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# Floristic Studies in the Canyon of the Colorado and Tributaries<sup>1</sup>

Elzada U. Clover and Lois Jotter

This report is based upon collections made during the summers of 1938 and 1939. The writers, with four other members of the "Nevills Colorado River Expedition of 1938," navigated the Green and Colorado Rivers from Greenriver, Utah, to Boulder Dam, Nevada, a distance of approximately 660 miles. The period spent in the canyon was forty-two days, from June 20 to August 1, 1938. In view of the fact that the Green and Colorado Rivers serve as a boundary line between counties, it seems advisable to list the chief collection areas alphabetically with counties designated.<sup>2</sup>

- Bass Trail, Coconino County, Arizona  
Bed Rock Rapids, Coconino County, Arizona  
Boulder City, Clark County, Nevada  
Bridge Canyon, San Juan County, Utah  
Bright Angel Creek, Coconino County, Arizona  
Conquistadore Aisle, Coconino County, Arizona  
Dark Canyon, San Juan County, Utah  
Deer Creek Falls, Coconino County, Arizona  
Diamond Creek, Mojave County, Arizona  
Dirty Devil River, Garfield County, Utah  
Elves' Chasm, Coconino County, Arizona  
Emory Falls, Lake Mead, Mojave County, Arizona  
Escalante River, Kane County, Utah  
Forbidding Canyon, San Juan County, Utah  
Granite Rapids, Coconino County, Arizona  
Greenriver (east bank), Grand County, Utah  
Havasupai Canyon, Coconino County, Arizona  
Hell Roaring Canyon, Grand County, Utah  
Hermit Creek, Coconino County, Arizona  
Hite Ranch, Garfield County, Utah  
Lee's Ferry, Coconino County, Arizona  
Mile 12 $\frac{1}{2}$  in Marble Canyon, Coconino County, Arizona  
Mile 26 $\frac{1}{2}$  in Marble Canyon, Coconino County, Arizona  
Mile 84 on the Green River, Grand County, Utah  
Mile Rapids, Cataract Canyon, San Juan County, Utah  
Moki Creek, San Juan County, Utah  
Mooney Falls, Havasupai Canyon, Coconino County, Arizona  
Music Temple, Kane County, Utah  
Navajo Falls, Havasupai Canyon, Coconino County, Arizona  
North Rim, at Grand Canyon Village, Coconino County, Arizona  
Port Royal, North Rim at Grand Canyon, Coconino County, Arizona  
President Harding Rapids, Coconino County, Arizona  
Quartermaster Canyon, Mojave County, Arizona  
Rainbow Bridge, San Juan County, Utah  
Rapids 13, Cataract Canyon, San Juan County, Utah  
Saddle Canyon, Coconino County, Arizona  
Separation Rapids, Mojave County, Arizona  
Site of Julian's Name, San Juan County, Utah  
South Rim, at Grand Canyon Village, Coconino County, Arizona  
Spencer Canyon, Mojave County, Arizona  
Surprise Canyon, Lake Mead, Mojave County, Arizona  
Surprise Valley, San Juan County, Utah  
Tanner Rapids, Coconino County, Arizona

<sup>1</sup> Paper No. 778 from the Department of Botany and the Botanical Gardens of the University of Michigan.

<sup>2</sup> Place names along the rivers were taken from U. S. Geol. Surv. Maps. 84, 85.

Ticaboo Creek, Garfield County, Utah  
 Upset Rapids, Coconino County, Arizona  
 Vasey's Paradise, Coconino County, Arizona

Virgin Canyon, Clark County, Nevada  
 Walthenburg Rapids, Coconino County, Arizona  
 Yokey's Flat, Kane County, Utah.

The senior author spent the summer of 1939 exploring side canyons and collecting at accessible places along the Colorado. Collections were made at Lee's Ferry, on the north and south rims of Grand Canyon, in the Rainbow Bridge Area, in certain selected side canyons along Lake Mead from the head of the lake to the Dam, and in Havasupai Canyon. Detailed work is being continued.

Since the middle of the last century, collections of plants have been made by various botanists on the plateaus and in other areas not far from the Colorado River and tributaries. Botanical specimens from this region were obtained in 1851 by the United States and Mexican Boundary Survey (34); by S. W. Woodhouse of Captain Sitgreaves' expedition (29); by J. M. Bigelow of the Whipple exploring expedition for a railway to the Pacific in 1853-1854 (4); by J. S. Newberry accompanying Lt. J. C. Ives in 1858 (20) up the lower Colorado and into the Grand Canyon region. L. F. Ward, A. S. Hitchcock, Ivar Tidestrom, and A. E. Hitchcock collected in the region of the Grand Canyon in the early 1900's. More recently, Seth Bertram Benson (3) obtained some plants from the Rainbow Bridge area and Navajo Mountain during a biological reconnaissance; Helen Dixon (11) made an ecological study of the high plateaus of Utah; Edward H. Graham (17) did extensive work in the Uinta Basin; Vasco M. Tanner (32) made life-zone studies in southwestern Utah; and Susan D. McKelvey (23) collected yuccas in and near the Colorado Canyon at accessible points. Prior to the present investigations very little botanical work was done within the canyon walls except at Grand Canyon Village. Edwin D. McKee, formerly Park Naturalist at Grand Canyon National Park, is largely responsible for collections used in compiling the check list of Grand Canyon plants (18) although there were also other participants in botanizing in Grand Canyon National Park.

### Geology and Physiography

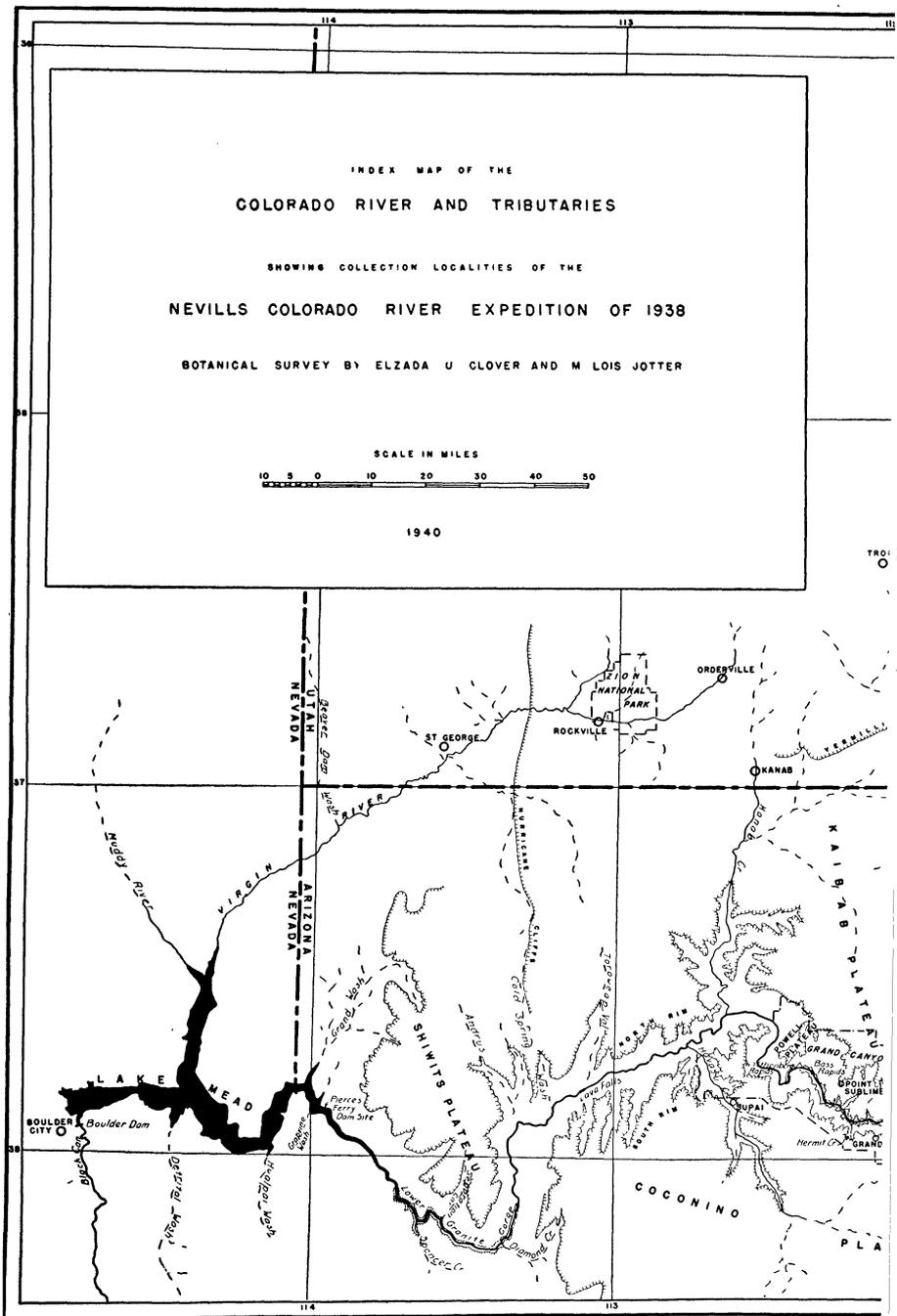
The Colorado River was discovered in 1540 by a detachment of Coronado's party under the guidance of Captain Diaz. About the same time another of Coronado's captains, Cárdenas, took a small band of men, with Indian guides, to the "Famous Cañon of the Colorado" (39).

Lieutenant Joseph C. Ives, under the direction of the office of Explorations and Surveys, United States War Department, reported on the geology of the lower regions of the Colorado (20).

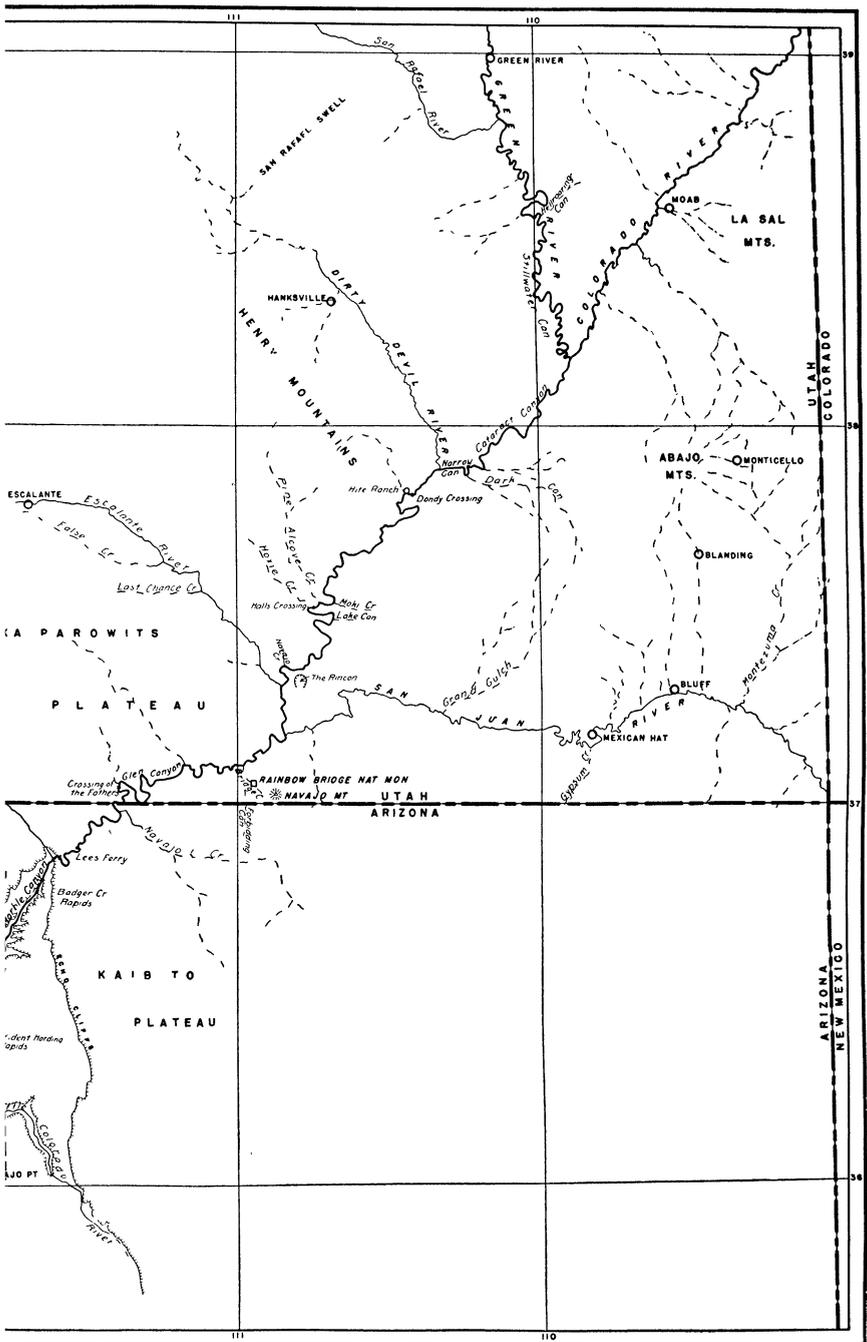
Major J. W. Powell, a one-armed Civil War veteran and geologist, in 1869 left Green River, Wyoming, and was the first to travel through the canyons of the Green and Colorado to the Virgin River (28). Two years later Powell repeated the trip (9), this time stopping at Kanab Canyon because of flood waters. Since that time several geological and other expeditions have explored the canyons, without making botanical collections of record.



Fig. 1.—Aerial view of junction of Separation Canyon with the Canyon of the Colorado; inner gorge approximately eight hundred feet deep. Photograph by Fairchild Aerial Surveys, Inc.



Map 1.—Index map of the Colorado River and tributaries. By A. J. Eardley.



The entire drainage basin of the Colorado comprises 244,000 square miles or one-thirteenth of the area of the United States, and is situated in seven states. Water discharge is from less than 3,000 second-feet during late summer to 200,000 in the highest reported flood stage. Echo Monocline just below Lee's Ferry is an obstacle in the river's path. The cherty limestone and the necessity of eroding this hard rock have delayed erosion, allowing the river above to reduce its course practically to grade (13). The river carries about ten per cent silt, or fine sand, which is the greatest grinding agent. Erosion is aided by the high velocity of the water, which in certain seasons reaches twenty to thirty miles an hour. There are 105,000 acre-feet of silt deposited annually, much of it brought down side canyons.

The present chief tributaries on the east side are the San Juan in southern Utah, the Little Colorado in northern Arizona, and Havasupai Creek. On the west the Dirty Devil (Fremont) River comes in above Hite Ranch, the only habitation along the entire course of the greater Colorado above Boulder Dam. Escalante and Paria Creeks drain the area between this stream and Lee's Ferry. Kanab Creek cuts through the Kaibab Plateau from the north. The waters of Lake Mead now extend thirty miles or more up the Virgin River which drains southwestern Utah and southeastern Nevada.

The San Juan River, entering the Colorado about eighty miles above Lee's Ferry contributes considerable to the already heavy load. Water of the San Juan is used for irrigation in southern Colorado and New Mexico so that the stream is inconsequential in late summer; but trunks of trees and debris found many feet above the canyon floor, and enormous accumulations of coarse alluvium, prove the force of the current during spring floods.

Canyons through which the Green and Colorado Rivers flow have received individual names. To avoid confusion with lateral canyons, those of the main channel from Greenriver downstream are listed as follows: on the Green River, Gray and Labyrinth Canyons; on the Colorado, Cataract, Narrow, Glen, Marble, and Grand Canyons, the latter subdivided into Upper Granite Gorge and Lower Granite Gorge. Cataract Canyon begins at the confluence of the Green and Colorado Rivers and its 63 rapids extend approximately forty-five miles. These rapids are caused by differential erosion of the stream bed and by boulders brought down side canyons during floods. Water percolating through sandstone is stopped by layers of shale high up on the walls. This water, emerging as seeps, softens rock and soil and starts slides. Great boulders, often fifteen feet in diameter, are thrown into the stream or along the shore, and rock fragments accumulate as talus at the foot of walls.

The bed of the Colorado drops 4,000 feet from the mouth of the Green River to the Gulf of California, a distance of 1,215 miles. In its course through the Grand Canyon the stream descends from 3,600 to about 1,000 feet above sea level. The average fall is seven and one-half feet per mile (15). The river, except in extremes of drought or flood, is approximately 300-400 feet wide and about forty feet deep; but in places where the depth is much greater it narrows down to something like fifty feet.

The portion of the river in Grand and Marble Canyons has cut through



Fig. 2.—Aerial view of the Grand Canyon at Hermit Creek to show the various formations. 1. Schists and granites (Archaean Era); 2. Sandstones, limestones and shales (Algonkian Era); 3. Tonto formations (Cambrian Period); 4. Redwell Limestone (Mississippian Period); 5. Supai Sandstone and Shale (Permian Period); 6. Hermit Shale (Permian Period); 7. Coconino Sandstone (Permian Period); 8. Kaibab Limestone (Permian Period). Photograph by Spence Air Photos.

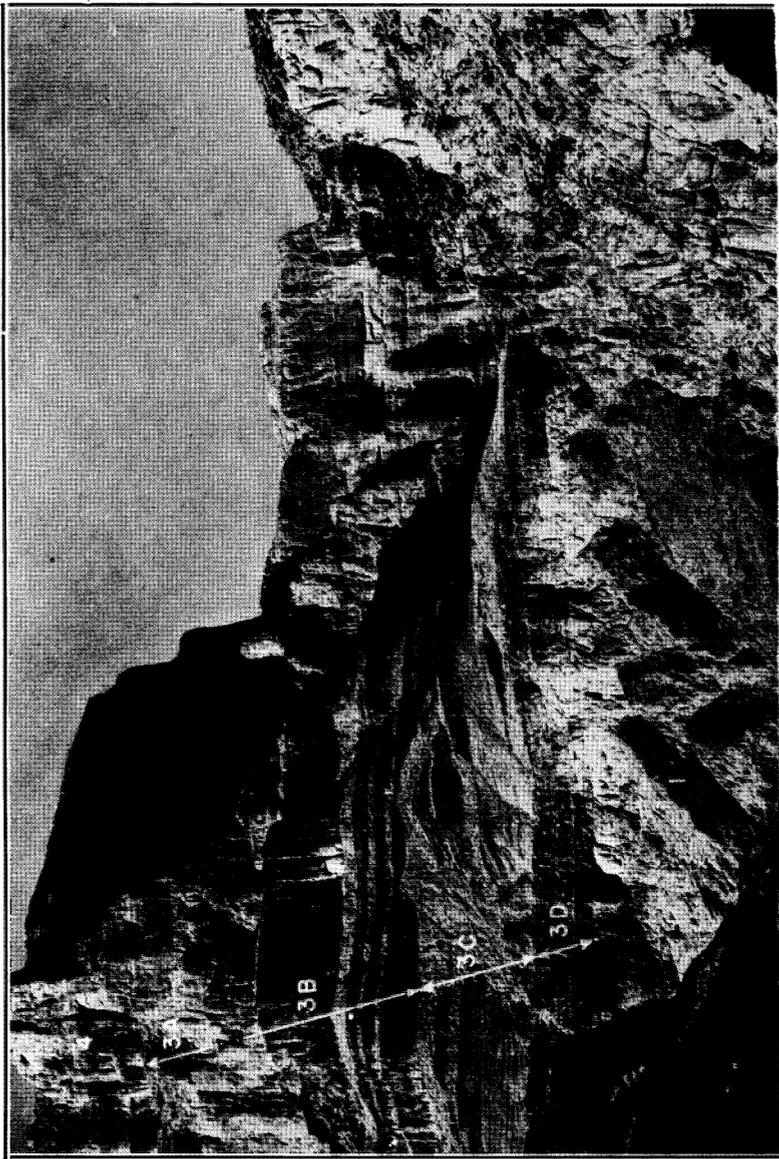


Fig. 3.—Formations of Upper Lake Mead near Surprise Canyon, numbered to correspond with Fig. 2. 1. Pre-Cambrian granites and schists; 3. Tonto formations: 3A. Devonian (no formational name), 3B. Mauv Limestone (Middle Cambrian), 3C. Bright Angel Shale (Lower and Middle Cambrian), and 3D. Tapeats Sandstone (Lower Cambrian); and 4. Redwall Limestone (Mississippian Period). Photograph by George Grant, National Park Service.

