had been published first.

Many similar cases exist with agave names. The best description, finely illustrated, of one species, *Agave pendula Schnitts.*, is what was named *Agave caespitosa* by Todaro in 1876. Karl Koch called it *Agave sartorii* and then *Agave aloina* in 1860 in a local German horticultural journal. Although Todaro's account of this species is superior to those of Koch and Schnittspaugh, the latter has priority because it was technically described and published in 1857; so *Agave pendula* Schnitts. is the legitimate name.

No herbarium specimens were cited by any of these authors. However, a collection in the Kew Herbarium, dated 1877, was designated as the neotype by Gentry in 1982, thus completing the authentic status of this name 125 years after its first literary introduction.

There were no international rules for naming plants in the 19th century. Botanists acted independently, frequently not recognizing or knowing of contemporary works. This general

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Dr. Howard Scott Gentry is research botanist for the Desert Botanical Garden. His definitive monograph, "Agaves of Continental North America," was released by University of Arizona Press, Tucson, November 12, 1982.

condition, the lack of specimens and ignorance of natural variation within *Agave* species, led to the plethora of names. Many have been abandoned to synonomy or reduced to varieties.

We may regard species as discrete units with fixed limits. Recognizing them with scientific names supports this impression, and the practice does provide a needed stable basis of reference. However, with Charles Darwin we have come to realize that species are changeable entities. In nature most changes occur slowly, but there are species in a more dynamic flux of evolution. Species cannot be defined in fixed formulas, like chemical compounds or molecular formulas. Taxonomy is as much art as science, because its definitions are made not only on the basis of available evidence (specimens), but also according to the *judgment* of the *taxonomist* in any given case. The genus *Agave* is rich in taxonomic puzzles. If you are clever at puzzles, it *may* follow that you will be a good agave taxonomist.

The Kinds of Species in Agave

There are many kinds of species in the genus *Agave*. There are ancient species and modern species. There are inbreeders and outbreeders and others that do not breed at all. These latter are the clonal kind, which may have nearly reached the end of their evolutionary road. There are some that propagate themselves both sexually via seed and asexually by vegetative reproduction of offsets and bulbils. There appear to be hybrid species spawned by gene-trading parents — *Agave gracilipes*, for example, apparently derived from hybridization between *A. neomexicana* and *A. lechuguilla*. In such cases we can see and study the origin of species; but to establish origins scientifically we need to study the chromosomes and make crosses to recreate artifically what appears to have happened in nature.

There are perennial species and monocarpic or "multi-annual" species that flower once and die. There are edible species and poisonous species. Some species appear highly cooperative and live symbiotically with bees, bats and man; other species remain distinctive, alone and conservative in a species-conservative niche geologically old, like *A. dasylirioides*.

All these different kinds of species, with their vast array of variations, have been dumbfounding to taxonomists and others. No one set of criteria can be established for defining these species. Flower morphology works well in the Group Parviflorae,

Dr. Gentry prepares to clip flowers from an Agave bovicornuta *for cross-pollination studies at the Desert Botanical Garden.*

but is inadequate by itself for separating species in the Group Deserticolae where the flowers are generally too similar. The floral drawings and their ideographs, Figs. 1 and 2 (from Gentry 1982, pp. 196, 356) for these two groups clarify the comparisons. The Parviflorae have relatively specialized flowers with good specific differences. They are coadaptive with pollinators, while no such specific floral agents are known for the Deserticolae. The latter, however, are more specialized in epidermis, leaf form and method of vegetative reproduction. To understand their development, the two groups had to be studied separately by using two different sets of characters; and species then had to be delineated accordingly. *(Please see p. 12)*

Environment and its Effects

The modern taxonomist profits by the study of his subject's environments or, more specifically, their habitats. Climate, soils, and the biota are all interactive; they influence the subject and eventually mold its character. Some basic indications of environments are outlined in Fig. 3 (Gentry 1982, pp. 199, 355). Here the dry and rainy seasons are given as silhouettes, and the flowering seasons as crossbars from January to December (J-D) for several taxa of the Parviflorae and Deserticolae. The cooler, montane climate of the Parviflorae contasts generally with the drier, hotter climate of the Deserticolae. The flowering of the Parviflorae follows the dry spring, perhaps timed with the emergence of adult bees, while the flowering of the Deserticolae follows more closely the winter rains, before desiccation of soils in late spring and summer. The growth of the inflorescence and the following maturation of flowers and fruits are very costly to the plant's hoarded water. The process, over several months, usually drains the sap completely from leaves and stem, leaving only a dry and fully spent plant mummy under a cave of open sky. The winds waft away the flaky seeds from the dry monumental masts.

With the many kinds of species with their many variable problems we could use some more sons of Mayahuel, the Goddess of Maguey. Mayahuel was reported to have 400 sons — so many, she explained, were needed to guide the many kinds of people in the proper uses of maguey. There is Park Nobel, physiologist of the University of California at Los Angeles, working on the water relations of desert species of *Agave*. A *(continued on page 12)*

FLOWERING PERIODS FOR DESERT PLANTS

Above: Desert chicory (Rafinesquia neomexicana)

by William G. McGinnies

This informal study was made originally as a result of inquiries from relatives and friends living outside Arizona who wanted to know the best time to visit Arizona to see early spring flowers. In checking the literature in 1966, I had found few references to specific flowering dates; as a result I began a series of observations for common desert plants including dates of beginning and ending of flowering, with a notation of the peak when this could be determined (in less favorable years, there did not seem to be any particular peak). I continued these observations from 1966 to 1982 and have summarized them in the following general discussion and a table of average peak dates for some of the more common plants in the vicinity of Tucson. The actual flowering dates may vary from place to place but, in general, the information presented here should serve as a guide for all of the southwestern part of Arizona.

William G. McGinnies, Ph.D. is director emeritus of the Office of Arid Land Studies, College of Agriculture, University of Arizona, Tucson.

Determination of flowering periods

Flowering periods for non-woody plants are determined by favorable moisture and temperature conditions. Winter annuals need cool but not cold weather and adequate soil moisture. Summer annuals require higher temperatures and favorable moisture. Woody plants and succulents appear to have a predetermined flowering period less influenced by temperature and moisture.

Adequate information for the exact determination of the effect of temperatures was not available, but on the basis of observations, it appeared that flowering dates of spring annuals were affected by variation in temperature. An unusually cold winter can retard flowering of herbaceous species as much as a week or ten days, while a warm winter, provided there is enough moisture, is followed by an early flowering season. Temperatures appear to have little effect on succulents and woody species except that early flowering plants, such as fairy duster and brittlebush, might not flower if flower buds are frozen prior to the usual flowering season.

