

DRAFT

Preliminary Flora of the Pantano Formation, Claystone Member  
Deposits, Pima County, Arizona: 2002 Summary Report

15 November 2002

---

**Biological Consulting Services**  
**Contract No. 1604-S-130066-1001**



Prepared by

Russell B. Duncan  
**Sage Landscape Architecture &  
Environmental, Inc.**  
2315 East Speedway Boulevard  
Tucson, Arizona 85719

Prepared for

**Pima County Department of  
Transportation and Flood Control District**  
201 North Stone Avenue, Third Floor  
Tucson, Arizona 85701



**S A G E**  
L A N D S C A P E  
A R C H I T E C T U R E  
& E N V I R O N M E N T A L

2315 EAST SPEEDWAY BLVD  
TUCSON, AZ 85719-4730  
TEL 520.740.0950  
FAX 520.740.0707



## ABSTRACT

A preliminary flora of the Pantano Formation, Claystone Member Deposits, Pima County, Arizona was conducted from June through October 2002 by Sage Landscape Architecture & Environmental, Inc. Tucson (SAGE) under Pima County biological services contract # 1604-S-130066-1001. From 15 July through 10 November 2002, 151 plant species in 51 families were documented in the Pantano Formation, Claystone Member Deposit area of Pima County, Arizona. A checklist of the plants identified in the area are provided in Appendix A. Eighty person hours were spent in the field sampling plants. The majority of the plants that were identified were native. Of the 151 species collected to date, 10% (15) were non-native (see separate section that follows on non-native species). Only one species was located that is currently classified as a special status species, needle-spine pineapple cactus (*Echinomastus erectocentrus* var. *erectocentrus*). In some areas of the Pantano Formation, Claystone Member Deposit area, needle-spine pineapple cactus is so dense that over 130 individuals were counted in a single 30 × 30 m survey area; however, this cactus is for the most part uncommon in the area. In addition, an as yet unidentified variety of *Eriogonum ericifolium* was located in the clay deposit area. This species of *Eriogonum*, commonly known as heathleaf or Yavapai wild buckwheat, grows locally and scattered on arid, sparsely vegetated low rolling clay hills within Pantano Formation, Claystone Member Deposits with some gypsum evident on the surface in desert scrub and desert grassland with *Larrea divaricata*, *Tiquilia canescens*, *Acacia neovernicosa*, and *Erioneuron pulchellum*. It appears that this population is endemic to the Pantano Formation, Claystone Member Deposits. Species identification was confirmed by Dr. James L. Reveal, Professor Emeritus, University of Maryland. Currently there are three recognized varieties of *E. ericifolium*, each from widely disjunct populations, two in Arizona (var. *ericifolium*: Yavapai Co, Verde Valley; var. *pulchellum* (Eastw.) Reveal: Coconino Co., Meteor Crater and vicinity near Winslow) and one in California (var. *thornei* Reveal & Henrickson: San Bernardino Co., New York Mountains). Until now, Arizona populations of *E. ericifolium* were limited to Tertiary gypseous limestone lakebed deposits (Verde Valley) and sandstone and limestone substrates (Meteor Crater and vicinity). The new *E. ericifolium* population reported on here represents the first record of this species from Pima County and most southerly locality in Arizona, which is a 282 km range gap between the nearest other population in Yavapai County. It is not known at this time whether or not this newly discovered Pima County population represents a new taxon



(A more complete taxonomic assessment will be provided following a more thorough review). Due to the rareness of this species in Pima County, land management agencies should be aware of the potential impacts that could result from various activities including clay mining, urban development, off-road vehicle use, livestock grazing/trampling, construction of roads and utility corridors, and recreational developments. Conservation measures are recommended.



## INTRODUCTION

Local floras are essential for assessment of biological diversity and for making biogeographical comparisons (e.g., McLaughlin 1986, 1992, Schultz et al. 1987, McLaughlin and Bowers 1999). Arizona is especially rich in its biological diversity due to the commingling of several major biogeographic provinces (e.g., Brown and Lowe 1980, Brown 1982 and authors therein). In southern Arizona, several studies have contributed to our knowledge of local floras and the plant community dynamics therein, including the pioneering work of Shreve (1915) and the comprehensive efforts of Whittaker and Niering (1964, 1965, 1968a, 1968b, 1975), Whittaker et al. (1968), and Niering and Lowe (1984), and the more recent works by Toolin et al. (1979), Bowers and Turner (1985), Bowers and McLaughlin (1987), McLaughlin and Bowers (1990), Rondeau (1996), Mauz (1999), and Wiens (2000). Most floras in Arizona cover mountain ranges or areas managed by individual land management agencies, such as National Parks. One of the latest floras to be published for southern Arizona is that of Mauz (2002), which focuses on a geographically small area, the West Branch of the Santa Cruz River at Tucson.

The flora reported on here is also of a restricted area, both physically and geologically, the Pantano Formation, Claystone Member Deposits (as mapped by Drewes 1977), east of Tucson in Pima County, Arizona. The Pantano Formation, Claystone Member Deposits is a landscape anomaly, i.e. a regionally restricted habitat created by geological, edaphic, and/or hydrological factors. Barrens, cliff faces, canyons, hanging gardens, and playas are all examples of landscape anomalies in the American West (Kelso et al. 2000). Such sites often sustain an unusual local ecology, including endemic, disjunct, or relictual plant species. To my knowledge no one has previously documented the flora of the Pantano Formation, Claystone Member Deposits (hereafter clay deposits), either directly or indirectly. The clay deposits is a highly localized mineralized area that is dominated by sedimentary rocks, primarily clay and associated gypsum. The impetus to survey these clay deposits was the result of discussions with Pima County personnel who were concerned over the management of the clay deposits, primarily the extent to which they were being mined on Arizona State Trust Lands and how certain clay and gypsum deposits in the American Southwest are known to support unique floras and often include unique endemic plant species because of limiting edaphic conditions of these substrate types. This should be considered a preliminary report, as surveys to date have only been



conducted from mid-July through mid-November to focus on the summer monsoon season, when many plant species in the area are most productive. The survey was conducted by Russell B. Duncan, employee with Sage Landscape Architecture & Environmental, Inc. Tucson (SAGE) under Pima County Department of Transportation and Flood Control District, Water Resources Division biological services contract # 1604-S-130066-1001.