TABLE 1.—Records of Precipitation\*

Station	Altitude	Period	Winter			Spring			Summer			Fall			Annual		
			Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest	Mean	Driest	Wettest
Green River, Emery County, Utah	4,087	1931-1939	1.32	.99	1.67	1.26	.57	2.39	1.47	.43	3.17	1.23	.26	2.36	5.28	3.11	7.70
Hite, Garfield Co., Utah	3,500	1900-1914	2.03	.54	2.28	1.56	1.13	3.87	1.43	1.13	.64	2.26	.32	5.57	7.28	3.12	12.36
Escalante, Garfield Co., Utah	5,700	1901-1927	2.76	2.00	3.90	2.08	1.46	1.10	4.05	3.73	9.10	2.94	1.51	7.60	11.83	8.70	21.70
Lee's Ferry, Coconino Co., Ariz.	3,142	1916-1930 1931-1936	1.38 1.62	.47 .78	2.60 2.58	1.29 .94	.46 .34	2.99 1.85	1.88 2.34	.10 1.36	3.39 3.26	1.65 1.03	.89 .57	4.09 1.35	6.20 5.92	3.17 4.32	8.41 7.25
Grand Canyon, Coconino Co., Ariz.	6,866	1931-1939	4.43	2.06	6.87	2.89	1.64	5.20	3.78	2.00	5.29	3.65	1.21	9.81	14.76	10.43	19.26
Paria, Kane County, Utah	4,700	1895-1900	1.97	1.50	3.30	1.80	.25	4.75	2.69	1.80	2.70	1.99	1.30	3.34	8.45	4.35	14.09
Kanab, Kane County, Utah	4,925	1899-1927 1931-1939	3.82 3.18	2.57 3.51	6.60 7.39	4.05 2.46	2.10 .47	8.90 5.73	2.96 2.59	.96 .38	3.30 4.57	3.24 2.60	1.66 .42	1.90 8.29	14.07 12.86	7.29 10.48	20.70 14.34
Supai, Coconino Co., Ariz.	3,200	1899-1930 1931-1932	2.46 5.75	.07 3.89	5.69 7.62	1.65 2.11	.38 1.14	3.48 3.09	2.85 1.61	.60 1.13	10.23 2.08	1.93 1.20	.57 .35	3.85 2.04	8.89 10.67	4.50 8.46	13.87 12.88
Boulder City, Clark Co., Nev.	2,525	1932-1936 1938-1939	1.84 1.93	.97 1.83	3.15 2.04	.47 1.76	.21 1.04	1.01 2.48	1.42 .77	.35 .57	2.91 .97	.93 2.36	.07 .54	1.62 4.19	4.66 6.83	3.11 5.63	6.54 8.03

\* Compiled from Climatological Data: Utah and Arizona Sections, United States Department Agriculture Weather Bureau.

10,000 to 16,000 feet of beds, reaching a maximum depth in the Kaibab Plateau. The present Grand Canyon represents only the erosion through the Carboniferous and the Archaean (Fig. 2). The inner gorge in the Kaibab Plateau section is several hundred feet deep. For a number of miles it is a sharp V-shaped notch cut in the Pre-Cambrian crystalline rocks (2). Walls are high and usually steep, and rapids are numerous for most of the distance between Lee's Ferry and Lake Mead.

Precipitation varies in this desert region from 29 inches annually on Navajo Mountain in southern Utah, to 4.66 inches at Boulder City (Table 1). Few locations except on plateaus have more than 4 to 6 inches annually. Since vegetation is intimately related to the water supply the plant cover is very sparse. "Many plants have no near neighbors; they stand as individuals in tracts of several acres, or are present by two or threes in areas of several miles. Large areas are utterly devoid of vegetation" (19). The above review of some geologic and physiographic aspects of the Canyon Country, with tables on precipitation (Table 1) and temperature (Table 2) will give an idea of the precarious existence of plants growing within the gorges.

### Vegetation

Plants which survive here are, in general, those especially adapted to conditions of extreme heat and drought. However, mesophytes and hydrophytes flourish in certain favored situations. The vegetation owes its heterogeneity to a diversity of habitats which depend upon climatic and edaphic factors. Conditions within canyon walls furnish interesting opportunities for microclimatic studies (16,27). Within a small area several separate influences may act as association determiners. Extreme exposure to sun, topographic peculiarities, soil structure, and conditions of moisture may cause variations in a habitat climate. The effect of moisture and shade is exemplified by the plants growing in and near gushing or seeping springs. Hydrophytes and hydromesophytes are able to survive desert temperatures if the immediate habitat is favorable. The exposed side of a canyon may sustain only typical desert scrub and sun-resistant herbaceous plants, while broadleaved trees such as red-bud and hack-berry grow under sheltering overhangs on the opposite, shaded wall. *Primula specuicola*, *Adiantum Capillus-Veneris* and mosses grow on the under side of the ledges if sufficient moisture is present. Lateral canyons frequently have a more abundant vegetation than is found along the Colorado. This may be accounted for in several ways: (1) sultry updrafts lose their desiccating effect as they leave the main channel; (2) many of these deep canyons are extremely narrow and the sun's rays are directed into them for only brief periods daily; (3) downdrafts caused by the rapid cooling of the desert at night limit the upward progression of lowland plants and at the same time favor the extension of montane species to lower levels.

A collection area of the extent covered in this study naturally has many differences in altitude, latitude, and geologic make-up. For that reason it is impossible to give the composition of definite plant communities as typical throughout the canyon. However, there are similar habitats throughout the portion of the canyon which we visited, and these typical habitats have plant

groupings that change gradually along the course of the river. In order to make it possible to see the changes at a glance, as well as to see what particular types of habitats were either missing, or inaccessible, or not studied within certain stretches, we have prepared a chart (Chart 1) in which the typical habitats are listed horizontally. Vertically from north to south are the several named "canyons" or segments of the big Canyon. Each habitat is therefore dealt with in a vertical column, and by running down a particular column from top to bottom the reader may see the gradual changes in the vegetation of a habitat from north to south. By reading from left to right the names of character plants of all the habitats at a particular locality will pass under the eye, beginning with the moist habitats and ending with the dry upper talus. Collections were made in July and August, too late for ephemerals, which are fairly abundant, judging from the dried remnants.

TABLE 2.—Records of Temperature (Annual)\*

Station	Altitude	Mean Temperature	Highest Monthly Mean	Lowest Monthly Mean	Highest Temperature	Lowest Temperature	Years included in record
Greenriver, Utah	4,087	53.5° F	81.1° F	20.7° F	112° F	-42° F	1931-1939
Hite, Utah	3,500	59.7	73.9	45.5	115	-1	
Escalante, Utah	5,700	48.5	71.0	25.4	102	-22	1931-1939
Kanab, Utah	4,925	55.4	76.5	35.9	106	-20	1931-1939
Lee's Ferry, Arizona	3,142	62.1	88.4	36.6	114	5	1931-1936
Grand Canyon, Ariz.	6,866	49.9	71.6	29.1	103	-14	1931-1939
Supai, Arizona	3,200	60.4	79.9	33.6	108	-2	1931-1932
Boulder City, Nevada	2,525	67.5	89.8	45.3	112	12	1932-1936
		66.7	89.6	45.3	112	28	1938-1939

TABLE 2.—Showing annual temperatures at various stations.

\* Compiled from Climatological data: Utah Section. United States Department Agricultural Weather Bureau.

## TYPICAL PLANT HABITATS (Chart 1)

1. *Margin of moist sand*.—*Tamarix gallica*,<sup>3</sup> *Baccharis* spp., and *Salix* spp. are most prominent in the vegetation found in wet sand near the river's edge. Northern species of *Baccharis* and *Salix* are supplanted by others farther south, but *Tamarix gallica* grows the entire length of the area studied, with the exception of a considerable stretch in Marble Canyon.

Bowknot Bend, an entrenched meander on the Green River, offers an

<sup>3</sup> *T. gallica* was introduced into this country from Europe over one hundred years ago, and has been used as a sand-binding plant on river banks, becoming naturalized.

example of the effect of *Salix* as a soil-binder. Here the red walls of Chinle topped by Wingate sandstone have the usual sparse desert growth which contrasts with the deep green, dense strip of willows at the base of cliffs. The river flows on each side of a sandy flat covered with an equally heavy stand.

In the lower part of the Grand Canyon willows become so well established in some locations as to attain a height of thirty to forty feet (Fig. 6B). High floods may remove so much sand from around the trees that they are torn out completely or barely retain a footing on the crumbling shore until sand again packs around the roots. *Cynodon Dactylon* is an apparently recent colonist which acts as a soil-binder on alluvial flats. It is rapidly becoming established along Lake Mead shores in submerged side canyons and in coves with sufficient detrital deposits.

2. *Springs and waterfalls*.—Gushing springs pour from apertures high on the walls, and seeps may emerge from travertine above impervious shale layers. In such situations hydrophytes and hydromesophytes predominate, although typical desert plants grow almost to the edge of the moist area. Numbers of springs occur along the river's course, but only a few are more than seeps. Vasey's Paradise, named in honor of Dr. George W. Vasey, who was at one time a botanist in the United States Department of Agriculture (Map 1) (Fig. 5A) is a beautiful spring spouting from the wall at least seventy feet above the river. Mosses, liverworts and algae grow in the water and in the spray behind the fall, and a mass of vegetation dominated by *Rhus radicans*, *Cercis occidentalis*, and *Mimulus cardinalis* flourishes in the moist soil bordering the stream. Deer Creek Falls below Grand Canyon is unusual in having a luxuriant growth of *Phragmites communis*, *Amorpha truticosa* var. *occidentalis*, and *Urtica holosericea* in addition to plants more commonly occurring in similar situations. *U. holosericea* is reported by Dixon (11) as a montane hydromesophyte; by Tanner (32) as occurring at altitudes of 8,500 to 10,000 feet on the Aquarius Plateau; and Munz (26) mentions the species as growing on the western side of the mountains of California and in the montane zone.

3. *Dry sandy shore*.—Stretches of dry sand undisturbed recently by floods have some of the same plants which inhabit the immediate shore line. These are often somewhat dwarfed or misshapen, and half buried by sand. Atriplex, certain of the *Platyopuntiae* and grasses predominate, with *Phacelia* and occasionally *Cucurbita* along the outer margin. A variation may occur in such situations as at Nankoweap Rapids, where the canyon is wide enough to allow the development of an extensive sandy flat not flooded except in extremely high water. A heavy growth of plants (6) similar to those found on the talus may take hold, and catclaws, cacti and certain tall grasses become the most prominent species.

4. *Rubble and boulder area*.—Great boulders brought down by flood-waters and landslides form an important part of the limited "terrain" within the walls. Smaller water-worn rocks and brush are lodged among them. In such situations, unless frequently subjected to the action of high water, numbers of

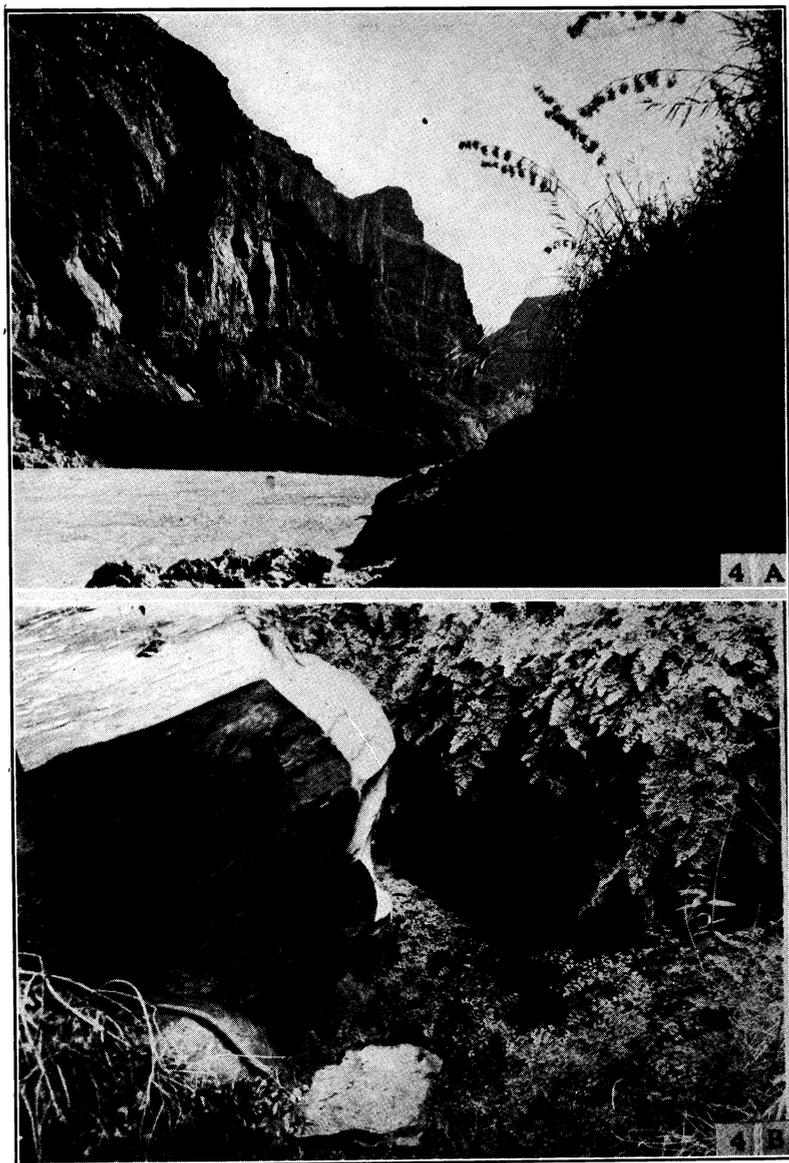


Fig. 4.—A. *Cladium Mariscus californicum* and *Phragmites communis* growing at margin of seepage area near river, Lava Falls (Courtesy of Emery Kolb). B. Spring in recess near mouth of Dark Canyon surrounded by *Adiantum Capillus-Veneris* and *Aquilegia chrysantha*.

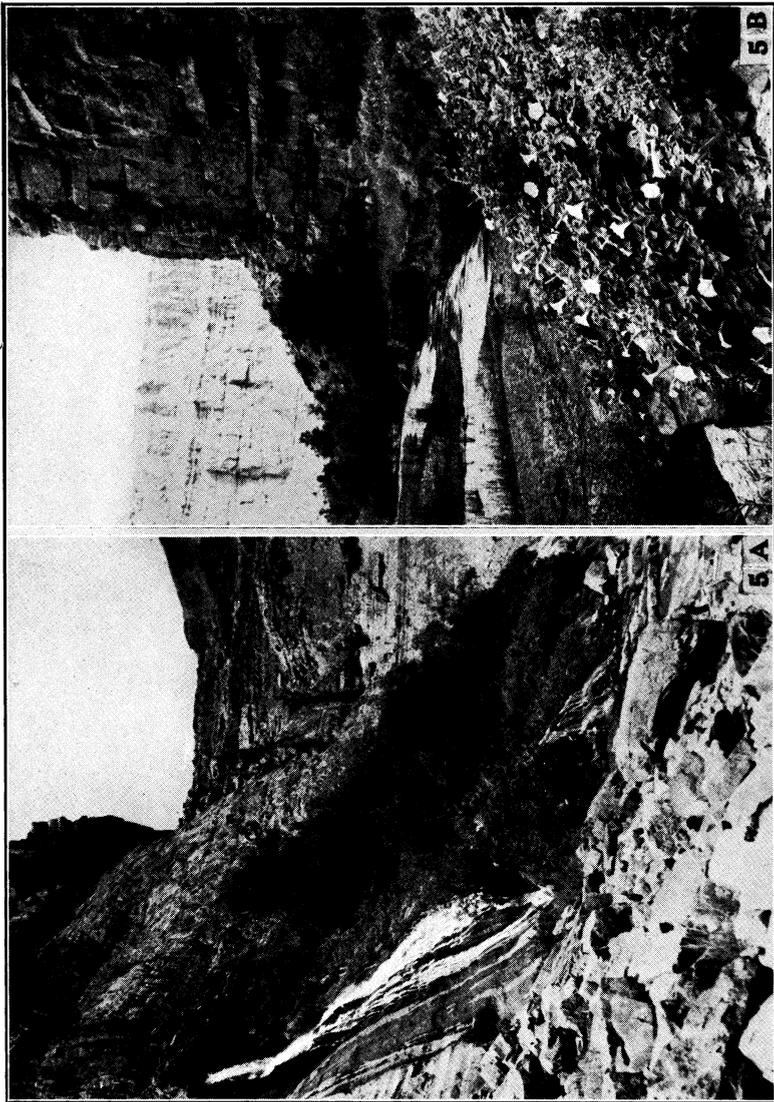


Fig. 5.—A. The effect of moisture at Vasey's Paradise. Dense growth of *Cercis occidentalis* and *Rhus radicans* near fall, in contrast to the xerophytic vegetation on either side. Note figures at base of waterfall. These may serve as a scale of measurement. B. *Datura meteloides* near creek at cliff base, Havasupai Canyon. Willows and cottonwoods are in the background.

plants get a start. These boulders afford shelter for germinating seeds unable to stand the full force of a summer sun. Other plants, brought down by water, and lodged between boulders frequently take root. This rubble and boulder area produces a meager vegetation with the more prominent members consisting usually of *Celtis reticulata*, *Opuntia brachyclada*, *O. erinacea*, *Oryzopsis hymenoides*, *Cleome lutea*, *Sphaeralcea grossulariaefolia*, and *Atriplex canescens* in the northern portion; and *Acacia Greggii*, *Chilopsis linearis*, *Baccharis glutinosa*, *Stanleya pinnata*, *Sphaeralcea grossulariaefolia*, *Cucurbita* spp., *Oryzopsis hymenoides*, *Triodia pulchella*, *Opuntia basilaris*, and *O. erinacea* farther south. Frequently the first plants to come into these areas so often denuded by water are *Oryzopsis hymenoides*, *Oenothera multijuga*, and *Sal-sola Kali*.