Many woody plants have more than one flowering season. The mesquite, for example, produces flowers in winter and summer, while the creosote bush may flower whenever moisture conditions are favorable. Desert marigold may also flower in winter and summer, and fairy duster may flower in spring and fall — rarely in summer.

The length of the flowering season varies widely among plants, and appreciably between years. The yuccas, Joshua tree, blue palo verde, beavertail cactus, saguaro and ironwood have flowering periods of less than 30 days. Ocotillo, foothill palo verde, hedgehog cactus, cholla, prickly pear and desert mallow have a flowering season of 30 to 45 days, and barrel cactus more than 60 days.

The length of the flowering season for spring annuals, largely determined by the duration of soil moisture, may be as short as 30 days or as long as 45

days. Such plants as fairy duster, brittlebush, desert marigold, creosote bush, paper flower and Parry penstemon may flower for longer periods depending on availability of moisture.

While luxuriance of flowering for most plants is controlled by the amount of moisture received, the cacti seem to be little affected by moisture conditions. In fact, it has been observed that the saguaro may flower most profusely in dry years. Some shrubs such as fairy duster and brittlebush are affected by rainfall and temperature, whereas the palo verdes show little response to variation in temperature and moisture.

As a rule, exceptional spring flowering seasons are preceded by above-average precipitation in November and December. In 1941, the best year I can remember, the November-December precipitation at Tucson was more than four inches, and the total for the November-March period was nearly 10 inches. With November-December precipitation of nearly four inches, 1968 was the first good year during the 1966/1982 observation period, followed by a very good year in 1978 and another very good year in 1979.

The November-December 1982 precipitation was well above average, and as we might have expected 1983 was another banner flowering year.

Based on observations over the sixteen-year period 1966-1981, the last half of March is the best time to see the flowers of desert spring annuals and non-woody perennials. The peak flowering season may vary a week or ten days from March 20, depending on temperature and precipitation during the preceding five-month period, November through March.

If one were to make a calendar of flowering events for average years, it might be as follows:

February: Sand verbena, bladderpod mustard, evening primrose and Parry penstemon should be showing by the end of the month. In some years, fairy duster and brittlebush might also show.

March 1-15: Sand verbena and evening primrose should be ending their peak of flowering, and desert hyacinth, Parry penstemon and wild onion flowers should be common. Joshua tree and the broad leaf yuccas may be flowering but perhaps reach their peak later.

March 16-31: This is the peak flowering season for most low-growing plants. These include desert mallow, desert star, fiddleneck, several species of gilia, lupine, owl clover, gold poppy, tackstem, verbena, wild onion, desert chicory and goldfields. Some of the members of the sunflower family, such as desert dandelion and desert daisy, may lag behind other early spring flowers. Fairy duster and brittlebush should be in full bloom.

Also during this period, Joshua tree will end its flowering season. The common broadleaf yuccas will be in flower along with late blooming brittlebushes and fairy dusters. Creosote bush, which seems to be very sensitive to precipitation, may flower if there is plenty of moisture in the soil.

April 1-15: Hedgehog cacti are among the first succulents to flower, ocotillo will be showing color, and orange mariposa lily may begin to flower. Most of the flowers listed for the March 16-31 period will still be showing, but in the drier years they may start to wane and such early blooming flowers as sand verbena may be gone.

April 16-30: Beavertail cactus will flower early followed by chollas and other prickly pears. Toward the end of the month, mesquite flowers will appear in favorable years. Some people believe that the appearance of mesquite leaves marks the beginning of the frostless season. On the average, mesquite leaves become fully developed by April 10 or develop earlier in warm years and later in cooler years. *Arizona Climate* shows that the probability of temperatures 32° or lower is 10 percent for April 10.

Blue palo verde has an average flowering date of April 24 with a range of about one week either way. Blue palo verde comes on with a burst of flowers everywhere with little variation in individual trees. Ocotillo reaches its maximum flowering during this period.

The early spring flowers — gold poppy, lupine, owl clover, Parry Penstemon, desert mallow, fairy duster, beavertail and hedgehog cacti and many others — have concluded their flowering season.

May 1-15: Chollas and prickly pears will complete their flowering. Blue palo verde will reach the end of flowering early in the month and foothill palo verde will be in full flower within 10 days before or after May 10. Mesquite will set pods.

May 16-31: Coral bean, desert senna, ironwood and saguaro bloom during this period. The average peak date for saguaro is May 20, with the usual flowering season between May 10 and June 10.

June: The driest month of the year marks the end of the flowering season for most herbaceous plants, but a few woody plants and succulents are able to flower, thanks to stored moisture. Soaptree yucca, sotol, night blooming cereus, organ pipe cactus, old man cactus, and teddy bear cactus are notable in this group and are sometimes joined by ironwood, desert marigold, desert senna and creosote bush.

July-August: The summer flowering season is variable in time and amount depending on the seasonal distribution and amount of precipitation. Notable plants flowering during this season include barrel cactus, jumping cholla, fishook cactus, devils claw, Jimson week and Arizona poppy.

September-November: The fall season is characterized by a paucity of flowers and is represented mostly by members of the sunflower family — asters, fleabane, rabbit bush and desert broom.

December-January: Winter is a resting period for most woody plants and succulents. While herbaceous flowering plants are not conspicuous, this is a very important season for future flowering.

Peak flowering dates for the more common desert flowering plants are listed in the following table. While a specific date is indicated for each flowering plant, the actual peak flowering time may vary as much as 10 days either way from year to year.