## STUDY AREA AND METHODS

The Pantano Formation, Claystone Member Deposits (as mapped by Drewes 1977) are located about 25 miles southeast of downtown Tucson and the main bodies of the deposit are accessed north of Interstate Highway 10 by way of Marsh Station Road east of Vail (Figure 1). Land ownership associated with the clay deposits is mostly Arizona State Trust Land system and to a lesser extent Pima County and private. The majority of the clay deposits are located north of Pima County's Cienega Creek Natural Preserve. A disjunct outcrop of the deposits is located a few miles to the north of the main body in and adjacent to Pima County's Colossal Cave Mountain Park. Smaller areas of clay deposits are also located south of Cienega Creek near Davidson Canyon and I-10.

The climate of the clay deposit area in southeastern Arizona is semiarid. Average annual rainfall ranges from 9 to 25 inches (229 to 635 mm). The rainfall pattern in southeastern Arizona is bimodal. Summer precipitation during July, August, and September ranges from less than 50% of the annual total in the northwestern part of the area to more than 70% in the southeastern part. The period of summer precipitation (known as the summer "monsoon") is quite sharply defined, beginning around the last week of June and lasting until the middle of September. Precipitation mainly occurs from convective cells initiated by surface heating, convergence or, less commonly, orographic lifting (Sellers and Hill 1974).

The clay deposits are located in a transitional area between the Chihuahuan and Sonoran deserts (See Brown 1982, Turner and Brown 1982). The Chihuahuan Desert covers most of north-central Mexico. The question of this desert extending across western Texas and southern New Mexico into Arizona is a source of conflicting opinions since in Arizona it represents of more a zone of transition between the Chihuahuan and Sonoran deserts and desert or semidesert grassland than true Chihuahuan Desert (Schmidt, 1979). Creosote bush (*Larrea divaricata*) in the



Figure 1. To be included here with the assistance of Pima County GIS staff when report is finalized. For now a figure of the Pantano Formation, Claystone Member Deposits rendered by McGann and Associates (1994, Figure 4-H) for the Cienega Creek Natural Preserve is attached at the end of this draft report.



Pantano Formation, Claystone Member Deposit area is most like the Chihuahuan ecotype, i.e. they are generally shorter with sparser foliage, straighter stems and are more open at the base than their Sonoran counterparts (see Brown 1982, Figure 99).

As mapped by Turner (1974) and Brown and Lowe (1980), the clay deposit area is dominated by a desert grassland or semi-desert grassland community. It is often difficult to draw a line separating desertscrub from semidesert grassland in the area because plants from one coexist with those of the other, thus forming discontinuous, diverse ecotones. Semidesert grassland is here represented by a relatively open mixed grass-mixed scrub association of mesquite (primarily *Prosopis glandulosa*), acacia (*Acacia constricta*, *A. greggii*, and *A. neovernicosa*), mariola (*Parthenium incanum*), burroweed (*Isocoma tenuisecta*), snakeweed (*Gutierrezia sarothrae*), desert zinnia (*Zinnia acerosa*), fairy duster (*Calliandra eriophylla*), little coldenia (*Tiquilia canescens*), and various grasses and cacti. Grasses identified in the area included three awns (*Aristida* spp.), cane blue stem grass (*Bothriochloa barbinodis*), Rothrock grama (*Bouteloua rothrockii*), Lehmann lovegrass (*Eragrostis lehmanniana*), fluffgrass (*Erioneuron pulchellum*), curley mesquite grass (*Hilaria berlangeri*), bush muhly (*Muhlenbergia porteri*), tobosa (*Pleuraphis mutica*), Arizona cottontop (*Trichachne californica*), and others. Summer rains produce an abundance of annual grass productivity in the area including sixweeks needle grass (*Bouteloua aristidoides*) and sixweeks grama (*Bouteloua barbata*). Other shrubs identified included ocotillo (*Fouquieria splendens*), longleaf joint-fir (*Ephedra truiifurca*), soaptree yucca (*Yucca elata*), and others. Cacti identified in the area included mostly pricklypear and cholla, and many of those found in desertscrub.

## RESULTS AND DISCUSSION

From 15 July through 10 November 2002, 151 plant species in 51 families were documented in the Pantano Formation, Claystone Member Deposit area of Pima County, Arizona. A checklist of the plants identified in the area are provided in Appendix A. Eighty person hours were spent in the field sampling plants and the number of person-hours spent in the office or at the University of Arizona herbarium identifying and cataloguing plants was 24 hours. The majority of the plants that were identified were native. Of the 151 species collected to date, 10% (15) were non-native (see separate section that follows on non-native species). One species (*Echinomastus erectocentrus* var. *erectocentrus*) was located that is currently classified as a



special status species (see separate section on rare and endangered species). Also one species previously not documented in Pima County and considered endemic to the Pantano Formation, Claystone Member Deposit area was located (see separate section on undescribed species and additions to Pima County, Arizona).

### **Introduced Species**

As previously stated, the majority of the plants identified in the Pantano Formation Clay member Deposits were native and of the 151 species collected to date, 10% (15) were non-native. Of the 15 non-native species seven were grasses, one of which was a cool season or winter annual (*Bromus rubens*), one was warm season annual (*Rhynchelytrum repens*) and the remaining five were warm season perennials. There were also two non-native succulents, *Agave americana* and *Opuntia lindheimeri* var. *linguiformis*, which were growing in the area as the result of illegal dumping.

Four non-native grasses from the African Continent are present— *Eragrostis lehmanniana*, *Pennisetum ciliare*, and *Pennisetum setaceum*. *Eragrostis lehmanniana* was purposefully introduced into rangelands in Arizona for cattle forage. The latter three species are becoming increasingly prevalent in the Tucson Basin and elsewhere in southern Arizona. They are usually found in highly disturbed sites such as along roadways and along the railroad tracks but can become established in seemingly undisturbed sites such as desert riparian habitats and on south- and west-facing rocky slopes. These non-native perennial grasses have not yet established themselves in undisturbed natural habitats in the survey area. Once established, these perennial nonnative grasses in Arizona carry wildfires through habitats like desertscrub that are not adapted to fire (Búrquez-Montijo et al. 2002).

