WHICH WOODY PLANTS GROW WHERE AT THE GRAND CANYON

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This paper is a hiker's list of trees and shrubs at key places along certain of the South Rim trails at the Grand Canyon National Park. It also contains discussion of several patterns of distribution found among Grand Canyon woody plants; and these patterns are interpreted historically from the standpoint of scientific creationism and flood geology. Some hints at distinguishing between pairs of plants that resemble each other are also included.

Introduction

There are several excellent books in which plants of Northern Arizona have been thoroughly described and carefully illustrated. These books also designate altitude zones at which particular plants may be found. Learning the trees and shrubs becomes easier, however, if one has a checklist stating which ones are found in each exact locality.

In part I of this paper are lists of plants found at different points along the trails at the Grand Canyon. Attention centers on trees and shrubs rather than herbs because the former are present and easily identified throughout the entire year.

Altitudes, landmarks, and permanent trail signs are listed in sequence along the South Kaibab Trail to Bright Angel Campground. Next there is a similar survey of landmarks along the River Trail and the Bright Angel Trail up to and including sections of the South Rim. Plant lists are also provided for some areas of the South Rim and for the nearby settlement of Tusayan.

These trail materials of part I have been arranged on the assumption that the hiker will go down the South Kaibab Trail and up the Bright Angel Trail. One may use the lists in reverse if the opposite hiking pattern is selected.

While hiking these trails, one passes through a sequence of rock strata. A list of trees and shrubs for each whole rock layer is given first. Then the various altitudes and other landmarks within that particular rock span are given along with special assemblages of plants found here or there.

Altitudes may be measured with an inexpensive altimeter available at most sporting goods stores. The altimeter can be calibrated at the South Kaibab trailhead to 7200 feet. Recalibration may be carried out in keeping with altitude signs along the trail. It was my experience, however, that the altimeter readings were sometimes more accurate than certain of the altitude markings along the trail! Although there is a measure of inaccuracy and non-repeatability in this procedure, it helps to narrow the selection of trees and shrubs and thereby assists in the more rapid identification of woody plants. Common names are used for these plants in part I since people learning plants generally find the common names most useful.

In part II each plant is listed alphabetically as a separate entry with its full common name, scientific name, and brief description. After each plant in part II there is also a statement regarding the life zones where it is usually found together with its general range in the Park. The plant is given a number in part II which corresponds to one of the numbered patterns described in part III.

Part II contains a discussion of plant distribution in reference to altitude and to the interpretive framework of special creationism and flood geology. Plants are assigned one of several numbered categories depending on their distribution.

Full and final identification of plants can be confirmed by use of several inexpensive books which may be carried in a day-pack and used in conjunction with this trail list. Some that I have found quite helpful are listed under general references.

Correspondence is welcome from any who wish to comment regarding the lists and their use along the trails. Possible additions, corrections, or suggested deletions are invited and will be considered when this publication is revised and expanded.

I. Part I. Plants at Various Trail and Altitude Points, South Rim, Grand Canyon.

A. South Kaibab Trail

1. Kaibab Limestone:
   banana yucca, cliffrose, Douglas fir, Gambel oak, jointfir, pinyon pine, sagebrush, serviceberry, Utah juniper.
   a. at trailhead:
      banana yucca, cliffrose, pinyon pine, sagebrush, serviceberry, Utah juniper.
   b. climate belt sign about 6900 feet altitude: douglas fir, Gambel oak, jointfir, pinyon pine.
   c. sign at junction of Kaibab Limestone and Toroweap Formation: banana yucca, jointfir, pinyon pine, serviceberry.
2. Toroweap Formation and Coconino Sandstone: apache plume, banana yucca, cliffrose, douglas fir, jointfir, opuntia, pinyon pine, sagebrush, serviceberry, Utah agave, Utah juniper.
   a. sign "South Rim 0.5 miles": cliffrose, pinyon pine, serviceberry, Utah juniper.
   b. 6800 feet altitude: cliffrose, sagebrush.
   c. 6600 feet altitude: apache plume.
   d. 6500 feet altitude: jointfir, pinyon pine, Utah juniper.
   e. 6400 feet altitude: jointfir, pinyon pine, sagebrush, serviceberry.
   f. sign at contact between Coconino Sandstone and Hermit Shale: (6300 feet altitude) jointfir, pinyon pine, serviceberry, Utah juniper.

