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A DEBT TO THE FUTURE: SCIENTIFIC ACHIEVEMENTS OF THE DESERT LABORATORY, TUMAMOC HILL, TUCSON, ARIZONA

by Janice E. Bowers

(This is the first of a two-part article which originally appeared in *Desert Plants*; it is re-edited and reprinted here with the permission of *Desert Plants*.)

"It won't be many moons now before we shall have a laboratory here that will do your eyes good to see," wrote William A. Cannon to Daniel T. MacDougal on October 17, 1903.(1) Cannon was a plant anatomist, and MacDougal, a plant physiologist, was his employer. The laboratory in question was the Desert Laboratory on Tumamoc Hill two miles west of downtown Tucson, Arizona. Its stone walls had been completed a month earlier, and, even as Cannon wrote, painters and carpenters were putting the finishing touches on the interior. The following month Cannon told MacDougal, "This is absolutely the finest place to work...that could possibly be found; I am more and more pleased with the prospects for research as time goes on."(2)

Over the next thirty-seven years, more than sixty scientists would find the lab a fine place to work, and they published some 350 papers and books based on research there.(3) Their fields of study included geomorphology, climatology, geography, botany, emtomology and mammology. Though the laboratory has most often been singled out as a locus of early ecological work (McGinnies 1981, McIntosh 1983), Desert Laboratory biologists were also physiologists, anatomists, morphologists and geneticists. Some became top researchers in their fields, scientific superstars such as geographer Ellsworth Huntington, ecologists Forrest Shreve and Fredric Clements, and plant physiologists Daniel T. MacDougal and Burton E. Livingston.

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PRESIDENT'S LETTER

Happy New Year to all! May 1993 prove to be a healthy, happy and productive year for you and for our society as we continue to work toward realizing our goals of increasing awareness and appreciation of Arizona's native plants, working towards protection and restoration of native plants and their habitats, and promoting the use of low water-demanding landscaping, particularly with native plants.

Well, the state election is history, and Proposition 102 didn't pass. Much the pity, because its provisions are badly needed by our state's land managers for the purposes which I outlined in the last issue of *The Plant Press*. Lack of funds for getting the word out on the need for Prop 102, coupled with a general disinclination to give any more authority to state "bureaucrats" of any kind probably account for this unfortunate failure.

In the last issue of *The Plant Press*, some specific aspects of our society's purposes and principles were related to the current and potential activities of the ANPS. I would like to continue exploring areas covered in our Statement of Purpose and Principles from the point of view of what we are doing or can be doing to realize our goals. The general area that I will discuss is conservation.

The first purpose of the ANPS is to preserve native plants in their habitats through the passage of laws and ordinances intended to protect those plants, to promote the salvage of plants that cannot be preserved in place, and to support the enforcement and strengthening of existing plant preservation laws. Our past involvement in the drafting of the Arizona Native Plant Law (NPL) and ongoing involvement in Rules formulation via input to the NPL Technical Advisory Board will hopefully act to bring this goal closer to realization. We need to continue to collaborate with the Arizona Department of Agriculture to do much needed extension work aimed at clear information to the general public about the provisions of the NPL in terms of citizen responsibilities and opportunities.

The second purpose of the ANPS is to protect and/or restore special habitats, such as riparian areas, areas containing threatened and endangered species, and naturally diverse habitats with otherwise special combinations of native plant and/or animal communities. This is an area in which the ANPS has been very active over the years. Successive chairpersons and members of our Conservation Committee have put considerable effort into pursuing these goals, often in cooperation with other environmental advocacy groups such as the Sierra Club, the Nature Conservancy and the Audubon Society, among others. An important aspect of protecting sensitive plant populations is having adequate knowledge of the real extent of the populations in question. This is an area in which the ANPS has a potentially positive role to play by utilizing our extensive schedule of statewide field excursions as an opportunity to maintain a sharp lookout for populations of rare or endangered Arizona natives. Sightings can be reported to the local chapter conservation chairperson who in turn can turn them in to our state Corresponding Secretary, Karen Breunig. Chapter conservation chairs could make available information covering the sensitive species likely to be encountered in their areas. Flagstaff ANPS chapter member Dr. Barbara Phillips is currently carrying out such a program for the Coconino National Forest.

The third purpose of our Society is to expand protected native plant habitats through changes of public land classification to more protective status; to continue protection of those areas already designated with special protective status; and to foster acquisition of public or private sites by appropriate entities. We in the ANPS can help in this area by bringing forward for public or private non-profit consideration special native plant habitats that currently lack proper or adequate protective status. This is a goal that would have been moved forward significantly by passage of Prop 102, so "If at first you don't succeed....." Once more, best wishes for a great New Year!

- Bill Feldman

WATCH FOR THE SPECIAL MAILING REGARDING THE ANNUAL MEETING PLANNED FOR MARCH IN YUMA.

EDITOR'S DESK

Shortly after the turn of the century, on a low hill overlooking what is now downtown Tucson, a group of scientists gathered in a quest for knowledge. Shreve... Cannon... MacDougal... Livingston... these were pioneers eager to investigate the secrets of desert life. In fact, much of what we know today about Sonoran Desert plants results from their far-reaching work. In this issue of *The Plant Press*, Janice Bowers chronicles the fascinating history of the Desert Laboratory and the achievements of these scientists.

There are, of course, many ways that we as individuals can appreciate and learn from our natural environment. Robert Zahner writes about a program called the National Register of Big Trees where citizens are encouraged to identify and help register the largest specimens of tree species. See "The Champion Trees of Arizona."

With the annual meeting coming up in March in Yuma, Steve McLaughlin and Janice Bowers have put together a Yuma Dunes plant list. If you plan to attend (and hopefully many of you can), be sure to take it along as it should be very helpful for both field trips and discussions.