### **Rare and Endangered Species**

To the best of my knowledge there are currently no federally listed, proposed, or candidate plant species for listing as threatened or endangered under the Endangered Species Act (ESA) in the Pantano Formation, Claystone Member Deposit area. The one special status species that was identified in the area was the needle-spined pineapple cactus (*Echinomastus erectocentrus* var. *erectocentrus*). The needle-spined pineapple cactus is not an ESA protected species but is classified as “Salvage Restricted” under Arizona Native Plant Law as administered



by Arizona Department of Agriculture. It is also a “Priority Vulnerable Species” as defined by Pima County in their draft Sonoran Desert Protection Plan (SDCP 2002).

The needle-spined pineapple cactus is a small, solitary stemmed, ovoid or somewhat cylindroid cactus that grows about 6-15 cm (2½-6 in) tall and 6-12 cm (2½-5 in) in diameter with one or two “erect” central spines and 11-15 radial spines on each tubercle; the radial spines are dense and obscure the stem surface. See species accounts in Benson (1969, 1982), Arizona Game and Fish Department (AGFD 1997), and Arizona Rare Plant Committee (2001) for more detailed descriptions. Currently there are two varieties of *Echinomastus erectocentrus*, variety *erectocentrus* and var. *acunensis*, which are virtually indistinguishable, and may not be taxonomically distinct (Pinkava 1995). The characters that were formerly used to separate the two varieties were the size and color of the flowers, but according to Pinkava (op. cit.), these are not good indicators of taxonomic uniqueness. The two varieties are separated geographically, with var. *erectocentrus* occurring from the general Tucson area east and south to the Mexican border, and var. *acunensis* in northern Sonora, Organpipe Cactus National Monument, northward and east to the Florence area in Pinal County. Variety *acunensis* is currently a candidate species for listing as threatened or endangered under the ESA.

According to AGFD (1997), needle-spined pineapple cactus is found on alluvial fans and hills and near disturbed areas. It is found at elevations of 915-1,403 m (3,000-4,600 feet) on southern and western exposures. The substrate is alluvial soils with rock and gravel cover over sandstone conglomerate and also limestone. Also according to AGFD (1997), the plant community associated with needle-spined pineapple cactus is Arizona Upland Subdivision of the Sonoran Desertscrub and Semidesert Grassland. Dominant associated species are *Larrea divaricata* ssp. *tridentata*, *Cercidium microphyllum*, *Fouquieria splendens*, *Yucca angustissima*, *Opuntia phaeacantha*, *Prosopis velutina*, *Coryphantha* spp., *Zinnia pumila*, *Allionia incarnata*, *Dyssodia* spp., *Psilostophe cooperi*, *Aristida purpurea*, and *Erioneuron pulchellum*.

In the Pantano Formation, Claystone Member Deposit area, needle-spined pineapple cactus is found on west and south-facing slopes and benches in Semidesert Grassland with Chihuahuan Desertscrub influence. Dominant associated species are *Larrea divaricata* ssp. *tridentata*, *Cercidium microphyllum*, *Prosopis velutina*, *Krameria erecta*, *Zinnia acerosa*, *Tiquilia canescens*, *Opuntia phaeacantha*, *Dyssodia* spp., *Aristida* spp., *Erioneuron pulchellum*, *Hillaria belangeri*, and others. In one area of the Pantano Formation, Claystone Member

Deposit, over 130 individual plants were counted on 3 November 2002 in a 30 × 30 m survey area (Figure 2).



Figure 2. Example of *Echinomastus erectocentrus* var. *erectocentrus* habitat on a W-facing hillside in the Pantano Formation, Claystone Member Deposit survey area, Pima County, Arizona. Red pin flags indicate over 130 individual cacti located on 3 November 2002 within a 30 × 30 m survey area; not all flags are visible in this photo.

### **Undescribed Species and Additions to the Flora of Pima County, Arizona**

One species of particular interest, an as yet unidentified variety of *Eriogonum ericifolium*, was discovered in the clay deposit survey area between July and November 2002. *Eriogonum ericifolium* is commonly known as heathleaf or Yavapai wild buckwheat. Fresh plant specimens and photographic vouchers of this plant's habitat were sent to Dr. James L. Reveal, Professor Emeritus, University of Maryland on 7 November 2002. Dr. Reveal, a noted authority on *Eriogonum* and related genera, is currently a Research Associate with the Academy of Natural Sciences of Philadelphia. In responding, Dr. Reveal (pers. comm. 8 Nov 2002) indicated that the



specimens from the Pantano Formation, Claystone Member Deposits were in fact *Eriogonum ericifolium* and possibly a new variety of the species.

The *E. ericifolium* are local and scattered on arid, sparsely vegetated low rolling clay hills within Pantano Formation, Claystone Member Deposits with some gypsum evident on the surface in desert scrub and desert grassland with *Larrea divaricata*, *Tiquilia canescens*, *Acacia neovernicosa*, and *Erioneuron pulchellum*. Specimens were collected in flower from 19 August – 7 November 2002 and deposited at ARIZ, NY, and US (presently uncatalogued). Figures 1 and 2 depict one aspect of *Eriogonum ericifolium* habitat and a close-up photo of an in situ plant.

Currently there are three recognized varieties of *E. ericifolium* (USDA, NRCS. 2002). The PLANTS Database, Version 3.5 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA.), each from widely disjunct populations, two in Arizona (var. *ericifolium*: Yavapai Co, Verde Valley; var. *pulchellum* (Eastw.) Reveal: Coconino Co., Meteor Crater and vicinity near Winslow) and one in California (var. *thornei* Reveal & Henrickson: San Bernardino Co., New York Mountains). Until now, Arizona populations of *E. ericifolium* were limited to Tertiary gypseous limestone lakebed deposits (Verde Valley) and sandstone and limestone substrates (Meteor Crater and vicinity).