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3. Hermit Shale:
banana yucca, Douglas fir, four-wing saltbush, jointfir, pinyon pine, serviceberry, Utah agave, Utah juniper.
   a. sign "You can come down 1500"': banana yucca, jointfir, pinyon pine, serviceberry, Utah juniper.
   b. sign at junction between Hermit Shale and Supai Formation: cliffrose, jointfir, pinyon pine, serviceberry, Utah agave.
4. Supai Formation:
ash, banana yucca, blackbrush, cliffrose, curlleaf mountain-mahogany, four-wing saltbush, jointfir, pinyon pine, rabbitbrush, serviceberry, Utah agave, Utah juniper.
   a. 5900 feet altitude, a "saddle": cliffrose, jointfir, pinyon pine, Utah juniper.
   b. 5800 feet altitude: banana yucca, Utah agave.
   c. 5400 feet altitude: blackbrush, Utah agave, Utah juniper.
   d. 5300 feet altitude: pinyon pine still present.
   e. 5200 feet altitude: cliffrose, four-wing saltbush, rabbitbrush, Utah juniper.
   f. sign at contact between Supai and Redwall Limestone (about 4900 feet altitude).
5. Redwall Limestone:
baccharis, banana yucca, blackbrush, catclaw, cliffrose, curlleaf mountain-mahogany, four-wing saltbush,jointfir, opuntia, pinyon pine, rabbitbrush, soaptree yucca, Torrey ephedra, Utah agave, wafer ash.
   a. 4800 feet altitude: four-wing saltbush, Utah agave.
   b. 4700 feet altitude: curlleaf mountain-mahogany, jointfir, Utah agave.
   c. 4700 feet altitude, sign indicating 3.5 miles to South Rim, 3.8 miles to Phantom Ranch: catclaw, jointfir.
   d. 4600 feet altitude: baccharis.
   e. 4500 feet altitude: soaptree yucca, wafer ash.
   f. 4200 feet altitude, sign discussing "unconformity" - purple rock of Temple Butte Formation visible: catclaw, four-wing saltbush, jointfir, rabbitbrush.
   g. sign at contact between Muave and Bright Angel Shale: blackbrush, four-wing saltbush, jointfir, rabbitbrush, Torrey ephedra.
6. Bright Angel Shale, Tapeats Formation, and Shinomo Quartizite: baccharis, banana yucca, blackbrush, brittlebush, catclaw, four-wing saltbush, jointfir, opuntia, rabbitbrush, serviceberry, soaptree yucca, Utah agave, wafer ash.
   a. desert animal sign 4100 feet altitude: catclaw, four-wing saltbush, rabbitbrush.
   b. sign stating River Trail 2.4 miles: four-wing saltbush, jointfir, rabbitbrush, wafer ash.
   c. 4000 feet altitude: blackbrush.
   d. desert sign at 3900 feet: banana yucca, blackbrush, jointfir.
   e. desert plant sign: blackbrush, catclaw, Utah agave.
   f. emergency telephone: brittlebush, four-wing saltbush, jointfir.
   g. sign at contact between Tapeats Formation and Shinomo Quartzite: brittlebush, jointfir, opuntia, rabbitbrush.
   h. 3800 feet altitude: wafer ash.
   i. Shinomo Ripple Mark sign at 3600 feet altitude: jointfir, soaptree yucca.
7. Hakatai Shale:
brittlebush, catclaw, jointfir, opuntia, rabbitbrush.
   a. sign "South Rim Trail 1.4 miles" 3500 feet altitude.
   b. 3400 feet altitude: brittlebush, catclaw, jointfir, opuntia.
   c. 3200 feet altitude: catclaw, jointfir, opuntia.
8. Bass Limestone: (marker at about 3100 feet altitude)
brittlebush, catclaw, jointfir, opuntia.
9. Brahma Schist:
brittlebush, catclaw, jointfir, soaptree yucca, Utah agave.
   a. Brahma Schist sign at 2900 feet altitude: brittlebush, catclaw, jointfir.
   b. Colorado River Sign at 2700 feet altitude: jointfir, soaptree yucca.

B. Along the Colorado River from bridge to and including Bright Angel Campground:
baccharis, brittlebush, catclaw, four-wing saltbush, mesquite, opuntia, rabbitbrush, tamarix, Utah agave, willow.

C. River Trail from the western bridge to the upward ascent of Bright Angel Trail:
baccharis, catclaw, jointfir, opuntia, rabbitbrush, soaptree yucca.
   1. Zoroaster Granite sign:
   catclaw.
   2. Wind and water sign:
   baccharis, catclaw, jointfir, soaptree yucca.

D. Bright Angel Trail:
   1. Brahma Schist and Tapeats Sandstone:
   baccharis, blackbrush, brittlebush, California redbud, canyon grape, catclaw, four-wing saltbush, Fremont cottonwood, hollygrape, jointfir, opuntia, tamarix, Utah agave, wafer ash, willow.
      a. 2500 feet altitude: catclaw, jointfir, opuntia.
      b. 2600 feet altitude: Fremont cottonwood along creek catclaw, jointfir.
      c. 2700 feet altitude: much jointfir here.
      d. desert animal sign at 2700 feet: catclaw, jointfir.
      e. 2900 feet altitude: California redbud.
      f. polished rock sign: catclaw, jointfir, opuntia.
      g. 3400 feet altitude: still have some tamarix along stream, jointfir, hollygrape.
      h. 3800 feet altitude: wafer ash.
      i. 3900 feet altitude: California redbud.
      j. just above sign at contact between Tapeats Sandstone and Bright Angel Shale: blackbrush, brittlebush, Fremont cottonwood, jointfir, Utah agave.

