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River in the Grand Canyon Area of Arizona**

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Jeanne Suttkus

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# Mammals of the Riparian Region of the Colorado River in the Grand Canyon Area of Arizona

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## ABSTRACT

Information assembled during field activities carried out periodically from September 1970 to September 1976 is summarized for 31 species of mammals that occur in the riparian region along the Colorado River in the Grand Canyon. Some recent changes in the habitats of mammals in the area are discussed, and some influences of these habitat changes on the distribution and abundance of mammals are summarized.

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# Mammals of the Riparian Region of the Colorado River in the Grand Canyon Area of Arizona<sup>1</sup>

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## Introduction

Studies of mammals along the Colorado River in the bottom of the Grand Canyon have been carried out infrequently during the past century. The early interests and corresponding field activities in this area by the Bureau of Biological Survey were summarized in the reports by Merriam (1890), Bailey (1935), and Goldman (1937). General information on the distribution of mammals in the area was provided by Hall and Kelson (1959), Cockrum (1960, 1964), and Hoffmeister and Durham (1971). Hoffmeister (1971) presented a comprehensive review of the mammals in the Grand Canyon National Park. Some recent distributional information was provided by Ruffner and Carothers (1975). Ruffner and Tomko (1976) studied demographic characteristics and diets of some rodents at about four localities in this geographic area.

In recent years increasing concerns about a wide array of management practices in arid lands in general and the Colorado River in the Grand Canyon in particular have created new demands for knowledge of wildlife resources and habitats in these areas. Some examples of concerns and controversies about environmental management of the Colorado River within the Grand Canyon were given by Dolan *et al.* (1974, 1977) and Eiseman (1978).

The purposes of this report are to provide some basic information on the mammals that occur along the Colorado River in the Grand Canyon and to identify locations of materials and related information for use by biologists and others working on natural history problems in this geographic area.

## Methods and Materials

Fifteen float trips on the Colorado River were made from September 1970 to September 1976. Six float trips (September 1970, August 1971, July 1972, May and August 1973, May 1974) were made with commercial river runner companies. Float trips and some other studies on the river in cooperation with the National Park Service were carried out in April, June, July, and September 1975, and in May, June, and September 1976.

In addition to specific work on mammals, the purposes of these expeditions were to gather information on fishes, reptiles, amphibians, vegetation, and other aspects of the habitats of the area. Some of the data on fishes of the Colorado River within the Grand Canyon have been published elsewhere (Suttkus and Clemmer, 1977).

Specimens of mammals, consisting of study skins, skulls, skeletons, and some embryos, were obtained from 41 locations (Figure 1) within the study area (see the list of localities). These localities coincided with camp sites used during river trips; mammals were collected as time allowed. Ten localities were chosen for major emphasis and were studied systematically during the late phases of our studies of mammals. The major study sites were selected either because of heavy use by the visitors on the river or the unique faunas and habitats that occur there, as well as to avoid duplication of effort by other researchers in the area. Sight records and signs of mammals were recorded whenever they were observed. Mammals were collected during both the night and day. Most mammals were trapped, a few were netted, and some were shot. Museum specials and rat traps were placed about 10 m apart in transect lines before dusk, checked at least twice during the night, and picked up after dawn. Traps were set occasionally at sites where signs of mammals were observed. Traps were baited with either

<sup>1</sup>Contribution Number 16, Tulane University, Museum of Natural History.

rolled oats or peanut butter or a mixture of both. Mist nets for bats were set over water, across ravines, over trails, over openings between rocks, and among vegetation. Nets were maintained normally for 3 to 4 hrs. after dusk. All specimens of mammals were prepared in the field. Specimens, field notes, catalogues, photographs, and related information are deposited at the Museum of Natural History, Tulane University, and the National Fish and Wildlife Laboratory, National Museum of Natural History. Specimens examined are listed in the accounts for each species.

The study area includes both banks of the Colorado River from Lee's Ferry, Coconino County, Arizona, to Sand Point, Mohave County, Arizona. This part of the Colorado River extends for 291.5 miles from just below the Utah-Arizona border to the south shore of Mead Reservoir near the Nevada-Arizona state line. All of the area studied is within the Arizona climatic pattern, which is a regime with winter precipitation, spring drought, summer precipitation, and fall drought (Lowe, 1964). The upper part of the study area is in the Navahonian biotic province, and the lower portion is included in the Mohavian biotic province (Lowe, 1964).

The riparian vegetation along the Colorado River is described and illustrated by Dolan *et al.* (1977). Vegetation on the river banks and at the mouths of tributaries includes *Pluchea sericea*, *Tamarix pentandra*, *Salix exigua*, *Baccharis glutinosa*, *Baccharis sergiloides*, and *Brickellia atractyloides*; high beaches and dunes support *Pluchea sericea*, *Bromus rubens*, *Alhagi camelorum*, *Salsola kali*, and *Dicoria brandegei*; upper slopes and terraces have stands of *Fallugia paradoxa*, *Acacia greggii*, *Prosopis juliflora*, *Encelia frutescens*, and *Baccharis sarothroides*. McDougall (1964) described and provided keys for 975 kinds of plants from the Grand Canyon National Park, and he indicated those found within the Grand Canyon. Some additional comments, maps, and photographs of the riparian vegetation and desert scrub of the inner gorge were provided by Hoffmeister (1971). A summary of the flora for part of the bottom of the Grand Canyon was presented by Theroux (1976).

In the following list of localities, brief descriptions are provided for the major study areas. The numbers of species of mammals and the total numbers of specimens obtained are provided for the 10 major study sites. The distances down the river for all localities were taken from Lee's Ferry, river mile 0, in accordance with the Belknap (1975), Grand Canyon River Guide. Numbers preceding localities are those used in Figure 1.

1. Lee's Ferry, river mile 0, right bank (Figure 2). 9 species, 95 specimens.

The gentle lower slopes of the area are mostly of the Moenkopi formation; these slopes are dissected by arroyos. The top of the Kaibab limestone is apparent on the down river side of this area. Lee's Ferry is the starting point for boat traffic through the Grand Canyon, and there is a large camping facility; this area receives very heavy human use. In addition, there is a long history of human habitation at this site. Desert scrub vegetation

is dominant in the area, but there are thick stands of *Tamarix* along the Colorado River, especially near the boat launching site and near the mouth of the Paria River. According to Rusho and Crampton (1975), Thales Haskell noted in his diary in 1859 that grass and cottonwood trees were present near the mouth of the Paria River; these authors included a photograph of the Lee's Ferry Ranch in which there is a large cottonwood tree in the foreground. There are no large cottonwood trees in the area at the present time. A few cottonwood saplings occur near the mouth of the Paria River, but these trees are cut down regularly by beavers.

2. 3.9 miles N Marble Canyon, river mile 2, right bank.