PEAK FLOWERING DATES FOR S

	Feb.	March 1-15	March 16-31	April 1-15	April 16-30	May 1-15	May 16-31	Summer
Ajo Lily *Hesperocallis undulata*			X					
Arizona poppy*+ *Kallstroemia grandiflora*								X
Beaver tail cactus *Opuntia basilaris*					X			
Bladderpod mustard *Lesquerella gordoni*	X							
Brittle bush *Encelia farinosa*			X					
Cholla cactus *Opuntia spp.*					X			
Coral bean *Erythrina flabelliformis*							X	
Covena (Desert hyacinth) *Brodiaea pulchella*		X						
Creosote bush *Larrea tridentata*				X				
Desert chicory *Rafinesquia neomexicana*			X					
Desert daisy *Melampodium leucanthum*			X					
Desert dandelion* *Malacothrix glabrata*			X					
Desert mallow *Sphaeralcea spp.*			X					
Desert marigold *Baileya multiradiata*				X				
Desert senna *Cassia covesii*							X	
Desert star* *Monoptilon bellioides*			X					
Devils claw+ *Proboscidea spp.*								X
Evening primrose *Oenothera spp.*	X							
Fairy duster *Calliandra eriophylla*			X					
Fiddle neck *Amsinckia intermedia*			X					
Fishhook cactus+ *Mammillaria spp.*								X
Goldfields* *Baeria chrysostoma*			X					

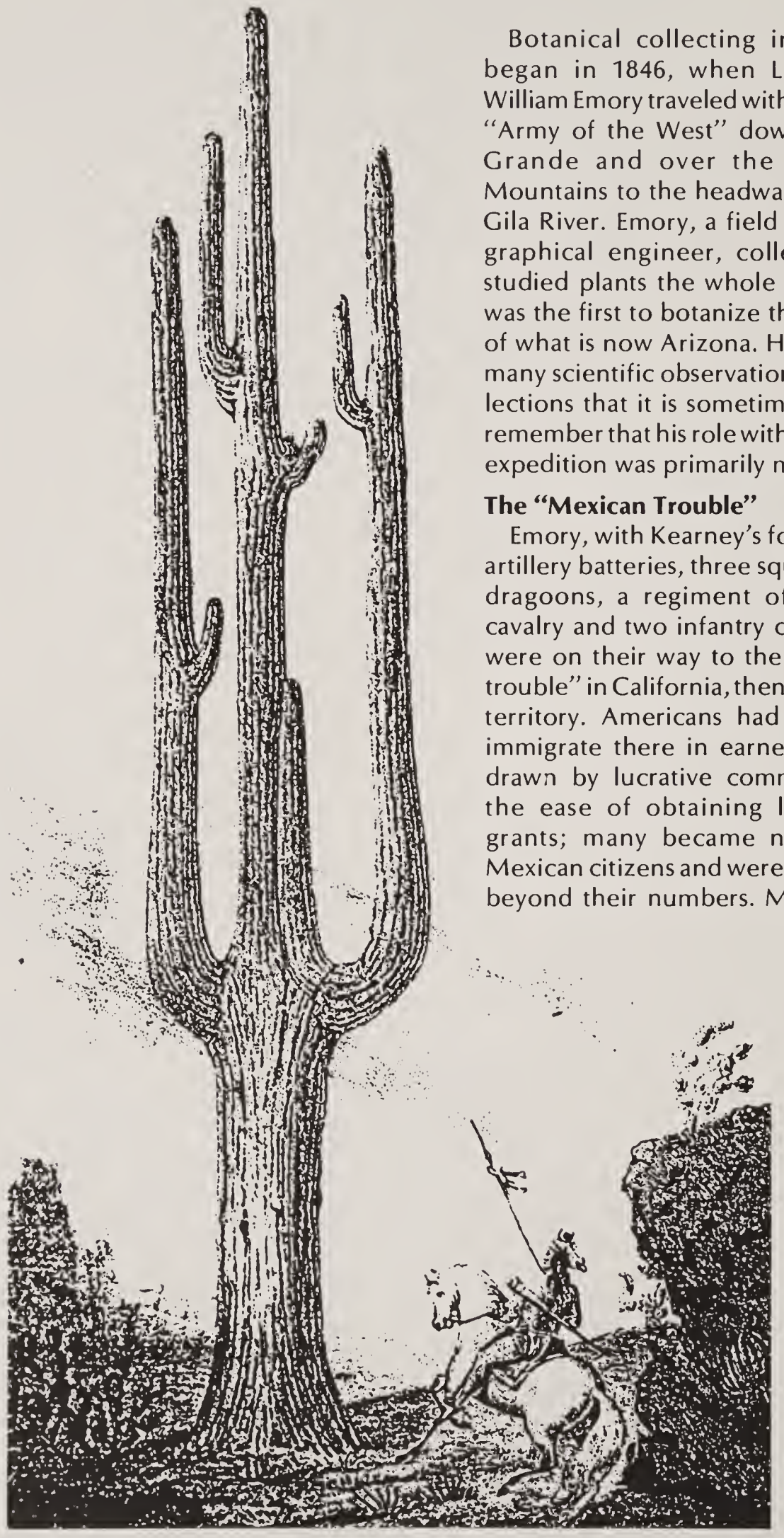
*** Based on general observations only**
+ Summer flowering — July/August

ME COMMON DESERT PLANTS

	Feb.	March 1-15	March 16-31	April 1-15	April 16-30	May 1-15	May 16-31	Summer
Gold poppy *Eschscholtzia mexicana*			X					
Hedgehog cactus *Echinocereus spp.*				X				
Ironwood *Olneya tesota*							X	
Joshua tree *Yucca brevifolia*		X						
Jumping cholla*+ *Opuntia fulgida*								X
Lupine *Lupinus spp.*			X					
Mariposa lily *Calochortus kennedyi*					X			
Mesquite *Prosopis velutina*					X			
Ocotillo *Fouquieria splendens*					X			
Owl clover *Orthocarpus purpurascens*			X					
Palo verde — blue *Cercidium floridum*					X			
Palo verde — foothill *Cercidium microphyllum*						X		
Parry penstemon *Penstemon parryi*		X						
Prickly pears *Opuntia spp.*						X		
Sand verbena* *Abronia villosa*	X							
Saguaro *Carnegiea gigantea*							X	
Soaptree yucca *Yucca elata*							X	
Tackstem* *Calycoseris wrightii*			X					
Teddy bear cactus* *Opuntia bigelovii*							X	
Verbena* *Verbena spp.*			X					
Wild onion *Allium deserticola*		X						
Yuccas — broadleaf *Yucca baccata, Yucca schidigera*			X					

A BOTANICAL RECONNAISSANCE

by Vera Gamet



Botanical collecting in Arizona began in 1846, when Lieutenant William Emory traveled with Kearney's "Army of the West" down the Rio Grande and over the Mimbres Mountains to the headwaters of the Gila River. Emory, a field and topographical engineer, collected and studied plants the whole way — he was the first to botanize the breadth of what is now Arizona. He made so many scientific observations and collections that it is sometimes hard to remember that his role with Kearney's expedition was primarily military.