We have something a little different in "The Native Landscaper" this issue. Dr. Jimmy L. Tipton gives us the latest research findings and expert advice on getting our beautiful natives off to a good start in the landscape. And Susan Husband introduces us to some delightful postcard books in "Pressed Pages."

If you miss the Conservation Page in this issue, take heart. Julia Fonseca has stepped forward to take over as editor in this capacity. Look for it in the next issue of *The Plant Press.*

Hope you are all enjoying the new year. I'll be gone for several months, and Dean Brennan, who handles layout and production aspects, will take over all editorial duties. See you in time for the Fall Issue!

Balbir Backhaus

Workshop on "The Use of Native Grasses"

Saturday, February 6, 1993, 9 am to 4 pm
Red Rock State Park, Sedona

Speakers include Barbara Phillips, Tony Burgess, Dan James and Dave Kopec. Cost is $9.00 plus $3.00 per car parking fee (lunch included). Preregistration is required by January 30, 1993. Please mail your name, address and payment to:

Carole I. Binswanger
P.O. Box 10207
Sedona, Az 86336 (602) 282-1206

Jointly sponsored by the Coconino National Forest Service, University of Arizona Cooperative Extension, The Arboretum at Flagstaff, Sierra Club, Sedona-Verde Valley Group, Arizona Native Plant Society, Keep Sedona Beautiful, and the Arizona Department of Transportation.

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Roots of the Desert Laboratory

The idea for a laboratory devoted to desert plants was Frederick V. Coville's. As chief botanist of the U.S. Department of Agriculture, he explored Death Valley in 1891 and came away impressed by the clear need for intensive research on deserts, largely an unknown environment. He presented his case to the Carnegie Institution of Washington's botanical advisory committee. They agreed that "there should be established at some point in the desert region of the southwestern United States a laboratory for the study of the life history of plants under desert conditions, with special reference to the absorption, storage and transpiration of water" (*Carnegie Yearbook*. Vol. 1. 1902: p.5).

In December 1902, the Carnegie Institution appropriated $8,000 for the Desert Botanical Laboratory, as it was first called. From January 24 to February 28, 1903, Coville and MacDougal, then director of laboratories at the New York Botanical Garden, toured the southwestern United States and Mexico in search of a location for the proposed lab. They realized that the most important criterion was that the new research station be situated not in a city but in undeveloped desert. After traveling as far south as Guaymas, Sonora, and as far west as Los Angeles, they settled on Tucson as the most suitable site. Here they found a "distinctly desert climate and flora" in combination with "habitability" and "ready accessibility" (Coville and MacDougal, 1903: p. 12).

The Earliest Years-- 1903-1905

Construction of the laboratory proceeded rapidly after four local builders submitted bids in March, 1903. Coville supervised the process as minutely as possible from Washington, D.C. By September 1, Cannon, as the first resident investigator, was on the spot and could supervise the final phases of construction. As soon as the facilities were workable, Cannon immersed himself in research. The year before, as a research assistant at the New York Botanical Garden, he had worked on anatomy of plant hybrids, research confined largely within laboratory walls. Once he moved to Tucson however, he found himself stimulated in unexpected ways, and his interests turned increasingly towards native plants in natural habitats.

After a year of solid work, Cannon told MacDougal, "To tell the truth there is enough here for several men to work on at once and for some time to come. To choose wisely from the abundance is the main difficulty."[4] Between 1903 and 1905, Cannon also compiled a 250-citation bibliography on transpiration, developed an apparatus for measuring transpiration in place, measured transpiration of a variety of desert plants, compared the anatomy of irrigated and nonirrigated plants and examined seasonal changes in diameter of saguaro cactus (*Carnegiea gigantea*) and *Ferocactus wizlizenii*. The successful launching of the Desert Laboratory was, in fact, due in large part to Cannon's diligence and creativity.

Another key to the Desert Laboratory's early success was Volney M. Spalding, a modest, courtly, well-respected botany professor who retired from the University of Michigan in 1904 after nearly thirty years of teaching. He came to the Desert Laboratory as a visiting investigator in December 1903 with the enthusiastic support of MacDougal.

One of Spalding's first projects at the Desert Laboratory was determining transpiration rates of creosote bush (*Larrea tridentata*) in soils of different moisture content. He found that leaves of *Larrea* and several other desert perennials showed "a very limited capacity for absorption of water vapor from the atmosphere" (Spalding, 1906: p. 373). More important to their water economy, however, were periods of high humidity and the consequent reduction in transpiration.

While Cannon and Spalding launched the Desert Laboratory, MacDougal publicized it in every conceivable venue. He wrote brief notices for the *Journal of the New York Botanical Garden* (1903a), *Plant World* (1903b), *Botanical Gazette* (1903c) and *Science* (1903d). He told readers of the *Plant World* that, "while any of the more important phases of botany might be the subject of investigation by means of the facilities offered by this laboratory, yet its special function consists of an inquiry into the morphology, physiology, habit and general life-history of the species indigenous to the deserts of North America" (MacDougal, 1903b: p. 249).

Before long, various scientists, among them plant anatomist Francis E. Lloyd, lichenologist Bruce Fink, mammologist Charles B. Davenport, and plant physiologist Burton E. Livingston, had expressed interest in pursuing studies at the Desert Laboratory. Visiting investigators were uniformly impressed and delighted by the new facilities, which by 1907 included 860 acres of the surrounding desert. Livingston, upon receipt of a grant to work at the Desert Laboratory, told MacDougal, "this is the best thing that ever happened to yours truly, excepting my coming to your lab last fall, and I am duly elated over the affair." [5]

The Carnegie Institution formally reorganized the Desert Laboratory as the Department of Botanical Research in December 1905 and appointed MacDougal its first director. MacDougal assembled his crew: he hired Cannon, Spalding, Livingston and Lloyd as staff members and Godfrey Sykes (a jack-of-all-trades who had supported himself variously as an explorer, geographer and civil engineer) as laboratory superintendent.