5. *Talus slopes*.—Attack of weathering and erosion on the walls is mainly directed against the edges of horizontal strata, and variation with respect to durability results in differential weathering with a rapid disintegration of softer beds, forming a talus (Figs. 2 and 3). The harder beds thus undermined, break off at the joints, and fragmental material adds to the talus below. The slopes are in a state of constant change as the older material is being disintegrated and carried off while new is added toward the top. The transitory nature of many slopes, especially in Cataract Canyon, make any but a pioneer vegetation impossible, but at other places with stabilized talus a climax composed of mesquite and *Acacia* forms a thicket. At President Harding Rapids the shaded portion of the talus is covered from the base to the vertical wall with such a growth (Fig. 8A), which in time will probably cover the remainder now dominated by grasses and cacti.

A series of talus slopes may be seen from the floor to the rim, particularly in Grand Canyon (Fig. 3), many of them with a pitch of forty-five degrees or more. *Ephedra* spp., *Eriogonum inflatum*, *Atriplex canescens*, and *Oryzopsis hymenoides* are prominent from the lowest to the highest talus throughout the river's course. Dominants on the talus depend on local conditions (Fig. 8B). Gullies on the talus are usually filled with oaks, sumac, and *Cowanina*. *Bernardia incana* and *Mortonia scabrella* var. *utahensis* dominate many such situations in Havasupai Canyon. *Larrea glutinosa* and *Acacia Greggii* may be found separately or together in gullies from Lava Falls to lower Lake Mead. Spencer Canyon is selected to show the type of vegetation to be found on talus in the lower canyon (Fig. 3).

1. Below talus on canyon floor near stream.—*Cynodon Dactylon*, *Baccharis glutinosa*, *Heliotropium curassavicum*, *Datura meteloides*, *Acacia Greggii*, *Prosopis juliflora* var. *glandulosa*, *Sphaeralcea grossulariaefolia*.

2. Talus of the Pre-Cambrian schists (Fig. 3, No. 1).—*Acacia Greggii* and *Prosopis juliflora* var. *glandulosa* on lower portion forming a thicket, decreasing in size higher on the talus; *Mirabilis Bigelovii*, *Ditaxis neomexicana*, *Physalis crassifolia*, *Eriogonum fasciculatum*, *Opuntia basilaris*, *O. Bigelovii*, *Franseria dumosa*, *Yucca whipplei*, *Triodia pulchella*, *Bromus rubens*, *Eragrostis cilianensis*, *Peucephyllum Schottii*, *Atriplex canescens* and *Eriogonum inflatum*.

3. On granite, top of the Archaean.—*Phellosperma tetrancistra*, *Ferocactus acan-*

Chart 1.—Correlation of species growing under similar conditions in certain selected collection

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfalls
Greenriver, Utah	4,080	39°	<i>Baccharis Emoryi</i> <i>Glycyrrhiza lepidota</i> <i>Populus Fremontii</i> <i>Rhus trilobata</i> <i>Salix amygdaloides</i> <i>Sarcobatus vermiculatus</i> <i>Scirpus americana</i> <i>Tamarix gallica</i>	Lacking
Hell Roaring Canyon on the Green River	.....	38°30'*	<i>Baccharis Emoryi</i> <i>Salix amygdaloides</i> <i>Salix exigua</i> <i>Sarcobatus vermiculatus</i> <i>Tamarix gallica</i>	Lacking
Mouth of Dark Canyon in Cataract Canyon	3,510	38°	<i>Apocynum cannabinum</i> <i>Briqellia longifolia</i> <i>Cercis occidentalis</i> <i>Mentzelia pumila</i> <i>Panicum obtusum</i> <i>Salix exigua</i> <i>Tamarix gallica</i>	<i>Adiantum Capillus-</i> <i>Veneris</i> <i>Aquilegia chrysantha</i> <i>Cercis occidentalis</i> <i>Equisetum praealtum</i>

\* Approximately

areas of the Colorado Canyon and tributaries.

		Talus	
		Lower Portion	Upper Portion
Dry sand (Alkali flat)	Rubble & Boulder Area (Rocky hillside)		
<i>Brickellia scabra</i> <i>Cleome lutea</i> <i>Cryptantha crassisejala</i> <i>Eriogonum inflatum</i> <i>Eurotia lanata</i> <i>Lepidium Eastwoodiae</i> <i>Opuntia rhodantha</i> <i>Oryzopsis hymenoides</i> <i>Salsola Kali</i> <i>Sarcobatus vermiculatus</i> <i>Sporobolus cryptandrus</i> <i>Suaeda Torreyana</i> <i>Tripterocalyx pedunculatus</i>	<i>Chrysothamnus viscidiflorus</i> var. <i>stenopyllus</i> <i>Ephedra Torreyana</i> <i>Eriogonum inflatum</i> <i>Hilaria Jamesii</i> <i>Mentzelia albicaulis</i> <i>Mentzelia pumila</i> var. <i>multiflora</i> <i>Oryzopsis hymenoides</i> <i>Sphaeralcea grossulariaefolia</i>	Lacking	Lacking
Lacking	<i>Agropyron Smithii</i> <i>Atriplex canescens</i> <i>Distichlis stricta</i> <i>Ephedra Torreyana</i> <i>Forestiera neomexicana</i> <i>Opuntia hystricina</i> <i>Opuntia rhodantha</i> <i>Oryzopsis hymenoides</i> <i>Rhus trilobata</i> <i>Sclerocactus Whipplei</i> <i>Triodia pulchella</i>	Not Collected	Not Collected
Lacking	<i>Fraxinus anomala</i> <i>Juniperus utahensis</i> <i>Oryzopsis hymenoides</i> <i>Salsola Kali</i> <i>Sphaeralcea Fendleri</i> <i>Stanleya pinnata</i> <i>Stephanomeria pauciflora</i>	<i>Apocynum cannabinum</i> <i>Astragalus Preussii</i> <i>Atriplex canescens</i> <i>Celtis reticulata</i> <i>Oryzopsis hymenoides</i> <i>Phacelia corrugata</i> <i>Rhamnus betulaeifolia</i> <i>Triodia pulchella</i> <i>Yucca angustissima</i>	<i>Ephedra Torreyana</i> <i>Phacelia corrugata</i> <i>Rhus trilobata</i> <i>Yucca angustissima</i>

CHART 1.—(Continued)

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfalls
Mouth of Forbidding Canyon	3,260	37° 10'*	<i>Salix exigua</i>	Lacking
Rainbow Bridge, 6 miles from the Colo- rado River (Fig. 1)	3,800	37° 10'*	Lacking	<i>Adiantum Capillus- Veneris</i> <i>Agrostis verticillata</i> <i>Aquilegia chrysantha</i> <i>Cercis occidentalis</i> <i>Clematis ligusticifolia</i> <i>Juncus Torreyi</i> <i>Penstemon ambiguus</i> <i>Petalostemon flavescens</i>
Lee's Ferry	3,148	36° 50'*	<i>Aplopappus acradenius</i> <i>Aster spinosus</i> <i>Atriplex canescens</i> <i>Atriplex Jonesii</i> <i>Baccharis glutinosa</i> <i>Chrysothamnus nauseosus</i> <i>Distichlis dentata</i> <i>Glycyrrhiza lepidota</i> <i>Salix exigua</i> and <i>S. Gooddingi</i> <i>Tamarix gallica</i>	Lacking
President Harding Rapids	2,825	36° 30'*	No vegetation (recent deposit)	Lacking

Dry sand	Rubble & Boulder Area	Talus	
		Lower Portion	Upper Portion
<i>Atriplex canescens</i> <i>Baccharis Emoryi</i> <i>Echinocereus Engelmannii</i> <i>Ephedra Torreyana</i> <i>Oryzopsis hymenoides</i> <i>Phellosperma tetrancistra</i> <i>Salix exigua</i> <i>Salix Goodingii</i> <i>Sclerocactus parviflorus</i> <i>Triodia pulchella</i> <i>Yucca</i> sp.	Lacking	(Low horizontal ledge)  <i>Atriplex canescens</i> <i>Salix Goodingii</i> <i>Salix exigua</i>	(No talus)
Lacking in area	(On canyon floor) <i>Atriplex canescens</i> <i>Castilleja linariaefolia</i> <i>Chrysopsis villosa</i> <i>Cleome lutea</i> <i>Cowania Stansburiana</i> <i>Datura meteloides</i> <i>Ephedra Torreyana</i> <i>Ephedra viridis</i> <i>Frasera utahensis</i> <i>Fraxinus anomala</i> <i>Funastrum cynanchoides</i> <i>Oryzopsis hymenoides</i> <i>Panicum virgatum</i> <i>Polypogon monspeliensis</i> <i>Rhus trilobata</i>		Very little talus present; due to the nature of the canyon walls of sandstone.
<i>Atriplex canescens</i> <i>Eriogonum deflexum</i> <i>Pluchea sericea</i>	<i>Amsonia Eastwoodiana</i> <i>Datura meteloides</i> <i>Eriogonum inflatum</i> <i>Eriogonum Wetherillii</i> <i>Parryella filifolia</i> <i>Sporobolus cryptandrus</i> <i>Xanthium saccharatum</i>	(On rocky hillside) <i>Chrysothamnus nauseosus</i> <i>Coldenia hispidissima</i> <i>Echinocereus Engelmannii</i> <i>Ephedra Torreyana</i> <i>Franseria acanthocarpa</i> <i>Opuntia hystricina</i> <i>Salsola Kali</i>	
<i>Andropogon saccharoides</i> <i>Atriplex canescens</i> <i>Echinocereus Engelmannii</i> <i>E. Fendleri</i> [nii] <i>Ephedra Torreyana</i> <i>Lepidium Jonesii</i> <i>Opuntia basilaris</i> <i>Oryzopsis hymenoides</i> <i>Plantago</i> sp. <i>Triodia pulchella</i>	<i>Dyssodia Thurberi</i> <i>Echinocereus Engelmannii</i> <i>Echinocereus Fendleri</i> <i>Eriogonum inflatum</i> <i>Oenothera multijuga</i> <i>Opuntia phaeacantha</i> <i>Plantago</i> sp. <i>Sphaeralcea grossulariae-folia</i> <i>Triodia pulchella</i>	(On western exposure) <i>Eriogonum inflatum</i> <i>Opuntia erinacea</i> <i>O. Engelmannii</i> <i>Oryzopsis hymenoides</i> <i>Plantago</i> sp. <i>Triodia pulchella</i>	In shaded portion of talus <i>Prosopis juliflora</i> var. <i>glandulosa</i> and <i>Acacia Greggii</i> . Very dense, no undercover developed.

CHART 1.—(Continued)

Location See index map	Altitude	Latitude	Moist sand	Springs and Waterfalls
Deer Creek Falls	1,938	36°30'*	<i>Baccharis Emoryi</i> <i>Salix exigua</i>	<i>Adiantum Capillus-Veneris</i> <i>Amorpha fruticosa</i> var. <i>occidentalis</i> <i>Apocynum cannabinum</i> <i>Baccharis Emoryi</i> <i>Phragmites communis</i> <i>Urtica holosericea</i>
Havasupai Canyon (about 8 miles up Supai Creek from the Colorado)		36°10'*	<i>Baccharis Emoryi</i> <i>Pluchea sericea</i> <i>Salix</i> sp. p.	(In creek, and at waterfalls) <i>Adiantum Capillus-Veneris</i> <i>Apium graveolens</i> <i>Chara contraria</i> <i>Equisetum laevigatum</i> <i>Mimulus cardinalis</i> <i>Riccia fluitans</i> <i>Rorippa Nasturtium-aquaticum</i>
Lava Falls	1,675	36°10'*	(Moist sandy area from spring to river's edge) <i>Cladium Mariscus</i> var. <i>californicum</i> <i>Eleocharis calva</i> <i>Eleocharis rostellata</i> <i>Phragmites communis</i> <i>Salix exigua</i> <i>Scirpus Olneyi</i> <i>Typha latifolia</i>	<i>Adiantum Capillus-Veneris</i> <i>Cladium Mariscus</i> var. <i>californicum</i> <i>Didymodon tophaceus</i> <i>Phragmites communis</i>
Separation Rapids	1,190	36°50'*	No vegetation on river's edge at mouth of Separation Canyon; the following occur up small side canyons of Separation: <i>Cyperus erythrorhizos</i> <i>Juncus Torreyi</i>	Lacking

Dry sand	Rubble & Boulder Area	Talus	
		Lower Portion	Upper Portion
		<i>Nolina microcarpa</i> <i>Ephedra Torreyana</i> <i>Ephedra viridis</i> <i>Oryzopsis hymenoides</i> <i>Triodia pulchella</i>	
(On canyon floor) <i>Acer interius</i> <i>Bouteloua aristidoides</i> <i>Clematis ligusticifolia</i> <i>Chilopsis linearis</i> (dry washes) <i>Cucurbita foetidissima</i> <i>Eragrostis trichodes</i> <i>Ferocactus acanthodes</i> <i>Fraxinus velutina</i> var. <i>glabra</i> <i>Martynia parviflora</i> <i>Oenothera micrantha</i> <i>exfoliata</i> <i>Opuntia Engelmannii</i> <i>Phellosperma tetrancistra</i> <i>Polypogon monspeliensis</i> <i>Populus Fremontii</i> <i>Salix amygdaloides</i> <i>Sphaeralcea grossulariaefolia</i> <i>Stanleya pinnata</i> <i>Thelypodium Wrightii</i> <i>Vitis arizonica</i>	(At edge of talus) Heavy thicket of: <i>Acacia Greggii</i> <i>Chrysothamnus nauseosus</i> <i>Cleome lutea</i> <i>Condalia lyciodes canescens</i> <i>Parthenocissus vitacea</i> <i>Prosopis juliflora</i> var. <i>glandulosa</i>		<i>Agave utahensis</i> <i>Nolina microcarpa</i> <i>Echinocereus</i> spp. <i>Ephedra</i> spp. <i>Mortonia scabrella</i> var. <i>utahensis</i> <i>Opuntia</i> spp. <i>Rhus trilobata</i>
Lacking	Lacking	<i>Agrostis verticillata</i> <i>Baccharis sarothroides</i> <i>Cirsium undulatum</i> <i>Ferocactus acanthodes</i> <i>Gutierrezia</i> sp. <i>Larrea glutinosa</i> <i>Muhlenbergia asperifolia</i> —in quantity a short distance above spring. <i>Notholaena Parryi</i> <i>Opuntia acanthocarpa</i> <i>Oryzopsis hymenoides</i>	<i>Fouquieria splendens</i> <i>Oryzopsis hymenoides</i> <i>Triodia pulchella</i>
<i>Chilopsis linearis</i> <i>Corispermum nitidum</i> <i>Cucurbita palmata</i> <i>Eucnide urens</i> <i>Encelia farinosa</i> <i>Franseria acanthocarpa</i> <i>Oryzopsis hymenoides</i> <i>Salsola Kali</i> <i>Tidestromia oblongifolia</i>	<i>Aristida glauca</i> <i>Brickellia atractyloides</i> <i>Eragrostis cilianensis</i> <i>Maurandya antirrhiniflora</i> <i>Oryzopsis hymenoides</i> <i>Polypogon monspeliensis</i> <i>Triodia pulchella</i> <i>Wislizenia refracta</i>	<i>Agave utahensis</i> <i>Cryptantha barbigera</i> <i>Ferocactus acanthodes</i> <i>Larrea glutinosa</i> <i>Opuntia basilaris</i> , O. <i>erinacea</i> & O. <i>phaeacantha</i> <i>Oryzopsis hymenoides</i> <i>Triodia pulchella</i>	

*thodes*, *Opuntia Bigelovii*, *Larrea glutinosa* (stunted), *Bromus rubens*, *Ephedra nevadensis*, *Eriogonum inflatum* and *Oryzopsis hymenoides*.

4. Bright Angel Shale (Fig. 3, 3C).—*Fouquieria splendens* (most prominent), *Ferocactus acanthodes*, *Opuntia basilaris*, *Acacia Greggii* (stunted), *Larrea glutinosa*, *Ephedra nevadensis*, *E. viridis*, *Sphaeralcea ambigua*, *Atriplex canescens*, *Eriogonum inflatum*, *Triodia pulchella*, *Eragrostis cilianensis*, *Oryzopsis hymenoides*.

5. Finely broken granite, north slope.—*Tortula ruralis*, *Grimmia trichophylla* and lichens.

### Plant Distribution

Merriam's (25) delimitation of life zones is useful within the canyon only in a broad way as it is based chiefly on temperature variations as affected by altitude, and fails to take into account that a difference of a single degree in one part of the temperature scale may be of much greater significance than a single degree at another part of the scale. Altitude decreases southward from Greenriver, Utah (4,080 feet), to Boulder Dam (725 feet) as well as downward from the rim to the canyon floor, a change in altitude which may be as much as 7,000 feet. Other conditions such as length of growing season, soils, and moisture must be considered in conjunction with the life-zone concept.

Stanton (31) mentions mixing of zones in mountainous areas. The canyon is comparable in altitudinal changes with a mountain, and we find a similar mixing of zones along the canyon floor and up its sides. Some of the Lower Sonoran plants extend into the Upper Sonoran while those of the upper zone tend to migrate downward.

In a consideration of the northward extension of life zones, the Colorado drainage system must not be overlooked as a possible path of migration for species. The authors are in agreement with Graham (17) that *Fraxinus anomala* and other plants may have entered the Uinta Basin along the channel of the Green River. Tanner (32), in studies made in Utah near the Escalante River about twenty miles northwest of Glen Canyon, mentions that the majority of plants and animals in the Kaiparowits region are of northern origin. In spite of this he believes that the occurrence of a greater number of southern species in the desert and Colorado River portions of this region suggests that the river is serving as a southern portal for invasion by species.

Stanton (31) mentions that fifteen per cent of the flora of Mt. Ellen (northmost peak of the Henry mountains) (Map 1) is composed of plants derived from the Colorado drainage system.