This *E. ericifolium* collection represents the first record of this species from Pima County and most southerly locality in Arizona, which is a 282 km range gap between the nearest other population in Yavapai County. It is not known at this time whether or not this new Pima County population represents a new taxon (A more complete taxonomic assessment will be provided following a more thorough review). Land ownership associated with this new *E. ericifolium* population is mostly Arizona State Trust Land system and to a lesser extent Pima County and private. No federal lands are located in the clay deposit area.

Due to the rareness of this species in Pima County, land management agencies should be aware of the potential impacts that could result from various activities including clay mining, urban development, off-road vehicle use, livestock grazing/trampling, construction of roads and utility corridors, and recreational developments. Conservation measures are recommended, including consideration for protection under Arizona Native Plant Law as administered by Arizona Department of Agriculture. It is also recommended that Pima County's Scientific and Technical Advisory Team (STAT) consider *E. ericifolium* for coverage under the multi-species habitat conservation plan known as the Sonoran Desert Conservation Plan (SDCP).



Figure 3. *Eriogonum ericifolium* habitat within Pantano Formation, Claystone Member Deposits both on flats with desert pavement covered surface and on hillsides in background, Pima County, Arizona.



Figure 4. Close-up of *Eriogonum ericifolium* on desert pavement covered flats in Figure 4.



## **Recommendations for Further Study of the Pantano Formation, Claystone Member Deposit Flora**

It is recommended that the habitat characteristics, distribution, and status of the newly identified *Eriogonum ericifolium* population in the Pantano Formation, Claystone Member Deposits, Pima County, Arizona be conducted. Geographic coordinates, environmental attributes and associated species data should be collected at each site. Predictive maps can then be developed from the coordinate data recorded at each site by locating the position of each site in a geographic information system (GIS) containing slope, elevation, aspect, soils and geologic data.

In addition, a monitoring program should be instituted to study the effects of existing land uses on this endemic plant and its habitat in the area. Such a restricted species can be relatively easily surveyed and monitored, and provide opportunities for comparative studies. It is also recommended that Pima County announce to the public to capture the public's interest in clay deposit area as a unique and isolated habitat and the fact that newly identified endemic *E. ericifolium* population, not previously known from Pima County was discovered there.

In addition to the detailed studies on the newly discovered population of *E. ericifolium*, it is also recommended that additional general plant surveys and collections be conducted in the Pantano Formation, Claystone Member Deposits. It is especially important to survey the area during the winter/spring annual plant productivity period, February through April. To date surveys have concentrated on the summer rainy (monsoon) season and into the post monsoon season, July through November when most perennial plant species are most productive in southern Arizona. Additional sampling during the spring will add to the total number of plants already identified in the area.



## LITERATURE CITED

- Aitken, M., D. W. Roberts and L. M. Shultz. 2002. Predictive modeling of rare plant habitat in the eastern Great Basin. Pp. *In* Third Southwestern Rare and Endangered Plant Conference, Flagstaff, Arizona, September 25-28, 2000. General Technical Report RMRS- USDA-Forest Service, Rocky Mountain Forest and Range Experimental Station, Ft. Collins, CO.
- Arizona Game and Fish Department. 1997. *Echinomastus erectocentrus* var. *erectocentrus*. Unpublished abstract compiled and edited by the Heritage Data Management System, Arizona Game and Fish Department, Phoenix, AZ. 3 pp.
- Arizona Rare Plant Committee. 2001. Arizona rare plant field guide. A collaboration of agencies and organizations.
- Benson, L. 1969. The cacti of Arizona. University of Arizona Press, Tucson.
- Benson, L. 1982. The cacti of the United States and Canada. Stanford University Press, Stanford, CA.
- Bowers, J. E. and S. P. McLaughlin. 1986. Flora and vegetation of the Rincon Mountains, Pima County, Arizona. *Desert Plants* 8: 51-94.
- Bowers, J. E. and S. P. McLaughlin. 1996. Flora of the Huachuca Mountains, a botanically rich and historically significant sky island in Cochise County, Arizona. *Journal of the Arizona-Nevada Academy of Science* 29: 66-107.
- Bowers, J. E. and R.M. Turner. 1985. A revised vascular flora of Tumamoc Hill, Tucson, Arizona. *Madroño* 32:225-252.
- Brown, D.E. 1982. Chihuahuan desert scrub. *Desert Plants* 4:169-79.
- Brown, D. E. and C. H. Lowe. 1980. Biotic communities of the southwest. General Technical Report-RM- 78. USDA-Forest Service, Rocky Mountain Forest and Range Experimental Station, Ft. Collins, CO. 1 p. map.
- Búrquez,-Montijo, M.M. Miller, and A. Martínez-Yrizar. 2002. Mexican grasslands, thornscrub, and the transformation of the Sonoran Desert by invasive exotic buffelgrass (*Pennisetum ciliare*). Chapter 8 *In* Tellman, B. (Ed.). *Invasive exotic species in the Sonoran Region*. University of Arizona Press and the Arizona-Sonora Desert Museum, Tucson.
- Drewes, H. 1977. Geologic map and cross sections of the Rincon Valley, Pima County, Arizona. Misc. Investigations Series Map-1-997. U.S. Geological Survey, Washington, D.C.
- Kearney, T.H. and R.H. Peebles. 1960. Arizona flora. Second edition with supplement by J.T. Howell and E. McClintock. University California Press, Berkeley.