The Productive Years-- 1906-1917

The earliest years of the Desert Laboratory were characterized by excitement and uncoordinated projects. Once the permanence of the lab seemed assured, however, the staff confidently began many long-term projects and initiated the

laboratory's most productive era. Permanence brought expansion; remodeling of the laboratory building started in March 1906 and was finished before the end of the year.

Tumamocville, as its inhabitants called it, was a pleasant place to work and live. At first, the laboratory staff lived in tents on the grounds. These measured about twelve feet by fourteen feet and were erected over wooden frames. Eventually, MacDougal, Livingston, Shreve, Cannon and Sykes built real houses at the base of Tumamoc Hill, and visiting scientists were accomodated in the tents. The population of Tumamocville rose every summer with the influx of visitors; MacDougal said that the laboratory was "fast becoming the Mecca of North American botany."[6] The popularity of the lab was due partly to MacDougal's genial hospitality and partly to the unique opportunities for research.

During this period Cannon continued his ecological studies of roots. In excavating a variety of desert plants, he found two specialized types of root system in which either tap roots or lateral roots were prominent and a generalized type in which both tap and laterals were well developed (Cannon 1911). Cacti made a fourth, highly specialized category. Few cacti possessed deeply penetrating roots, he discovered; in most species, the roots branched profusely just beneath the soil surface. He hypothesized that *Carnegiea* was nearly restricted to rocky slopes because boulders provided both anchorage for shallow roots and extra runoff not available on flats. In contrast, *Larrea*, with its generalized root system, could thrive in a variety of habitats. His studies of roots in place eventually led him to undertake laboratory experiments to see how varying temperature, moisture and aeration regimes determine root development (Cannon, 1915, 1916). One of the most important contributions of this work was his discovery that cacti are abundant in regions where rain falls during the warm months; this is, he concluded, because their roots grow only when the soil is warm.

Once long-term projects at the Desert laboratory seemed assured of some continuity, Spalding set up nineteen permanent plots on the grounds. In 1906, with the assistance of Jacob Blumer, Spalding mapped the woody perennials on each plot. Around the same time, he supervised Blumer in the mapping of five perennial dominants, including the blue palo verde (*Cercidium floridum*) and *Carnegiea gigantea*, on the Desert Laboratory grounds.

The Desert Laboratory plots have been continually monitored since 1906, making them the longest-running in ecological history (White 1985). The populations of *Cercidium floridum* and *Carnegiea gigantea* have also been mapped at intervals, as have exotic annuals and perennials (Turner and Bowers, 1988). These long-term projects, a product of Spalding's foresight and perseverance, have provided a wealth of data and results that could not have been obtained by any other means.

(In the next issue, Forrest Shreve joins the staff of the Desert Laboratory.)

Janice E. Bowers, Ph.D, is Botanist with the U.S. Geological Survey's Research Project Office on Tumamoc Hill.

End Notes
AHS -- Arizona Historical Society

1. W. A. Cannon to D. T. Macdougal, 17 Oct. 1903, AHS.
2. W. A. Cannon to D. T. MacDougal, 23 Nov. 1903, AHS.
3. My estimate is based on the bibliography in McGinnies (1981) and does not include research carried on primarily at the Coastal Laboratory.
4. W. A. Cannon to D. T. MacDougal, 24 Oct. 1904, AHS.
5. B. E. Livingston to D. T. MacDougal, 17 March 1904, AHS.
6. D. T. MacDougal to A. M. Vail, 2 May 1913, AHS.

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THE NATIVE LANDSCAPER

Transplanting -- A Good Start for Your New Plant

Dr. Jimmy L. Tipton

There is a tendency among enthusiasts to emphasize the differences between native and exotic plants. I suspect this may hinder the acceptance of native plants by the general public, at least in some cases, because the exotic plants are more familiar. John and June Homeowner think (usually erroneously) that they know how to plant, water, fertilize and prune a pyracantha. Faced with a choice between the pyracantha and an evergreen sumac, the latter with presumably unknown cultural requirements, I believe John and June will choose the former. So I prefer, where possible, to emphasize the similarities between native and exotic plants. One area where this is possible, at least for the majority of plants, is in transplanting.

In general, plants are observed to perform better when grown in soft, deep soils often rich in organic matter. Such observations have resulted in transplanting practices designed to simulate these conditions. In Arizona, said practices include a large planting hole (to 6 feet wide and deep) to provide a loose, deep soil; and amending the backfill with organic matter to improve water percolation and cation exchange capacity and provide a transition to the unimproved soil. Research conducted over the past decade or so indicates that these traditional transplanting practices may not benefit and may even be detrimental to the tree or shrub. Relevant results from this research can be summarized as follows:

1. Trees and shrubs planted in a non-compacted soil develop a root system that extends 1.5 to 2 or even 4 times the canopy diameter. This lateral root system is within 2 or 3 feet of the soil surface. One year after transplanting a container-produced tree, only 50% of the root system is within the container media. The above relationship (i.e., lateral root system well beyond the canopy) is usually established within three years following transplanting. In 1911, W.A. Cannon examined the roots of a native creosote bush growing on a deep soil in the Tucson area. Numerous lateral roots radiated from the shrub to a distance of 7 feet (about 1.4 times the shrub height). These roots were 8 to 18 inches deep, but occasional sinker roots penetrated to a depth of 7 feet.