Dixon (11) is of the opinion that some plants in desert canyons of the high plateaus in Utah represent a northern extension of the Lower Sonoran flora. This is attributed partly to the lower altitude and also to the fact that "the water courses of the Colorado River system must serve as the highway of migration for the Lower Sonoran flora, since overland passage to the north is blocked by the high plateaus in Arizona." It seems very logical that the Colorado River should serve as a path of migration for plants. According to our observations, however, there is some discontinuity of species, notably in stretches of Marble Canyon. Those requiring a sandy shore have never reached

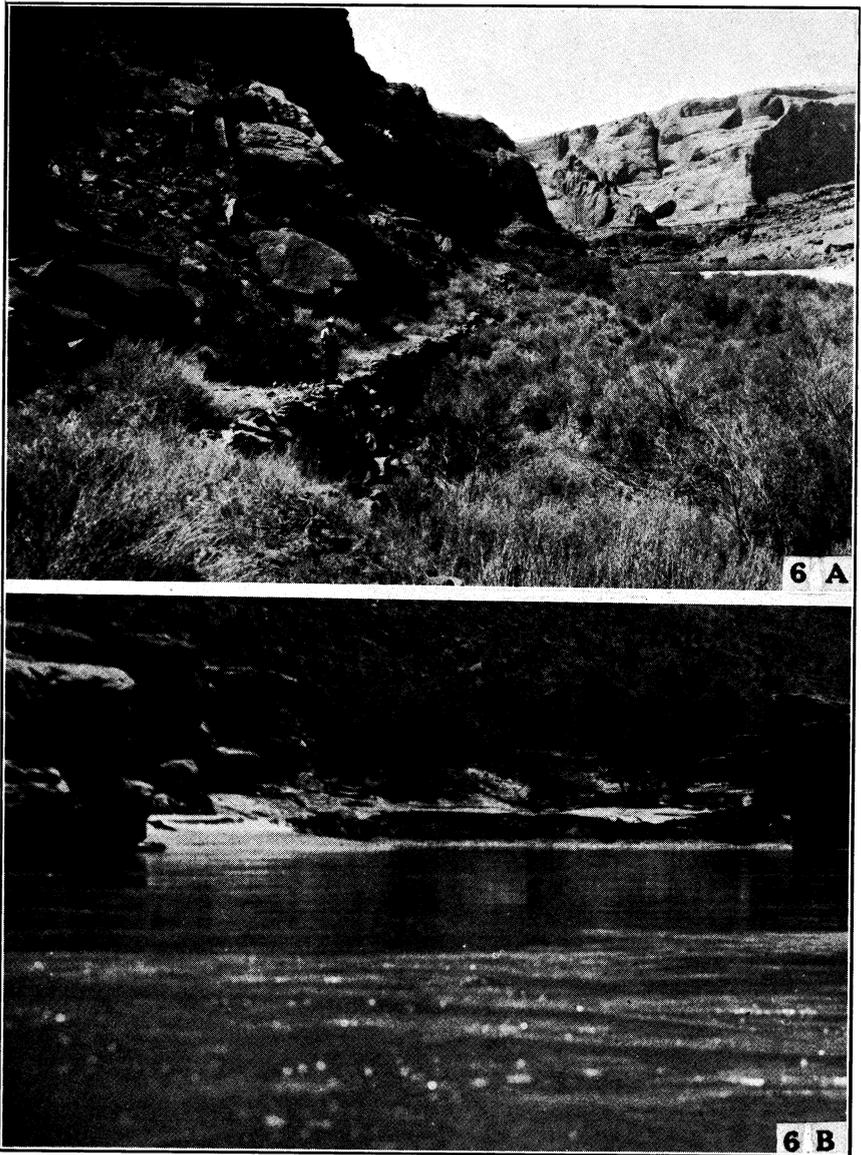


Fig. 6.—A. *Quercus Gambelii* forming a thicket along a rock wall built in Glen Canyon by the Mormons in the early days. B. Willows sometimes grow to a height of thirty or forty feet. A sudden rise in water may entirely or partially uproot them. Lower Grand Canyon.

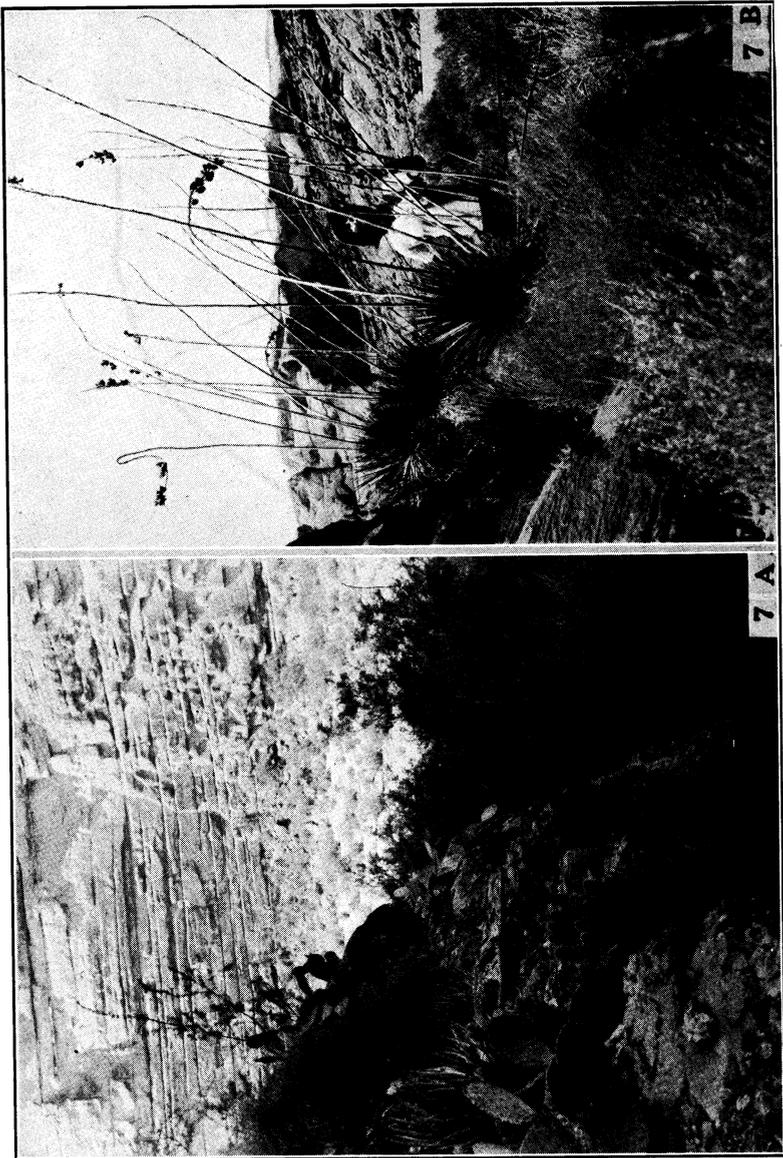


Fig. 7.—A. Plant association on ledge at the head of Havasupai Canyon consisting of *Agave utahensis*, *Opuntia mojavensis*, *Echinocereus coccineus*, some *Acacia Greggii* and grasses. *A. Greggii* forms a dense thicket below the talus. *Atriplex canescens* is most prominent on the canyon floor. B. *Yucca* sp. with flower stalk often reaching a height of ten to fifteen feet, found in Glen Canyon between Hite Ranch and the Mormon trail.

this portion or they have been washed out by floods. In many places water flows against sheer rock walls (at least in flood stage) for several miles. Some of the species which Dixon thought might have entered the plateaus through this channel were not found at all in the canyon. There is a possibility that plants able to tolerate high summer temperatures and drought have traveled northward high on the walls by this route. The winter temperature might be enough warmer below the rim than it is on the plateau to allow their survival.

It is to be expected that the canyon floor would provide better conditions for species of southern latitude than would the desert above. Plants collected indicate this to be true. While Upper Sonoran or Transition zone plants occupy areas on higher lands, typical Lower Sonoran species such as *Acacia Greggii*, *Prosopis juliflora* var. *glandulosa*, *Pluchea sericea*, and *Ferocactus acanthodes* extend up the floor of the canyon almost as far as Lee's Ferry, near the northern border of Arizona. *Phellosperma tetrancistra* is found as far north as the mouth of Forbidding Canyon. Judging from the fact that these typical Lower Sonoran species are almost entirely absent above Lee's Ferry, one might be justified in stating that the Lower Sonoran zone does not extend as far as the Dirty Devil River and that beyond thirty-seven degrees latitude the Colorado Canyon is over-rated as a path of migration of southern species. Cottam (7) states that Dixie County in extreme southwestern Utah is the only part of the state having a Southern Desert flora. The plants listed in Dixon's Southern Desert zone include only three which could properly be called Lower Sonoran: *Mirabilis Froebelii* (Behr) Greene (*Quamoclidion Froebelii* Standl.), *Asclepias labrifformis* Jones and *Yucca Harrimaniae* Trel. *Mirabilis Froebelii* is reported by Jepson (21) from the San Jacinto Mountains, and from San Felipe, California, and by Munz (26) from Inyo County and the Mojave Desert to the western edge of the Colorado Desert, Nevada, and Lower California. It seems more logical that the species which grows in "draws" (11) has come into this area from the west rather than up the Colorado. *Asclepias labrifformis* is reported from southern Utah by Tidestrom (33) growing in canyons and on dry hillsides of the Artemisia and Pinyon belt, *Yucca Harrimaniae* by Tidestrom (33), and by Wootton and Standley (40) from southern Utah and Colorado, northeastern Arizona and northwestern New Mexico. We found *Y. Harrimaniae* in the vicinity of Moab and southward, and *Asclepias labrifformis* in Surprise Valley, where it has probably come in from the upland. It seems more likely that these southern plants of higher altitudes have been distributed northward on desert plateaus rather than up the canyon floor.

*Acer interius* reported by Dixon grows also in Glen Canyon across the river from "Music Temple," and in Havasupai Canyon. It may have traveled by way of the canyon but certainly cannot be called "Lower Sonoran," as it occurs as far north as Saskatchewan and Manitoba. This species and *Amorpha fruticosa* var. *occidentalis*, *Fraxinus velutina* var. *glabra* and *Juglans rupestris* might be explained as relicts of an earlier mesophytic flora. Such grasses as *Andropogon barbimodis*, *A. glomeratus*, *A. saccharoides*, *Sporobolus cryptandrus*, *Digitaria sanguinalis*, *Echinochloa Crusgalli* var. *zelayensis*, *Elymus canadensis*, *Hilaria Jamesii*, *Muhlenbergia asperifolia*, with *Cercis occidentalis*

may have remained in the canyon long after the species of a mesophytic or a prairie flora had vanished. Clements (5) finds that canyon walls afford protection from grazing, and states that he is almost sure of locating relicts along canyon edges and on the floor, especially near protecting boulders. *Sporobolus* and *Andropogon* are more apt to be found on the side receiving most protection from the sun's rays. *Cercis*, *Muhlenbergia*, *Digitaria* and *Echinochloa* are found in abundance near water, and certainly could not exist on the blistering desert.

One might speculate further regarding relict vegetation within the canyon, suggesting that shrubs extended northward "on top," probably during drier conditions of the Miocene, when the present drainage system was already in existence. Later, grasses came in as a result of greater precipitation. Shrubs remained as relicts on dry exposed walls during the subsequent wet phase, finally becoming established on floors of canyons under present desert conditions.

#### METHODS OF DISTRIBUTION

Landslides and floods are rapid and effective means of plant distribution characteristic of canyons. Large blocks of rock break off high walls initiating slides of such magnitude that all vegetation is swept down with them, often to be buried in the talus below. Occasionally seeds or vegetative portions of plants not covered by debris become established at lower levels in the canyon. *Cylindropuntia* found on talus near the river in Lower Grand Canyon were probably brought down vertically in this way.

Floods are frequent along the Colorado. Increases in volume of water may occur either sporadically as the result of local cloudbursts near side canyons, or seasonally, because of the melting snow and spring rains near the source. A sudden rise in water level will result in flooding of low, sandy areas, the drowning of some plants, and the ripping out of others. In this canyon the natural tendency for plants to migrate downstream is accelerated by sudden variations in water level and velocity resulting from floods. Cacti, willows and *Tamarix* transported by water will root if given an opportunity.

Species of steep slopes or high ledges are aided in seed dissemination by gravity. *Pinus edulis* and *Juniperus utahensis* in Surprise Valley above Rainbow Bridge may be found from the rim to the floor of the canyon, usually singly or in small clumps in pockets of sandstone. Air-borne seeds may be carried vertically by the down drafts of cool air peculiar to the canyons and resulting from the rise of superheated air in the central gorge. In addition to this down current, winds blowing daily from the warmer areas downstream distribute seeds horizontally.

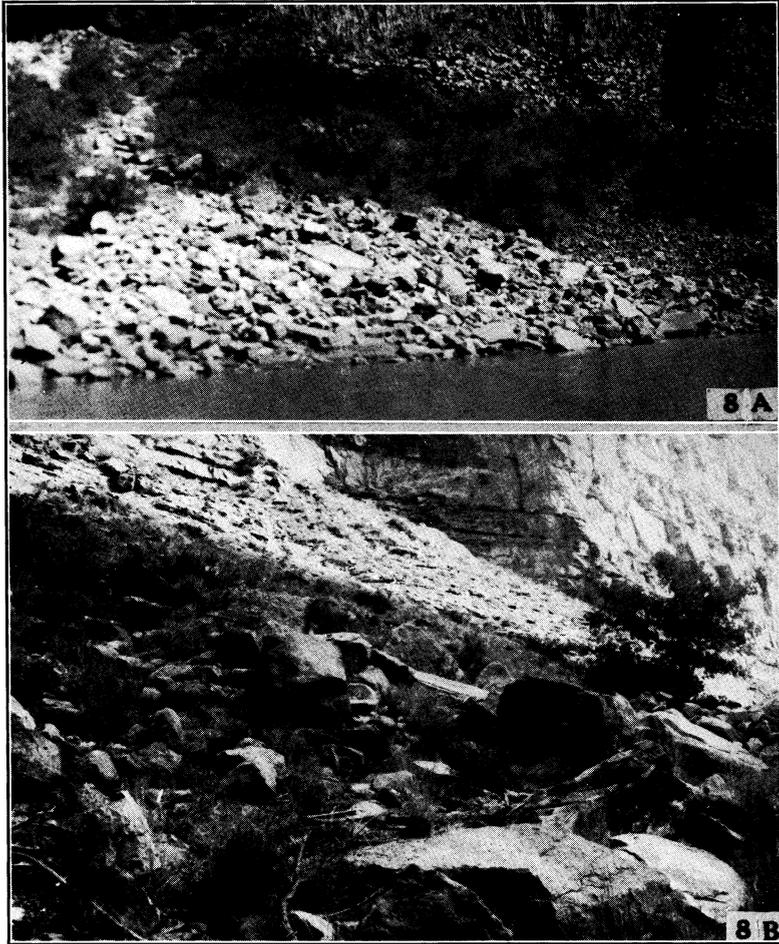


Fig. 8.—A. Climax composed of *Acacia Greggii* and mesquite on talus below President Harding Rapids in Marble Canyon. B. Talus near Rapids 13 of Cataract Canyon, with *Oryzopsis hymenoides* forming typical clumps. The tree is *Celtis reticulata*, twenty feet in height. Species of *Ephedra* are common on the upper portion.

### Some Relations of Birds and Mammals to Plant Life in the Canyons

Plants have some dependence upon birds and mammals, especially for seed distribution, which is in part accomplished through the dung of animals; and it is not a little interesting that our knowledge of the late geological occurrence of certain living species of plants has been derived from botanical analysis of the dung of recently extinct animals.

The following species were identified from dung of the extinct giant ground sloth (*Nothrotherium*) remains of which were found in Rampart and Mauv Caves on Lake Mead (22): *Larrea divaricata* (= *glandulosa*\*), *Nolina Bigelovii*, *Yucca mojavensis*, *Sphaeralcea ambigua*\*, *Adiantum Capillus-Veneris*\*, *Atriplex hymenelytra*\*, *Cassia Covessii*\*, *Ferocactus acanthodes*\*, and *Ephedra nevadensis*\*. It is interesting to note that most of these species (marked by an asterisk) are growing along Lake Mead today, and new comparisons should be made to insure the correctness of the identifications of the rest.

Time and a particular technique are required for accurate field study of distribution and feeding habits of animals. This brief account, therefore, is not the result of detailed investigation (for which there was no opportunity), but a record of casual observations made during the time spent in the Canyon Country, combined with authoritative information on feeding habits from published and unpublished sources (12, 38, 35).

Mule deer apparently range over much of the desert adjacent to the Colorado. They come down side canyons to water singly or in twos and threes. Browsing in an area of such limited growth as is common in the canyon may seriously affect spread of a plant species. The big horn mountain sheep inhabit high, dry ledges along the river, and were observed by the writers at the lower end of Cataract Canyon in Utah, on the San Juan River about twenty miles above its mouth, below Deer Creek Falls, at the mouth of Havasupai Canyon and on upper Lake Mead below Separation Rapids. They appeared usually in bands of from five to ten. These rare animals live on an extremely small amount of water (38) and depend partly on certain members of the *Platyopuntiae* and on *Ferocactus* as a source of supply. The rather bitter, gelatinous pulp contains considerable water. Beavers live in banks of the river and apparently subsist largely on willows. Herds of burros roam the deserts below Grand Canyon feeding on tufts of grass and shrubby plants. They are increasing in number to the extent of becoming a nuisance, threatening to deplete the supply of forage plants available for deer and mountain sheep. Range cattle graze at mouths of side canyons on their periodic trips to water.

Hoofed animals are doubtless responsible for seed distribution from one locality to another. Fruits of mesquite are greatly favored by most desert animals as food and the seeds are still viable after passing through the digestive tract. Russel Grater, former Park Naturalist at Lake Mead, made a study of feeding habits of animals. He observed that the pocket mouse ranged from rim to floor of the canyons and stored seeds on overhanging cliffs. These seeds often germinated and produced plants or fell to lower ledges. Thus

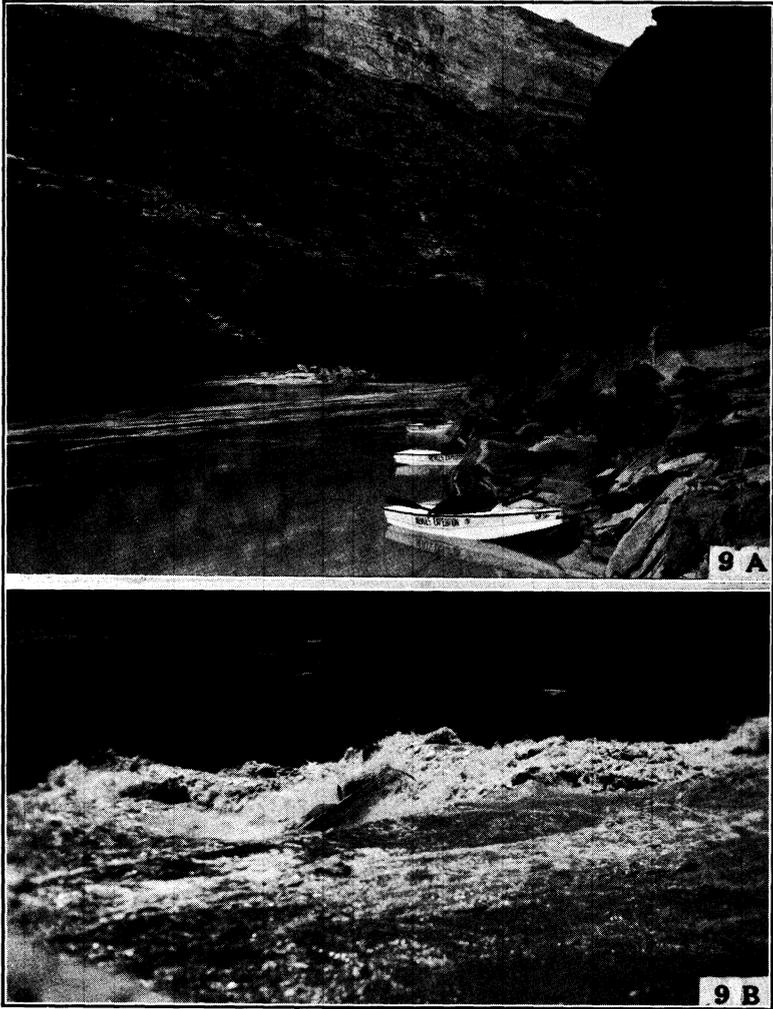


Fig. 9.—A. In Marble Canyon marginal sand bars are lacking for some miles, and in places very little vegetation is found on the steep walls. B. The boatman throws himself forward to prevent the boat from standing on end in Upset Rapids. All botanical materials were carried in waterproof hatches.

migration vertically is aided materially. Other small mammals of the desert of equal importance in seed dissemination are the wood rat, kangaroo rat, harvest mouse, white-footed mouse, antelope squirrel, rock squirrel and chipmunk. The numerous birds inhabiting canyon and desert cannot be ignored as a factor in seed dispersal.