3. House Rock, river mile 17, right bank.

4. River mile 19, left bank (Figure 3). 9 species, 44 specimens.

This site is at the base of the Supai formation. The talus slope is narrow and steep. On the upriver side, there is a small ravine between the cliff and the sandbar at the base. The mouth of the ravine is flooded frequently, and supports a dense growth of sedges in the bottom and *Tamarix* on the sides. This area receives frequent, but mostly short term, visits by river tourists.

5. River mile 22, left bank.

6. River mile 26, left bank.

7. Stanton Cave, river mile 31.8, right bank.

8. Buck Farm Canyon, river mile 41, right bank (Figures 4, 5). 11 species, 157 specimens.

An extensive deltaic fan of sand and boulders (Figure 4) from Buck Farm Canyon abuts against the steep slope of the Muav limestone, which in turn slopes up to the base of the vertical Redwall limestone. A ravine extends along the base of the cliff on the downriver side of the canyon to a marshy area at the junction with the Colorado River (Figure 5). Some very large mesquite trees are on the deltaic side of the ravine. Sedges, grasses, and thick clumps of *Tamarix* vegetate the wet area at the mouth of the ravine. This area is used frequently as a campsite by river parties.

9. President Harding Rapid, river mile 44, left bank.

10. Little Nankoweap, river mile 50, right bank.

11. Kwagunt Creek, river mile 56, right bank.

12. Kwagunt Rapid, river mile 56.5, left bank.

13. Lava Canyon, river mile 65.5, left bank.

14. Cardenas Creek, river mile 71, left bank.

15. Unkar Rapid, river mile 72, right bank (Figure 6). 7 species, 88 specimens.

A small beach with a steep sandy area in back extends up against a steep slope of Dox sandstone of the Grand Canyon Series. The upper slope has very sparse vegetation, but clumps of *Tamarix* are found on the sandy areas. This area receives some use by campers, and is visited frequently for short stops by river runners.

16. Boucher Creek, river mile 96.5, left bank (Figure 7). 7 species, 33 specimens.

The jagged Vishnu schist and Zoroaster granite walls are only a short distance from the river at this study site. There is a narrow sandy area between the walls and the river; on the upriver side this joins the small boulder

strewn fan of Boucher Creek, a small flowing tributary of the Colorado River, and on the downriver side the schist and granite form a vertical wall at the edge of the river. *Tamarix* is the dominant vegetation on the sandy strip; typical desert scrub occurs in Boucher Creek Canyon. This area is used frequently as a campsite by river travelers.

17. Crystal Creek, river mile 98.2, right bank.

18. Tuna Creek, river mile 99.3, left bank.

19. Lower Bass Camp, river mile 108.5, right bank (Figure 8). 8 species, 58 specimens.

This study site is a sandy beach with a high jutting mass of Vishnu schist on the down river side. The Lower Grand Canyon Series is exposed above the Upper Granite Gorge formation. There are numerous dense clusters of *Tamarix* scattered over the beach area. This area receives heavy use by humans.

20. River mile 112, right bank.

21. River mile 114, right bank.

22. Elves Chasm, river mile 116, left bank.

23. River mile 119.5, left bank.

24. River mile 124, left bank.

25. Stone Creek, river mile 132, right bank.

26. Deer Creek Falls, river mile 136.2, left bank (Figure 9). 6 species, 54 specimens.

This study site is directly across the Colorado River from Deer Creek Falls. There is a small sandy area surrounded by slopes composed of Vishnu schist and Zoroaster granite. Much of the lower surface is either buried or littered with debris from the formations above. The Tapeats sandstone forms a cliff above the schist and granite. This area is used as a campsite and for short stops by people on the river. There is a small stand of *Tamarix* at the edge of the river, with desert scrub on the surrounding slopes. There is a considerable amount of grass on a protected slope on the downriver side of this locality.

27. Overhang, river mile 137, left bank.

28. Fishtail Canyon, river mile 139, right bank.

29. River mile 151.5, right bank.

30. Tuckup Canyon, river mile 164.5, right bank (Figure 10). 6 species, 35 specimens.

This is a steep walled canyon with a small narrow deltaic fan along the nearly vertical wall of the Muav, Devonian, and Redwall limestones. Underlying beds of Bright Angel shale are exposed at river level just below the study area. Desert scrub vegetation prevails where there is adequate substrate; there is very little *Tamarix* in this area. This place is used as a campsite by river parties.

31. National Canyon, river mile 166.5, left bank.

32. Fern Glen Canyon, river mile 168, right bank.

33. Mohawk Canyon, river mile 171.5, left bank.

34. Lava Falls Rapid, river mile 182, right bank.

35. Whitmore Wash, river mile 188, right bank.

36. River mile 196, left bank.

37. River mile 212.5, left bank.

38. 220 Mile Canyon, river mile 220, right bank.

39. Bridge Canyon dam site, river mile 238, left bank (Figure 11). 5 species, 91 specimens.

The steep jagged slope of the Lower Granite Gorge extends down to the river and surrounds a small sandy area. There are a few scattered clumps of *Tamarix* near the river, with sparse vegetation, mostly mesquite and barrel cactus, on the slopes. This area is heavily utilized by people from the river parties and from boat traffic on Mead Reservoir.

40. Scorpion Island, river mile 279.5, left bank (Figures 12, 13). 7 species, 63 specimens.

This study site is outside of the Grand Wash Cliffs on the south side of Mead Reservoir. The area is a flat terrace of sand and gravels, with an abrupt concave slope down to the water (Figure 12). A few types of desert scrub vegetation, including creosote bushes, are widely spaced over the terrace (Figure 13). *Tamarix* is established along the shore line. This area is visited frequently by people.

41. Sand Point, river mile 294.5, left bank.

## Results and Discussion

Hoffmeister (1971) listed 74 species of mammals for the Grand Canyon National Park; four species (*Ursus horribilis*, *Canis lupus*, *Felis onca*, *Antilocapra americana*) have been extirpated from the area. Ruffner and Carothers (1975) added two more species for the Park, one native and one introduced. Of the 72 species currently known from the Park, 27 were found in the bottom of the Grand Canyon along the Colorado River. In addition, four more species were encountered along the Colorado River in the upper parts of Mead Reservoir. We examined 1,053 specimens for this study.

### *Myotis californicus*

This species was taken at six localities along the upper portion of the river. Most animals were captured in mist nets stretched across arroyos near walls of the canyon. Two bats were caught as they flew about lights in a campground. One animal was shot as it flew above a sandy beach. Hoffmeister (1971) considered this the most common *Myotis* within the Grand Canyon.

Animals with single embryos were captured on 31 May 1976, 1; 1 June 1976, 4 and 3 June 1976, 1. Measurements of crown-rump lengths of embryos ranged from 4.1 to 8.7 mm ( $\bar{x} = 6.60$  mm).

Specimens examined, 12.—Coconino County: Lee's Ferry, river mile 0, right bank, 2; River mile 19, left bank, 2; River mile 26, left bank, 1; Buck Farm Canyon, river mile 41, right bank, 5; Boucher Creek, river mile 96.5, left bank, 1; River mile 112, right bank, 1.