2. Urban soils are typically compacted, either as a result of building activities or by traffic. One site in Washington, D.C., which was subject to pedestrian traffic only, had compacted to the density of a brick. Compaction reduces gas exchange between the soil and atmosphere. As a result roots do not grow as well in a compacted soil due to a lack of oxygen.

3. The tap root found on trees and shrubs growing in place from seed is destroyed by common nursery practices and is not regenerated. Nursery-produced plants can develop deep roots, but not generally a tap root. Even in native stands, the tap root may not be as dominant as is often assumed. The creosote bush mentioned above had a tap root that penetrated only 1 foot deep.

4. Plants transplanted into holes deeper than the container tend to sink as soil beneath them subsides. This subsidence can be due to decomposition of organic amendments in the backfill as well as compaction due to irrigation. When soil fills in this subsidence, the susceptible stem is subjected to various soil borne diseases.

5. Root growth may be constrained by interfaces, such as that between the container media and backfill, and between backfill and the native soil (particularly if the native soil is compacted or has a high clay content). Excessive organic amendmants in the backfill can exacerbate this problem. In extreme cases the root system may be confined to the planting hole except for very shallow laterals.

6. Organic amendments very rarely result in increased growth. A well-digested compost is the preferred organic amendment. Undigested wood chips or 'mulch' is more common. This material decomposes in the soil resulting in local shortages of nitrogen and the loss of beneficial microbes.

These research results have caused many to modify their transplanting practices. Perhaps the best-known modification is the elimination of organic amendments in the backfill to avoid interfaces and nitrogen shortages. The American Forestry Association now recommends a less dramatic planting hole as deep as the container and five times as wide to encourage lateral root spread. The International Society of Arboriculture recommends a hole as deep as the container and twice as wide with an unamended backfill. My recommended steps for transplanting most container trees and shrubs (native or exotic) are:

1. Prepare a planting area 3 to 5 times the diameter of the container. Till this area to the depth of the root ball to aerate compacted soil.

2. Dig a planting hole in the center of the area no deeper than the container. Make sure the root ball will rest on undisturbed, firm soil and that the top will be at or slightly above the soil surface. This is important to prevent the plant from sinking.

3. Remove the plant from the container. This is usually very easy if you hold the plant by its trunk, turn it upside down and gently knock the edge of the container on a hard surface (wall or fence). If the plant is too big, cut the container rather than lifting the plant by its trunk.

4. Either disentangle and spread encircling roots or cut and remove them. Score the sides of the root ball to encourage lateral root growth.

5. Place the plant in the hole and backfill with unamended soil. Do not tamp backfill with your feet.

6. Remove any nuresery stakes. Stake trees only if necessary. Prune only damaged branches Do not remove one third of the foliage. Root initiation and growth is stimulated by stem buds and leaves. Therefore shoot pruning reduces root growth and prolongs establishment.

7. Form a well just outside the original root ball. Fill this well with water to irrigate the plant and settle the soil without compaction. Even if you intend to irrigate the plant with a drip system, continue to hand water for several weeks or months (depending upon the type of plant and season of year).

8. If you wish to fertilize the plant (which may or may not be beneficial), apply a nitrogen fertilizer over the entire area prepared in step 1. Use no more than 15% actual nitrogen per 1000 square feet.

9. Apply 3-4 inches of an organic mulch over the entire area prepared in Step 1. Keep mulch away from the base of the plant. Even desert shrubs will benefit from an organic mulch.

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SAND DUNES OF THE SONORAN DESERT

Steven P. McLaughlin and Janice E. Bowers

Sand dunes, an uncommon landform in the Sonoran Desert, supports a remarkable if not particularly diverse flora. About twenty percent of Sonoran Desert dune plants are endemic, that is, found only on dunes. Many of these endemics are closely adapted to their unique environment. Desert sand dunes are relatively moist habitats, especially compared to surrounding plains, but there are other stresses. On active dunes, where sand blows freely in the wind, solar radiation is high, nutrients are scarce, and moving sand constantly threatens plants with burial or excavation. Sand dune endemics have adapted to these hazards in several ways. Rapid shoot growth keeps leaves and flowers above accumulating sand, and rapid root growth anchors the plants, helping them withstand excavation. Formation of adventitious roots facilitates the search for water as the sand levels change.

While superbly adapted for life on dunes, sand dune endemics are poorly suited to survive in other habitats. By the same token, few plants of rocky or gravelly habitats are fitted to survive on dunes. For this reason, sand dune floras are usually small and contain a high percentage of endemic species.

The following list, based on several different floras, includes most of the sand dune plants of southwestern Arizona, southeasternmost California and northwestern Sonora. Sand dune endemics are noted with an asterisk. (*)

Aizoaceae

Mollugo cerviana (L.) Ser. Tread-stem carpet weed.

Amaranthaceae

Amaranthus fimbriatus (Torr.) Benth. ex S. Wats. Fringed amaranth.
Tidestromia lanuginosa (Nutt.) Standl.

Asclepiadaceae

Asclepias subulata Decne. Reed-stem milkweed.

Asteraceae

Ambrosia dumosa (A. Gray) Payne. White bursage.
Baileya pauciradiata Harv. & A. Gray. Lax flower.
Baileya pleniradiata Harv. & A. Gray. Desert marigold.
Dicoria canescens Torr. & A. Gray ssp. *canescens*. Bugweed. *
Chaenactis stevioides Hook. & Arn. Pincushion flower.
Geraea canescens Torr. & A. Gray. Desert sunflower.
Helianthus niveus (Benth.) Brandegee ssp. *tephrodes* (Gray) Heiser. Dune sunflower. *
Palafoxia arida Turner & Morris var. *arida*. Spainish needles.
Palafoxia arida Turner & Morris var. *gigantea* (Jones) Turner & Morris. Giant Spainish needles. *
Pectis papposa Harv. & A. Gray. Cinch weed.
Perityle emoryi Torr. Rock daisy.
Stephanomeria exigua Nutt. Desert straw.
Tessaria sericea (Nutt.) Shinners. Arrowweed.