The "Mexican Trouble"

Emory, with Kearney's force of two artillery batteries, three squadrons of dragoons, a regiment of Missouri cavalry and two infantry companies, were on their way to the "Mexican trouble" in California, then a Mexican territory. Americans had begun to immigrate there in earnest in 1840, drawn by lucrative commerce and the ease of obtaining large land grants; many became naturalized Mexican citizens and were influential beyond their numbers. Mexicans in California resented American acquisition of land, and the Mexican government feared American ambitions — with good reason, for by 1845 American settlement seemed likely to gain the province. Mexico refused to cede the territory, and President James Polk, who was determined to have California for the United States, ordered General Zachery Taylor to move his troops across the Nueces River to the banks of the Rio Grande. Hostilities ensued, Polk declared war on Mexico in May, 1846, and the American Navy occupied all California ports.

Emory had received his orders to link up with Kearney at Fort Leavenworth, Kansas, in early June. He knew that Kearney's objective was "to strike a blow at the northern provinces of Mexico, more especially New Mexico and California." In a report to the Chief of the Corps of Topographical Engineers more than a year later, he wrote,

> Anticipating that the route of Colonel Kearney's command would be through unexplored regions, your suggestions required that, in all cases where it did not interfere with other and more immediate military demands of the service, (I) should be employed in collecting data which would give the govenment some idea of the regions traversed.

In other words, he was to describe, among other areas, the entire Gila watershed. To prepare for this expedition, he was allowed barely 24 hours in Washington to collect military equipment and survey instruments before leaving for Fort Leavenworth.

The huge region Emory was to traverse was largely unexplored. Information about the land west of the Mississippi was scarce and about the desert nearly nonexistent. The country

was virgin territory as far as botanical exploration was concerned, and Emory was to find a considerable number of important plants. A better man could not have been sent to do the job: a young career officer, 35 years old, his sensitive observations on the plant and animal life around him were interspersed among his accounts of the hardships, dangers and privations of the trip, his military concerns, his anxiety about the men with whom he traveled, as well as the horses and mules whose lives were as important as theirs.

First Sight of the Gila

He first sighted the Gila as it came "clear and swift, bouncing out of the great mountains to the north" near the present Virden, New Mexico. Plants new to his observations were hummingbird trumpet (*Zauschneria californica*), a grass, a kind of sagebrush (*Artemisia cana*) and several varieties of mesquite (*Prosopis* spp.). On October 30 he wrote in his diary, "On the hills we found a new shrub bearing a delicious nutritious nut, and in sufficient abundance to form an article of food for the Apaches. . ." He had found jojoba (*Simmondsia chinensis*).

Finding some deserted Indian ruins in southeastern Arizona, Emory was poking through the debris when he observed that a fire had recently bared the ground of grass and shrubbery, disclosing "a great vegetable curiosity, a cactus 18 inches tall and 18 inches at its greatest diameter, containing 20 vertical volutes and armed with strong spines" — a *Ferocactus*.

His trail continued, a succession of steep ascents, high black peaks and descents paved with sharp fragments of basalt. Out of the dark ravines grew unearthly-looking cacti "which stuck out from the rocks like the ears of Mephistopheles." An opuntia?

Reaching what is the San Carlos River on modern maps, Emory stopped to rest men and horses, and took time to look for a trail by which they could pass the formidable range of mountains through which the Gila cut its way. There was none and they detoured through the Mescal Mountains. Before leaving the Gila on this cutoff, they discovered a Cereus six feet in circumference and so high that Emory could not reach halfway to the top with the point of his sabre, not by many feet. ". . .and a short distance up the ravine is a grove of these plants, much larger than the one I measured, and with large branches. These plants bear a saccharine fruit much prized by the Indians." He had discovered the saguaro, later named by George Engelmann, *Cereus giganteus*.

Near Winkelman, in the stronghold of the Apaches, Emory strolled the hills looking for seeds and geological specimens. This young man from Maine looked around and was forcibly struck by the fact that not one object within his view — animal, vegetable or mineral — had anything in common with anything he knew in the States, except the ubiquitous cottonwoods that grew anywhere near water. From where he stood he could see creosote bush (he called it *Larrea mexicana* and he despised it), many varieties of cactus, "green acacia" (apparently palo verde), chamiza, mesquite, open space and bare, gravelly desert.

He described the country as barren mountains, utterly worthless, when he was practically sitting on the Christmas mine, one of the great early copper strikes.

Barren plains, little grass

About 60 miles northwest of Tucson, approaching what is now Coolidge, the Gila left the mountains and flowed quietly onto an open plain which extended south as far as the eye could see — barren, sandy, gravelly desert, nearly devoid of vegetation. The soil appeared totally without organic material. The group found a little mesquite, chamiza, "green acacia," sagebrush and pitahaya (today's alternate common name for Organpipe Cactus, in Emory's usage, meant any large, columnar cactus with edible fruit, and in this case was apparently used to designate the saguaro). This area offered no more grass for the mules and very little water.

They followed the Gila into what is now Maricopa County, reached the confluence of the Salt and Gila, then bypassed the river to march diagonally southwest to Gila Bend, a brutal, waterless stretch of desert dreary beyond description. Now and then they saw a single acacia or a dwarfed creosote bush struggling for life, but little else. Every day was the same as they plowed their way toward the Colorado River — tablelands of sand and oppressive dust, covered sparsely with tufts of creosote and wild wormwood.

The group crossed a final sandy plain and descended into the wide bed of the Colorado River, thickly overgrown with cottonwoods, willows and mesquites to which still clung a few beans. When they discovered how avidly the horses ate them, the men went in search of more.

Junction of the Colorado

On 23 November, 1846, a stormy, windy day, Emory and two colleagues "saddled up to visit the junction of the Gila and Colorado, which we found due north from our camp, and about a mile and a half distant." They were near what is now Yuma, and they could see the remains of a church built in the 17th century by Father Kino, later sacked by Indians, "the inhabitants all murdered or driven off. It will probably yet be the seat of a city of wealth and importance," Emory speculated in his diary, "most of the mineral and fur regions of a vast extent of country being drained by the two rivers."