2. Bright Angel Shale and Redwall Limestone:
   apache plume, ash, banana yucca, blackbrush, brittlebush, California redbud, catclaw, cliffrose, four-wing saltbush, Fremont cottonwood, hollygrape, jointfir, opuntia, pinyon pine, rabbitbrush, turpentine-broom, Utah agave, Utah juniper, wafer ash, willow.
   a. sign before reaching Indian Gardens indicating 0.4 miles to Indian Gardens: apache plume, Fremont cottonwood.
   b. juncture of Tonto Trail with Bright Angel Trail: apache plume, blackbrush, Fremont cottonwood, jointfir, Utah juniper, willow.
   c. Indian Gardens area: apache plume, ash, blackbrush, brittlebush, California redbud, catclaw, cliffrose, four-wing saltbush, jointfir, opuntia, Utah agave.
   d. flash flood sign above Indian Gardens: apache plume, catclaw, turpentine-broom.
   e. 4100 feet altitude in ravine just above Indian Gardens: Utah juniper.
   f. 4200 feet altitude: pinyon pine.
   g. 4300 feet altitude: banana yucca.
   h. 4400 feet altitude: apache plume, ash, Utah juniper.
3. Supai Formation:
   ash, banana yucca, currant, hollygrape, jointfir, opuntia, pinyon pine, serviceberry, shrub live oak, Utah agave, Utah juniper, wafer ash.
   a. sign at contact between Redwall Limestone and Supai Formation at the 3 mile rest house, 5000 feet altitude: ash, jointfir, pinyon pine, serviceberry, Utah agave, Utah juniper.
   b. sign indicating South rim 2.3 miles: banana yucca, currant, hollygrape, jointfir, opuntia, pinyon pine, shrub live oak, wafer ash.
   c. sign indicating South Rim 2 miles, 5400 feet altitude: banana yucca, hollygrape, opuntia, pinyon pine, shrub live oak, Utah juniper, wafer ash.
   d. sign with words "Do not cut across switchbacks" about 5700 feet altitude: banana yucca, hollygrape, jointfir, shrub live oak, Utah juniper, wafer ash.
4. Hermit Shale:
   ash, banana yucca, creeping mahonia, Douglas fir, gambel oak, jointfir, pinyon pine, serviceberry, Utah juniper, wafer ash.
   a. sign at contact of Supai Formation and Hermit Shale, 5900 feet altitude: jointfir, pinyon pine, serviceberry.
   b. thickets of Gambel oak exist.
   c. rest house at 6200 feet altitude: pinyon pine.
5. Coconino Sandstone:
   bamama uicca. creeping mahonia, Douglas fir, Gambel oak, hollygrape, jointfir, pinyon pine, serviceberry, wafer ash.
   a. sign at contact of Coconino Sandstone and discussing that sandstone, 6000 feet altitude: creeping mahonia, Douglas fir.
   b. on the talus wedge: here one trudges up a triangular talus wedge that has a shorter and shorter switchback up to the top which is a bowl of Coconino Sandstone: banana yucca, Douglas fir, hollygrape, pinyon pine, Gambel oak.
6. Kaibab Limestone:
   banana yucca, Douglas fir, fernbush, Gambel oak, hollygrape, jointfir, pinyon pine, serviceberry.
   a. sign indicating transition from Toroweap to Kaibab Limestone: Douglas fir (dead), Gambel oak, hollygrape, serviceberry.
   b. right near the South Rim and back a way at the trailhead of Bright Angel trail: banana yucca, fernbush, pinyon pine, ponderosa pine, sagebrush, Utah juniper.
   c. walking along the road one sees many seedlings of pinyon pine and Utah juniper.
   d. center strip in the road near Yavapi Point: fernbush, sagebrush, Utah agave.
   e. other plants along road to the South Kaibab trailhead from the Bright Angel trailhead: banana yucca, pinyon pine, Utah juniper.
   f. right at Mather Point: much cliffrose.

II. Part II. Alphabetical List of South Rim Trail Woody Plants.

agave, see Utah agave.

apache plume, *Fallugia paradoxa*
Shrub. Short, brittle, mat-like, resembling cliffrose. Peely grey to reddish bark. Fruit with feathery appendage - dozens in cluster. Leaves like small mittens varying from one on up to 5 or 7 lobes. Type 7. See thumbnail sketch#1.

ash, *Fraxinus sp.*
Short tree. See also wafer ash.

baccharis, *Baccharis spp.*
Shrub, Leaves resemble willow. Many branches from close to ground level. Several species in Grand Canyon. Type 6 and 1.

banana yucca, *Yucca baccata*
Leaves up to 3 cm broad. Tip of leaf spearlike, margin of leaf has long white threads, unlike the margin of a similar plant - Utah agave which is saw-toothed. Broad leaves easily separate it from the other Grand Canyon yuccas.

barberry, see creeping mahonia.