### Conclusions

1. Owing to constantly changing conditions of the talus caused by landslides, and of the river's edge in consequence of periodic floods, there is little climax vegetation in the Canyon of the Colorado. However, vegetation may remain undisturbed for years, chiefly at springs and on stabilized portions of the lower talus.

2. Although the Colorado Canyon serves as a path of migration for Lower Sonoran species it is apparently not so important as previously supposed, i.e., typical Lower Sonoran species are not found in the canyon much above Lee's Ferry, Arizona. Therefore, migration up the river has either taken place in the past, or plants with southern affinities have migrated "overland," or southern plants at the northward are relicts of formerly more widespread distribution.

3. There are evidences of relicts of prairie, mesophytic, hydromesophytic and hydrophytic floras in the canyon. Numerous grasses, as *Sporobolus*, *Andropogon*; such trees as *Fraxinus velutina* var. *glabra*, *Cercis* and *Acer interius*; *Adiantum Capillus-Veneris*, *Epipactis gigantea*, *Aquilegia chrysantha*, mosses and algae serve as examples of species typical of floras existing in a more favorable climate. The northern extension of shrubs in the canyon may possibly be explained by the alternation of dry and moist periods dating back to the Miocene. Shrubs may have advanced "overland" during a dry period, and survived on dry canyon walls under conditions of too much moisture. With the present extreme desert climate they now persist in protected pockets and on shaded walls of side canyons, and in the Canyon of the Colorado.

4. Altitude, moisture, light and temperature are more influential in determining the range of species within the canyon than are the underlying geologic formations.

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## Plant List

## BRYOPHYTA

## HEPATICAEE

*Ricciaceae*

*Riccia fluitans* L. (4372) (5016) (5017) (5214) (5215) (5216). In stream and irrigation ditches above village in Havasupai Canyon.

## MUSCI

*Pottiaceae*

*Barbula Ehrenbergii* (Lor.) Fleisch. Common on walls at Emory Falls on Lake Mead (4195); near seep in wall two miles above Emory Falls (4297A); edge of pool below waterfall (5238) (5240) (5242) (5298), Mooney Falls (5304), and travertine formed from this species at Mooney Falls (5291) in Havasupai Canyon.

*Didymodon mexicanus* Besch. var. *subulatus* Thér. & Bartram. Conquistador Aisle (2321A).

*Didymodon tophaceus* (Brid.) Jur. Two miles above Emory Falls (5293) (5297).

*Didymodon trifarius* (Hedw.) Brid. Edge of spring (5206), and edge of pool below waterfall (5239) (5241) (5301) in Havasupai Canyon.

*Eucladium verticillatum* (Brid.) Bry. eur. Dark Canyon (2179) (2180A); President Harding Rapids (2284A); at 50 Foot Falls (5212), and Navajo (Bridal Veil) Falls (5302) in Havasupai Canyon.

*Pleurochaete squarrosa* (Brid.) Lindb. Vasey's Paradise (2251A); Bed Rock Rapids (2337); at spring in Havasupai Canyon (5212B).

*Tortula atrovirens* Lindb. (Desmatodon convolutus (Brid.) Grout) Dark Canyon near spring (2181); dry talus slope in Havasupai Canyon (5299).

*Tortula aurea* Bartram. Conquistador Aisle on dry soil (2321B).

*Tortula inermis* (Brid.) Mont. Mile 26½ in Marble Canyon (2237A); common in seepage area, Deer Creek Falls (2337A).

*Tortula obtusissima* (C. Müll.) Mitt. On talus in Dark Canyon (2181A); Conquistador Aisle (2321B).

*Tortula ruralis* (Hedw.) Smith. Dark Canyon (2181B); Deer Creek Falls (2337B); on dry walls in Spencer Canyon (4257A) (4258).

*Grimmiaceae*

*Grimmia trichophylla* Grev. at Mile 26½ in Marble Canyon (2238); Tanner Rapids among boulders (2300A); near Bass Trail on rocks covered with sand (2304); on dry walls of Spencer Canyon (4257).

*Funariaceae*

*Funaria hygrometrica* Hedw. In spring (5205) and at 50 Foot Falls (5218) in Havasupai Canyon.

*Funaria Muhlenbergii* Turn. Conquistador Aisle (2321C).

*Bartramiaceae*

*Philonotis capillaris* Lindb. Vasey's Paradise (2249) (2250).

*Bryaceae*

*Bryum cirratum* Hoppe & Hornsch. Dark Canyon near spring (2181C).

*Hypnaceae*

*Campyllum chrysophyllum* (Brid.) Bryhn. Dark Canyon near spring (2180); Havasupai Canyon in springs (5219) (5220) (5236) (5237) (5269) (5301) (5304A).

*Eurhynchium rusciforme* (Neck.) Milde. At Mile 26½ in Marble Canyon (2236A); Elves' Chasm at water's edge (2320).

*Hygroamblystegium orthocladon* (Beauv.) Grout. Vasey's Paradise on rocks splashed by water (2246) (2247); growing under water, near village in Havasupai Canyon (5221).

## PTERIDOPHYTA

*Polypodiaceae*

*Adiantum Capillus-Veneris* L. Cataract Canyon at mouth of Dark Canyon (2137) (2138); Rainbow Bridge (4032); Marble Canyon at Mile 26½ (2234); and Vasey's Paradise (2244); in Grand Canyon at Deer Creek Falls (2339), Havasupai Canyon (4407) (4422A), Lava Falls (2361); on Lake Mead two miles above Emory Falls (4283) (4295A), and at Emory Falls (4193).

*Cheilanthes Feei* Moore. Near mouth of Dirty Devil River in Narrow Canyon (2185).

*Notholaena Jonesii* Maxon. Fairly abundant at Vasey's Paradise (2254) in Marble Canyon. Maxon reports this as rare.

*Notholaena limitanea* Maxon. Near mouth of Dirty Devil River (2183); Vasey's Paradise (2253).

*Notholaena Parryi* D. C. Eaton. In Grand Canyon at Lava Falls (2363), Deer Creek Falls, Mile 193 (2387), and at mouth of Spencer Canyon (4255A).

*Equisetaceae*

*Equisetum laevigatum* A. Br. Above village (4403) and at mouth of Havasupai Canyon (2359).

*Equisetum praealtum* Raf. At site of Julian's name on the Green River (2063); mouth of Dark Canyon (2152); Surprise Valley and Bridge Canyon; Vasey's Paradise in Marble Canyon (2252).

## SPERMATOPHYTA

## GYMNOSPERMAE

*Pinaceae*

*Juniperus scopulorum* Sarg. Rapids 13 in Cataract Canyon (2127B). The only specimen found along the entire course of the river; dwarfed, 1½ feet tall and growing on canyon floor.

*Juniperus utahensis* (Engelm.) Lemmon. Outside the canyon between Greenriver and Moab (1969); five miles above the confluence of the Green and Colorado Rivers (2109); above Dark Canyon (2182); Surprise Valley and Rainbow Bridge; upper walls of Havasupai and Hualapai Canyons.

*Pinus edulis* Engelm. Between Navajo Mt. and Rainbow Bridge and in Surprise Valley; common on North Rim (4301); South Rim; Hualapai Canyon.

*Gnetaceae*

*Ephedra Coryi* Reed (or *E. viridis* Cov.; species not distinguishable without fruit). Port Royal on North Rim (4322) (4323); between Mooney Falls and the Colorado in Havasupai Canyon (4421); Spencer Canyon (4255); Quartermaster Canyon.

*Ephedra nevadensis* S. Wats. Spencer Canyon (4256).

*Ephedra Torreyana* S. Wats. Greenriver (1958); on the Green River at Mile 84 (2047) and near mouth of Hell Roaring Canyon (2073) (2088); in Cataract Canyon at Rapids 13 (2130), and at mouth of Dark Canyon (2148); Lee's Ferry (4343) (4422); in Marble Canyon at Mile 26½ (2233), and at Vasey's Paradise (2266); Tanner Rapids (2295), and above Bass Trail in Grand Canyon (2308).

*Ephedra trifurca* Torr. Near Boulder Dock (4190).

*Ephedra viridis* Cov. Forbidding Canyon (4069); ½ mile below South Rim near Kaibab Trail (4133); above Bass Trail (2309); mouth of 205 Mile Canyon (2386); Separation Canyon (4249); below Quartermaster Canyon; two miles above Emory Falls; below Virgin Canyon.

## ANGIOSPERMAE

*Typhaceae*

*Typha angustifolia* L. Bridge Canyon; near Colorado River in Havasupai Canyon. (Too old for herbarium material.)

*Typha latifolia* L. Elves' Chasm; in Havasupai Canyon near the village; Lava Falls. (Too old for herbarium material.)

*Gramineae*

*Agrostis alba* L. Upper Kaibab Trail, South Rim (4120).

*Agrostis verticillata* Vill. Rainbow Bridge (4033) (4047), Bridge Canyon (4042), and floor of Forbidding Canyon (4071); mouth of Bright Angel Creek (4086) (4094A) (4101); Hermit Rapids (2290A); Havasupai Canyon (4415); Lava Falls (2378); along stream at Separation Rapids (4203); Surprise Canyon (4269).

*Agropyron Smithii* Rydb. At ancient Indian granaries above Hell Roaring Canyon (2095); Cataract Canyon below Rapids 7 (2110).

*Andropogon barbinodis* Lag. Hermit Rapids (2289A).

*Andropogon glomeratus* (Walt.) B. S. P. Mouth of Bright Angel Creek (4089).

*Andropogon saccharoides* Swartz. In Marble Canyon at Mile 26½ (2230), and Vasey's Paradise (2256).

*Aristida Adscensionis* L. Mouth of Bright Angel Creek (4085) (4098).

*Aristida glauca* (Nees) Walp. Although not reported by Dixon or by Graham, this species was found in Utah on the Green River at Hell Roaring Canyon (2085); below Mile Rapids in Cataract Canyon (2115); in Marble Canyon at Mile 26½ (2222), President Harding Rapids (2277); mouth of Bright Angel Creek (4099); mouth of Diamond Creek (2392); Separation Rapids (4200) (4205).

*Aristida longiseta* Steud. Greenriver (1955); near Moab (2011). Although Hitchcock reports the species from Arizona, it was not found within the Canyon.

*Avena sativa* L. Depauperate form found on the second half mile of Kaibab Trail, South Rim (4136); probably dropped from feed bags on trail.

*Bouteloua aristidoides* (H.B.K.) Griseb. Near Creek in Havasupai Canyon (4377).

*Bouteloua barbata* Lag. Common in sand and gravel along stream in Separation Canyon (4198).

*Bouteloua curtispindula* (Michx.) Torr. Near Rainbow Bridge (4036).

*Bouteloua Parryi* (Fourn.) Griffiths. Among boulders in Separation Canyon (4201).

*Bouteloua trifida* Thurb. Surprise Canyon on Lake Mead (4207); abnormal spikelets with elongated awns.

*Bromus ciliatus* L. Upper Kaibab Trail on South Rim (4114).

*Bromus rigidus* Roth. Mouth of Havasupai Canyon (2356).

*Bromus rubens* L. Two miles above Emory Falls (4295). Common along the lake, often dwarfed.

*Bromus tectorum* L. Mouth of Dark Canyon (2159).

*Cenchrus pauciflorus* Benth. Edge of cornfield in Havasupai Canyon (4398).

*Cynodon Dactylon* (L.) Pers. Common along Bright Angel Creek (4081); in Havasupai Canyon abundant from village to Colorado River (2358); common at water's edge in Separation Canyon (4199). This species is found only where water is available.

*Digitaria sanguinalis* (L.) Scop. Near stream above village in Havasupai Canyon (4404).

*Distichlis dentata* Rydb. Along river at Lee's Ferry (2195).

*Distichlis stricta* (Torr.) Rydb. Green river (1926); Hell Roaring Canyon (2080).

*Echinochloa Crusgalli* var. *zelayensis* (H.B.K.) Hitchc. At edge of cornfield in Havasupai Canyon (4399).

*Elymus canadensis* L. Floor of Forbidding Canyon (4062); Vasey's Paradise (2269).

*Eragrostis cilianensis* (All.) Link. Spencer Canyon (4263); from Separation Canyon to Emory Falls.

*Eragrostis diffusa* Buckl. Near stream above village in Havasupai Canyon (4402) (4403).

*Eragrostis trichodes* (Nutt.) Nash. Along irrigation ditch in Havasupai Canyon (4367A).

*Festuca octoflora* Walt. Below Mile Rapids in Cataract Canyon (2126); Hermit Rapids (2288A); Tanner Rapids (2294).

*Hilaria Jamesii* (Torr.) Benth. Although this species is reported throughout Utah, and is used by the Indians in the Painted Desert of Arizona, we failed to find it farther south than Mile 84 on the Green River. Greenriver (1954); roadside east of Greenriver (1968) and at Mile 84 (2054).

*Hordeum jubatum* L. Greenriver (1921), and at ancient Indian granaries above Hell Roaring Canyon (2092); Navajo Mt.; Kaibab limestone on the South Rim.

*Imperata Hookeri* Rupr. Mouth of Bright Angel Creek (4096); mouth of Havasupai Canyon (2353).

*Lolium perenne* L. Mouth of Bright Angel Creek (4094).

*Muhlenbergia asperifolia* (Nees & Mey.) Parodi. Mouth of Bright Angel Creek (4083); very abundant at Lava Falls (2365).

*Oryzopsis hymenoides* (Roem. & Schult.) Ricker. This species is one of the most common along the river, and occupies recently flooded areas soon after the water recedes. Greenriver (1917) (1978A) and Mile 84 (2043); in Cataract Canyon below Mile Rapids (2116), and common at mouth of Dark Canyon (2172); in Marble Canyon at Mile 26½ (2223), and common at President Harding Rapids; common on South Rim and on North Rim at Port Royal (4326); common at Hermit Rapids; at Elves' Chasm (2233); common at Separation Rapids (4223); Boulder Dock (4186).

*Panicum hirticaule* Presl. Occasional at Separation Rapids (4229).

*Panicum obtusum* H. B. K. Mouth of Dark Canyon (2144).

*Panicum virgatum* L. Bridge Canyon (4043); floor of Forbidding Canyon (4059).

*Phragmites communis* Trin. Above Hell Roaring Canyon (2057); common in the vicinity of Paiute Farms on the San Juan River; mouth of Bright Angel Creek; in Grand Canyon at Deer Creek Falls (2341), two miles south of Upset Rapids, infrequent about a mile above Havasupai Canyon, and below village in Havasupai Canyon.

*Poa longiligula* Scribn. & Williams. Mouth of Dark Canyon (2162).

*Polypogon monspeliensis* (L.) Desf. Among rocks and on sand near Rainbow Bridge (4035), floors of Bridge and Forbidding Canyons (4063); in Grand Canyon at Tanner Rapids (2291), mouth of Bright Angel Creek (4088); Havasupai Canyon from the village to the Colorado River (2354) (4414); common at Separation Canyon (4230).

*Setaria lutescens* (Weig.) Hubb. Hitherto not reported from Arizona. Cornfield above village in Havasupai Canyon (4396A). Introduced.

*Setaria macrostachya* H.B.K. President Harding Rapids; mouth of Bright Angel Creek (4082); Elves' Chasm (2334); above village in Havasupai Canyon (4396).

*Setaria viridis* (L.) Beauv. Hitchcock reports this species as infrequent in southern United States although common in cooler U. S. and Canada. This collection is the first from the canyons. Edge of cornfield in Havasupai Canyon (4397A).

*Sitanion hystrix* (Nutt.) J. G. Smith. Fairly abundant south of Moab (1998); common on the Colorado about a mile above the mouth of Havasupai Canyon.

*Sitanion jubatum* J. G. Smith. Third half mile near the Kaibab Trail on the South Rim (4147).

*Sporobolus airoides* (Torr.) Torr. Mile 84 on the Green River (2049).

*Sporobolus contractus* Hitchc. First collections from within the canyon. Floor of Forbidding Canyon (4064) (4066) (4070); Granite Rapids in Grand Canyon (2301A).

*Sporobolus cryptandrus* (Torr.) A. Gray. First collections from within the canyon. Greenriver (1916); Lee's Ferry near the Colorado (4353); four miles up Havasupai Canyon (4423); among boulders at Separation Canyon (4202).

*Sporobolus flexuosus* (Thurb.) Rydb. Below Mile Rapids in Cataract Canyon (2125); Kanab Trail (2345).

*Stipa arida* Jones. Mile 26½ in Marble Canyon (2209). Hitchcock reports this as rare.

*Stipa comata* Trin. & Rupr.? Mouth of Dark Canyon (2159).

*Stipa coronata* Thurb. The first collection from Arizona, although Hitchcock's collection (13062) from Bright Angel is referred to a variety. This collection is nearly as tall as that of Hitchcock but the panicle is smaller. Fourth half mile near the Kaibab Trail on the South Rim (4157).

*Stipa spartea* Trin. Outside the canyon south of Moab (2008) below Mile Rapid in Cataract Canyon.

*Stipa speciosa* Trin. & Rupr. Below Mile Rapids in Cataract Canyon (2119) (2120) (2127A); Mile 26½ in Marble Canyon (2231); first half mile near the Kaibab Trail on the South Rim (4131).