- Kelso, S., C. Hall, and G. Maentz. 2002. The role of landscape anomalies in regional plant conservation. Pp. *In* Maschinski, J. and L. Holter (tech. Eds.). Third Southwestern Rare and Endangered Plant Conference, Flagstaff, Arizona, September 25-28, 2000. Proceedings RMRS-P-23. USDA-Forest Service, Rocky Mountain Forest and Range Experimental Station, Ft. Collins, CO.
- Lehr, J.H. 1978. A catalogue of the flora of Arizona. Desert Botanical Garden, Phoenix, AZ.
- Lehr, J.H. and D.J. Pinkava. 1980. A catalogue of the flora of Arizona: Supplement I. *J. Arizona-Nevada Academy Science* 15:17-32.
- Lehr, J.H. and D.J. Pinkava. 1982. A catalogue of the flora of Arizona: Supplement II. *J. Arizona-Nevada Academy Science* 17:19-26.
- Mauz, K. 2002. Flora of the Sawtooth Mountains, Pinal County, Arizona. *Desert Plants* 18:3-27.
- Mauz, K. 2002. Plants of the Santa Cruz Valley at Tucson. *Desert Plants* 18:3-36.
- McGann & Associates, Inc. 1994. Cienega Creek Natural Preserve Management Plan. Prepared for Pima County Department of Transportation and Flood Control District by McGann & Associates, Landscape Architects and Planners, Tucson, AZ.
- McLaughlin, S. P. 1986. A floristic analysis of the southwestern United States. *Great Basin Naturalist* 46: 46-65.
- McLaughlin, S. P. 1992. Are floristic areas hierarchically arranged? *Journal of Biogeography* 19: 21-32.
- McLaughlin, S. P., and J. E. Bowers. 1990. A floristic analysis and checklist for the northern Santa Rita Mountains, Pima County, Arizona. *The Southwestern Naturalist* 35: 61-75.
- McLaughlin, S. P., and J. E. Bowers. 1999. Diversity and affinities of the flora of the Sonoran Floristic Province. *In*: R. H. Robichaux (ed.), *Ecology of the Sonoran Desert Plants and Plant Communities*. The University of Arizona Press, Tucson.
- MacMahon, J.A. 1988. Warm deserts. Pp. 232-264 *In* Barbour, M.G. and Billings, W.D. (eds), *North American terrestrial vegetation*. Cambridge University Press, Cambridge, UK.
- Niering, W.A. and C.H. Lowe. 1984. Vegetation of the Santa Catalina Mountains: community types and dynamics. *Vegetatio* 58: 3-28.
- Pinkava, D.J. 1995. Cactaceae, part 1, cactus family, the cereoid cacti. *Journal of the Arizona-Nevada Academy of Science* 29:6-12.
- Reveal, J.L. 1976. *Eriogonum* (*Polygonaceae*) of Arizona and New Mexico. *Phytologia* 34: 409-484.



- Reveal, J.L. & J. Henrickson. 1975. A new variety of *Eriogonum ericifolium* (*Polygonaceae*). *Madroño* 23: 205-209.
- Rondeau, R., T.R. VanDevender, C.D. Bertelson, P. Jenkins, R.K. Wilson, and M.A. Dimmitt. 1996. Annotated flora and vegetation of the Tucson Mountains, Pima County, Arizona. *Desert Plants* 12: 3-46.
- Schimdt, R.H. 1979. A climatic delineation of the real Chihuahuan Desert. *Journal of Arid Environments* 2:243-250.
- Schultz, L.M. 1993. Patterns of endemism in the Utah flora. Pp. 249-269 *In* Sivinski, R. and K. Lightfoot (eds.). *Southwestern rare and endangered plants. Proceedings of the Southwestern rare and endangered plant conference, 30 March – 2 April 1992, Santa Fe, NM. Misc. Publ. No. 2. New Mexico Forestry and Resources Conservation Division, Santa Fe, NM.*
- Schultz, L.M., E.E. Neely, and J.S. Tuhy. 1987. Flora of the Orange Cliffs of Utah. *Great Basin Naturalist* 47: 287-298.
- SDCP (Sonoran Desert Conservation Plan). 2002. Draft Preliminary Sonoran Desert Conservation Plan Pima County Board of Supervisors, Tucson, AZ. (<http://www.co.pima.az.us/cmo/sdcp/sdcp2/prelimSDCP/prelim.html>).
- Sellers, W.D. and R.H. Hill. 1974. *Arizona climate 1931-1972*. University of Arizona Press, Tucson.
- Shreve, F. 1915. *Vegetation of a desert mountain range as conditioned by climatic factors*. Carnegie Inst. Wash., Pub. 217.
- Toolin, L. J., T. R. Van Devender, and J. M. Kaiser. 1979. The flora of Sycamore Canyon, Pajarito Mountains, Santa Cruz County, Arizona. *Journal of Arizona-Nevada Academy of Science* 14: 66-74.
- Turner, B.L. and A.M. Powell. 1979. Deserts, gypsum, and endemism. Pp 96-116 *In* Goodin, J.R. and D.K. Northington (eds.). *Arid land plant resources: proceedings of the International Arid Lands Conference on Plant Resources; 1978; Texas Tech University. Lubbock (TX): Texas Tech University, International Center for Arid and Semi-arid Land Studies.*
- Turner, R. M. 1974. Map showing vegetation in the Tucson area, Arizona. Map I-844-H. U.S. Geological Survey, Reston, VA.
- Turner, R.M. and D.E. Brown 1982. Sonoran desert scrub. *Desert Plants* 4: 181-221.



- USDA-NRCS (Natural Resources Conservation Service). 2002. The PLANTS Database, Version 3.5 (<http://plants.usda.gov>). National Plant Data Center, Baton Rouge, LA.
- Whittaker, R.H., S.W. Buol, W.A. Niering & Y. H. Havens. 1968. A soil and vegetation pattern in the Santa Catalina Mountains, Arizona. *Soil Science* 105(6): 440-450.
- Whittaker, R.H. & W.A. Niering. 1964. Vegetation of the Santa Catalina Mountains, Arizona. I. Ecological classification and distribution of species. *J. Arizona Acad. Sci.* 3 (1): 9-34.
- Whittaker, R.H. & W.A. Niering. 1965. Vegetation of the Santa Catalina Mountains, Arizona: a gradient analysis of the south slope. *Ecology* 46 (4): 429-452.
- Whittaker, R.H. & W.A. Niering. 1968a. Vegetation of the Santa Catalina Mountains, Arizona. III. Species distribution and floristic relations on the north slope. *J. Arizona Acad. Sci.* 5 (1): 2-21.
- Whittaker, R.H. & W.A. Niering. 1968b. Vegetation of the Santa Catalina Mountains, Arizona. IV. Limestone and acid soils. *Ecology* 56: 523-544.
- Whittaker, R.H. & W.A. Niering. 1975. Vegetation of the Santa Catalina Mountains, Arizona. V. Biomass, production, and diversity along the elevation gradient. *Ecology* 56 (4): 771-190
- Wiens, J.F. 2000. Vegetation and flora of Ragged Top, Pima County, Arizona. *Desert Plants* 16:3-31.