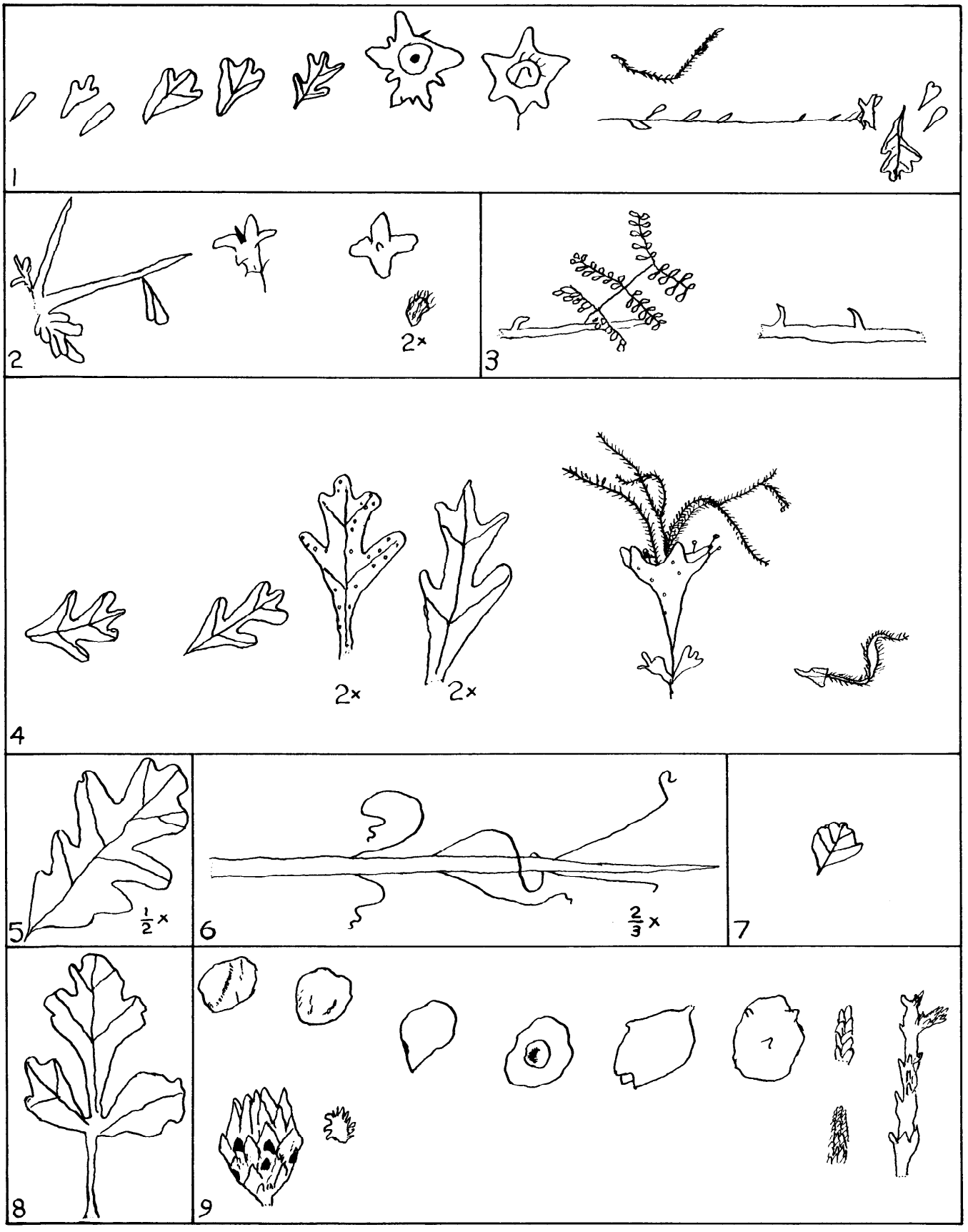
blackbrush, *Coleogyne ramosissima*
Shrub. Leaves slender, linear, of various sizes. Branch tips sharp. Great numbers of blackbrush plants from a distance look like huge flocks of sheep scattered out on the Tonto Plateau. Type 7. See thumbnail sketches #2.

brittlebush, *Encelia farinosa*
Short shrub. Much branched. Flowers showy, yellow, resembling little sunflowers. Type 6.

burrowbrush, see blackbrush.