### *Myotis thysanodes*

A single specimen of the fringed myotis was caught in a mist net set across a small arroyo near its junction with the Colorado River. The arroyo contained stands of *Tamarix* along the sides. Numerous bats were seen flying and feeding about these shrubs. The fringed

myotis has not been reported from the bottom of the Grand Canyon (Hoffmeister, 1971).

Specimens examined, 1.—Coconino County: River mile 19, left bank, 1.

#### *Myotis yumanensis*

Specimens of the Yuma myotis were obtained at one locality in the canyon and on the south shore of Mead Reservoir. Cockrum (1960) listed materials from Jacobs Pools and Supai Canyon. Hoffmeister (1971) reported that these bats were common at Phantom Ranch and in Havasu Canyon. At Buck Farm Canyon, animals were captured in mist nets set across an arroyo near a sheer rock wall and across a passage between boulders. The latter area was used as a night roost by numerous bats.

Twelve females captured on 1 June 1976 each carried a single embryo. Crown-rump lengths of the embryos ranged from 3.5 to 10.1 mm ( $\bar{x}$  = 5.05 mm).

Specimens examined, 16.—Coconino County: Buck Farm Canyon, river mile 41, right bank, 15. Mohave County: Sand Point, river mile 294.5, left bank, 1.

#### *Pipistrellus hesperus*

We obtained specimens of the western pipistrelle at seven localities along the Colorado River. Hoffmeister (1971) plotted three localities on the river for this species. All of the specimens reported herein were shot as they foraged either in the mouths of side canyons or over beaches. We agree with Hoffmeister (1971) that these are the most common bats in the Grand Canyon, especially along the lower portions of the river. These animals were observed frequently during the middle of the day while flying over the river, especially in narrow parts of the canyon.

Two specimens shot on 3 June 1976 each contained a small embryo. The embryos were not measured.

Specimens examined, 25.—Coconino County: River mile 50, right bank, 3; Boucher Creek, river mile 96.5, left bank, 2; Lower Bass Camp, river mile 108.5, right bank, 3; Deer Creek Falls, river mile 136.2, left bank, 9; Overhang, river mile 137, left bank, 3. Mohave County: Scorpion Island, river mile 279.5, left bank, 4; Sand Point, river mile 294.5, left bank, 1.

#### *Plecotus townsendii*

The western big eared bat was not reported from within the rims of the Grand Canyon by Hoffmeister (1971). However, Rullner and Carothers (1975) reported five females taken from Stanton Cave on 6-7 June 1970 and 11 July 1972. We obtained specimens of *P. townsendii* at six places along the river. Animals were caught in mist nets placed either between stands of *Tamarix* or between steep rock walls in narrow gorges. On 2 September 1976 several hundreds of these bats were found roosting during the day in Stanton Cave. Whether *P. townsendii* is a resident of this cave is not known, but this seems likely since Rullner and Carothers (1975) re-

ported two females with embryos. Remains of *Eptesicus* and *Myotis* were reported by Euler (1978) from archeological and paleobiological investigations at Stanton Cave. The colony of *P. townsendii* in Stanton Cave is apparently the largest assemblage of bats of this species that has been located in recent years. For a review of colony sizes of this species, see the report by Humphrey and Kunz (1976).

One female captured on 31 May 1976 contained an embryo that had a crown-rump length of 9.8 mm.

Specimens examined, 12.—Coconino County: River mile 19, left bank, 2; Stanton Cave, river mile 31.8, right bank, 5; Buck Farm Canyon, river mile 41, right bank, 1; Unkar Rapid, river mile 72, right bank, 2; Lower Bass Camp, river mile 108.5, right bank, 1. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 1.

#### *Antrozous pallidus*

Pallid bats were found at two localities along the upper portion of the river. The animals were captured in mist nets, one as it flew around lights in a campground and the others as they flew among *Tamarix* trees in an arroyo. Hoffmeister (1971) plotted a single locality on the Colorado River for this species, but noted the common occurrence of these animals in the Grand Canyon.

Specimens examined, 3.—Coconino County: Lee's Ferry, river mile 0, right bank, 1; River mile 19, left bank, 2.

#### *Tadarida brasiliensis*

One specimen of the free-tailed bat was shot during this study. Hoffmeister (1971) postulated that *T. brasiliensis* probably occurred in many areas in the bottom of the canyon. Although these bats usually colonize caves, we found no evidence of the species in Stanton Cave. Bat Cave, river mile 266, right bank, which was mined for guano at one time, contained no bats when we visited there on 8 September 1976. However, the presence of some fairly fresh fecal material indicated that some bats still use this cave.

Specimens examined, 1.—Coconino County: Lower Bass Camp, river mile 108.5, right bank, 1.

#### *Lepus californicus*

This species was seen in the vicinity of Lee's Ferry and at Scorpion Island. Because of its preference for open country, these are the only suitable places for this species in the areas studied.

Specimens examined, 0.

#### *Ammospermophilus harrisi*

This species was recorded at a single locality near the south shore of Mead Reservoir. This taxon has not been reported from within the Grand Canyon (Hoffmeister, 1971). For some information about the distribution of *A. harrisi* along the east side of the lower Colorado River, see the work by Cockrum (1960).



Specimens examined, 3.—Mohave County: Scorpion Island, river mile 279.5, left bank, 3.

#### *Ammospermophilus leucurus*

A small series of specimens of this species was obtained at the upper end of the study area, where these animals were abundant and active in late summer. There is little published information available about the occurrence and distribution of this form along the river and in the bottom of the Grand Canyon (Cockrum, 1960, Hoffmeister, 1971). On 2 September 1976 we saw at close range an *A. leucurus* among rocks on a small sandy beach at river mile 24, right bank, but we were not able to collect a voucher specimen. Ruffner and Carothers (1975) mentioned sightings of this form along the river but listed no specimens.

Specimens examined, 75.—Coconino County: Lee's Ferry, river mile 0, right bank, 75.

#### *Spermophilus variegatus*

We collected specimens of the rock squirrel at three localities in the canyon. According to Cockrum (1960) and Hoffmeister (1971), this species occurs along the Colorado River above the Nevada-Arizona state line. We saw *S. variegatus* frequently as they sat on the tops of rocks during the early hours of the day. Rock squirrels were especially common in the vicinity of Phantom Ranch.

Specimens examined, 4.—Coconino County: House Rock, river mile 17, right bank, 1; River mile 19, left bank, 2; Elves Chasm, river mile 116, 1.

#### *Perognathus amplus*

We obtained specimens of the Arizona pocket mouse only on Scorpion Island where it was the least common rodent trapped. The current distribution and status of this species in the vicinity of the Mead Reservoir seems unclear. A series of specimens of *P. amplus* was collected near Pierce Ferry, Arizona, in 1912 (Cockrum, 1960). This species has not been recorded from within the Grand Canyon (Hoffmeister, 1971).