Bignoniaceae

Chilopsis linearia (Cav.) Sweet. Desert willow.

Boraginaceae

Cryptantha angustifolia (Torr.) Greene. Narrow-leaf popcorn flower.
Cryptantha costata Brandegee. Ribbed popcorn flower.
Cryptantha micrantha (Torr.) M. C. Johnst. Dwarf popcorn flower.
Tiquilia palmeri (A. Gray) Richards. Palmer coldenia.
Tiquilia plicata (Torr.) Richards. Pleated coldenia. *

Brassicaceae

Dimorphocarpa pinnatifida Rollins. Spectacle pod. *
Dithyrea californica Harv. Spectacle pod.

Cactaceae

Opuntia echinocarpa Engelm. & Bigel. Silver cholla.

Caryophyllaceae

Achyronychia cooperi A. Gray. Frost mat.
Drymaria viscosa S. Wats.

Chenopodiaceae

Atriplex canescens (Pursh) Nutt. ssp. *linearis* (S. Wats.) Hall & Clem. Fourwing saltbush.
Salsola kali L. Tumbleweed, Russian thistle (nonnative).

Cucurbitaceae

Cucurbita palmata S. Wats. Coyote melon.

Ephedraceae

Ephedra trifurca Torr. Mormon tea.

Euphorbiaceae

Argythamnia serrata Muell. Arg. Yuma ditaxis.
Chamaesyce platyaperma (Engelm.) Shinners. Dune spurge. *
Croton wigginsii Wheeler. Wiggin's croton. *
Stillingia linearifolia S. Wats. Narrow-leaf stillingia.
Stillingia spinulosa Torr. Annual stillingia. *

Fabaceae

Astragalus insularis Kell. var. *harwoodii* Munz & McBurney. Sand locoweed. *

Astragalus lentiginosus Dougl. var. *borreganus* Jones. Borrego locoweed. *

Astragalus magdalenae Greene var. *peirsonii* (Munz & Barneby) Barneby. Peirson's locoweed. *

Cercidium floridum Benth. Blue paloverde.

Dalea mollis Benth. Silky dalea.

Lotus strigosus (Nutt.) Greene var. *tomentellus* (Greene) Isely. Desert lotus.

Lupinus arizonicus (S. Wats.) S. Wats. ssp. *sonorensis* Christ. & Dunn. Arizona lupine.

Olneya tesota A. Gray Ironwood.

Prosopis glandulosa Torr. var. *torreyana* (Benson) M. C. Johnst. Honey mesquite.

Psorothamnus emoryi (A. Gray) Rydb. Dune peabush. *

Psorothamnus spinosus (A. Gray) Barneby. Smoke tree.

Geraniaceae

Erodium texanum A. Gray. Texas filaree.

Hydrophyllaceae

Nama hispidum A. Gray. var. *spathulatum* (Torr.) Hitchc.

Phacelia ambigua Jones var. *minutiflora* (Voss) Atwood. Heliotrope phacelia.

Phacelia pediculoides (J. T. Howell) Constance.

Lennoaceae

Ammobroma sonorae Torr. Sand food. *

Liliaceae

Hesperocallis undulata A. Gray. Ajo Lily.

Triteliopsis palmeri (S. Wats.) Hoover. Blue sand lily. *

Loasaceae

Mentzelia albicaulis Dougl. White-stemmed blazing star.

Mentzelia multiflora A. Gray. ssp. *longiloba* (Darl.) Thompson & Zavortink. Dune blazing star.

Petalonyx thurberi A. Gray ssp. *thurberi*. Sandpaper plant.

Malveceae

Sphaeralcea orcuttii Rose. Globemallow.

Nyctaginaceae

Abronia villosa S. Wats. var. *villosa*. Sand verbena. *

Onagraceae

Camissonia boothii (Dougl.) Raven ssp. *condensata* (Munz) Raven. Woody bottle washer.

Camissonia claviformis (Torr & Frem.) Raven ssp. *yumae* (Raven) Raven. *

Camissonia claviformis (Torr & Frem.) Raven ssp. *rubescens* (Raven) Raven.

Oenothera deltoides Torr & Frem. ssp. *deltoides*. Dune primrose.

Plantaginaceae

Plantago fastigiata Morris. Woolly plantain.

Poaceae

Aristida californica Thurb. Mojave three-awns.

Bouteloua aristidoides (HBK.) Griseb. Needle grama.

Bouteloua barbata Lag. Six-week grama.

Hilaria rigida (Thurb.) Benth. ex Scribn. Big galleta.

Oryzopsis hymenoides (Roem. & Schult.) Rick. Indian ricegrass.

Panicum urvilleanum Kunth. d'Urville's panic grass. *

Polemoniaceae

Langloisia setosissima (Torr. & A. Gray) Greene.

Linanthus bigelovii (A. Gray) Greene.

Loeseliastrum schottii (Torr.) Timbrook.

Polygonaceae

Chorizanthe brevicornu Torr. ssp. *brevicornu*. Brittle spiny flower.

Chorizanthe rigida (Torr.) Torr. & Gray. Turk's head.

Eriogonum deserticola S. Wats. Dune buckwheat. *

Eriogonum inflatum Torr. & Frem. Desert trumpet.

Eriogonum trichopes Torr. Yellow trumpet.

Nemacaulis denudata Nutt. var. *gracilis* Goodm. & Bens. Woolly heads.

Rafflesiaceae

Pilostyles thruberi A, Gray. Parasitic on *Psorothamnus emoryi*.