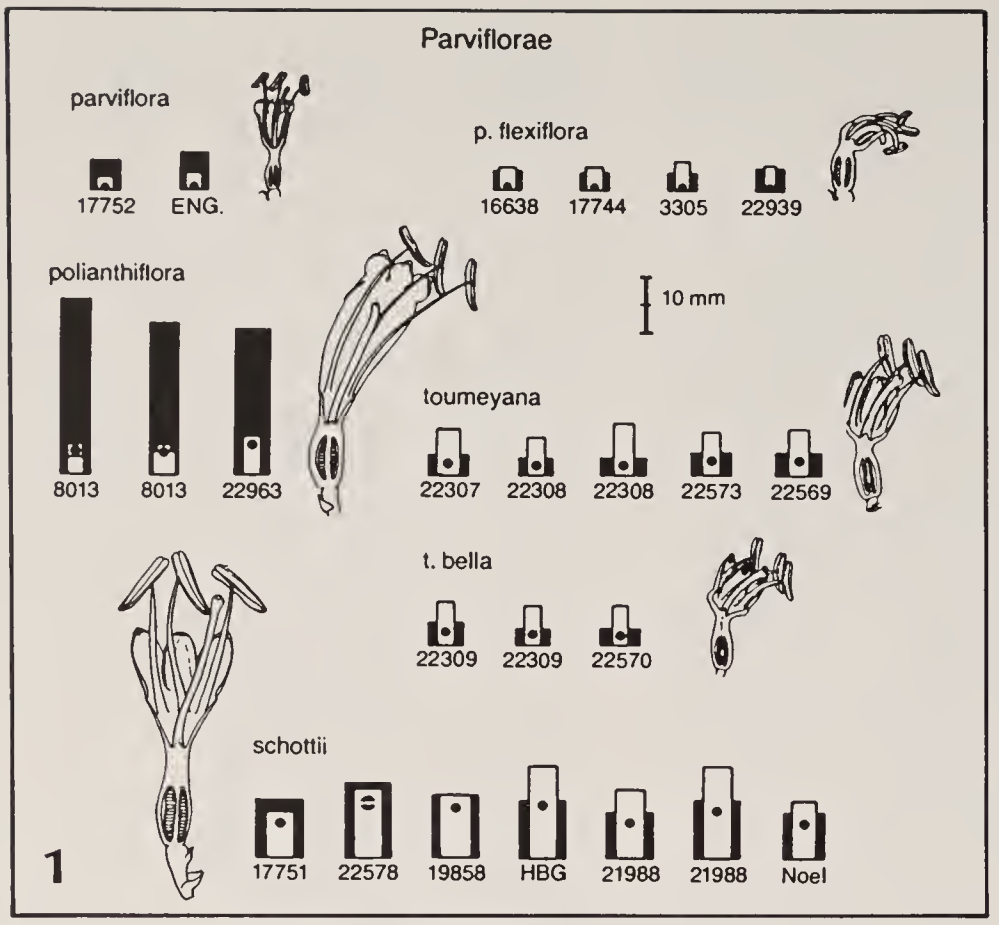
On November 25, the expedition left the Gila River, all men hoping they would never see it again, and crossed the Colorado into California to start the long trek to San Diego. Kearney had brought 110 men from Fort Leavenworth (then in Missouri), Lt. William Emory with them, without losing a man. Along the way Emory, in addition to his military duties, had discovered *Dalea formosa; Zinnia grandiflora; Baileya multiradiata;*

(continued on page 13)

Vera Gamet, a Docent of the Desert Botanical Garden, has written many articles for Saguaroland Bulletin.

The many kinds of species in Agave...

(continued from page 5)



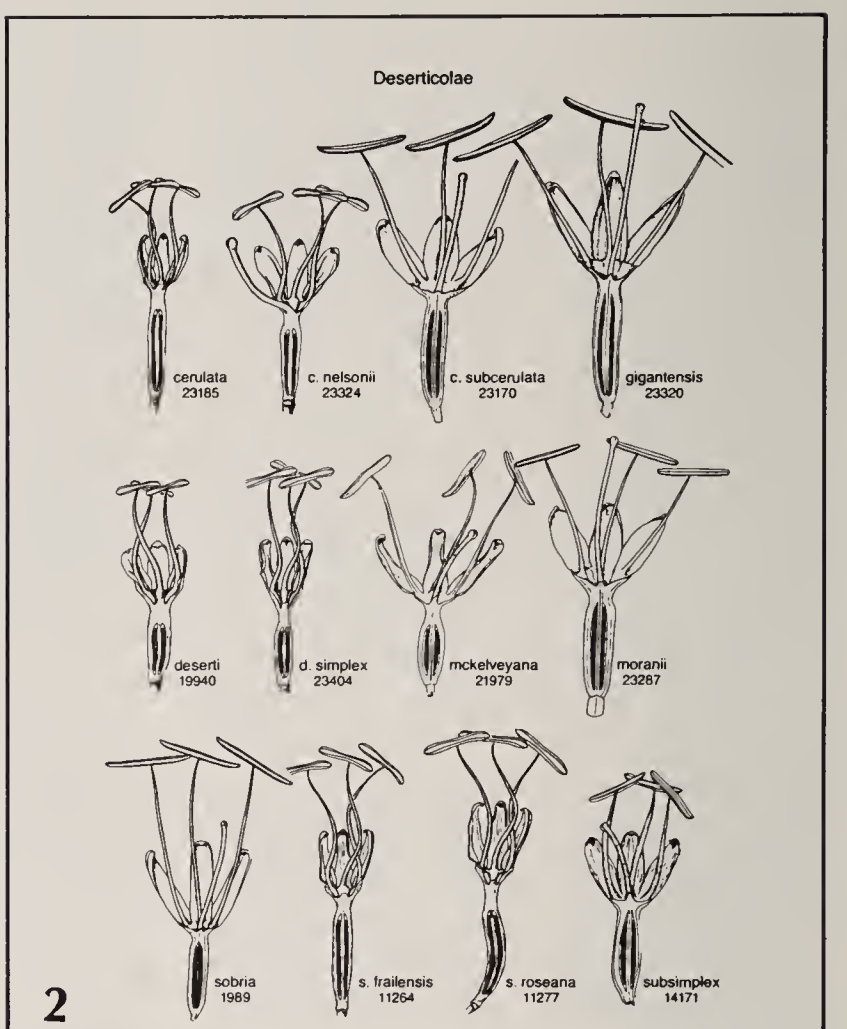
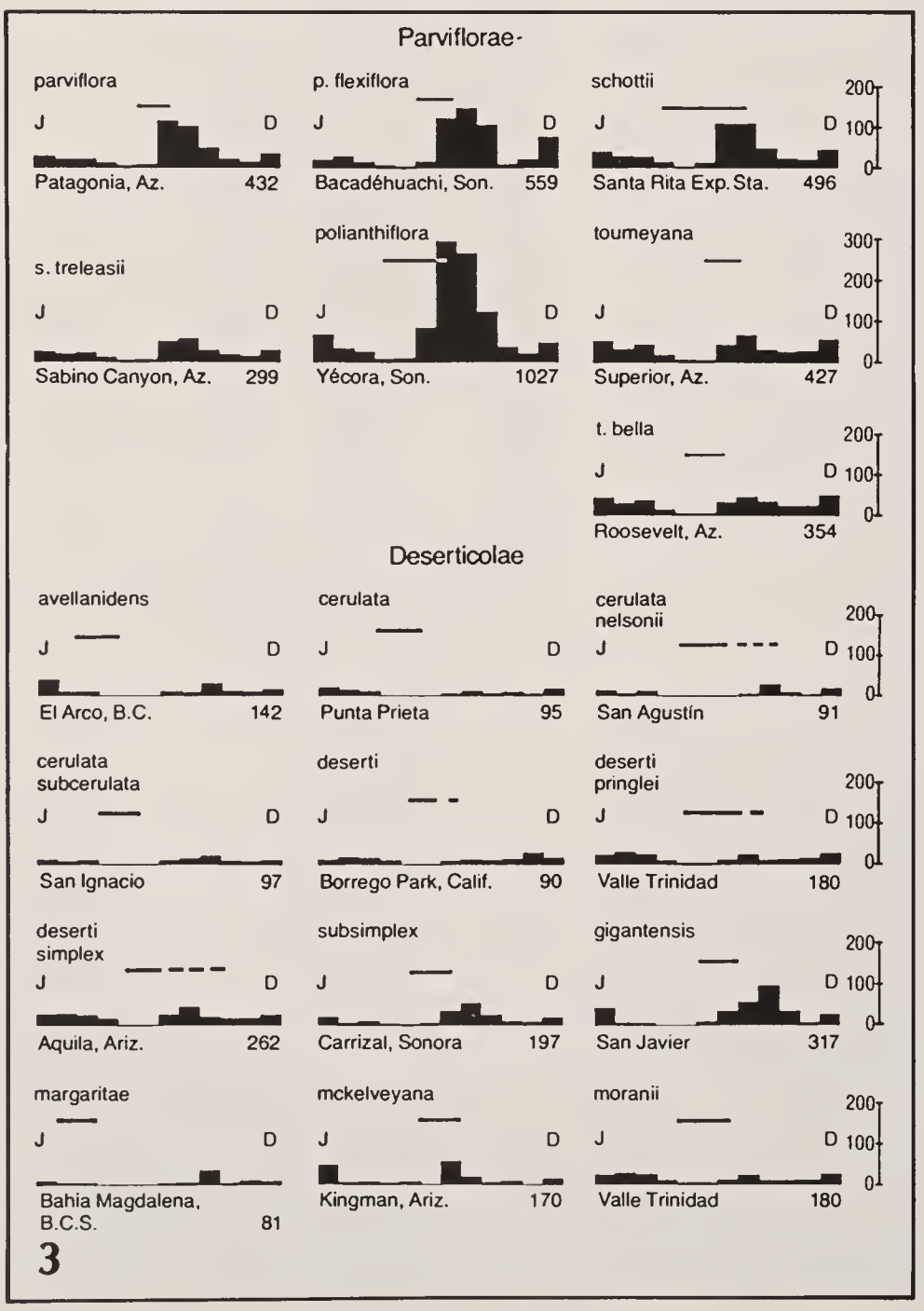