Specimens examined, 2.—Mohave County: Scorpion Island, river mile 279.5, left bank, 2.

#### *Perognathus formosus*

We found the long-tailed pocket mouse along the north side of the Colorado River at six localities in the upper portions of the canyon. As anticipated by Hoffmeister (1971), the distribution of this species in the bottom of the Grand Canyon is considerably more extensive than thought previously (see the distribution maps by Cockrum, 1960, and Hall and Kelson, 1959). This *Perognathus* was especially abundant in the vicinity of Unkar Rapid, river mile 72, right bank. Animals were trapped mostly along an interface between a rocky slope and sand dunes. The rocky slope had little vegetation; the dunes supported considerable *Tamarix pentandra* and *Prosopis juliflora* and some sparse grasses.

Specimens examined, 29.—Coconino County: Lee's Ferry, river mile 0, right bank, 1; 3.9 miles N Marble Canyon, river mile 2, right bank, 1; Buck Farm Canyon, river mile 41, right bank, 3; Little Nankowcap, river mile 50, right bank, 3; Unkar Rapid, river mile 72, right bank, 20; Fishtail Canyon, river mile 139, right bank, 1.

#### *Perognathus intermedius*

Specimens of the rock pocket mouse were trapped at 18 localities along the left bank of the Colorado River. All of our records are downriver from the junction of the Little Colorado River. Cockrum (1960) and Hoffmeister (1971) summarized previous records of this species from the Grand Canyon and the lower Colorado River. Habitat preferences of these mice were discussed by Hoffmeister (1971). These animals seemed especially common at the Bridge Canyon dam site, river mile 238, left bank, where they were trapped mostly on sandy substrata strewn with rocks near the bases of cliffs and on steep rocky slopes.

Specimens examined, 91.—Coconino County: Lava Canyon, river mile 65, left bank, 2; Cardenas Creek, river mile 71, left bank, 1; Boucher Creek, river mile 96.5, left bank, 6; River mile 119.5, left bank, 1; Deer Creek Falls, river mile 136.2, left bank, 11; Overhang, river mile 137, left bank, 7; National Canyon, river mile 166.5, left bank, 1; Mohawk Canyon, river mile 171.5, left bank, 1; River mile 196, left bank, 3. Mohave County: Bridge Canyon dam site, river mile 238, left bank, 51; Scorpion Island, river mile 279.5, left bank, 6; Sand Point, river mile 294.5, left bank, 1.

#### *Dipodomys merriami*

We found this species at two localities on the lower parts of the river. On Scorpion Island, river mile 279.5, left bank, this kangaroo rat was the most frequently trapped mammal. This form was not reported from the Grand Canyon National Park by Hoffmeister (1971), who discussed some reasons why kangaroo rats probably do not occur in the canyon.

Two pregnant animals were trapped on 8 June 1976. One contained three embryos that measured 25.9, 26.9, and 27.1 mm; one had two embryos that were 19.5 and 21.7 mm in crown-rump length.

Specimens examined, 46.—Mohave County: Scorpion Island, river mile 279.5, left bank, 43; Sand Point, river mile 294.5, left bank, 3.

#### *Castor canadensis*

No beavers were collected during this study. Tracks and signs of feeding by beavers were seen at several places along the river. There was a beaver lodge along the right bank of the Colorado River just below the boat launching area at Lee's Ferry. On 21 May 1977 a beaver in the river 3 to 8 m from the lodge was observed for about 20 minutes. A bank den was seen on the lower part of the Paria River near its confluence with the

Colorado River. On several occasions while seining fishes at night in the mouth of the Paria River, we heard beavers slapping the water with their tails. Other bank dens and lodges were seen along the river, and many signs of these animals were recorded in the vicinity of Fern Glen Canyon, river mile 168. For information on the historical and current distribution, as well as the status of *C. canadensis* along the Colorado River, see the maps and discussions by Cockrum (1960) and Hoffmeister (1971).

Specimens examined, 0.

#### *Reithrodontomys megalotis*

We obtained specimens of this species at one locality; Hoffmeister (1971) cited two localities in the bottom of the canyon for the western harvest mouse. Our specimens were trapped in a rather mesic area with grasses and willows. Considerable efforts were made to trap these mice during subsequent stops in the area, but without success.

Specimens examined, 3.—Coconino County: Buck Farm Canyon, river mile 41, right bank, 3.

#### *Peromyscus boylii*

The brush mouse was obtained at eight localities in the study area. Although *P. boylii* occurs throughout the Grand Canyon National Park, few were previously recorded from along the Colorado River (Hoffmeister, 1971). Brush mice were not common at any of the localities where we encountered them.

An animal captured on 1 June 1976 contained three embryos that measured 8.4, 8.5, and 8.8 mm, crown-rump length. A female taken on 4 June 1975 contained five embryos that were 12.3, 13.0, 13.1, 13.2, and 13.3 mm, crown-rump length.

Specimens examined, 20.—Coconino County: Lee's Ferry, river mile 0, right bank, 1; River mile 19, left bank, 3; Buck Farm Canyon, river mile 41, right bank, 7; Little Nankoweap, river mile 50, right bank, 2; Unkar Rapid, river mile 72, right bank, 4; Boucher Creek, river mile 96.5, left bank, 1. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 1; Fern Glen Canyon, river mile 168, right bank, 1.

#### *Peromyscus crinitus*

We obtained specimens of the canyon mouse at 22 sites along the Colorado River. We agree with Hoffmeister (1971), who stated that this species was found frequently in barren rocky places, especially canyon walls. This was the most abundant *Peromyscus* at Buck Farm Canyon, river mile 41, right bank; the animals were scampering over our luggage and sleeping bags most of the night. These mice were trapped among clumps of grasses and rocks on the broad deltaic fan at the mouth of the canyon (Figure 4). Hoffmeister (1971) correlated the distribution of this species with the presence of seed producing plants on rocky slopes in the

Grand Canyon. In addition, he mentioned some possible effects of food materials supplied by humans on the distribution and abundance of this species in the vicinity of Phantom Ranch. The canyon mouse was abundant at House Rock, river mile 17, right bank, in September 1970. A sheltered area beneath an overhanging ledge was a popular campsite until the ledge broke off and occluded most of the high beach area. There was a pronounced scarcity of canyon mice when we made a return visit to this site during 1975, which was more than two years after the rock fall.

A pregnant female was obtained on 4 June 1975. The embryos measured 22.1, 22.9, and 23.3 mm in crown-rump length.