California redbud, *Cercis occidentalis*
Short tree. Leaves heartshaped, rounded. Bark dark grey. Pods reddish when dried. Buds and flowers red in Spring. Type 7.

canyon grape, *Vitis arizonica*
Vine.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catclaw, *Acacia greggii*
Short tree. Stem with backward pointing spines and linear grey-brown stripes. Leaves doubly compound, subleaflets up to 5 mm long. Pods brown, indented, twisted. Type 5. See thumbnail sketches #3.

century plant, see Utah agave.

cliffrose, *Cowania mexicana*
Dwarf tree or shrub. Leaves small, variably shaped but many look like three-fingered mittens. Leaves with small white dots. Fruit with a tail. Cliffrose leaves resemble those of apache plume but fruits of cliffrose are borne farther down in a more trumpet-shaped flower tube than apache plume. Cliffrose fruits in clusters of 5 while apache plume fruits in clusters of many more than 5. Old cliffrose plants at Mather Point resemble Utah juniper but a close look at the leaves will distinguish. Type 8. Thumbnail sketches #4.

cottonwood, see Fremont cottonwood.

creeping mahonia, *Berberis repens*
Small shrub, close to ground. Leaflets with spines like hollygrape. Type 10.

curlleaf mountain-mahogany, *Cercocarpus ledifolius*
Shrub or short tree. Leaves slender, grey-green, rolled under along the edges, approximately 3 cm long. Older bark peels off in small chunks. Type 7.

currant, *Ribes sp.*
Type 7.

datil, see banana yucca.

douglas fir, *Pseudotsuga menziesii*
Tall trees. Leaves are needles which are not bound together in clusters but are spaced singly along the stem. Evergreen. Small cones have forked leaf or "bract" under each scale. Type 10.

ephedra, see jointfir and Torrey ephedra.

fernbush, *Chamaebatiaria millefolium*
Leaves small, divided into many sections and resembling a miniature fern leaf. In winter resembles sagebrush but has a redder color to its bark and dried flowers than does sagebrush. Type 10.

fir, see douglas fir or jointfir.

four-wing saltbush, *Atriplex canescens*
Shrub. Leaves slender and fuzzy. Fruit with four wing-like appendages. Type 6.

Fremont cottonwood, *Populus fremontii*
Large trees. Leaves triangular, margins toothed. Near water. Types 6 and 1.

Fremont mahonia, see hollygrape.

Gambel oak, *Quercus gambelii*
Short tree forming thickets or clumps. Rocky habitats, north facing slopes. Leaf or typical "oak" shape. Type 10. See thumbnail sketch #5.

grape, see canyon grape, hollygrape, and creeping mahonia.

hollygrape, *Berberis fremontii*
Tall shrub. Each leaf has 5 to 7 leaflets with pointed margins. Bark striped when young but stripes not perfectly straight. Type 9.

honey mesquite, see mesquite.

hop tree, see wafer ash.

jointfir, *Ephedra viridis.*
Low shrub. Leaves only 2 papery projections at each joint of stem. Stem green, resembling another species also found in Grand Canyon - Torrey ephedra. Type 4.

juniper, see Utah juniper.

live oak, see shrub live oak.

mahonia, see hollygrape.

mesquite, *Prosopis juliflora*
Large tree, some plants up to 1 foot in diameter. Thorns come straight out from stem in pairs. Bark slippery grey with furrows. Leaves doubly divided but has only 2 leaflets, each leaflet having up to 34 subleaflets, each about 2 cm. long. Type 2.

mormon tea, see jointfir.

mountain-mahogany, see curlleaf mountain-mahogany

narrowleaf yucca, *Yucca angustissima*
Leaves very narrow - less than 1/2 inch wide. It has a simple flower stalk (unbranched) not to be confused with soaptree yucca at lower altitudes in the Canyon and along the Colorado River - soaptree yucca

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On the facing page are thumbnail sketches of some of the plants, common at the Grand Canyon, mentioned in this article.

1. Apache plume, *Fallugia paradoxa.* Shows various leaf shapes, flowers, fruit with tail, stem with flower, and more leaves.

2. Blackbrush, *Coleogyne ramosissima.* Shows spines at stem tips with leaf clusters. Farther right are flowers; then at the extreme right one of the hairy seeds, shown enlarged.

3. Catclaw, *Acacia greggii.* Shows double compound leaf and thorns along the stem.

4. Cliffrose, *Cowania mexicana.* Shows leaves normal size, then enlarged so dots appear on the back. Flower and fruit are seen at the right.

5. Gambel oak *Quercus gambelii.* Shows a typical leaf. Somewhat reduced.

6. Narrowleaf yucca, *Yucca angustissima.* Shows leaf with thin strands curling off the margins. The soaptree yucca is similar; but the strands of the banana leaf yucca are much thicker. Utah agave has spines, not strands along leaf. Somewhat reduced.