Fig. 1. The Parviflorae have relatively specialized flowers with good specific differences, as shown by the ideographs and correspondent long sections (**1,** above left).

Fig. 2. In the Deserticolae group, flower morphology is inadequate for use in separating species. Characters used for delineating species in this group are epidermis, leaf form and method of vegetative reproduction (**2,** upper right).

Fig. 3. Rainfall (silouettes) and flowering seasons (crossbars) of the Parviflorae and Deserticolae. The flowering of the Parviflorae flowers the dry spring, while the flowering of the Deserticolae takes place after winter rains (**3,** lower left)



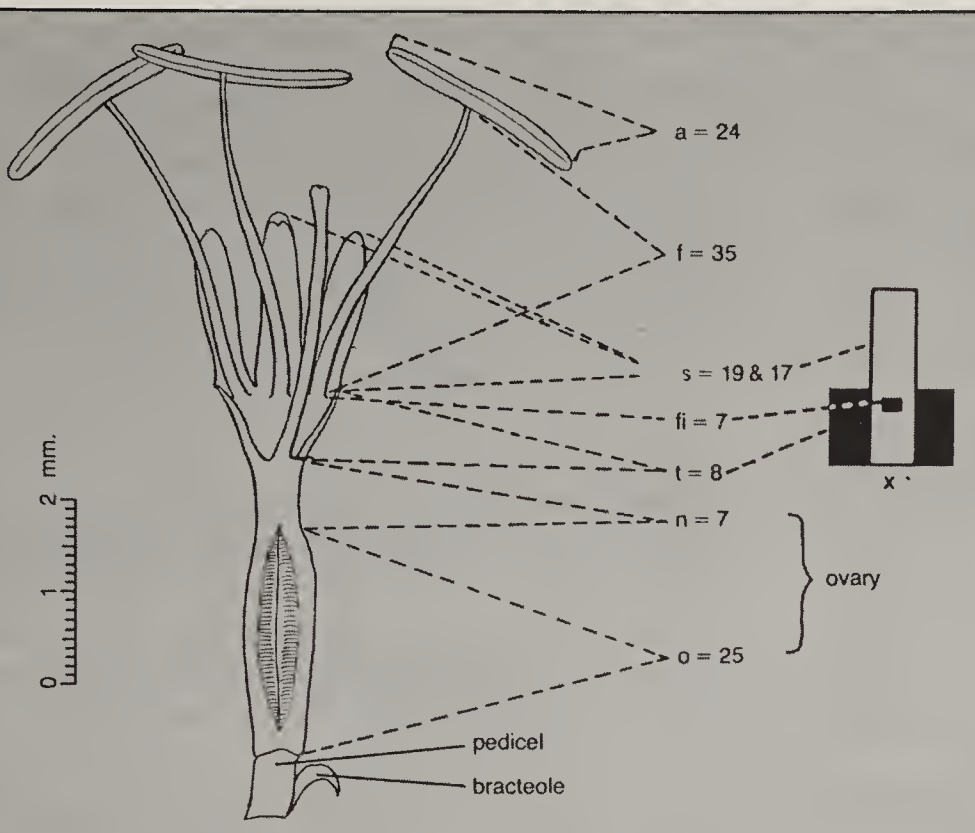


Fig. 4. Cross section of an agave flower with parts measured and a tube/tepal ideogram, **x.** The white column represents the tepal, the black the tube, and the black square the insertion in the tube. **o,** ovary body length; **n,** neck of ovary length; **t,** tube length; **fi,** filament insertion; **s,** tepal lengths; **f,** filament length; **a,** anther length.