Specimens examined, 210.—Coconino County: House Rock, river mile 17, right bank, 6; River mile 19, left bank, 6; River mile 22, left bank, 5; Buck Farm Canyon, river mile 41, right bank, 80; Little Nankoweap, river mile 50, right bank, 4; Kwagunt Creek, river mile 56, right bank, 2; Unkar Rapid, river mile 72, right bank, 7; Boucher Creek, river mile 96.5, left bank, 5; Crystal Creek, river mile 98.2, right bank, 1; Lower Bass Camp, river mile 108.5, right bank, 21; River mile 114, right bank, 4; Stone Creek, river mile 132, right bank, 3; Deer Creek Falls, river mile 136.2, left bank, 8; Overhang, river mile 137, left bank, 8; Fishtail Canyon, river mile 139, right bank, 1; River mile 151.5, right bank, 2. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 14; Fern Glen Canyon, river mile 168, right bank, 17; Lava Falls Rapid, river mile 182, right bank, 3; Whitmore Wash, river mile 188, right bank, 4; 220 Mile Canyon, river mile 220, right bank, 5; Bridge Canyon dam site, river mile 238, left bank, 4.

#### *Peromyscus eremicus*

Merriam (1890) described this species as the most abundant mammal found in the Grand Canyon during his work there. According to Hoffmeister (1971), "Cactus mice are the principal white-footed mouse inhabitants of the inner parts of the canyon, except for the rocky walls where canyon mice live." The cactus mouse was the most cosmopolitan *Peromyscus* that we encountered during our work along the Colorado River; this species was recorded from 34 localities. We were impressed by the abundance of these mice at our campsite at Fern Glen Canyon, river mile 168, right bank, on the night of 6 September 1976. While eating dinner, we fed these mice bits of food from our plates.

The number of embryos in pregnant females ranged from one to five (Table 1). Two pregnant females, taken on 2 June 1976 and 30 July 1975, had the gray juvenile pelage; these mice had embryos that were much smaller than those from other females taken at the same time.

Specimens examined, 387.—Coconino County: Lee's Ferry, river mile 0, right bank, 5; River mile 19, left bank, 25; River mile 22, left bank, 14; River mile 26, left bank, 2; Buck Farm Canyon, river mile 41, right bank, 32; President Harding Rapid, river mile 44, left

bank, 2; Little Nankoweap, river mile 50, right bank, 7; Kwagunt Creek, river mile 56, right bank, 6; Kwagunt Rapid, river mile 56.5, left bank, 12; Lava Canyon, river mile 65.5, left bank, 14; Cardenas Creek, river mile 71, left bank, 4; Unkar Rapid, river mile 72, right bank, 49; Boucher Creek, river mile 96.5, left bank, 13; Crystal Creek, river mile 98.2, right bank, 2; Tuna Creek, river mile 99.3, left bank, 5; Lower Bass Camp, river mile 108.5, right bank, 20; River mile 114, right bank, 5; River mile 119.5, left bank, 6; River mile 124, left bank, 2; Stone Creek, river mile 132, right bank, 5; Deer Creek Falls, river mile 136.2, left bank 19; Overhang, river mile 137, left bank, 20; Fishtail Canyon, river mile 139, right bank, 3. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 17; National Canyon, river mile 166.5, left bank, 6; Fern Glen Canyon, river mile 168, right bank, 34; Mohawk Canyon, river mile 171.5, left bank, 4; Lava Falls Rapid, river mile 182, right bank, 7; Whitmore Wash, river mile 188, right bank, 6; River mile 196, left bank, 4; River mile 212.5, left bank, 2; 220 Mile Canyon, river mile 220, right bank, 5; Bridge Canyon dam site, river mile 238, left bank, 20; Scorpion Island, river mile 279.5, left bank, 4; Sand Point, river mile 294.5, left bank, 6.

#### *Peromyscus maniculatus*

The deer mouse was collected at five localities along the upper parts of the Colorado River in the Grand Canyon. Hoffmeister (1971) examined specimens of this species from three localities along the river, and reported that these mice were especially uncommon in the bottom of the canyon. Ruffner and Carothers (1975) referred to two additional localities (River mile 122, right bank, River mile 274, right bank). At Lee's Ferry, river mile 0, right bank, this species seemed almost as common as other *Peromyscus*, but elsewhere *P. maniculatus* was trapped much less frequently than most of the other members of the genus.

Specimens examined, 13.—Coconino County: Lee's Ferry, river mile 0, right bank, 7; Buck Farm Canyon, river mile 41, right bank, 1; Lava Canyon, river mile 65.5, left bank, 2; Unkar Rapid, river mile 72, right bank, 1; Boucher Creek, river mile 96.5, left bank, 2.

#### *Peromyscus truei*

We obtained this species at three localities along the river. The piñon mouse was not previously reported within the inner gorge along the Colorado River (Hoffmeister, 1971).

A female captured on 4 May 1976 contained three embryos that measured 17.1, 17.8, and 19.9 mm in crown-rump length.

Specimens examined, 3.—Coconino County: Lee's Ferry, river mile 0, right bank, 1; Buck Farm Canyon, river mile 41, right bank, 1. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 1.

#### *Neotoma albigula*

The white-throated wood rat was found at only two localities during this study. There are few records for *N. albigula* in the bottom of the Grand Canyon (Hoffmeister, 1971).

Specimens examined, 2.—Coconino County: Lava Canyon, river mile 65.5, left bank, 1; Cardenas Creek, river mile 71, left bank, 1.

#### *Neotoma lepida*

This species was taken at 28 localities along both sides of the river throughout the study area. Desert wood rats seemed common everywhere; piles of nest materials and droppings, as well as animals, were seen at nearly every place that we spent time. These animals were especially abundant at the Bridge Canyon dam site, river mile 238, left bank. Based on trapping results and observations of signs, this species seems most abundant in rocky habitats, but animals were also trapped on sandy beaches.

Specimens examined, 87.—Coconino County: Lee's Ferry, river mile 0, right bank, 2; River mile 19, left bank, 1; River mile 22, left bank, 3; Buck Farm Canyon, river mile 41, right bank, 9; Little Nankoweap, river mile 50, right bank, 3; Kwagunt Creek, river mile 56, right bank, 2; Kwagunt Rapid, river mile 56.5, left bank, 1; Lava Canyon, river mile 65.5, left bank, 1; Unkar Rapid, river mile 72, right bank, 5; Boucher Creek, river mile 96.5, left bank, 3; Crystal Creek, river mile 98.2, right bank, 2; Tuna Creek, river mile 99.3, left bank, 2; Lower Bass Camp, river mile 108.5, right bank, 10; River mile 112, right bank, 1; River mile 114, right bank, 1; River mile 119.5, left bank, 2; River mile 124, left bank, 1; Deer Creek Falls, river mile 136.2, left bank, 6; Overhang, river mile 137, left bank, 1; Fishtail Canyon, river mile 139, right bank, 1. Mohave County: Tuckup Canyon, river mile 164.5, right bank, 1; Fern Glen Canyon, river mile 168, right bank, 3; Mohawk Canyon, river mile 171.5, left bank, 2; Whitmore Wash, river mile 188, right bank, 1; River mile 196, left bank, 2; Bridge Canyon dam site, river mile 238, left bank, 19; Scorpion Island, river mile 279.5, left bank, 1; Sand Point, river mile 294.5, left bank, 1.