*Triodia pulchella* H. B. K. Common along the Green and Colorado Rivers, from the lower edge of the talus slopes to high ledges. Ancient Indian granaries on the Green River above Hell Roaring Canyon (2089); in Cataract Canyon below Mile Rapids, abundant at Dark Canyon (2130A); abundant throughout Glen Canyon; Marble Canyon at President Harding Rapids (2280); in Grand Canyon common on Kaibab Trail of the South Rim, Tanner Rapids, common at Hermit Rapids, Havasupai Canyon, mouth of Diamond Creek (2292), and Separation Rapids; common on dry canyon walls in Spencer Canyon (4197); Boulder Dock (4168). On talus the entire length of Lake Mead.

#### Cyperaceae

*Carex subfusca* Boott. Two miles above Emory Falls on Lake Mead (4292).

*Carex Thurberi* Dewey. Mouth of Bright Angel Creek (4100).

*Cladium Mariscus* var. *californicum* S. Wats. This is a tropical and subtropical species. Tidestrom reports it from southern Nevada. Lava Falls (2372); two miles above Emory Falls on Lake Mead (4292).

*Cyperus erythrorhizos* Muhl. Below Mile Rapids in Cataract Canyon (2126A); Separation Rapids (4236).

*Eleocharis calva* Torr. Graham reports a collection by Hermann (in 1933) on the south slope of the Uinta Mountains as the first from Utah, representing a westward extension of the range. Mile Rapids in Cataract Canyon (2128A); and at Lava Falls (2364).

*Eleocharis rostellata* Torr. Lava Falls (2366) (2369).

*Scirpus americanus* Pers. Greenriver (1960).

*Scirpus Olneyi* A. Gray. Lava Falls (2362) (2368).

*Scirpus paludosus* A. Nels. Mile Rapids in Cataract Canyon (2119A).

*Juncus Dudleyi* Wieg. Mouth of Bright Angel Creek (4095). Graham reports this species from Vernal, Utah.

*Juncus saximontanus* A. Nels. Mouth of Bright Angel Creek (4091).

*Juncus Torryi* Cov. Graham has collected a single specimen near Vernal, Utah, but our first collection was no farther north than Rainbow Bridge (4052). Mouth of Bright Angel Creek (4090); Separation Canyon, common (4237).

#### Liliaceae

*Calochortus Nuttallii* Torr. and Gray. Outside the canyon south of Moab (1989).

*Nolina microcarpa* S. Wats. Elves' Chasm (2330); Havasupai Canyon; two miles below Kanab Canyon.

*Yucca angustissima* Engelm. Common below mouth of Clearwater Canyon in Cataract Canyon; Bridge Canyon and Surprise Valley; mouth of Moki Creek in Glen Canyon; in Marble Canyon at Mile 26½ (2218), and at Vasey's Paradise (2255); Hualapai Canyon; on top of Supai Formation in Havasupai Canyon (5199).

*Yucca baccata* Torr. Outside the canyon south of Montecello (2023); on top of the Supai Formation in Havasupai Canyon (5288).

*Yucca Harrimaniae* Trelease. Outside the canyon between Greenriver and Moab (1974), and south of Moab (1991); Mile 26 on the Green River (2099); below the Mile Rapids in Cataract Canyon (2118); occasional in Grand Canyon.

*Yucca Whipplei* Torr. Spencer Canyon (4263); ten miles above Emory Falls on Lake Mead (5278).

#### Amaryllidaceae

*Agave utahensis* Engelm. In Marble Canyon at Mile 26½ (2213) (2215) (2216) (2217), at Mile 19, and at Mile 39; in Grand Canyon at Saddle Canyon, Hermit Creek Rapids, and near mouth of Havasupai Canyon and Separation Rapids. Fairly common from Marble Canyon to Lake Mead.

#### Orchidaceae

*Epipactis gigantea* Dougl. Rainbow Bridge (4033A); Havasupai Canyon below Mooney Falls; Conquistadore Aisle in Grand Canyon (2323); two miles above Emory Falls on Lake Mead (4298).

#### Salicaceae

*Populus arizonica* Sarg. Havasupai Canyon (2352).

*Populus Fremontii* S. Wats. Near Yokey's Flat on the Green River (2086); in Glen Canyon at Hite Ranch, Ticaboo Creek, mouth of the Escalante River, and Bridge Canyon; Havasupai Canyon.

*Populus italica* DuRoi. Havasupai Canyon [Col. for Clover by Lorenzo and Harriet Sinyella (23)].

*Salix amygdaloides* Andersson. Greenriver (1931) (1940A);

*Salix exigua* Nutt. On the Green River at Mile 84 (2042), and mouth of Hell Roaring Canyon (2070); above Dark Canyon (2175); in Glen Canyon at Hite Ranch, mouth of Ticaboo Creek, California Bar, mouth of Moki Creek, Warm Springs Creek, and Bridge Canyon; along river at Lee's Ferry (2190); in Grand Canyon at Deer Creek Falls (2338), Lava Falls (2365A), and Mile 192 (2385).

*Salix Goodingii* Ball. Common at Lee's Ferry (2194); Mile 192 in Grand Canyon (2379).

*Salix laevigata* Bebb var. *araquipa* (Jeps.) Ball. Common in Havasupai Canyon (4432) [Col. for Clover by Sinyella (12)].

#### Juglandaceae

*Juglans rupestris* var. *major* Torr. Havasupai Canyon (4406). Rare.

#### Fagaceae

*Quercus Gambelii* Nutt. (Fig. 6 A) At Red Creek near the mouth of the Dirty Devil River (2185A); in Glen Canyon at Mouth of Moki Canyon, California Bar, Klondike Bar, mouth of Lake Canyon at Mile 113 (2186A); Surprise Valley (4005) (4008) (4016) (4017); South Rim in first half mile near Kaibab Trail (4113), North Rim at Port Royal (4358).

*Quercus turbinella* Greene. Surprise Valley (4010); Hualapai Canyon; Grapevine Springs in Havasupai Canyon.

#### Ulmaceae

*Celtis reticulata* Torr. Cataract Canyon at Mile Rapids (2120A), one mile south of Clear water Canyon, Mile 184½, and mouth of Dark Canyon; in Glen Canyon near mouth of Sevenmile Creek, Mile 104, Bridge Canyon, and nine miles above Lee's Ferry; in Marble Canyon at Mile 19 and Saddle Canyon; in Grand Canyon at Elves' Chasm, two miles below the mouth of Kanab Canyon, Havasupai Canyon, Lava Falls, and Mile 192.

*Urticaceae*

*Parietaria pennsylvanica* Muhl. Navajo (Bridal Veil) Falls in Havasupai Canyon (4410).

*Urtica holosericea* Nutt. Deer Creek Falls in Grand Canyon (2243).

*Loranthaceae*

*Phoradendron californicum* Nutt. On *Acacia* in Cataract Canyon above Mile 192 of the Grand Canyon (2376); on mesquite at Mile 192 (2381); on mesquite at 217 Mile Canyon in Grand Canyon (2394) (2395), Spencer Canyon.

*Santalaceae*

*Comandra pallida* A. DC. Surprise Valley (4009).

*Polygonaceae*

*Chorizanthe rigida* (Torr.) Torr. & Gray. Abundant near Boulder Dock (4169).

*Eriogonum aureum* M. E. Jones. Bridge Canyon (4039); fairly common at Port Royal on North Rim. (4304) (4314).

*Eriogonum deflexum* Torr. Common at Lee's Ferry (2188) (4337); common with *E. inflatum* at Boulder Dock (4188).

*Eriogonum fasciculatum* Benth.? Infrequent at mouth of Spencer Canyon (4253); near Boulder Dock (4185).

*Eriogonum inflatum* Torr. & Frem. Greenriver (1943) and Mile 84 on the Green River (2041); in Cataract Canyon at Rapids 13 (2123A), and infrequent at mouth of Dark Canyon (2163); Surprise Valley; Lee's Ferry (4338); President Harding Rapids in Marble Canyon; Boulder Dock (4170) (4187). Occasional to common throughout the canyon.

*Eriogonum ovalifolium* Nutt. var. *purpureum* Stokes. Outside the canyon between Moab and Montecello (1999).

*Eriogonum Simpsoni* Benth. South Rim below the Coconino sandstone near the Kaibab Trail (4123) (4124).

*Eriogonum Wetherillii* Eastw. Lee's Ferry (4339).

*Polygonum aviculare* L. Havasupai Canyon (4385).

*Polygonum buxiforme* Small. Havasupai Canyon (4392).

*Rumex crispus* L. South Rim below the Coconino sandstone near the Kaibab Trail (4117); above village in Havasupai Canyon (4319).

*Rumex Patientia* L. Outside the canyon south of Moab (1993).

*Chenopodiaceae*

*Atriplex canescens* (Pursh) Nutt. Outside the canyon east of Greenriver (1965); common from Greenriver (1929) to Mile 84 (2032) (2027) (2035) (2038), site of Julian's name (2060), and mouth of Hell Roaring Canyon (2077); in Cataract Canyon below Mile Rapids (2112A), abundant at Rapids 13 (2123) (2128) (2132A), and at mouth of Dark Canyon (2148A); in Glen Canyon at Forbidding Canyon (4061), and mouth of Moki Canyon; at Lee's Ferry (2186B) (4346) (4347); in Marble Canyon at Mile 19, President Harding Rapids, and from Saddle Canyon to mouth of Bright Angel Creek; South Rim near the Kaibab Trail in first half mile (4128), and fourth half mile (4153); common at Port Royal on North Rim (4312); common throughout Hualapai and Havasupai Canyons (4368); Separation Canyon; between mouth of Quartermaster Canyon and Upper Travertine Springs; two miles above Emory Falls on Lake Mead (4281).

*Atriplex hymenelytra* (Torr.) S. Wats. Two miles above Emory Falls on Lake Mead (4291). Apparently new to Mojave Co., Ariz.

*Atriplex Jonesii* Standl. Greenriver (1937); Lee's Ferry (4340) (4355).

*Atriplex Nuttallii* S. Wats. Outside the canyon on flats east of Greenriver (1966A).

*Atriplex rosea* L. Near the Kaibab Trail in third half mile below the South Rim (4148).

*Chenopodium album* L. Mile 84 on the Green River (2028).

*Corispermum nitidum* Kit. Separation Rapids (4211).

*Echinopsilon hyssopifolius* (Pall.) Moq. Common at Separation Rapids (4209).

*Eurotia lanata* (Pursh) Moq. Greenriver (1957); mouth of Hell Roaring Canyon (2094).

*Salsola Kali* L. var. *tenuifolia* Tausch. (*S. pestifer* A. Nels.) Outside the canyon at Montecello (2020A); Greenriver (1924); common in Cataract Canyon at Rapids 13 (2131A), and at mouth of Dark Canyon (2165); in Glen Canyon at mouth of Moki Canyon; Lee's Ferry (4351); common in stream bed at Separation Canyon (4212); near Boulder Dock (4182) (4184).

*Sarcobatus vermiculatus* (Hook.) Torr. Greenriver (1915); common at Mile 84 on the Green River (2023A), and abundant at mouth of Hell Roaring Canyon (2074) (2078A).

*Suaeda Torreyana* S. Wats. Greenriver (1924); mouth of Hell Roaring Canyon (2075), Tanner Rapids in the Grand Canyon (2291A).

#### Amaranthaceae

*Amaranthus blitoides* S. Wats. Navajo (Bridal Veil) Falls in Havasupai Canyon (4408A); upper Lake Mead in Quartermaster Canyon (4271A) (4272A).

*Amaranthus hybridus* L., (Immature). Common near creek throughout Havasupai Canyon (4405A).

*Amaranthus Powellii* S. Wats. Common near creek in Havasupai Canyon (4406A).

*Tidestromia oblongifolia* (S. Wats.) Standl. Mouth of Diamond Creek (2391); mouth of Separation Canyon (4231) (4239); two miles above Emory Falls (4285).

#### Nyctaginaceae

*Abronia glabra* Rydb. Outside the canyon between Moab and Montecello (2006).

*Abronia fallax* Heimerl. Outside the canyon between Moab and Montecello (2010).

*Abronia pumila* Rydb. Infrequent at Mile 84 on the Green River (2025).

*Allionia incarnata* L. In Marble Canyon at President Harding Rapids (2286); in Grand Canyon at Tanner Rapids (2293)?; Havasupai Canyon (4420).

*Allionia linearis* Pursh. Greenriver (1948), and Mile 84 on the Green River (2029A); Cataract Canyon at Rapids 13 (2133).

*Boerhaavia Torreyana* (S. Wats.) Standl. Above village in Havasupai Canyon (4386).

*Mirabilis Bigelovii* A. Gray. Spencer Canyon (4250).

*Mirabilis multiflora* (Torr.) A. Gray. Kaibab Trail, second half mile from the South Rim (4141); Grand Canyon at Conquistadore Aisle (2332).

*Tripterocalyx pedunculatus* (M. E. Jones) Standl. Outside the canyon south of Moab (1983); Greenriver (1919) and fairly common at Mile 84 (2033); Cataract Canyon below Rapids 7 (2108).

#### Aizoaceae

*Sesuvium sessile* Pers. On the Green River near Yokey's Flat (2091).

#### Ranunculaceae

*Aquilegia chrysantha* A. Gray. Near spring at mouth of Dark Canyon (2139); at spring, Rainbow Bridge (4030); two miles above Emory Falls (4296) (4196), and at Emory Falls (4191).

*Clematis ligusticifolia* Nutt. Bridge Canyon (4040); abundant near spring in Havasupai Canyon (4405).

*Berberidaceae*

*Berberis Fremontii* Torr. Outside the canyon between Moab and Montecello (1997).

*Papaveraceae*

*Argemone platyceras* Link & Otto. Cataract Canyon at Rapids 13 (2136A).

*Cruciferae*

*Arabis perennans* S. Wats.? Marble Canyon at Mile 16½ (2204), and Mile 26½ (2224).

*Descurainia pinnata* (Walt.) Britton subsp. *glabra* (Woot. and Standl.) Detling. Common throughout the upper part of Havasupai Canyon [Col. for Clover by Sinyella (2)].

*Lepidium Eastwoodiae* Wooton. Greenriver (1918).

*Lepidium Jonesii* Rydb. Outside the canyon between Moab and Montecello (2000) (2014); Greenriver (1952), and at the site of Julian's name on the Green River (2055) (2056); Cataract Canyon below Mile Rapids (2117). Common at Lee's Ferry (2197).

*Lepidium montanum* Nutt. (Probably var. *glabrum* C. L. Hitchcock). On Kaibab limestone, South Rim (4119).

*Rorippa Nasturtium-aquaticum* (L.) Shinz & Thell. Marble Canyon at Vasey's Paradise (2245); Grand Canyon at Hermit Rapids (2296A), and very abundant in Havasupai Canyon (4376).

*Stanleya pinnata* (Pursh) Britton. Outside the canyon at Montecello (2018); from Greenriver to the confluence of the Green and the Colorado Rivers, Mile 26 (2097); in Cataract Canyon below Rapids 7 (2106), infrequent below Mile Rapids (2122), and mouth of Dark Canyon (2177); near Kaibab Trail in the third half mile below the South Rim (4143); near Navajo (Bridal Veil) Falls in Havasupai Canyon (4409).

*Thelypodium integrifolium* (Nutt.) Endl. South Rim near Kaibab Trail (4115); Havasupai Canyon one mile above village (4364) and common throughout the canyon (4408); on Lake Mead two miles above Emory Falls (4284).

*Thelypodium rhomboideum* Greene. One mile above village in Havasupai Canyon (4379).

*Capparidaceae*

*Cleome lutea* Hook. Greenriver (1914) (1914A); mouth of Forbidding Canyon (4076) (4076A); Havasupai Canyon (4381) (4395).

*Wislizenia refracta* Engelm. Mouth of Separation Canyon (4217).

*Saxifragaceae*

*Fendlera rupicola* A. Gray. South Rim near Kaibab Trail, third half mile (4139), and fourth half mile (4161).

*Ribes inebrians* Lindl. Port Royal on North Rim (4311).

*Ribes velutinum* Greene. Port Royal on the North Rim (4316).

*Rosaceae*

*Amelanchier utahensis* Koehne. North Rim at Port Royal (4306); South Rim below the Coconino sandstone (4126); on trail to Supai down Hualapai Canyon.

*Cercocarpus intricatus* S. Wats. var. *villosus* C. K. Schneid. Common on the upper Kaibab Trail, South Rim (4160); North Rim at Port Royal (4315).

*Chamaebatiaria Millefolium* (Torr.) Maxim. South Rim on Coconino sandstone near the Kaibab Trail (4109); North Rim at Port Royal (4307).

*Coleogyne ramosissima* Torr. Outside the canyon between Greenriver and Moab (1973); between Navajo Mt. and Rainbow Bridge, and Surprise Valley (4029); on trail to Supai down Hualapai Canyon.

*Cowania Stansburiana* Torr. Between Rainbow Bridge and Navajo Mt., Surprise Valley, and abundant in Bridge Canyon (4050A); abundant in Marble Canyon at Mile 39, Saddle Canyon, and Vasey's Paradise (2262). Not seen for some distance

immediately above Vasey's Paradise. In Grand Canyon at Hermit Rapids (2303A), and common on both rims of the Grand Canyon.

*Fallugia paradoxa* (Don.) Endl. Common at Mile 26½ in Marble Canyon (2225).

*Petrophytum caespitosum* (Nutt.) Rydb. Mouth of Hell Roaring Canyon (2083A).

*Prunus fasciculata* (Torr.) A. Gray. In Grand Canyon from Saddle Canyon to Bright Angel Crossing, at Tanner Rapids (2298), and at Hermit Rapids (2298A) (2299A).

*Purpusia arizonica* Eastw. North Rim at Port Royal (4328).

*Rosa oreophila* Rydb. Outside the canyon at Montecello (2021).

#### Leguminosae

*Acacia Greggii* A. Gray. First seen forty miles below Lee's Ferry in Marble Canyon; common at President Harding Rapids (2285); common from Saddle Canyon at Mile 47 to Bright Angel Crossing; Elves' Chasm; Conquistadore Aisle; mouth of Kanab Canyon; near Upset Rapids; Havasupai and Hualapai Canyons; Lava Falls; Hurricane Fault; common at Mile 189 & Mile 193; Diamond Creek; luxuriant growth in Separation Canyon (4225); abundant in Spencer Canyon; mouth of Surprise Canyon; abundant between Quartermaster Canyon and Travertine Springs in seeps from base of Mauv limestone below the Bright Angel shale; two miles above Emory Falls and at Emory Falls; occasional in Virgin Canyon.

*Amorpha fruticosa* L. var. *occidentalis* (Abrams) Kearney & Peebles. Grand Canyon at Deer Creek Falls, very common in seepage areas down stream from the falls (2340).

*Astragalus ceramicus* Sheldon var. *imperfectus* Sheldon. Outside the canyon between Montecello and Moab (2001).

*Astragalus Preussii* A. Gray. Abundant at mouth of Dark Canyon (2142).