IDEOGRAPHS

An ideograph is a form of taxonomic shorthand devised from measurements of flower parts. While a whole agave flower and its parts vary in size on the same inflorescence and between individual plants, the **ratios** between the respective organs remain more constant; measurements of the organs are helpful in analyzing variability and for correlating with leaf variations.

However, any flower varies in measurements according to its stage of development. In order to assure uniformity in comparisons, therefore, flowers should be measured at or about the time of anthesis (flower opening), which occurs in a single day. Fortunately, the agave flower continues flowering for several weeks from the base upward, so that the first few days the whole presents a sequence of flowers in all stages and one can select flowers just reaching anthesis for measurements. (Taken from Gentry, Howard Scott. 1982. *Agaves of continental North America.* University of Arizona Press, Tucson, Arizona.)

sweet-minded group, Freeman, Worthington and Reid of the University of Texas at El Paso, is investigating the chemistry of agave nectar. Donna Howell of Purdue University, studies bat pollination and will, I hope, follow the nectar flyway in Mexico. Burgess of the University of Arizona, Tucson, is making doctoral flourishes on variations and species problems. Victor Gass of the Desert Botanical Garden uses a helicopter and other means to save the rare *Agave arizonica* from extinction. Donald Pinkava and students at Arizona State University, Tempe, are studying chomosomes and hybridization in *Agave*. Still others who have been brushed by the wide wings of Mayahuel are chemists in England, fiber specialists from Mexico to Africa to Australia, and tequila tipplers everywhere. All, even the unlikely collectors of agaves, may help us understand the way of nature with *Agave*.

REFERENCE

Gentry, Howard Scott. 1982. Agaves of continental North America. University of Arizona Press, Tucson, Arizona.

A Botanical Reconnaissance...

(continued from page 11)

William H. Emory in later life, after he had become a lieutenant colonel in the U.S. Army.

Fouquieria spinosa (the ocotillo, later to be called *F. splendens*); a slender-leaved member of the morning-glory family, *Ipomoea leptophylla;* several mammillarias and opuntias; an oak; and three species of *Echinocactus.* Of one of these last, George Engelmann wrote to Emory, who had sent him specimens for identification:

> This species is distinct from all other New Mexican species examined by me, and is most probably undescribed. I propose to name it after its zealous discoverer, who has, surmounting numberless difficulties, though occupied by severe and arduous duties, found leisure to do so much for the advancement of our knowledge of the wild countries traversed by him — *Echinocactus Emoryi.*

REFERENCE

Emory, W.H. 1848. Notes of a military reconnoissance, from Fort Leavenworth, in Missouri, to San Diego, in California, including parts of the Arkansas, del Norte, and Gila Rivers. Made in 1846-7, with the advanced guard of the "Army of the West." Wendell and Van Benthuysen, Printers, Washington.

The Book Nook

BIOTIC COMMUNITIES OF THE AMERICAN SOUTHWEST — UNITED STATES AND MEXICO

David E. Brown, Editor, Desert Plants 4 (1-4): 3-341. 1983. $13.95, available from Boyce Thompson Arboretum, P.O. Box AB, Superior, Arizona 85273.

This carefully written, lucid, and succinct review of the biotic communities of the North American Southwest culminates a series of research efforts of top naturalists, botanists and zoologists over many years. The region extends from 26° to 38° N latitudes and 103° to 118° W longitudes and includes all of Arizona, New Mexico, Sonora, Chihuahua and Baja California Norte plus portions of California, Nevada, Utah, Colorado, Texas, Coahuila, Sinaloa, and Baja California Sur.

Before launching into descriptions of each community, the reader is treated to fine introductory comments and Cenozoic history of the region (by C.H. Lowe and Brown) as well as the history of ecological and taxonomic studies (by Brown, W.L. Minckley and J.P. Collins). Seven formations with their subdivisions are presented — Tundra (by Charles Pase), Forests and Woodlands (by Pase, Brown and H.S. Gentry), Scrublands (by Pase and Brown), Grasslands (by Brown), and Wetlands (by Brown and Minckley). Prefacing each is a brief thumbnail "definition" of the formation. The subdivisions are then presented in detail with ample illustrations, some in color, each subdivision description including distributions, highlights of its uniqueness, and details of its flora and vertebrate fauna. Appendix II conveniently summarizes for each subdivision the scientific and common names cited in the text. Appropriate comments are made throughout concerning man's impact on vegetation.

Another major feature underlying the whole text is a digitized step-down classification system for the biotic communities of North America with community (series) and association for the Southwest (Appendix I). Ambitiously, this open-ended system is designed to accommodate communities worldwide. This digitized system of classification for the Southwest is coordinated with a revised, multi-colored map (48" x 60", scale of 1:1,000,000; D.E. Brown and C.H. Lowe, 1980, USDA Forest Service General Technical Report RM-78). This map is separate, not included in this *Desert Plants* volume.

This publication is well-edited and uniformly presented. It surely will benefit ecologists, foresters, land and game managers, teachers and many others. However, most sections are brief and the reader often finds himself looking for more; but references are provided for those seeking additional information. Most welcome is the biota approach, the inclusion of plants and animals at each level of classification. Different from earlier and preliminary treatments of this topic is the addition and prominence of the Wetlands section, a welcome entry, too long omitted or given but passing recognition. Also, the Forest and Woodland formations, separate in the past, are combined herein as one entry. The map reflects neither of these changes. The value of this volume to the reader will increase as his background in ecology and his familiarity of the region increases.

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Department of Botany and Microbiology
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Editor's note: reprints of the second edition of the map will be available in the near future from USDA Forest Service, Rocky Mountain Station, Fort Collins, Colorado 80526.

The Garden Spot

Growing Plants — Back to Basics

by Victor Gass
Curator of living collections
Desert Botanical Garden

Growing plants can be a pleasant and rewarding pasttime. Your knowledge of the basic aspects of working with plants will make the effort much easier. Here are the eight areas with which you should be familiar to ensure success.

Planning: Be sure you know why you want the plants: for shade, screening, color, attracting birds, food production, or some other use. Know your local conditions and select the proper plants for your purposes, plants that can survive where you want to plant them.

Light is vital for growth. Plants often will grow in poor conditions, but they will not necessarily look or do their best. Be sure you know the plant's light requirements before you plant.

Preparation. Make certain the planting area is in good condition before planting. This may mean working with the soils, either adding elements or building up better soil totally if your plan is to put in plants that need special conditions. And be *selective:* try to buy only those plants that look green and healthy.