#### *Canis latrans*

A coyote was observed along the shore of Mead Reservoir at River mile 277, right bank, on 8 June 1976. Hoffmeister (1971) stated that this species occurred throughout the Grand Canyon National Park, but was more abundant above the inner gorge.

Specimens examined, 0.

#### *Urocyon cinereoargenteus*

The gray fox was observed at Lee's Ferry, river mile 0, right bank, on 30 May 1976 and at River mile 51, right bank, on 21 September 1975. Animals were seen in the ravines between the campground and the Colorado River

at Lee's Ferry. According to Hoffmeister (1971), the gray fox occurs throughout the Grand Canyon National Park.

Specimens examined, 0.

#### *Bassariscus astutus*

Specimens of this species were obtained from two localities during this study. Hoffmeister (1971) reported specimens from Phantom Ranch, and commented on the common occurrence of the ringtail in the Grand Canyon. Tracks of *B. astutus* were noted at nearly every site where we stopped along the river. On 4 September 1976 at Lower Bass Camp, river mile 108.5, right bank, we saw at least four different animals between 1830 and 2030 hrs. One animal passed through the middle of our camp and removed some specimens of rodents that were pinned to a drying tray. While we were camped at Overhang, river mile 137, left bank, for the night of 5 September 1976, we watched at least eight individual ringtails. The animals moved about along the Tapeats sandstone ledges of a cliff, and usually remained from about 3 to 10 m above the ground. Sometimes we saw as many as four animals at a time within the beam from a hand held lamp. Their vocalizations were heard several times during the night.

Specimens examined, 3.—Coconino County: Lower Bass Camp, river mile 108.5, right bank, 1; Overhang, river mile 137, left bank, 2.

#### *Spilogale gracilis*

"Spotted skunks are the commonest carnivores within the canyon . . ." (Hoffmeister, 1971). We obtained specimens at four localities and observed either animals or their signs elsewhere along the river. On 5 September 1976, while working at Overhang, river mile 137, left bank, we saw *S. gracilis* run along the base of the cliff, enter a pile of rocks, and emerge with a *Peromyscus*; this occurred on two occasions between 2200 and 2400 hrs. On this particular night, we frequently saw spotted skunks and ringtails at the same time on the lower ledges of the cliff. Two animals were caught by hand, one as it emerged from a hole in a rock pile, and the other as it attempted to take a rodent from a pre-parator.

Specimens examined, 4.—Coconino County: Lower Bass Camp, river mile 108.5, right bank, 1; Deer Creek Falls, river mile 136.2, left bank, 1; Overhang, river mile 137, left bank, 2.

#### *Equus asinus*

Feral burros are common in some parts of the canyon and along the Colorado River. For a concise summary of the history of this species in the Grand Canyon, see the account by Hoffmeister (1971). Distribution of feral burros on the south side of the Colorado River was depicted by Berger (1977). We saw a group of six animals near the water at River mile 185 on the right bank. Evidence of the presence of burros was most apparent from

the area around Lower Bass Camp, river mile 108.5, to the Bridge Canyon dam site, river mile 238. During our study a total of 14 sightings of burros was recorded from the right side of the Colorado River from River mile 208 to River mile 220.

Specimens examined, 0.

#### *Dama hemionus*

Mule deer are present in limited numbers in the canyon throughout the year, and they sometimes congregate in certain places near the river during the winter (Hoffmeister, 1971). Our observations of this species were recorded as follows: River mile 36.5, right bank, 1; River mile 50, right bank, 2; River mile 51.5, left bank, 1; River mile 54, right bank, 2; River mile 57.5, left bank, 2; River mile 58.7, left bank 1.

Specimens examined, 0.

#### *Ovis canadensis*

This species ranges throughout the Grand Canyon, but it is apparently more common on the south side of the river than on the north side (Hoffmeister, 1971). Berger (1977) mapped some localities for the occurrence of *O. canadensis* on the south side of the Colorado River, and reported that these sheep use the river as a primary source of water during the spring and summer, but they migrate to other elevations during the rest of the year. We saw bighorn sheep at the following places: River mile 105.5, left bank, 5; River mile 116, left bank, 1; River mile 126.7, left bank, 3; River mile 152, right bank, 1; River mile 165, left bank, 1; River mile 185, right bank, 1; River mile 202, left bank, 4; River mile 206, left bank, 1; River mile 215, left bank, 7.

Specimens examined, 1.—Coconino County: Tuna Creek, river mile 99.3, left bank, 1.

Habitats for mammals along the Colorado River within the area studied have changed considerably in recent years. For example, see the description above of the vegetation in the vicinity of Lee's Ferry. Numerous progressive habitat changes are related to the closure of Glen Canyon Dam in 1963, the subsequent fluctuations in water levels of the river, and the corresponding changes in the erosion and deposition of sediments along the river. In addition, heavy recreational use of the river and the available beaches impacts the habitats near the water. An excellent review of vegetational changes along the Colorado River is provided by Karpiscak (1976). His discussions of vegetational changes are documented by paired photographs, including pre-dam and contemporary habitat pictures. The general trends of the geomorphological changes along the Colorado River are summarized by Dolan *et al.* (1974, 1977), who indicated that the rates of degradation at many sites exceeds the capacity of the natural processes to reestablish natural landscapes. The changes in habitats along the Colorado River influence the distribution and abundance of mammals in the area.

No evidence of the occurrence of *Lutra canadensis* was obtained during this study. Hoffmeister (1971) summarized reports of the presence of the river otter in and along the Colorado River, and commented on the availability of food for this species. Since the closure of the Glen Canyon Dam, the persistent cold temperature and fluctuating water levels in the river, as well as other factors, have contributed to a rather depleted fish fauna in the Colorado River (Suttkus and Clemmer, 1977). There may be inadequate food resources to maintain river otters in this area.

The widespread incorporation of human debris into the sediment matrices at numerous beaches to form a "sand-box condition" is described in detail by Dolan *et al.* (1977). Small food particles, which constitute a large portion of the debris left in these areas by humans, may be an important factor contributing to the use of certain sites by mammals for foraging. Although it is difficult to quantify, we were impressed constantly by the presence and abundance of mammals in our camp areas at night. Hoffmeister (1971) mentioned only briefly some possible influences of food materials provided by humans on wild mammals in the vicinity of Phantom Ranch.

In the early phases of this investigation, studies of mammals were carried out at Sand Point, river mile 294.5, left bank. Large releases of water from Powell Reservoir were stored in the Mead Reservoir, and this study site and surrounding habitats were destroyed by inundation with several meters of water.

The area adjacent to the Colorado River in the Grand Canyon is an intriguing and challenging place for conducting studies of mammals. Because of the lack of knowledge about the details of distribution, status, and ecological relationships of mammals, the constantly occurring changes in habitats and the impacts of human activities, and the increasing environmental concerns for the region, a considerable amount of biological investigation remains to be carried out along the Colorado River in the Grand Canyon.