**Appendix A.**

PRELIMINARY CHECKLIST OF THE VASCULAR PLANTS OF  
THE PANTANO FORMATION, CLAYSTONE MEMBER DEPOSITS,  
PIMA COUNTY, ARIZONA



**PRELIMINARY CHECKLIST OF THE VASCULAR PLANTS OF  
THE PANTANO FORMATION, CLAYSTONE MEMBER DEPOSITS,  
PIMA COUNTY, ARIZONA**

The following is a preliminary checklist of the vascular plants of the Pantano Formation, Claystone Member Deposits Pima County, Arizona. All plants that are currently listed here were documented in the area from 15 July – 10 November 2002. The checklist is organized alphabetically by family, genus, and species. Nomenclature generally follows Lehr (1978) and Lehr and Pinkava (1980, 1982). This preliminary checklist should be considered a work in progress, as collections have not occurred throughout the year. To round-out the list, it will be important to make collections when winter annuals are most productive in the area, i.e., February – April. An † symbol indicates that the species is exotic. An asterisk (\*) denotes plants collected or photographed for voucher purposes by the author (to be accessioned into the University of Arizona herbarium). In the case of rare species, specimens will also be deposited with the New York Botanical Garden, Bronx, NY, and the U.S. National Herbarium, National Museum of Natural History, Smithsonian Institution, Washington, DC.

**Acanthaceae**—Acanthus Family

*Anisacanthus thurberi* (Torr.) Gray. Desert honeysuckle.

**Adiantaceae**—Fern Family

\* *Cheilanthes parryi* (D. C. Eaton) Domin. [*Notholaena parryi* D. C. Eaton.]. Parry lipfern.

\* *Notholaena cochisensis* Goodd. [*Notholaena sinuata* (Sw.) Kaulf. Var. *cochisensis* (Goodd.) Weatherby]. Helechillo.

\* *Notholaena standleyi* Maxon. Standley cloakfern.

**Agavaceae**—Agave Family

† *Agave americana* L. Century plant, Maguey. An occasional roadside plant where illegal dumping of plant material has occurred.

*Agave palmeri* Engelm. Palmer agave.

*Dasylyrion wheeleri* Wats. Sotol.

*Yucca elata* Engelm. Soap tree yucca.

**Aizoaceae**—Carpet Weed Family

*Trianthema portulacastrum* L. Horse purselane.

**Amaranthaceae**—Amaranth Family

*Amaranthus fimbriatus* (Torr.) Benth. Var. *fimbriatus*. Fringed amaranth.

*Amaranthus palmeri* Wats. Pigweed.

*Tidestromia lanuginosa* (Nutt.) Standl. Espanta vaqueras.

**Apocynaceae**—Dogbane Family

*Haplophyton crooksii* L. Cockroach plant.



**Asclepiadaceae**—Milkweed Family

*Cynanchum arizonicum* (Gray) Shinners. [*Metastelma arizonicum* Gray]. Milkweed vine.

**Asteraceae**—Sunflower Family

*Artemisia ludoviciana* Nutt. Ssp. *sulcata* (Rydb.) Keck. White sage.

*Baccharis sarothroides* Gray. Desert broom.

*Baileya multiradiata* Harv. & Gray. Desert marigold.

*Brickellia coulteri* Gray. Brickell & bush.

*Dyssodia pentachaeta* (DC.) Rob. [*Thymophylla pentachaeta* (DC.) Small]. Parvialena.

*Dyssodia porophylloides* Gray. [*Adenophyllum porophylloides* (Gray) Strother]. San Felipe fetid marigold.

*Encelia farinosa* Gray Brittle bush

*Ericameria laricifolia* (Gray) Shinners. [*Haplopappus laricifolius* Gray]. Turpentine bush.

*Erigeron divergens* T. & G. Fleabane daisy.

*Gutierrezia microcephala* (DC.) Gray. [incl. *G. linioides* Greene, *G. lucida* Greene]. Snakeweed.

*Heterotheca psammophila* Wagenkn. [*H. subaxillaris* (Lam.) Britt. & Rusby sensu K. & P.]. Camphor weed, telegraph plant.

*Isocoma tenuisecta* Greene. [*Haplopappus tenuisectus* (Greene) Blake]. Burro weed.

*Parthenium incanum* H.B.K. Mariola.

*Pectis papposa* Harv. & Gray. Chinchweed.

*Porophyllum gracile* Benth. Odora.

*Psilostrophe cooperi* (Gray) Greene. Paper flower.

*Senecio lemmonii* Gray. Groundsel.

*Stephanomeria pauciflora* (Torr.) A. Nels. Desert straw.

*Trixis californica* Kellogg.

*Zinnia acerosa* (DC.) Gray. [*Zinnia pumila* Gray]. Desert zinnia.

† *Xanthium strumarium* L. Common cocklebur

**Bignoniaceae**—Bignonia Family

*Chilopsis linearis* (Cav.) Sweet. Desert willow.

**Boraginaceae**—Borage Family

*Amsinckia intermedia* F. & M. Fiddleneck.

*Tiquilia canescens* (DC.) A. Richardson. [*Coldenia canescens* DC.].

**Cactaceae**—Cactus Family

*Echinocereus fasciculatus* (Engelm.) Benson. [*E. fendleri* Engelm. var. *robustus* L. Benson]. Hedgehog cactus.

\**Echinomastus erectocentrus* var. *erectocentrus* (Coulter) B & R.

*Ferocactus wislizenii* (Engelm.) Britt. & Rose. Fishhook barrel cactus.