7. Serviceberry, *Amelanchier utahensis.* Shows typical leaf.

8. Squawbush, *Rhus trilobata.* Shows typical leaf.

9. Utah juniper, *Juniperus osteosperma.* Top left to right shows three views of the seed, and then four views of the cone, which resembles a blue berry. Extreme and bottom right, both the smooth and the sharp folliage, as this plant has leaves of two types. Lower left, abnormal "cones" sometimes found.

having a branched flower stalk. Narrowleaf yucca is a short, ground-level plant while soaptree yucca gets to be 1 or 2 meters tall. Type 11. See thumbnail sketch #6.

nut pine, see pinyon pine.

oak, see Gambel oak or shrub live oak.

opuntia, *Opuntia spp.*
Cactus. There are several types of opuntia or prickly pear in the Canyon. Most species have needles or spines. Consult texts for characteristics of the various species. Type 3.

oregon grape, see creeping mahonia.

pinyon pine, *Pinus edulis*
Tree. Leaves short needles in clusters of 2. Needles shorter than those of ponderosa pine. Seed edible -"pine nut". Type 8.

pine, see pinyon pine or ponderosa pine.

ponderosa pine, *Pinus ponderosa*
Large tree. Leaves are needles in clusters of 3. Needles 4 to 5 inches long. Bark with picture-puzzle pattern and odor of vanilla. Type 10.

prickly pear, see opuntia.

rabbitbrush, *Chrysothamnus nauseosus*
Small shrub. Stems slender, greenish, topped with sprays of flowers. Plant has overall fan or top shape. Type 5.

redbud, see California redbud.

sagebrush, *Artemesia tridentata*
Shrub. Leaves small, whitish, three-forked. May be confused with fernbush which has a reddish tint. Type 10.

saltbush, see four-wing saltbush.

salt-cedar, see tamarix.

serviceberry, *Amelanchier utahensis*
See thumbnail sketch #7. Type 8.

shrub live oak, *Quercus turbinella*
Shrubby tree. Leaves small with many points on margins. Type 7.

soaptree yucca, *Yucca elata*
Older plants tall - up to 2 meters along Colorado River north shore. Flower stalk branched, unlike banana yucca which has unbranched flower stalk -narrowleafed yucca also has unbranched flower stalk. Leaves quite thin, like narrowleaved yucca. Type 6.

squawbush, *Rhus trilobata*
Trifoliate leaves. Resembles poison oak but has a more woody or shrub-like growth form. Present in the woodlands near Tusayan. See thumbnail sketch #8.

tamarix, *Tamarix pentandra*
Tree. Leaves tiny, scale-like. Flowers in bright pink clusters at Springtime. Along rivers and streams. Types 1 and 6.

Torrey ephedra, *Ephedra torreyana*
Looks much like jointfir but has 3 papery little projects at each stem joint, rather than 2. Low shrub. Leaves papery projects. Resembles jointfir which is much more prevalent. Type 7.

turpentine-broom, *Thamnosa montana*
Type 7. Beautiful blue flowers in Spring. Bare green stems.

Utah agave *Agave utahensis*
Cluster of thick, fleshy, spear-shaped leaves with sharply toothed margins. Long dried flower stalk. May be confused with banana yucca which has leaves of about the same size but with whitish fibers rather than spines along its margin. Type 3.

Utah serviceberry, see serviceberry.

Utah juniper, *Juniperus osteosperma*
Short tree. Leaves small, flat or sharp, closely pressed against stem. Cone resembles blush or reddish berry. Both male and female cones on same tree. Resembles another species *J. monosperma* which grows along the road between the South Rim and Flagstaff, Arizona. Monosperma has male and female cones on different trees. Sometimes Utah juniper produces abnormal cone-like growths that resemble tiny pine cones - see thumbnail sketch #9. Type 8.

wafer ash, *Ptelea angustifolia*
Short tree. Leaves three-parted, each made of three leaflets. Fruit broad, winged, wafer-like. Type 7.

western yellow pine, see ponderosa pine.

willow, *Salix* spp.
Short tree. Near streams or other water sources. Leaves slender. Flowers in short, drooping clusters called "catkins". Similar to *Baccharis* which also grows near streams. Types 6 and 1.

yucca, see banana yucca, narrowleaf yucca, or soaptree yucca.

III. Part III. Distribution Patterns Seen Among Woody Plants of The South Rim, Grand Canyon National Park.

A. Distribution classes. Each of the following classes is given a number. These numbers are listed at the end of each description in Part II so that a reader could discover, for example, that the Utah agave is a type 3 plant, meaning that it is present from the rim to the Colorado River but is nowhere dominant.

1. Associated with streams at various altitudes, sometimes also including the Colorado River -reparian: baccharis, Fremont Cottonwood, tamarix, willow.
2. Along the Colorado River only:
mesquite.
3. From the South Rim to the Colorado River, sporadically present but nowhere dominant:
four-wing saltbush, opuntia, Utah agave.
4. From the South Rim to the Colorado River, at various altitudes, dominant or prevalent in one zone only:
jointfir.
5. From the Colorado River up to middle altitudes -dominant at one altitude only (Lower Sonoran Life Zone of Merriam):
catclaw - prominent along the river and in Brahma Schist but scattered up to 5000 feet altitude on Redwall Limestone.
rabbitbrush - prominent at Tonto Plateau up to 4200 feet altitude at Indian Gardens.
6. From the Colorado River up to middle altitudes but nowhere dominant. Lower Sonoran Life Zone:

baccharis, brittlebush - up to the Bass Limestone on South Kaibab Trail and up to Bright Angel Shale on the Bright Angel Trail, Fremont cottonwood - along streams only but up to the Bright Angel Shale, soaptree yucca, tamarix -streams up to 3400 feet altitude, wafer ash.