*Astragalus Thompsonae* S. Wats. Greenriver (1939A), and in Gray Canyon at Mile 84 (2046); Cataract Canyon below Rapids 7 (2105A).

*Cassia Covesii* A. Gray. Lake Mead along stream at Quartermaster Canyon (4273A).

*Cercis occidentalis* Torr. Abundant at mouth of Dark Canyon (2168); in Glen Canyon below the California Bar, and at Rainbow Bridge (4053); infrequent in Marble Canyon, one tree at Mile 19, a few small trees at Mile 26½, several at Mile 39, and at Vasey's Paradise; at foot of Kanab Trail, and two miles below Kanab Canyon; Havasupai Canyon.

*Dalea amoena* S. Wats. *Surprise Valley* (4025).

*Dalea* sp. Infrequent at Conquistadore Aisle in Grand Canyon (2325).

*Glycyrrhiza lepidota* (Nutt.) Pursh. Greenriver (1933), Mile 84 (2048), and at site of Julian's name on the Green River (2051); Lee's Ferry (2200).

*Krameria parvifolia* Benth. var. *imparata* Macbr. In Grand Canyon at Mile 193 (2383), common at Diamond Creek (2389), and at Boulder Dock (4173A) (4189).

*Krameria parvifolia* Benth. var. *glandulosa* (Rose & Painter) Macbr. Boulder Dock (4173).

*Lupinus barbiger* S. Wats. Outside the canyon near Montecello (2019).

*Melilotus alba* Desr. Greenriver (1938); two miles above Dark Canyon (2173); common at Lee's Ferry (2193); Havasupai Canyon (4383).

*Melilotus indica* (L.) All. Mouth of Havasupai Canyon (2355).

*Parryella filifolia* Torr. & Gray. Lee's Ferry (4356).

*Petalostemon flavescens* S. Wats. *Surprise Valley* (4021), and in Bridge Canyon (4044).

*Prosopis juliflora* (Swartz) DC. var. *glandulosa* (Torr.) Cockerell. In Marble Canyon abundant on Red Wall limestone talus at Mile 39, at President Harding Rapids (2284), and from Saddle Canyon to Bright Angel crossing; on the trail through Hualapai Canyon to Supai, and in Havasupai Canyon (4369); in Grand Canyon below

Lava Falls at Mile 193 (2380), at mouth of Diamond Creek, 217 Mile Canyon (2395A), Separation Canyon (4226), Spencer Canyon; between Quartermaster Canyon and Upper Travertine Springs, and two miles above Emory Falls.

*Psoralea micrantha* A. Gray. On the Green River at Mile 26 (2089A).

*Vicia americana* Muhl. Outside the canyon near Montecello (2018B).

#### Linaceae

*Linum Lewisii* Pursh. South Rim near the third half mile of the Kaibab Trail (4145).

#### Zygophyllaceae

*Larrea glutinosa* Engelm. Lava Falls (2373), Hurricane Fault, Mile 189, mouth of Diamond Creek, Separation Canyon (4228), and Spencer Canyon; frequently dominant along Lake Mead, Quartermaster Canyon and Upper Travertine Springs, two miles above Emory Falls, at Surprise Canyon, below Virgin Canyon, and Boulder Dock (4172).

#### Rutaceae

*Ptelea Baldwinii* Torr. & Gray. South Rim near the Kaibab Trail, second half mile (4137), third half mile (4152), and fourth half mile (4154) (4162); on Kaibab limestone in Havasupai Canyon.

*Thamnosma montana* Torr. & Frem. In Grand Canyon at Granite Rapids on ledges and talus (2287A), and in Havasupai Canyon.

#### Euphorbiaceae

*Bernardia incana* Morton. Grand Canyon at Hermit Rapids (2315).

*Ditaxis neomexicana* (Muell. Arg.) Heller. Separation Canyon (4222), and Spencer Canyon (4251).

*Euphorbia bilobata* Engelm. Mile 16½ in Marble Canyon (2206).

*Euphorbia Fendleri* Torr. & Gray. South of Moab (1981; common on North Rim at Port Royal (4310).

*Euphorbia glyptosperma* Engelm. Floor of Forbidding Canyon (4058);

*Euphorbia polycarpa* Benth. Abundant near Boulder Dock (4175).

*Euphorbia polycarpa* Benth. var. *hirtella* Boiss. Abundant near Boulder Dock (4174) (4176).

#### Anacardiaceae

*Rhus radicans* L. Common at Vasey's Paradise.

*Rhus trilobata* Nutt. Common from Greenriver (1935) to Mile 84 (2021) (2068), and mouth of Hell Roaring Canyon (2084); Cataract Canyon at Rapids 1; Narrow Canyon near the mouth of the Dirty Devil River; Surprise Valley (4018). Hualapai and Havasupai Canyons.

*Rhus trilobata* Nutt. var. *simplicifolia* (Greene) Munz & Sloane. Dark Canyon (2170); Rainbow Bridge (4048); South Rim, fourth half mile near the Kaibab Trail (4156); Hualapai Canyon on the trail to Supai.

*Rhus utahensis* Goodding. Five miles above the confluence of the Green and Colorado Rivers (2103); second half mile below the South Rim near the Kaibab Trail (4138).

#### Celastraceae

*Mortonia scabrella* A. Gray var. *utahensis* Cov. On upper talus slopes, Havasupai Canyon. (5149).

#### Aceraceae

*Acer interius* Torr. Abundant across from Music Temple in Glen Canyon; In Havasupai Canyon abundant on canyon floor above Navajo Falls, associated with *Fraxinus velutina* (5210).

#### Rhamnaceae

*Condalia lycioides* (A. Gray) Weberb. *canescens* (A. Gray) Trelease. Cataract Canyon at Rapids 13 (2121); Surprise Valley and Rainbow Bridge; on trail to Supai

down Hualapai Canyon; Havasupai Canyon (4370); and at the junction of Havasupai Canyon with the Colorado (2357).

*Rhamnus betulaeifolia* Greene. Mouth of Dark Canyon (2154); Surprise Valley.

*Rhamnus betulaeifolia* Greene var. *obovata* Kearney & Peebles. South Rim in second half mile near the Kaibab Trail (4135).

#### Vitaceae

*Parthenocissus vitacea* (Knerr) Hitchc. Bridge Canyon; Havasupai Canyon (4388).

*Vitis arizonica* Engelm. Mouth of Havasupai Canyon (2347), and abundant along stream between village and the Colorado; in Grand Canyon at Mile 193; abundant two miles above Emory Falls on Lake Mead (4294).

#### Malvaceae

*Sida hederacea* (Dougl.) Torr. Mouth of Hell Roaring Canyon (2093).

*Sphaeralcea ambigua* A. Gray. Very common at Spencer Canyon (4260).

*Sphaeralcea coccinea* (Pursh) Rydb. Outside the canyon south of Moab (1984).

*Sphaeralcea Fendleri* A. Gray. Mouth of Dark Canyon (2161).

*Sphaeralcea grossulariaefolia* (Hook & Arn.) Rydb. Infrequent at Mile 84 on the Green River (2030); common at President Harding Rapids in Marble Canyon (2275).

*Sphaeralcea grossulariaefolia* (Hook & Arn.) Rydb. var. *pedata* (Torr.) Kearney. Havasupai Canyon (4361) (4380); mouth of Separation Canyon (4207) (4227).

*Sphaeralcea parvifolia* A. Nels. Roadside east of Greenriver (1967), Greenriver (1963), and common at Mile 84 from Greenriver (2031); common in Havasupai Canyon (4375).

*Sphaeralcea Rusbyi* A. Gray. Surprise Valley (4013).

#### Tamaricaceae

*Tamarix gallica* L. Greenriver (1925) to the confluence of the Green and the Colorado Rivers; common at Dark Canyon (2143) and south of Clearwater Canyon; in Glen Canyon common below the California Bar, occasional near Rainbow Bridge; above Lee's Ferry, and at Lee's Ferry (2191A); absent in Marble Canyon except below Vasey's Paradise and at mouth of Saddle Canyon; in the lower Grand Canyon at Lava Pinnacle (two miles above Lava Falls); Separation Rapids (4204). Introduced.

#### Fouquieriaceae

*Fouquieria splendens* Engelm. First seen three miles above the mouth of Havasupai Canyon on upper walls from Mauv limestone to the Kaibab limestone; on talus at Fern Glen Rapids; abundant at Red Slide Canyon; two miles below Lava Falls; at Hurricane Fault three miles below Lava Falls; high on ledges at Mile 192 and Mile 193; at the mouth of Diamond Creek; Separation Rapids; Quartermaster Canyon; Waterfall Canyon; Upper Travertine Springs; Emory Falls to Pierce Ferry on Lake Mead.

#### Cactaceae

*Echinocactus polycephalus* Engelm. & Bigelow. On trail to Supai down Hualapai Canyon; steep talus in Spencer Canyon (4447) (Mich. Bot. Gard. no. 17160); abundant two miles above Emory Falls on Lake Mead.

*Echinocereus acifer* (Otto) Lemaire? Mouth of the Dirty Devil River (2184).

*Echinocereus canyonensis* Clover & Jotter. Grand Canyon two miles above Bass Cable (2317) same as Mich. Bot. Gard. no. 16846). Occasional.

*Echinocereus coccineus* Engelm. Mouth of the Dirty Devil River (2186); Havasupai Canyon (Mich Bot. Gard. no. 17168) (17170).

*Echinocereus decumbens* Clover & Jotter. Marble Canyon at Mile 26½ (2212) same as (Mich. Bot. Gard. no. 16870). Rare.

*Echinocereus Engelmannii* (Parry) Rümpler. Glen Canyon along the Mormon Trail,

Lee's Ferry; in Marble Canyon abundant at President Harding Rapids (2273A), at Kwagunt Rapids and abundant at Nankoweap Rapids; mouth of Bright Angel Creek; abundant at Port Royal on the North Rim (4334); very abundant at Hermit Creek Rapids; Elves Chasm; in Havasupai and Hualapai Canyons; below Lava Falls at Mile 193; 205 Mile Canyon above Diamond Creek; on Lake Mead in Surprise Canyon and two miles above Emory Falls.

*Echinocereus Fendleri* (Engelm.) Rümpler. In Marble Canyon at Mile 26½, Vasey's Paradise, and President Harding Rapids (2281); mouth of Bright Angel Creek; Hermit Rapids; Elves' Chasm; mouth of Havasupai Canyon; Granite Rapids.

*Echinocereus mojavnensis* (Engelm. & Bigelow) Rümpler. Below Rapids 7 in Cataract Canyon (2112).

*Echinocereus octacanthus* (Mühlenpfordt) Britt. & Rose. At the mouth of the Dirty Devil River (2184A), Surprise Valley between Navajo Mt. and Rainbow Bridge; in Marble Canyon at Vasey's Paradise; mouth of Bright Angel Creek; Hermit Rapids (2303); two miles above Bass Cable (2317A); and Elves's Chasm.

*Ferocactus acanthodes* (Lemaire) Britt. & Rose. In Marble Canyon at Mile 26½ (2239), small plants at Vasey's Paradise (2271), rare at President Harding Rapids (2272), and occasional between Saddle Canyon and Bright Angel Crossing; in Grand Canyon at Hermit Rapids, at Walthenburg Rapids plants 2-5 feet high, Elves' Chasm, mouth of Havasupai Canyon (4444), Lava Falls (2371), Hurricane Fault, Mile 193, Diamond Creek, Separation Rapids (4443) (4254), Spencer Canyon; Surprise Canyon, small plants; abundant and vigorous between Quartermaster Canyon and Emory Falls; in Virgin Canyon abundant but small and often unhealthy.

*Echinomastus Johnsonii* Parry. Infrequent at foot of Navajo Mt.; some dead specimens at Boulder Dock; very abundant south of Pierce Ferry.

*Opuntia acanthocarpa* Engelm. & Bigelow. Hualapai Canyon; Lava Falls; Diamond Creek (2396); Quartermaster Canyon (4276) (4277); Surprise Canyon; mouth of Virgin Canyon; Boulder Dock (4180).

*Opuntia aurea* Baxter. Fourth half mile below South Rim near the Kaibab Trail (4165).

*Opuntia basilaris* Engelm. & Bigelow. In Cataract Canyon, rare ½ mile south of Clearwater Canyon; in Marble Canyon at Mile 26½, Mile 39, President Harding Rapids, and from Saddle Canyon to Bright Angel Creek; in Grand Canyon at Elves' Chasm, Mile 193, and 205 Mile Canyon above Diamond Creek, fairly abundant at Spencer Canyon (4440), Separation Rapids; two miles above Emory Falls, Boulder Dock.

*Opuntia basilaris* Engelm. var. *nana* Hort.? Separation Canyon (4248).

*Opuntia Bigelovii* Engelm. Mile 193 below Lava Falls (2388); Diamond Creek; Spencer Canyon (4257).

*Opuntia brachyclada* Griffiths. Cataract Canyon along Mile Rapids (2111); Forbidding Canyon (2403).

*Opuntia chlorotica* Engelm. & Bigelow. Lee's Ferry (4335); on canyon floor of Hualapai Canyon; abundant in Havasupai Canyon (4441) (Mich. Bot. Gard. no. 17166); Mile 142 in Grand Canyon.

*Opuntia echinocarpa* Engelm. & Bigelow. Mouth of Spencer Canyon (4450).

*Opuntia Engelmannii* Salm-Dyck. In Marble Canyon at President Harding Rapids, Kwagunt Rapids, and from Saddle Canyon to Bright Angel Creek; above Bass Trail (2316); Elves' Chasm; abundant at Granite Rapids; on the walls of Havasupai Canyon (4449) (4439).

*Opuntia erinacea* Engelm. & Bigelow. Mouth of Forbidding Canyon (2399), and between Navajo Mt. and Rainbow Bridge; abundant in Havasupai and in Hualapai Canyons.

*Opuntia humistrata* Griffiths? Port Royal on the North Rim (4331).

*Opuntia hystericina* Engelm. & Bigelow. Hell Roaring Canyon (2081); mouth of Forbidding Canyon (2401); Lee's Ferry (4333); near Bright Angel Creek; Port

Royal on the North Rim (4332) (4333); Nankoweap; mouth of Havasupai Canyon.

*Opuntia laevis* Coulter. Hermit Rapids (2301B).

*Opuntia longiareolata* Clover & Jotter. Granite Falls (2302) same as (Mich. Bot. Gard. no. 16852). Rare.

*Opuntia mojavenensis* Engelm. & Bigelow. Fairly common in Havasupai Canyon on Red Wall limestone (4438) (Mich. Bot. Gard. no. 17169).

*Opuntia molesta* Brandegee. Diamond Creek (2397).

*Opuntia phaeacantha* Engelm. Abundant at President Harding Rapids (2273); Nankoweap; near the Kaibab Trail in fourth half mile from the South Rim (4167).

*Opuntia polyacantha* Haworth. Outside the canyon between Moab and Montecello (1990) (2016); on the Green River at Mile 84; in Glen Canyon at Mile 142, above Moki Canyon, where a robust form and a normal one were seen; same robust form at Surprise Valley and Bridge Canyon; Lee's ferry; in Marble Canyon at President Harding Rapids; in Grand Canyon at Tanner Rapids, Kwagunt Rapids in association with *O. Engelmannii* and *Echinocereus Engelmannii* (2300), Nankoweap Rapids, and Hermit Rapids (2302A).

*Opuntia rhodantha* K. Schum. On the Green River near Yokey's Flat (2082) (2100), mouth of Hell Roaring Canyon (2078) (2079); Port Royal on the North Rim (4330); two miles above Emory Falls (4300).

*Opuntia tetracantha* Toumey. Mouth of Diamond Creek (2402).

*Opuntia Vaseyi* (Coulter) Britt. & Rose. In the Rainbow Bridge Area at Surprise Valley; floor of Hualapai Canyon; Grand Canyon two miles above Bass Cable (2318).

*Opuntia Whipplei* Engelm. & Bigelow. Marble Canyon at Vasey's Paradise; in Grand Canyon at Upset Rapids, Walthenburg Rapids (2319), on Kibab limestone in Hualapai Canyon (4437), mouth of Havasupai Canyon, Lava Falls, and Diamond Creek.

*Phellosperma tetrancistra* (Engelm.) Britt. & Rose. Fairly abundant from mouth of Forbidding Canyon (2400) to Pierce Ferry on Lake Mead; in Marble Canyon at Mile 26½ (2240), Vasey's Paradise, and abundant from Saddle Canyon to Bright Angel Creek; in Grand Canyon at Granite Rapids, Hermit Rapids, two miles above Bass Cable, Elves' Chasm, Havasupai Canyon (4442), Diamond Creek, abundant at Separation Canyon (4247), Spencer Canyon; two miles above Emory Falls on Lake Mead (4287).

*Sclerocactus parviflorus* Clover & Jotter. In Glen Canyon common from Mile 142, the mouth of Moki Canyon, to the mouth of Forbidding Canyon (2398) same as Mich. Bot. Gard. no. 16845); fairly common along lower San Juan River; Hualapai and Havasupai Canyons.

*Sclerocactus polyancistrus* (Engelm. & Bigelow) Britt. & Rose. Cataract Canyon below Mile Rapids (2113); between Navajo Mt. and Rainbow Bridge (mostly dead); Surprise Valley; Bridge Canyon.

*Sclerocactus Whipplei* (Engelm. & Bigelow) Britt. & Rose. On the Green River at Mile 84.

#### *Loasaceae*

*Eucnide urens* Parry. Occasional at Separation Canyon (4238).

*Mentzelia albicaulis* Dougl. Green River (1942) (1953).

*Mentzelia integra* (Jones) Tidestrom. Third half mile below South Rim near Kaibab Trail (4151).

*Mentzelia pumila* (Nutt.) Torr. and Gray. Mouth of Dark Canyon (2153).

*Mentzelia pumila* var. *multiflora* (Nutt.) Urb. & Gilg. Green River (1941); Dark Canyon (2153); Rainbow Bridge (4050).

*Petalonyx Thurberi* A. Gray. Fairly Common near Boulder Dock (4181).

#### *Elaeagnaceae*

*Shepherdia rotundifolia* Parry. Frequent on rocky slopes along the Green River

in Labyrinth Canyon, Mile 84 (2052); Rainbow Bridge; Port Royal on the North Rim (4305).

*Onagraceae*

*Gaura parviflora* Dougl. On the Green River at Mile 84 (2044A).

*Oenothera longissima* Rydb. Mouth of Dark Canyon (2147A).

*Oenothera micrantha* Hornem. var. *exfoliata* (A. Nels.) Munz. Grand Canyon at Conquistadore Aisle (2327); Havasupai Canyon (4384).

*Oenothera multijuga* S. Wats. Marble Canyon at President Harding Rapids (2274); Grand Canyon at the mouth of Havasupai Canyon; Lake Mead two miles above Emory Falls (4283) (2348).

*Oenothera multijuga* S. Wats. var. *orientalis* Munz. Marble Canyon at Mile 16½ (2208).