*Mammillaria grahamii* Engelm. [*M. microcarpa* Engelm.]. Fishhook pincushion.

*Opuntia fulgida* Engelm. var. *fulgida*. Chainfruit cholla.

*Opuntia leptocaulis* DC. Christmas cactus.

† *Opuntia lindheimeri* Engelm. var. *linguiformis* (Griffiths) L. Benson. [*O. engelmannii* Salm-Dyck var. var. *linguiformis* (Griffiths) Parfitt & Pinkava].



*Opuntia phaeacantha* var. *discata* (Griffiths) Benson & Walkington. [*O. engelmannii* Salm-Dyck var. *engelmannii*]. Cow's tongue prickly pear. Local exotic stem succulent; probably established as a result of illegal dumping of rubbish near clay pit south of Marsh Station Road with *Opuntia santa-rita*.

*Opuntia phaeacantha* Engelm. var. *major* Engelm. Sprawling prickly pear.

*Opuntia santa-rita* (Griffiths & Hare) Rose. [*Opuntia violacea* Engelm. var. *santa-rita* (Griffiths & Hare) L. Benson] Purple prickly pear. Local stem succulent; probably resulting from illegal dumping of rubbish near clay pit south of Marsh Station Road.

*Opuntia spinosior* (Engelm.) Toumey. Cane cholla.

*Opuntia macroentra* Engelm. [*Opuntia violacea* var. *macroentra* L. Benson]. Black-spined prickly pear.

### **Chenopodiaceae**—Goosefoot Family

*Atriplex canescens* (Pursh) Nutt. Fourwing Saltbush.

† *Salsola australis* R. Br. [*S. iberica* Sennen & Pau, *S. kali* L. var. *tenuifolia* (Tausch.) Aellen]. Russian thistle, tumbleweed.

### **Convolvulaceae**—Morning Glory Family

*Evolvulus alsinoides* L. Arizona blue eyes.

### **Cruciferae**—Mustard Family

† *Brassica tournefortii* Gouan. Mustard.

*Lepidium* sp. Peppergrass.

*Lesquerella gordonii* (Gray) Wats. Gordon bladderpod.

### **Cucurbitaceae**—Gourd Family

*Cucurbita digitata* Gray. Coyote gourd.

### **Cupresseaceae**—Cypress Family

*Juniperus monosperma* (Engelm.) Sarg. One-seed juniper

### **Cyperaceae**—Sedge Family

\* *Cyperus odoratus* L. Fragrant flat sedge.

*Cyperus* sp. Flat sedge

### **Ephedraceae**—Joint fir Family

*Ephedra trifurca* Torr. Longleaf jointfir.

### **Euphorbiaceae**—Spurge Family

*Ditaxis neomexicana* (Muell. Arg.) Heller. [*Argythamnia neomexicana* Muell. Arg.].

*Euphorbia abramsiana* L. C. Wheeler. [*Chamaesyce abramsiana* (L. C. Wheeler) Burch.]. Spurge.

*Euphorbia arizonica* Engelm. [*Chamaesyce arizonica* (Engelm.) Arthur.]. Spurge.

*Euphorbia florida* Engelm. [*Chamaesyce florida* (Engelm.) Millsp.]. Spurge.

*Euphorbia gracillima* Wats. [*Chamaesyce gracillima* (Wats.) Millsp.]. Spurge.

*Tragia nepetaefolia* Cav. Noseburn.



**Fouquieriaceae**—Ocotillo Family

*Fouquieria splendens* Engelm. Ocotillo.

**Geraniaceae**—Geranium Family

† *Erodium cicutarium* (L.) L'Her. Filaree.

**Gramineae**—Grass Family

*Aristida adscensionis* L. Six weeks threeawn.

*Aristida purpurea* Nutt. var. *purpurea* Nutt. Purple threeawn.

*Aristida ternipes* Cav. Spider grass.

*Bothriochloa barbinodis* (Lag.) Herter. [*Andropogon barbinodis* Lag.]. Cane beardgrass.

*Bouteloua aristidoides* (H.B.K.) Griseb. Six weeks needle grama.

*Bouteloua barbata* Lag. Six weeks grama.

*Bouteloua curtipendula* (Michx.) Torr. Sideoats grama.

*Bouteloua hirsuta* Lag. Hairy grama.

† *Bromus rubens* L. Foxtail chess; red brome.

*Chloris virgata* Swartz. Feather fingergrass.

*Cynodon dactylon* (L.) Pers. Bermuda grass.

*Digitaria californica* (Benth.) Henr. [*Trichachne californica* (Benth.) Chase]. Arizona cottontop.

*Echinochloa colonum* (L.) Link. Jungle ricegrass.

† *Eragrostis lehmanniana* Nees. Lehmann lovegrass.

*Erioneuron pulchellum* (H.B.K.). [*Tridens pulchellus* (H.B.K.) A. S. Hitchc.]. Fluff grass.

*Heteropogon contortus* (L.) Beauv. Tanglehead.

*Hilaria belangeri* (Steud.) Nash. Curly mesquite grass.

*Muhlenbergia porteri* Scribn. Bush muhly.

*Panicum obtusum* H.B.K. Vine mesquite.

*Pappophorum vaginatum* Buckl. [*P. mucronulatum* Nees.]. Pappus grass.

\* † *Pennisetum ciliare* (L.) Link. Buffel grass. Exotic perennial bunch grass; common along Southern Pacific Railroad tracks.

\* † *Pennisetum setaceum* (Forsk.) Chiov. Fountain grass. Exotic perennial bunch grass; rare along Marsh Station Road.

\* † *Phragmites australis* (Cav.) Trin. ex Steud. [*P. communis* Trin.]. Common reed.

*Pleuraphis mutica* (Thurb.) Benth. Ex Scribn. [*Hilaria mutica* (Buckl.) Benth.] Tobosa.

\* † *Rhynchelytrum repens* (Willd.) C.E. Hubb. [*R. roseum* Nees]. Natal grass.

*Scleropogon brevifolius* Phil. Burro grass.

† *Sorghum halepense* (L.) Pers. Johnson grass.