Solanaceae

Datura discolor Benth. Desert datura.

Zygophyllaceae

Larrea tridentata (Moc. & Sesse) Cov. ssp. *arenaria* L. Benson. Dune creosote bush. *

Larrea tridentata (Moc. & Sesse) Cov. ssp. *tridentata*. Creosote bush.

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THE CHAMPION TREES OF ARIZONA

by Robert Zahner

Do you know of an exceptionally large curlleaf mountain mahogany plant that has reached tree size? Or a Mexican jumping bean or a hopbush or even a chainfruit cholla as tall as a tree? If you have seen any of these, or any eyecatching, unusually large specimens of over 30 other native trees in Arizona, you may have discovered a new national champion for the United States.

The National Register of Big Trees, published biannually by American Forests, is a tribute to "nature's noblest vegetation," the largest known individuals of over 750 species of native trees throughout the country. Specimens discovered in the United States that have attained the greatest growth of which their species is capable are termed "champion trees." However, the largest of many species have not yet been ferreted out, and these are known as "species without champions." Arizona has about 40 species of native trees in this latter category, whose "champions" have not yet been reported, or perhaps, in some cases, have not yet been discovered.

Arizona does have its share of national champions. On the latest (1992) Register, there are individual big trees of 24 species located in Arizona (Table 1). One of the most impressive of these is, appropriately, an Arizona cypress *(Cupressus arizonica)* growing the Santa Catalina Mountains. This tree is 6 feet in diameter and over 75 feet tall, an impressive giant for our southwestern environment. The largest national champion in Arizona is an alligator juniper *(Juniperous deppeana)*, on the Tonto National Forest, that measures 9 1/2 feet in diameter.

As we might expect, many of Arizona's national champions are not big, big trees because most native species do not attain great size in our arid climate. The "smallest" of these big trees is a crucifixion thorn *(Canotia holacantha)*, about 9 inches in diameter, and at 16 feet tall makes it to the status of a tree. ("Trees" are defined as woody plants that reach a height of 4 meters, or 13 feet, at maturity.) Another small champion is an Arizona rosewood *(Vauquelinia californica)*, growing also in the Santa Catalina Mountains, at just over one foot in diameter and nearly 30 feet tall, a very impressive specimen for a species that is generally considered a shrub.

Large, charismatic trees are easy to spot, and most of these have been discovered, measured, and reported in the Register. Undetected are many less romantic species of smaller trees, which brings us to the other part of the Register, the Species Without Champions. The national list is quite long, with over 200 species; 37 of these are native to Arizona (Table 2). Here is an opportunity for Arizona native tree lovers to ferret out more champions. Some of the species on this list have very limited natural distributions, some exclusive to Arizona. It should not be a difficult task to locate and measure the largest specimens of some of these. For example, Goodding ash *(Fraxinus gooddingii)* is known in the United States only from the Atacosa Mountains in Santa Cruz County.

Many of these Arizona species without champions normally occur as shrubs but attain tree size in limited locations, especially in canyons and along washes. You have to know such a species well to recognize and appreciate how small or large a champion must be. The largest specimens of these small species, of which there are 25 listed in Table 2 without national champions, are out there somewhere waiting to be discovered.

At least six species of cactus qualify as trees, three of them chollas without champions that occasionally grow to over 15 feet in height. And saguaro, organ pipe cactus, and senita cactus do not currently have champion plants listed on the register. Certainly the largest of these unique-to-Arizona species can be located and reported. (Since the death of the previous champion saguaro, several new candidates

have been located but not yet proposed.) Even our desert ironwood *(Olneya tesota)*, of which there are several large specimens known to many people, does not have a designated champion. Mexican white pine (*Pinus strobiformis* = *P. flexilis* var. *reflexa*), a large tree in the mountains of southeastern Arizona, has no champion. Western hophornbeam *(Ostrya knowlonii)* should have a champion in Oak Creek Canyon where it reaches its best development in Arizona. For adventurous searchers, *Nolina bigelovii* reaches tree size in the Tinajas Atlas Mountains of Yuma County, and *Rhamnus betulaefolia* is reported as a tree near the western end of the north rim of the grand Canyon.

Champion trees are determined by a formula that gives size in girth of bole much more weight that total height, and height more weight than spread of crown. American Forests needs the following information for each nomination of a proposed champion: 1) verified correct name of species or variety; 2) circumference of the bole in inches, at 4 1/2 feet above ground for a single-stemmed tree, or at the narrowest point below forks for multiple-stemmed trees; 3) vertical height of tree in feet; 4) average diameter of crown, i.e., average of widest and narrowest spread; 5) geographic location; 6) date measured and by whom; 7) name and address of owner; 8) clear photograph(s) with date taken; 9) description of tree's physical condition and state of preservation; and 10) name and address of nominator. Send to National Register of Big Trees, P.O. Box 2000, Washington, DC, 20013 (phone 1-800-368-5748). Copies of the 1992 Register can be ordered from this address for $8.95 including mailing costs, with more information regarding measurements and nominations. More precise locations of individual champions are also available for persons wishing to seek them out.

Most of the national champions in Arizona have been discovered in their native "wild" habitats, but a few are located in urban settings. The champion *Lysiloma microphyllum*, for example, is on the campus of the University of Arizona. This species attains the size of a moderately large tree in Mexico, but occurs as a large shrub or at best a small tree in its restricted natural distribution in the United States. Some of the species without champions have been planted for many decades in Arizona botanical gardens, arboretums, parks, and old home sites; therefore such settings are excellent places to look for champion tree species like sweet acacia, ocotillo, and bitter condalia. Although there is some controversy over this question, the rules of the National Register permit planted urban trees to qualify.