Planting: Planting techniques vary with the type of material you use. In general, if you have prepared the soil carefully and have taken care not to disturb the roots of the plant when planting, you should be successful. In general, you can plant throughout the year, but there is no question that the best times are spring and fall. Of course, you must plant vegetables or annuals only during the proper season for success.

Watering: Water is a very important chore. It is an ongoing job and will determine your success. A general rule is to know your plant's needs and to check the plants consistently for proper water conditions, both in the soil and by the appearance of the soil itself. Take environmental conditions into account — they can change the plant's water needs drastically. Another general rule is to give your plants a thorough, deep watering less often, rather than frequent, shallow waterings. All the plant's life functions depend on the amount of water available to it. Remember, too much water can be just as bad as not enough. Give your plants what they need.

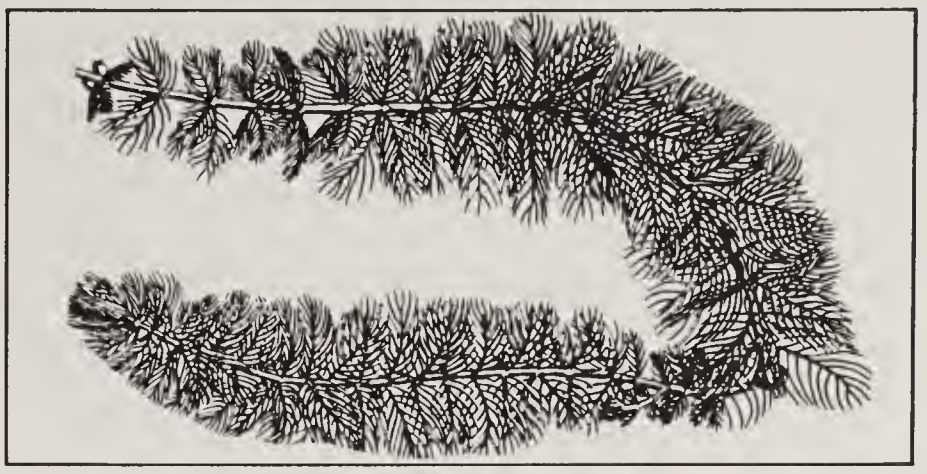
Fertilizing: Some plants need supplemental fertilizers; others will do very well without extra feedings, especially if the soil was well-prepared at the start. Often, water stress (either too much or too little) is interpreted as a need for fertilizer, so be sure your plants are receiving the proper amounts of water. Then if you want your plants to grow more vigorously, to become healthier, or to produce more flowers or fruit, addition of fertilizers may help. Again, be sure you know what you want the plants to do and then add the *proper* fertilizer in the proper *amounts* to make it happen.

Pruning: Now that the plants are growing well, they may need some pruning to remove weak branches or damaged areas, or to keep them within bounds. Often they need pruning to flower or fruit better, or to take on a desired shape. Don't wound the plant severely; and prune at the proper time — each plant has different pruning needs, too.

Pests and diseases: Pests or diseases sometimes do attack. Observe your plants: this is the best route to stopping a problem early. Keep trouble from starting by keeping conditions right for the plant. Remove dead material and severely infected and infested plants before the problem spreads. Identify pests first, before acting; then select the proper treatment to correct the trouble without causing further troubles. **PROCEED WITH CAUTION IF YOU USE A PESTICIDE: READ THE LABEL CAREFULLY.** Learn to ask questions. Have conditions changed? What are you doing differently to the plant, if anything? Are there obvious signs of insects or disease? What is the pest? What can be done to stop the problem? Usually, with a little research, the solution will become apparent.

Numerous sources of information about plants and their care are available at libraries and nurseries. Classes are offered at local schools and universities, and the County Agricultural Extension Service, as well as the Desert Botanical Garden, can be of service.

Remember the eight basic aspects of growing plants. Learn to observe and ask questions. And above all, keep right on trying and you're bound to have success with your growing plants.



Myriophyllum verticillatum L. in Arizona

by J. Harry Lehr
Curator of the Herbarium
Desert Botanical Garden

The New York Botanical Garden recently sent a set of plants to the Desert Botanical Garden that contained two collections of *Myriophyllum verticillatum* L. collected in Arizona. The genus *Myriophyllum,* water milfoil, has been represented hitherto by *M. brasilense* Cambess., parrot's feather or water feather; and *M. spicatum* L. ssp. *exalbescens (Fern.) Hult.;* these are the only members of the family Haloragaceae previously recorded in Arizona (Kearney and Peebles, 1960; Lehr, 1978).

The new collections of *M. verticillatum* broaden the western limits of its range (Aiken, 1981), listed by Correll and Correll (1975) as extending to Utah and northeastern Texas.

Collection data are as follows:

1. *Myriophyllum verticillatum* L. Submerged in water one to four feet deep, Peck's Lake, three miles east of Clarkdale, Prescott National Forest, Yavapai County, Arizona. 26 September, 1965. John C. Crutchfield 856, DES 24033.

2. *Myriophyllum verticillatum* L. Submerged in water five to six inches deep, Lake Wood at Lakeside, Navajo County, Arizona. 17 May, 1966. John R. Crutchfield 1560, DES 24034.

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Aiken S.G. 1981. A conspectus of *Myriophyllum verticillatum* (Haloragaceae) in North America. Brittonia **33** (1): 57-69.

Correll, Donovan S., and Helen B. Correll. 1975. Aquatic and wetland plants of the southwestern United States. Stanford University Press, Stanford, California.

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Lehr, J. Harry. 1978. A catalogue of the flora of Arizona. Desert Botanical Garden, Phoenix, Arizona.

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Agave vilmoriniana

agave
Quarterly Magazine of the Desert Botanical Garden, Phoenix, Arizona

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Desert Botanical Garden is a non-profit, incorporated, educational institution for the study and conservation of desert plants. Founded in 1937 by the Arizona Cactus and Native Flora Society, it is located on 150 acres in Papago Park, in the heart of metropolitan Phoenix. In a naturalistic setting are more than half the world's species of cacti and other succulents, and trees and shrubs from arid regions of Asia, Africa, Australia and the Americas. Research is carried on in the Earle Herbarium and Richter Library; educational programs, open to the public, include lectures, classes and field trips.

The Desert Botanical Garden is supported by memberships, contributions and admissions. Members receive many benefits, including the satisfaction of supporting the Garden's conservation effort at a time when destruction of the fragile desert is widespread.