*Sporobolus airoides* Torr. Alkali sacaton.

*Sporobolus wrightii* Munro ex Scribn. Sacaton.

**Hydrophyllaceae**—Water leaf Family

*Phacelia* cf. *distans* Benth. Caterpillar weed.

**Krameriaceae**—Ratany Family

*Krameria erecta* Willd. [*K. parvifolia* Benth.]. Range ratany.



**Labiatae**—Mint Family

*Salvia columbariae* Benth. Chia.

**Leguminosae**—Pea Family

*Acacia constricta* Benth. Whitethorn acacia.

*Acacia greggii* Gray. Catclaw acacia.

*Acacia neovernicosa* Isley. (*A. vernicosa* Standl.) Viscid acacia.

*Astragalus* cf. *lentiginosus* Dougl. var. *australis* Barneby. Locoweed.

*Calliandra eriophylla* Benth. Fairy duster.

*Dalea pringlei* Gray. Pringle indigo bush.

*Parkinsonia aculeata* L. Mexican paloverde.

*Parkinsonia microphylla* (*Cercidium microphyllum* (Torr.) Rose & Johnst. Foothills paloverde.

*Prosopis glandulosa* var. *torreyana* Benson. Western honey mesquite.

*Prosopis velutina* Woot. Velvet mesquite.

*Senna covesii* (Gray) Irwin & Barneby. [*Cassia covesii* Gray]. Desert senna.

**Loasaceae**—Stickleaf Family

*Mentzelia* cf. *affinis* Greene. Blazing star, stickleaf.

**Malpighiaceae**—Malpighia Family

*Janusia gracilis* Gray. Desert vine.

**Malvaceae**—Mallow Family

*Abutilon incanum* (Link) Sweet. Indian mallow.

*Herissantia crispa* (L.) Brizicky. [*Gayoides crispum* (L.) Small].

*Hibiscus coulteri* Harv. Desert rose mallow.

*Hibiscus denudatus* Benth. Rock rose mallow.

*Sphaeralcea ambigua* Gray var. *rosacea* (Munz & Johnst.) Kearney. Desert globe mallow.

**Nyctaginaceae**—Four o'clock Family

*Allionia incarnata* L. Trailing four & o'clock

*Boerhaavia coulteri* (Hook. f.) Wats. Spiderling.

**Oleaceae**—Olive Family

*Fraxinus pennsylvanica* ssp. *velutina* (Torr.) G.N. Miller. Velvet ash.

*Menodora scabra* Gray. Twinberry.

**Pedaliaceae**—Unicorn Plant Family

*Proboscidea altheaefolia* (Benth.) Decne. [incl. *P. arenaria* (Engelm.) Decne.]. Devil's claw

**Plantaginaceae**—Plantain Family

*Plantago* sp. Plantain

**Polygonaceae**—Buckwheat Family

\* *Eriogonum abertianum* Torr. Wild buckwheat.

\* *Eriogonum deflexum* Torr. Skeleton weed.



- \* *Eriogonum ericifolium* var. *Nova*. Heathleaf buckwheat (Species identification confirmed by Dr. James L. Reveal, Professor Emeritus, University of Maryland. Endemic to Pantano Formation, Claystone Member Deposits. Plants are both geographically restricted and locally sparse.

**Portulacaceae**—Portulaca Family

*Portulaca oleracea* L. [incl. *P. retusa* Engelm.]. Common purslane

- \* *Talinum aurantiacum* Engelm. Flame flower. [incl. *T. angustissimum* (Gray) Woot. & Small].

**Ranunculaceae**—Crowfoot Family

*Clematis drummondii* T. & G. Texas virgin's bower

**Rhamnaceae**—Buckthorn Family

*Condalia warnockii* M. C. Johnst. Mexican crucillo. [*Condalia spathulata* Gray sensu K. & P.].

*Ziziphus obtusifolia* (Hook. ex. T. & G.) Gray var. *canescens* (Gray) M. C. Johnst. [*Condalia lycioides* (Gray) Trel.]. Graythorn.

**Salicaceae**—Willow Family

*Populus fremontii* Wats. Fremont cottonwood.

*Salix gooddingii* Ball. Goodding willow

**Scrophulariaceae**—Figwort Family

*Maurandya antirrhiniflora* H. & B. Snapdragon vine.

*Penstemon parryi* Gray. Parry beard tongue.

**Solanaceae**—Potato Nightshade Family

*Datura wrightii* Regel. [*D. meteloides* DC.]. Sacred datura

*Lycium berlandieri* Dunal. var. *longistylum* (L.) Hitch. Berlandier wolfberry.

*Lycium* sp. wolfberry

† *Nicotiana glauca* Graham. Tree tobacco.

*Nicotiana obtusifolia* Mertens & Galeotti [*N. trigonophylla* Dunal]. Desert tobacco.

*Physalis crassifolia* Benth. Thicket ground cherry.

**Tamaricaceae**—Tamarix Family

*Tamarix ramosissima* Ledeb. [*T. chinensis* Loureiro, *T. pentandra* Pall. sensu K. & P.].  
Tamarisk.

**Typhaceae**—Cattail Family

*Typha domingensis* Pers. Cattail.

**Ulmaceae**—Elm Family

*Celtis pallida* Torr. Desert hackberry.

**Umbelliferae**—Parsley Family

*Daucus pusillus* Michx. Wild carrot.



**Verbenaceae**—Vervain Family

*Aloysia wrightii* (Gray) Heller. Oreganillo.

*Verbena gooddingii* Briq. [*Glandularia gooddingii* (Briq.) Solbrig]. Goodding vervain.

**Viscaceae**—Mistletoe Family

*Phoradendron californicum* Nutt. Desert mistletoe.

**Zygophyllaceae**—Caltrop Family

*Kallstroemia grandiflora* Torr. Arizona poppy.

*Larrea divaricata* Cav. ssp. *tridentata* (DC.) Felger & Lowe. [*L. Tridentata* (DC.) Cov.].

Creosotebush

† *Tribulus terrestris* L. Goathead, puncture vine.