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We owe our thanks to Jeanne Suttkus for providing the original stimulus to study the fauna and flora in the Grand Canyon. After attending a meeting of the Sierra Club in the spring of 1970, Jeanne made the following announcement: "I don't know what you are going to do this summer, but I am going to float down the Colorado River." Numerous people helped us in many ways throughout this study. We especially thank Lyn Branch, Steve Carothers, Sherrill Clemmer, Cindy Deacon, James Deacon, Maxine Deacon, Robert Esher, Robert Fisher, Gail Kohl, Linda Loetterle, Patricia Moss, Dawn Remington, George Ruffner, C. Robert Shoop, Mark Stevens, and James Williams for helping us collect and prepare specimens. Michael Bogan identified some specimens of *Myotis*. The photographs were taken and processed by Jeanne Suttkus. Personnel of the National Park Service and the Museum of Northern Arizona provided various kinds of logistic support; we appreciate

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Table 1. Reproduction of *Peromyscus eremicus* obtained during this study. The numbers include the ranges and the means of the embryos per adult and the ranges and means of the measurements (mm) of embryos.

Date	Adult	Embryo	Crown-rump length
20 May 1974	2	1-4 (2.50)	19.0-19.2 (19.10)
22 May 1974	1	4	16.9-17.2 (17.05)
2 Jun 1976	2	1-3 (2.00)	11.7-23.7 (19.42)
30 Jul 1975	3	3-5 (3.66)	7.8-22.0 (16.28)
3 Aug 1975	1	3	17.9-19.8 (18.73)
24 Sep 1975	1	2	13.4-13.7 (13.55)

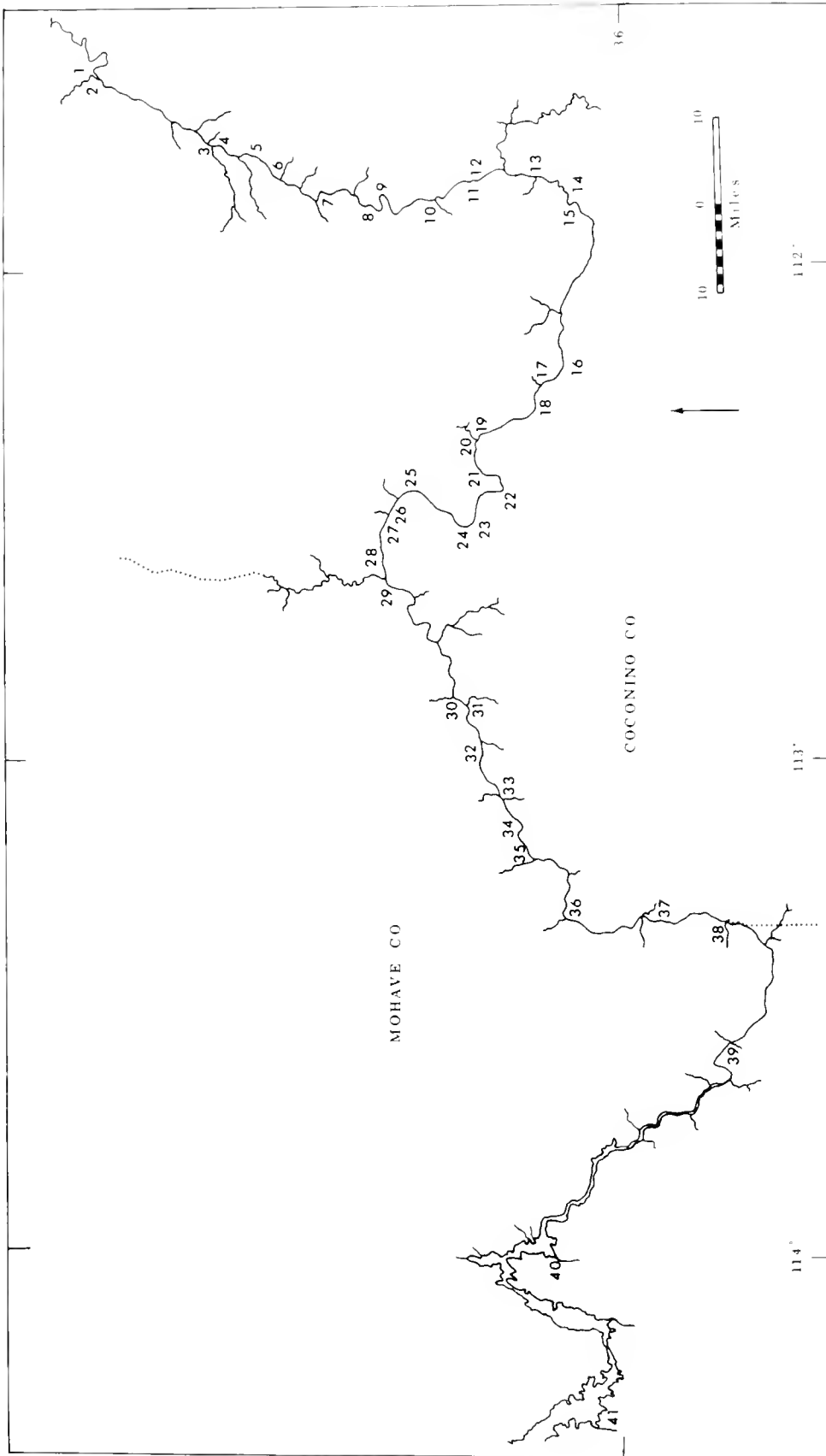


Figure 1. Map of the Colorado River in the Grand Canyon area of Arizona. Numbers correspond to the numbers in the list of localities.