7. At middle altitudes only;
ash - Bright Angel Shale, Supai, and Hermit Shale, blackbrush - dominant on Tonto Plateau and up to Supai in areas, California redbud -Bright Angel Shale, canyon grape - Tapeats on Bright Angel Trail, curleaf mountain-mahogany - Supai on Bright Angel Trail, currant - Supai, Torrey ephedra - Redwall of South Kaibab Trail, turpentine bush - Bright Angel Trail above Indian Gardens.
8. From the South Rim down to the Tonto Plateau - dominant at one altitude (Upper Sonoran Life Zone):
cliffrose - prominent near the Rim, pinyon pine, prominent near the Rim, serviceberry - prominent near the Rim on Kaibab and Toroweap formations, Utah juniper - prominent near the Rim.
9. From the South Rim to the Tonto Plateau but nowhere dominant (Upper Sonoran Life Zone):
hollygrape - from above Bright Angel Shale up to an including Kaibab Limestone on Bright Angel Trail, banana yucca.
10. Near South Rim only:
creeping mahonia - from the Hermit Shale to the Kaibab Limestone on Bright angel Trail, Douglas fir - Kaibab Limestone to the Hermit Shale on the Bright Angel Trail plus Toroweap and Kaibab formations on South Kaibab Trail, fernbush - Kaibab Limestone on Bright Angel Trail, Gambel oak Kaibab on South Kaibab Trail as well as from Supai to Kaibab on the Bright Angel Trail, ponderosa pine, sagebrush -down to the Coconino on the South Kaibab Trail.
11. Present near the settlement of Tusayan but not near the South Rim itself:
narrowleaved yucca, squawbush.

B. Discussion of South Rim Plants in Relationship to Creationism and Flood Geology:

The preflood fabric of vegetation contained plants which had varying amplitudes of tolerance to environmental factors. Some plants were suitable to grow over widespread land areas, others to grow sporadically in smaller numbers - nowhere being dominant. In the preflood environment presumably there were variations of climate: but these were much more moderate than present variations.

This tropical and temperate preflood world underwent violent change and diversification during and after the catastrophe. Plants became established in the many new habitats formed by the worldwide event. Depending on their designed limits of tolerance, plant types repopulated various ecological niches in the wake of the catastrophe.

After the flood the Creator may likewise have allowed such processes as gene mutation, natural selection, and polyploidy to equip these plants further for their new roles of clothing the earth with its diverse network of nascent habitats. There was thus an array of plant forms ready to cover the new-formed land surfaces as the waters receded. Plants like the jointfir were evidently present in moderate numbers within the preflood vegetation. But after the flood they apparently took on new proportions since their genetic tolerances were just what was required to fit the specificities of life in the Canyon gorges.

Since the time of the flood, it appears that the western United States region has undergone a warming and drying trend. A. M. Phillips asserted that at an earlier date plants like the juniper prevailed on the slopes of the inner gorge but that more recently have given way to desert shrubs and cacti.[1]

As I indicated five years ago, cactus species may have been present in low numbers within the original preflood fabric - frequenting drier areas even back then. But the unique patterns of water conservation may have destined cactus family members to become dominant in changed habitats of post-flood times.[2]

I assume that all plants presently growing in the Grand Canyon grew in various regions of the preflood world. After the flood there was a sorting of genotypes and as a result land areas were repopulated by clusters of species that had been best endowed to thrive under particular environmental constraints. This assumes that considerable "design" and "preadaptation" were programmed into the plants from the first days of creation. When conditions arose after the flood favoring one plant above others, it reproduced well and covered much of the open ground, becoming dominant.

Evidence from other localities can be interpreted, for instance, in line with the proposition that southwestern deserts and other biomes of today arose from one and the same preflood vegetational fabric. Professor T. Recht of California State University has found areas in Mexico where patches of true Chihuahuan desert lie adjacent to highly vegetated strips of a more mesic or verdant character.[3] He reports that the mesic strips are 200-400 meters by 20-50 meters while the nearby barren areas are playa-like, being 200 meters by 400 meters or more in dimensions. In the vegetated areas, rich stands of grass flourish together with opuntia cacti.

Recht also indicates that rich tropical scrub forests occur 90 km north of Mazatlan in Mexico. I believe the close proximity of such diverse biomes indicates that all these separate plant communities derived from one original plant assemblage which existed before the flood.

While some workers hold that plants changed gradually and adapted over vast periods of time to meet the changes in the environment, I believe that each plant type was originally formed with fixed amplitudes of survival. The environment changed drastically, displaying a vast array of extreme niches after the flood. Plants which were preadapted for growth in various niches grew there. Thus plants did not fill niches by slow change but by the fact that they had been created with the potential to fill those niches; and

that potential became fully manifest after the flood. In addition, each plant may have undergone further change after finding its series of niches in the postflood environment.