*Oenothera multijuga* S. Wats. var. *parviflora* (S. Wats.) Munz. Frequent in Separation Canyon (4232), and below Spencer Canyon (4268).

*Umbelliferae*

*Apium graveolens* L. Havasupai Canyon, abundant near Navajo (Bridal Veil) Falls (4418).

*Lomatium Parryi* (S. Wats.) Macbride. Surprise Valley (4006).

*Primulaceae*

*Primula specuicola* Rydb. Abundant on walls near Emory Falls on Lake Mead (4194). High on walls Colorado Canyon, southern Utah and Arizona.

*Oleaceae*

*Forestiera neomexicana* A. Gray. Mouth of Hell Roaring Canyon (2072); Cataract Canyon above Rapids 1 (2104).

*Fraxinus anomala* Torr. Outside the canyon, on roadside north of Moab (1975); on the Green River five miles above its confluence with the Colorado (2102); Cataract Canyon at Rapids 13 (2132), and mouth of Dark Canyon (2166) (2167); Rainbow Bridge (4056); abundant in Surprise Valley (4026), Bridge Canyon, and Forbidding Canyon (4079); South Rim in second half mile near the Kaibab Trail (4142); Hualapai Canyon.

*Fraxinus Lowellii* Sarg. Single small tree at mouth of Havasupai Canyon (2346).

*Fraxinus velutina* Torr. var. *glabra* (Thornber) Rehder. Common throughout Havasupai Canyon (4423A); on Lake Mead, two miles above Emory Falls (4478). Trees 35 feet in height and 7 inches in diameter, growing in seep at base of the dolomite of the Bright Angel Shale.

*Gentianaceae*

*Centaurium calycosum* (Buckl.) Fern. Rare, growing on coarse gravel near mouth of Bright Angel Creek (4087).

*Frasera speciosa* Dougl. North Rim at Port Royal (4360).

*Frasera utahensis* Jones. Forbidding Canyon (4077A); Hualapai Canyon.

*Apocynaceae*

*Amsonia Eastwoodiana* Rydb. Lee's Ferry on boulder strewn shore (4352).

*Apocynum cannabinum* L. On the Green River at Mile 84 (2044); mouth of Dark Canyon (2156); Bridge Canyon, and Surprise Valley; Marble Canyon at Mile 16½ (2205); Deer Creek Falls (2344); Havasupai Canyon.

*Apocynum Suksdorfii* Greene var. *angustifolium* (Woot.) Woodson. Common along river at Lee's Ferry (2189).

*Asclepiadaceae*

*Asclepias latifolia* (Torr.) Raf. Cataract Canyon at Rapids 7 (2114).

*Asclepias labriformis* M. E. Jones. Surprise Valley (4023).

*Asclepias galioides* H. B. K. On the Green River at site of Julian's name (2054), and mouth of Hell Roaring Canyon (2071); mouth of Dark Canyon (2140); Surprise Valley (4027).

*Funastrum cynanchoides* (Decaisne) Schlechter. Forbidding canyon (4075).

#### Convolvulaceae

*Cuscuta denticulata* Engelm. Parasitic on *Larrea* near boat dock at Boulder City (4177). Second record for Arizona.

#### Polemoniaceae

*Gilia arizonica* (Greene) Rydb. Floor of Forbidding Canyon (4069A), and in Surprise Valley (4011).

*Gilia Gunnisonii* Torr. & Gray. Greenriver (1946).

*Gilia longiflora* (Torr.) G. Don. Outside the canyon between Moab and Montecello (2015).

*Gilia spergulifolia* Rydb. Outside the canyon between Greenriver and Moab (1971).

*Gilia subnuda* Torr. Rare in Gray Canyon on the Green River and at the mouth of Dark Canyon (2150).

#### Hydrophyllaceae

*Phacelia corrugata* A. Nels. Infrequent at mouth of Dark Canyon (2142A) (2143A).

#### Boraginaceae

*Coldenia hispidissima* (Torr.) A. Gray. On the Green River at mouth of Hell Roaring Canyon (2083), and at Bow Knot Bend; in Cataract Canyon at Rapids 13 (2124A), and at mouth of Dark Canyon (2149); common at Lee's Ferry (4341); Vasey's Paradise (2244A); mouth of Havasupai Canyon (2350).

*Coldenia plicata* (Torr.) Cov. Near Boulder Dock (4183).

*Cryptantha barbiger* (A. Gray) Greene. Separation Canyon (4234).

*Cryptantha crassisepta* (Torr. & Gray) Greene. Outside the canyon near Moab (1982); Greenriver (1920) (1951).

*Cryptantha Fendleri* (A. Gray) Greene. Forbidding Canyon and Rainbow Bridge (4097).

*Cryptantha leucophaea* (Dougl.) Payson. Outside the canyon five miles north of Moab (1977), and abundant between Montecello and Moab (2003); abundant at Mile 84 on the Green River (2034); in Cataract Canyon frequent at mouth of Dark Canyon (2157).

*Cryptantha Wetherillii* (Eastw.) Payson. Greenriver (1950A).

*Heliotropium curassavicum* L. var. *oculatum* (Heller) Johnston. Spencer Canyon (4265).

#### Verbenaceae

*Lippia Wrightii* A. Gray. Havasupai Canyon at Navajo (Bridal Veil) Falls (4416).

*Verbena bracteata* Lag. & Rodr. Greenriver (1934).

#### Labiatae

*Hedeoma nanum* (Torr.) Greene. Separation Canyon (4245) (4246).

#### Solanaceae

*Datura meteloides* DC. Mouth of Dark Canyon (2171); Glen canyon below the Klondike Bar and nine miles above Lee's Ferry; Lee's Ferry (4336); Vasey's Paradise (2267) and occasional throughout Marble Canyon; mouth of Bright Angel Creek (4105); common in Havasupai Canyon; fairly common on Lake Mead and collected between Spencer Canyon and Emory Falls (4266).

*Nicotiana trigonophylla* Dunal. Between Navajo Mt. and Rainbow Bridge; in Grand

Canyon along Hermit Creek (2296A), and mouth of Havasupai Canyon (2349); growing abundantly and rankly along the creek in Quartermaster Canyon on Lake Mead (4275).

*Physalis crassifolia* Benth. Mouth of Bright Angel Creek (4092); common at Separation Rapids (4218) (4220), and fairly common in Spencer Canyon (4252).

*Physalis hederacfolia* A. Gray. On the Green River at ancient Indian granaries above Hell Roaring Canyon (2090); mouth of Dark Canyon (2151).

*Solanum Douglasii* Dunal. Havasupai Canyon near creek (4363); Separation Canyon.

#### Scrophulariaceae

*Castilleja linariaefolia* Benth. Surprise Valley (4007), Rainbow Bridge (4046), and floor of Forbidding Canyon (4072); North Rim at Port Royal (4308).

*Maurandya antirrhiniflora* Humb. & Bonpl. Marble Canyon at Mile 16½ (2209A); in Grand Canyon fairly common on sand bars at Conquistadore Aisle (2326), Elves' Chasm (2329), Separation Canyon (4242), one mile up Separation Canyon (4211), and Quartermaster Canyon on Lake Mead (4275A).

*Mimulus cardinalis* Dougl. Marble Canyon at Vasey's Paradise (2242) (2243); Havasupai Canyon (4425); dense growth at Quartermaster Canyon (4272) (4273 yellow-flowered) and at Emory Falls associated with *Aquilegia* in Rock crevices in spray of waterfall (4192).

*Penstemon ambiguus* Torr. Near Rainbow Bridge (4034).

*Penstemon barbatus* (Cav.) Roth. Mouth of Bright Angel Creek (4106).

*Penstemon comarrhenus* A. Gray. Outside the canyon south of Moab (1992).

*Penstemon Eatonii* A. Gray. Mouth of Dark Canyon (2155); Surprise Valley (4022).

*Penstemon pachyphyllus* A. Gray. Outside the canyon near Montecello (2020).

*Penstemon Palmeri* A. Gray. South Rim, occasional in first half mile near Kaibab Trail (4116).

*Penstemon strictus* Benth. Surprise Valley (4019).

#### Bignoniaceae

*Chilopsis linearis* (Cav.) Sweet. Marble Canyon at Mile 16½ (2211); Havasupai Canyon (4387); Separation Rapids (4243).

#### Martyniaceae

*Martynia parviflora* Woot. Havasupai Canyon (4377).

#### Plantaginaceae

*Plantago fastigiata* Morris. Grand Canyon at Tanner Rapids (2288).

*Plantago Purshii* Roem. & Schult. Outside the canyon south of Moab (1986); Greenriver (1949).

#### Rubiaceae

*Galium stellatum* Kellogg var. *eremicum* Hilend & Howell. On the Green River near Yokey's Fat (2081A); in Marble Canyon at Mile 16½ (2202), Mile 26½ (2221) (2226), and President Harding Rapids (2278).

*Galium Watsoni* (A. Gray) Heller. Elves' Chasm (2331).

#### Caprifoliaceae

*Symphoricarpos* sp. South Rim near top of Kaibab Trail (4111), North Rim at Port Royal (4302).

#### Cucurbitaceae

*Cucurbita foetidissima* H. B. K. Common near stream in Havasupai Canyon (4373).

*Cucurbita palmata* S. Wats. Lake Mead two miles above Emory Falls (4196A). Rare in Arizona and apparently new to Mojave Co.

## Compositae

*Actinea acaulis* (Pursh) Spreng. var. *arizonica* (Greene) Blake Outside the canyon between Moab and Montecello (1994).

*Actinea Cooperi* (A. Gray) Kuntze. First half mile down Kaibab Trail on South Rim (4112).

*Aplopappus acradenius* (Greene) Blake. Lee's Ferry (2198); Marble Canyon at Mile 26½ (2235); Separation Rapids (4221).

*Aplopappus heterophyllus* (A. Gray) Blake. Mouth of Diamond Creek (2393); Lee's Ferry (4342).

*Aplopappus Nuttallii* Torr. & Gray. Outside the canyon five miles north of Moab (1980).

*Aplopappus spinulosus* (Pursh) DC. var. *turbinellus* (Rydb.) Blake. Two miles above Emory Falls on Lake Mead (4299A).

*Artemisia frigida* Willd. Common at Port Royal on North Rim (4305A).

*Artemisia tridentata* Nutt. North Rim at Port Royal (4313).

*Aster adscendens* Lindl. Surprise Valley (4012).

*Aster cichoriaceus* (Greene) Blake. Rare at mouth of Dark Canyon (2145); Port Royal on North Rim (4327); fairly common in Havasupai Canyon (4367) (4413).

*Aster leiodes* Blake? Forbidding Canyon (4074A).

*Aster spinosus* Benth. Common at Lee's Ferry (2191)? (2192)? (Immature) (4345); in Marble Canyon abundant at Mile 16½ (2207) and Mile 19; Hualapai Canyon; two miles above Emory Falls.

*Aster tanacetifolius* H. B. K. Frequent on the Green River at Mile 84 (2019A).

*Baccharis Emoryi* A. Gray. Common near Greenriver (1936); in Gray Canyon above the mouth of Hell Roaring Canyon (2053); Bridge Canyon; in Grand Canyon along Hermit Creek (2294A), and at Deer Creek Falls (2342).

*Baccharis glutinosa* Pers. Common at Lee's Ferry (2192); in Grand Canyon along Hermit Creek (2293A), 205 Mile Canyon below Spring Canyon (2385A), Separation Canyon, Spencer Canyon, and Quartermaster Canyon.

*Baccharis sarothroides* A. Gray. Abundant at Lava Falls (2377)?; 205 Mile Canyon below Spring Canyon (2384).

*Baccharis sergiloides* A. Gray. Two miles above Emory Falls (4293).

*Bahia ourolepis* Blake. Greenriver (1959) (1950).

*Brickellia atractyloides* A. Gray. Common above Bass Crossing in Grand Canyon (2311); Separation Canyon (4206A).

*Brickellia longifolia* S. Wats. Cataract Canyon at Mile Rapids (2135A), and common along the river at mouth of Dark Canyon (2158); in Marble Canyon common at Vasey's Paradise (2265); third half mile near Kaibab Trail on South Rim (4144); common at Conquistadore Aisle in Grand Canyon (2322); two miles above Emory Falls (4299B).

*Brickellia oblongifolia* Nutt. var. *linifolia* (D. C. Eaton) Robinson. Greenriver (1962).

*Brickellia scabra* (A. Gray) A. Nels. Greenriver (1945).

*Chaenactis Douglasii* (Hook.) Hook. & Arn. Outside the canyon between Moab and Greenriver (1971).

*Chaenactis stevioides* Hook. & Arn. Outside the canyon between Montecello and Moab (2002).

*Chrysopsis villosa* (Pursh) Nutt. (form). Mouth of Dark Canyon (2174); Surprise Valley (4024), and Forbidding Canyon (4060).

*Chrysothamnus nauseosus* (Pall.) Britton. On the Green River at Mile 84 (2029) (2036); Cataract Canyon above Rapid 1 (2101), Mile Rapids (2129), and mouth of Dark Canyon (2164); common at Lee's Ferry (2196) (4348); Havasupai Canyon (4378).

*Chrysothamnus nauseosus* (Pall.) Britton var. *graveolens* (Nutt.) Hall. North Rim at Port Royal (4317).

*Chrysothamnus Parryi* (A. Gray) Greene var. *nevadensis* (A. Gray) Hall. North Rim at Port Royal (4318).

*Chrysothamnus viscidiflorus* (Hook.) Nutt. var. *stenophyllus* (A. Gray) Hall. Greenriver 1944; Kaibab Trail, third half mile below South Rim (4140) (4150).

*Cirsium canescens* Nutt. Infrequent at mouth of Dark Canyon (2176).

*Cirsium neomexicanum* A. Gray. Surprise Valley (4028).

*Cirsium Nidulus* (M. E. Jones) Petrak. Outside the canyon between Moab and Montecello (1995); first half mile below the South Rim near Kaibab Trail (4126) (4120A); Port Royal on the North Rim (4321).

*Cirsium pulchellum* (Greene) Woot. & Standl. (form). Surprise Valley (4015).

*Cirsium undulatum* (Nutt.) Spreng. Abundant at Lava Falls (2367); two miles above Emory Falls on Lake Mead (4297).

*Cirsium* sp. (near *C. mojavense* (Greene) Jeps.) Quartermaster Canyon on Lake Mead (4277A).

*Dyssodia Thurberi* (A. Gray) A. Nels. Abundant at President Harding Rapids (2276); Tanner Rapids (2296).

*Encelia farinosa* A. Gray. Abundant above Bass Trail (2307); common at Separation Rapids (4233).

*Encelia frutescens* A. Gray. Cataract Canyon below Mile Rapids (2125A); Havasupai Canyon near Navajo Falls (4417).

*Erigeron canadensis* L. Rainbow Bridge (4031), and Bridge Canyon (4051); Havasupai Canyon (4390).

*Erigeron divergens* Torr. & Gray. Bridge Canyon near Rainbow Bridge (4038).

*Erigeron lobatus* A. Nels. Mouth of Bright Angel Creek (4093); Separation Canyon (4240).

*Erigeron utahensis* A. Gray. Cataract Canyon below Mile Rapids (2124).

*Eupatorium herbaceum* (A. Gray) Greene. First half mile below the South Rim near Kaibab Trail (4134).

*Franseria acanthocarpa* (Hook.) Cov. Greenriver (1961), and at Mile 84 on the Green River (2037); Lee's Ferry (4344); Separation Canyon (4214).

*Franseria dumosa* A. Gray. Grand Canyon at Mile 193 (2382), and Spencer Canyon (4261); Boulder Dock, infested with *Cuscuta* sp. (4171) (4178).

*Gutierrezia divaricata* (Nutt.) Torr. & Gray. On the Green River at site of Julian's name (2065).

*Gutierrezia lucida* Greene. Havasupai Canyon above the village (4404A).

*Gutierrezia Sarothrae* (Pursh) Britton & Rusby. Mile 26½ in Marble Canyon (2098)?; frequent at Tanner Rapids (2297); North Rim at Port Royal (4329) (4330A); Havasupai Canyon (4374).

*Helianthus petiolaris* Nutt. (form). Greenriver (1947).

*Hofmeisteria pluriseta* A. Gray. Separation Rapids (4219).

*Hymenopappus lugens* Greene. Outside the canyon on roadside east of Greenriver (1966), five miles north of Moab (1979), and abundant between Moab and Montecello (2004).

*Iva axillaris* Pursh. Greenriver (1927) (1961).

*Lactuca scariola* L. var. *integrifolia* Bogenhard. Havasupai Canyon (4393).

*Laphamia Toumeyi* Rob. & Greenm. Kaibab Trail in first half mile below the South Rim (4110).

*Malacothrix sonchoides* (Nutt.) Torr. & Gray. On the Green River at Mile 84, infrequent (2024).

*Melampodium leucanthum* Torr. & Gray. Near mouth of Separation Canyon (4244).

*Peucephyllum Schottii* A. Gray. Between Spencer Canyon and Emory Falls on Lake Mead (4267).

*Pluchea sericea* (Nutt.) Cov. On the Green River in Gray Canyon (2062), and at mouth of Hell Roaring Canyon (2087); Forbidding Canyon (4074); Lee's Ferry (2187); Tanner Rapids (2287); fourth half mile below the South Rim near Kaibab Trail (4164); mouth of Hermit Creek (2292A); two miles above Emory Falls (4299).

*Psilostrophe sparsiflora* (A. Gray) A. Nels. South Rim in first half mile near Kaibab Trail (4127).

*Senecio stygius* Greene. Kaibab Trail in first half mile below the South Rim (4130).

*Solidago altissima* L. (form). Near Rainbow Bridge (4037).

*Solidago petradoria* Blake. Mouth of Bright Angel Creek (4108); Port Royal on the North Rim (4320).

*Solidago trinervata* Greene. Lee's Ferry (4359).

*Sonchus oleraceus* L. South Rim in first half mile near the Kaibab Trail (4129).

*Stephanomeria exigua* Nutt. Outside the canyon between Moab and Montecello (2017); on the Green River Mile 84 (2039).

*Stephanomeria pauciflora* (Torr.) A. Nels. Hell Roaring Canyon (2058); Cataract Canyon below Mile Rapids (2134A), and abundant in Dark Canyon (2169); Havasupai Canyon (4424).

*Stephanomeria tenuifolia* (Torr.) Hall. North Rim at Port Royal (4324).

*Townsendia incana* Nutt. Outside the canyon between Montecello and Moab (2007); floor of Forbidding Canyon (4080).

*Townsendia strigosa* Nutt. Outside the canyon south of Moab (1987).

*Trixis californica* Kellogg. Common above Bass Trail in Grand Canyon (2310).

*Verbesina encelioides* (Cav.) Benth. & Hook. var. *exauriculata* Rob. & Greenn. Havasupai Canyon (4394).

*Xanthium pennsylvanicum* Wallr. Havasupai Canyon (4389).

*Xanthium saccharatum* Wallr. Forbidding Canyon (4068); Lee's Ferry (4354).

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