Lysiloma and many other species that occur along the Mexican border bring into question the rule limiting champion trees to the United States, when it is known that many larger specimens of these species occur naturally in Mexico. For obvious logistical reasons, however, the Register is not organized to be international in scope.

This brings us to the purpose of this exercise in locating champion trees. It is perhaps a recreation to many enthusiasts, akin to a competition where the contenders (the big trees) provide a sense of intrigue and awe for the patrons (the tree lovers). There are also scientific and historical values to seeking out the largest specimens of a tree species; ecologists and historians are interested in the sizes and locations of specific plants and where each species grows best. But it is much more and much deeper than a quest for the "biggest and the best." Certainly the naming of a champion is a gesture to honor the potential of a species. Many of our southwestern trees are relicts of over 200 years of man-caused abuse and habitat degradation. Only a few have survived and lived long enough to grow to their potential. Locating and venerating such trees is important to our understanding of this magnificent natural heritage.

Robert Zahner is professor emeritus of forest ecology, Clemson University, now living in Tucson.

Table 1. Species on the 1992 National Register of Big Trees that have champions in the State of Arizona.

Species	Size*	Location
Arbutus arizonica (Arizona madrone)	143/53	Winchester Mountains
Canotia holacantha (cruifixion thorn)	27/16	Globe
Cercidium microphyllum (foothills palo verde)	112/48	Tucson Mountains
Chilopsis linearis (desert willow)	142/56	Gila County
Cupressus arizonica (Arizona cypress)	226/73	Santa Catalina Mtns.
Fraxinus anomala var. *lowellii* (Lowell ash)	47/50	Coconino Nat. For.
Juniperus deppeana (alligator juniper)	355/57	Tonto Nat. For.
Lysiloma microphylla (littleleaf lysiloma)	55/25	Univ. Ariz. campus
Parkinsonia aculeata (Mexican palo verde)	84/36	Florence
Pinus englemannii (Apache pine)	122/98	Coronado Nat. For.
Pinus leiophylla var. *chihuahuana* (Chihuahua pine)	111/87	Fort Apache Ind. Res.
Pinus ponderosa var. *arizonica* (Arizona pine)	136/104	Coronado Nat. For.
Pinus ponderosa var. *scopulorum* (Rocky Mtn. ponderosa pine)	200/120	Yavapai County
Prosopis velutina (velvet mesquite)	180/55	Coronado Nat. For.
Quercus arizonica (Arizona white oak)	143/37	Elgin
Quercus emoryi (Emory oak)	246/43	Empire Ranch
Quercus grisea (gray oak)	70/60	Coconino Nat. For.
Quercus hypoleucoides (silverleaf oak)	97/73	Cochise County
Quercus oblongifolia (Mexican blue oak)	123/34	Coronado Nat. For.
Quercus turbinella (shrub live oak)	132/30	Cane Springs
Rhus ovata (sugar sumac)	57/20	Gila County
Robinia neomexicana (New Mexican locust)	64/77	Coconino Nat. For.
Salix melanopsis (dusky willow)	48/30	Sedona
Vauqualinia californica (Arizona rosewood)	46/26	Santa Catalina Mtns.

* Size: circumference in inches/height in feet.

Table 2. Native Arizona tree species that have no national champion on the National Register of Big Trees.

Acacia farnesiana = A. *smallii* (sweet acacia)
Amalanchier alnifolia var. *utahensis* (Utah serviceberry)*
Buddleja sessiliflora (tree buddleja)*
Bursera microphylla (elephant tree)*
Castela emoryi (crucifixion thorn)*
Cercocarpus breviflorus (hairy mountain-mahogany)*
Cercocarpus ledifolius (curlleaf mountain-mahogany)*
Cereus giganteus (saguaro)
Cereus schottii (senita)
Cereus thurberi (organ-pipe cactus)
Condalia globosa (bitter condalia)*
Dodoanea viscosa (hopbush)*
Erythrina flabelliformis (coral bean)*
Eysenhardtia polystachya (kidneywood)*
Forestiera shreveii (desert olive)*
Fouquieria splendens (ocotillo)*
Fraxinus cuspidata var. *macropetala* (fragrant ash)*
Fraxinus gooddingii (Goodding ash)
Nolina bigelovii (Bigelow nolina)*
Koeberlinia spinosa var. *tenuispina* (crucifixion thorn)*
Olneya tesota (desert ironwood)
Opuntia fulgida (chainfruit cholla)*
Opuntia imbricata (tree cholla)*
Opuntia versicolor (staghorn cholla)*
Ostrya knowltonii (western hophornbeam)
Pinus strobiformis = P. *flexilis* var. *reflexa* (Mexican white pine)
Ptelea angustifolia (narrowleaf hoptree)*
Quercus dunni (Dunn oak)
Quercus toumeyi (Toumey oak)*
Quercus turbinella var. *ajoensis* (Ajo oak)
Quercus undulata = Q. *pungens* (wavyleaf oak)*
Rhamnus betulaefolia (birchleaf buckthorn)*
Rhus kearneyi (Kearney sumac)*
Salix nigra var. *vallicola* (western black willow)
Salix taxifolia (yewleaf willow)
Sapium biloculare (Mexican jumping bean)*
Yucca schottii (mountain yucca)*

* Species that, in the United States, usually occur as large shrubs, often with multiple stems, but may occasionally reach tree size (15 feet) with a single main stem.

PRESSED PAGES

by Susan Husband, Feature Editor

Three Postcard Books by Thomas Wiewandt

Cactus Flowers; introduction by Mark Dimmitt, Desert Rain, Desert Bloom; introduction by John Alcock, Ancient Sea Creatures; introduction by Peter L. Larson, Photographs by Thomas Wiewandt; and published by Wild Horizons Publishing, 1992.