Oddly enough, such a view implies "selection" - not the gradual selection of mutations within a species over long ages but the immediate selection and survival of suitable genotypes on the newly formed habitats as flood waters abated. As a result we find the fascinating array of plant distribution patterns seen in the Grand Canyon and described briefly in this paper. The following quotation from my earlier paper summarizes this view adequately:

> ". . . the Creator has reclothed the earth with biomes that can be traced both altitudinally (as here at the Canyon) and latitudinally from the equator to the poles. Particular types of plants are especially suited for life in each microhabitat. This adaption of plant types to their own habitats and the preparedness of each habitat on the other hand for its specific plant forms reflects the great wisdom of the Creator and shows that even in catastrophe (the flood) there was a design, direction, and finally, restoration."[4]

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References

[1]Phillips, A. M. III, 1977. A botanist's view. *Plateau* 49 (4): 10-17. (Spring).
[2]Golike, S., and G. Howe, 1975. The Grand Canyon - a winter ecology laboratory. *Bible-Science Newsletter* 13 (2):1-3.
[3]Recht, Tony, 1980. Personal correspondence with the author. Professor Recht is at California State University, Dominguez Hills, Carson, California.
[4]Golike, S., and G. Howe, 1975. The Grand Canyon - a winter ecology laboratory (continued). *Bible-Science Newsletter* 13 (3):4.
[5]Elmore, F. H. and J. R. Janish. 1976. Shrubs and trees of the southwest uplands. Southwest Parks and Monuments Association, P.O. Box 1562, Globe Arizone 85501 (available at Visitor's Center, South Rim, Grand Canyon.)
[6]McDougall, W. B. 1964. Grand Canyon wild flowers. museum of Northern Arizona, Flagstaff, Arizona. (available at Visitor's Center, South Rim.)
[7]Patraw, P. M. and Jr. Janish. 1977. Flowers of the southwest mesas, 6th edition. Southwest Parks and Monuments Association, 339 South Broad St., Box 1562, Globe Arizona 85501. (available at Museum of Northern Arizona booktable, Flagstaff, Arizona).
[8]Phillips, A. M. III and J. Richardson. 1979. Grand Canyon wildflowers. Grand Canyon Natural History Association. (available at Visitor's Center, South Rim).
[9]Stockert, J. W. 1979. Common wild flowers of the Grand Canyon. The Wheelwright Press, 925 South 300 West, Salt Lake City, Utah 84101. (available at Visitor's Center, South Rim.)
Two larger books that will be of great help to the more advanced students are:
[10]Kearney, T. H. and R. H. Peebles. 1960. Arizona flora. University of California Press, Berkeley.
[11]McDougall, W. B. 1973. Seed plants of Northern Arizona. The Museum of Northern Arizona, Flagstaff.

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in earlier papers by Williams and Herdklotz). Please note the following comments from the newsletter of a caving club.[1]

> The trip really became interesting when we came to the area just above the rubble slope which leads to the "Rattlesnake Room". The new growth was simply unbelievable. All who were familiar with the cave were engaged in a "come over here and see what is new" contest.
>
> The real shock came when someone pointed out the new growth behind the "Bat Burial" formation. Three new stalactites had grown and the longest was some longer than 12". The time since the last photo was taken of this wall was just over 3 months ago so the growth rate of the largest stalactite would be approximately 4" per month or 1 inch every 7.5 days. Unbelievable? Yes! In fact, if any caver believes this without seeing for himself it would surprise me. Luckily though we have been photographing the same spot for 15 years and have all the photos with dates.

References

[1]Trout, Jerry, Trip Reports of Guadalupe Grotto, *Cottonwood Cave*, November 24, 1975.

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[3]Premack, Ann J., 1976. Why chimps can read. Harper and Row, New York.
[4]Rumbaugh, Duane N. (ed.) 1977. Language learning by a chimpanzee: the Lana project. The Academic Press, New York.
[5]1980. Are those apes really talking? Time Magazine, 10 March, pp. 50 & 51.
[6]Wilson, Clifford, 1978. Monkeys will never talk. . . or will they? Master Books, San Diego.
[7]Terrace, Herbert S., 1979. How Nim Chimpsky changed my mind. Psychology Today.
[8]Terrace, Herbert S., 1979. Nim. Alfred A. Knoph, New York.
[9]Reference 7, p. 67.
[10]*Ibid.*, p. 68.
[11]*Ibid.*, p. 67.
[12]*Ibid.*, p. 75.
[13]Sebeok, Thomas, and Jean Umiker-Sebeok, 1980. Speaking of apes. The Plenum Press, New York
[14]Jastrow, Joseph, 1962. Error and eccentricity in human belief. Dover Publications, New York.

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References

[1]Marx, Jean L., 1980. Ape-language controversy flares up. Science 207 (4437):1330-1333.
[2]Terrace, Herbert, 1979, Nim: a chimpanzee who learned sign language - New York, Knopf.