What a feast for the eyes! These three books are like three tiny treasures that fit nicely in the hand. Each book is made of 21 detachable postcards. The photography is spectacular and each book features an informative introduction written by an expert in the field of study.

Postcard books are a relatively new publishing format. These books are made of high quality postcards, printed on heavy stock and bound together. The cards are perforated so they may be detached and mailed. When taken out of the book they become real postcards with places a message, the address and a stamp. There is also a brief description of the subject pictured on each one.

Cactus Flowers features vivid close-up color photographs of cactus blossoms from the American Southwest, Mexico, Central and South America. The reverse side has a detailed description of the cactus pictured including its common and Latin names.

Desert Rain, Desert Bloom displays a variety of landscapes including some stunning monsoon shots, as well as close-up views of wildflowers.

Ancient Sea Creatures presents fossils as art. For those who think fossils only reside in dusty rocks, these dynamic views of the past will open your eyes to a new world.

Tom Wiewandt, photographer, ecologist and native Southwesterner brings us a skillful blend of art and science. He has also authored Hidden Life of the Desert (Crown/Random House, 1990), which was included in the John Burroughs List of Outstanding Nature Books for Young Readers.

Each of these books will make wonderful gifts to others or for yourself. The difficult choice will be whether to share them by sending the postcards, or to keep them to enjoy again and again. An order form is reproduced below. **A donation of $2.00 will be made to ANPS for each book ordered using this form.**

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CHAPTER AND COMMITTEE NEWS

Meetings and events are open to all NPS members and not just to chapter members.

TUCSON CHAPTER:

Regular meetings are held on the second Wednesday of each month at 7:30 pm. at the Tucson Botanical Gardens, 2150 N. Alvernon Way.

Feb. Events: Meeting - Feb. 10 - Wayne Shifflett, Refuge Director at the Buenos Aires Wildlife Refuge - "Management Strategies for Masked Bobwhite Quail at the Buenos Aires Refuge."; Feb. 27 - Hike to the top of Table Top Mountain (near Casa Grande) with Dan James to see native grasses and the giant whip tail lizard. For more information and to sign up, please call 884-0847.
March Events: Meeting - March 10 - Richard S. Felger, Ph.D., Director of the Drylands Institute in Tucson - "Wetland Plants of the Colorado River Delta - Gulf of California.";
April Events: Meeting - April 14 - Dan Robinette, Area Range Conservationist with the U.S. Soil Conservation Service in Tucson - "Vegetative Change on Arizona Range Lands."; April 3 - Hike with Dave Bertelson up Finger Rock Trail to Mount Kimball to botanize and look for such species as *agave schottii*, *abutilon parishi* and others. For more information and to sign up, call 884-0847. April 24 - Hike with Kasey Anderson around the Waterman Mountains focusing on the healthy populations of elephant trees and turk's head cactus. For more information and to sign up, call 884-0847.
May Events: Meeting - May 12 - Barbara Timmermann, Ph. D., Associate Professor in the Department of Pharmaceutical Sciences and the Office of Arid Land Studies, University of Arizona - "Desert Plants as Sources of Medicinal and industrial Chemicals." May 2 - Hike with John Wiens to Sycamore Canyon in the Parajita Mountains to visit southern Arizona's botanical wonderland. For more information or to sign up, call John at 682-5746. May 8 - An inventory of the riparian habitat of the Cienega Creek Natural Preserve will be led by Julia Fonseca. For more information or to sign up, call Julia at 792-2690.
June Events: Meeting - June 9 - Lee Graham, Ph. D., Director of the G.A.P. Project at the School of Renewal Resources, University of Arizona. - "Remote Sensing: Vegetation Mapping for the 21st Century."

NOTE: Annual potluck will be held with the May 12 meeting. Potluck at 6:00 pm. and the speaker at 7:30 pm.

Contact Horace Miller at 297-4633 for details concerning the hikes and other events.

SIERRA VISTA SUBCHAPTER OF THE TUCSON CHAPTER

Regular meetings are held on the fourth Wednesday of each month at 6:30 pm. in the Conference Room of the Administration Building, Cochise College in Sierra Vista.

Feb. Events: Meeting - Feb. 24 - Guy McPherson, Ph. D., School of Renewal Resources, University of Arizona. - "Is the Oak Woodland/Grassland Boundary in the Huachucas Moving Up or Down."
March Events: Meeting - March 24 - Mima Parra-Szijj, Forest Botanist, Coronado National Forest. - "Sensitive Plant Monitoring in the Coronado Forest." March 7 - Exploration hike in the Tortilla Mountains.
April Events: Meeting - April 28 - Donna Howell, Ph.D., Southwest botanist and ecologist. - "Plant Defenses Against Browsers, Predators and Generally, Animal Varmints." April 9-10 - Car trip and rigorous hike into Redfield Canyon. April 17 - Jack Kaiser will lead a spring wildflower search in the Dragoon Mountains. April 25 - Gold Gulch Plant Survey. April 25 - Gold Gulch Survey.
May Events: Meeting - May 26 - Peter Gierlach, Desert Survivors. - "Propagation of Some Native Plants." May 23 - Herbarium plant collecting along the San Pedro.
June Events: June 5 - A trip to Desert Survivors in Tucson. June 9 - Gold Gulch Plant Survey.

Contact Nancy Stallcup at 378-1169.

Plant Press Newsletter Contributions

Contributions of articles, artwork, and letters to the editor are gladly received and may be handwritten, typed, or opn disk, ASCI preferred. Disk and diskettes will be returned.

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WATCH FOR THE SPECIAL MAILING REGARDING THE ANNUAL MEETING PLANNED FOR MARCH IN YUMA.

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