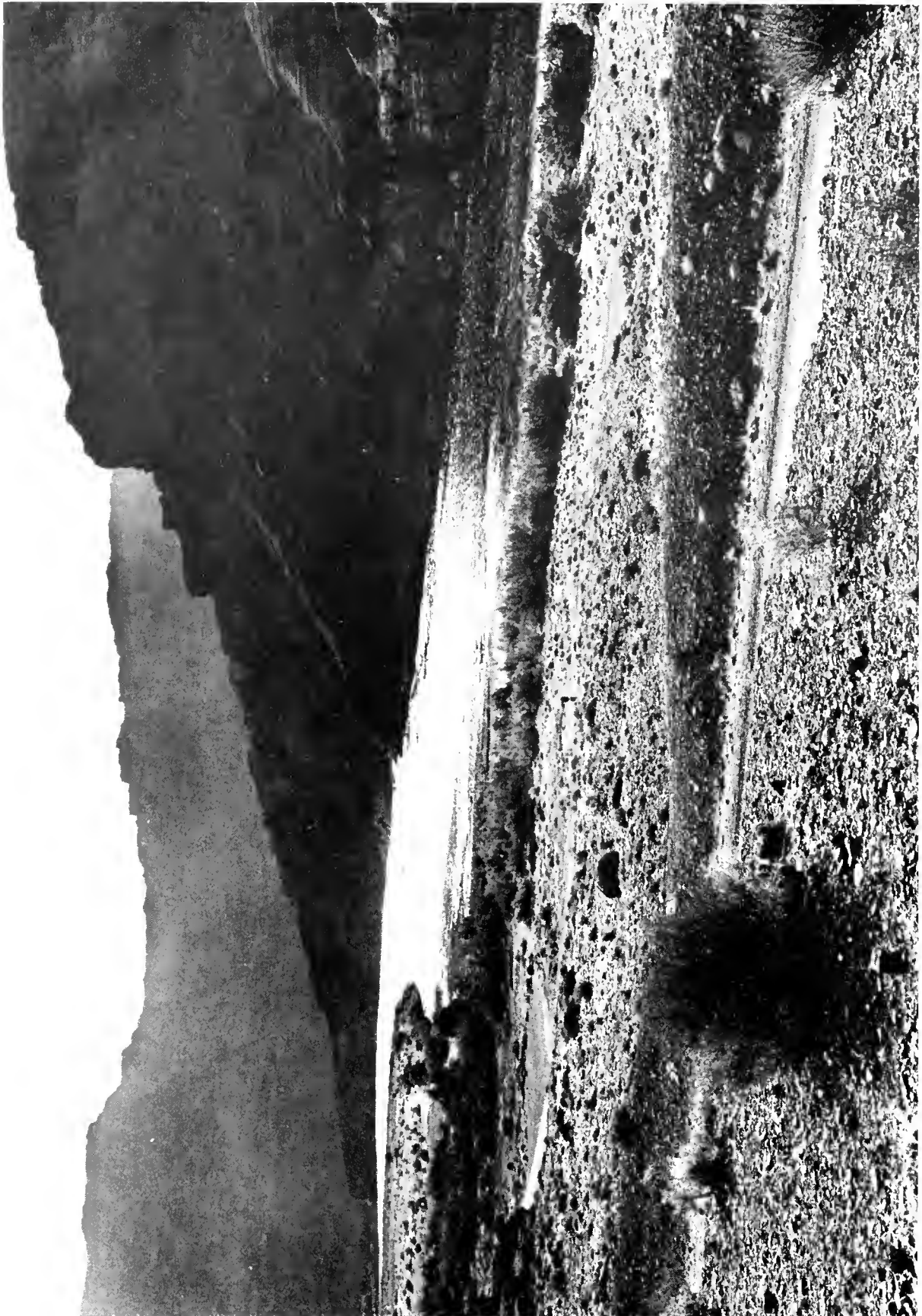


Figure 2. Lee's Ferry, river mile 0, right bank.





Figure 3. River mile 19, left bank.

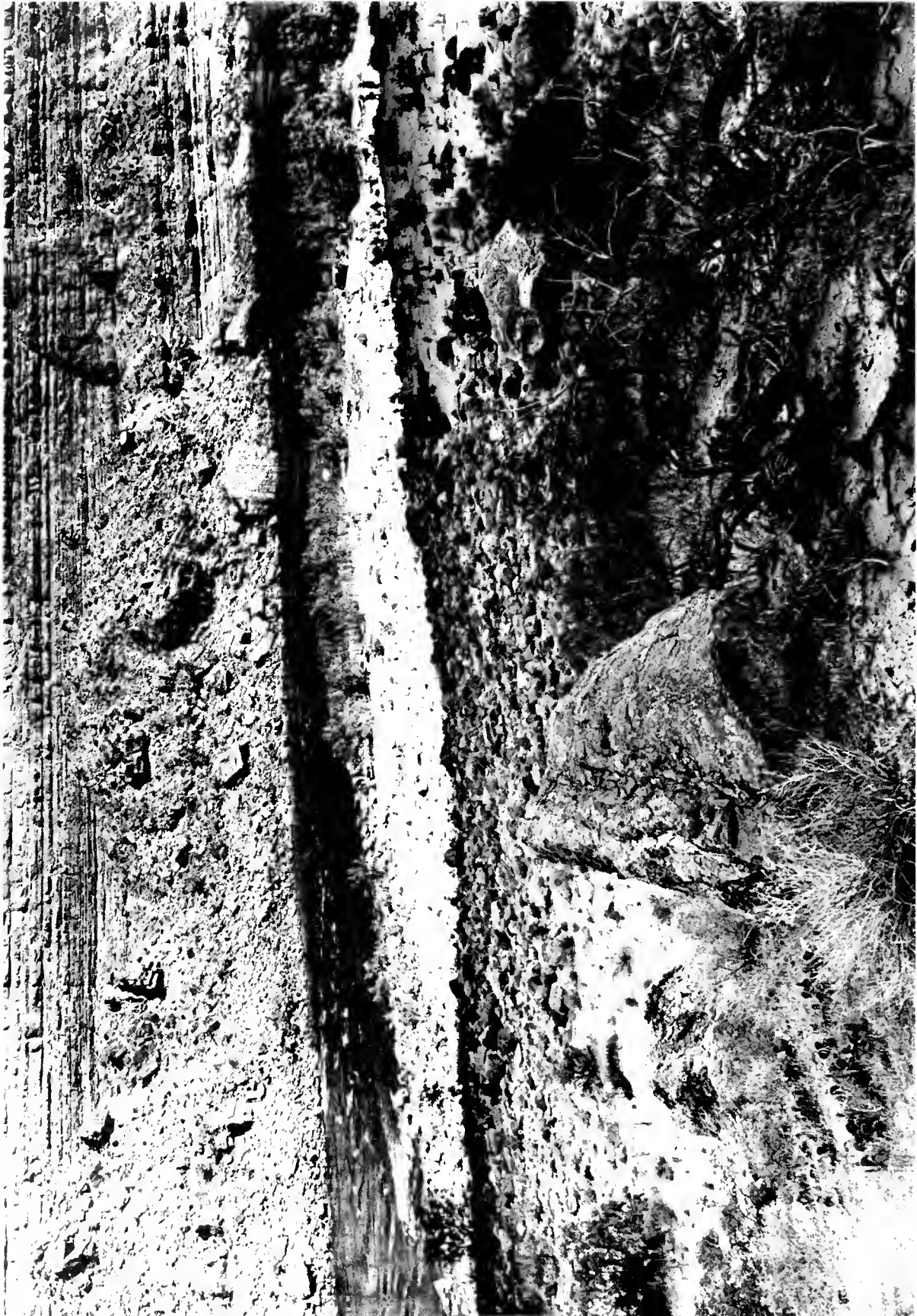


Figure 4. Buck Farm Canyon, river mile 41, right bank, deltaic fan at the mouth of the canyon.



Figure 5. Buck Farm Canyon, river mile 41, right bank, wash at the junction with the Colorado River.



Figure 6. Unkar Rapid, river mile 72, right bank.



Figure 7. Boucher Creek, river mile 96.5, left bank.

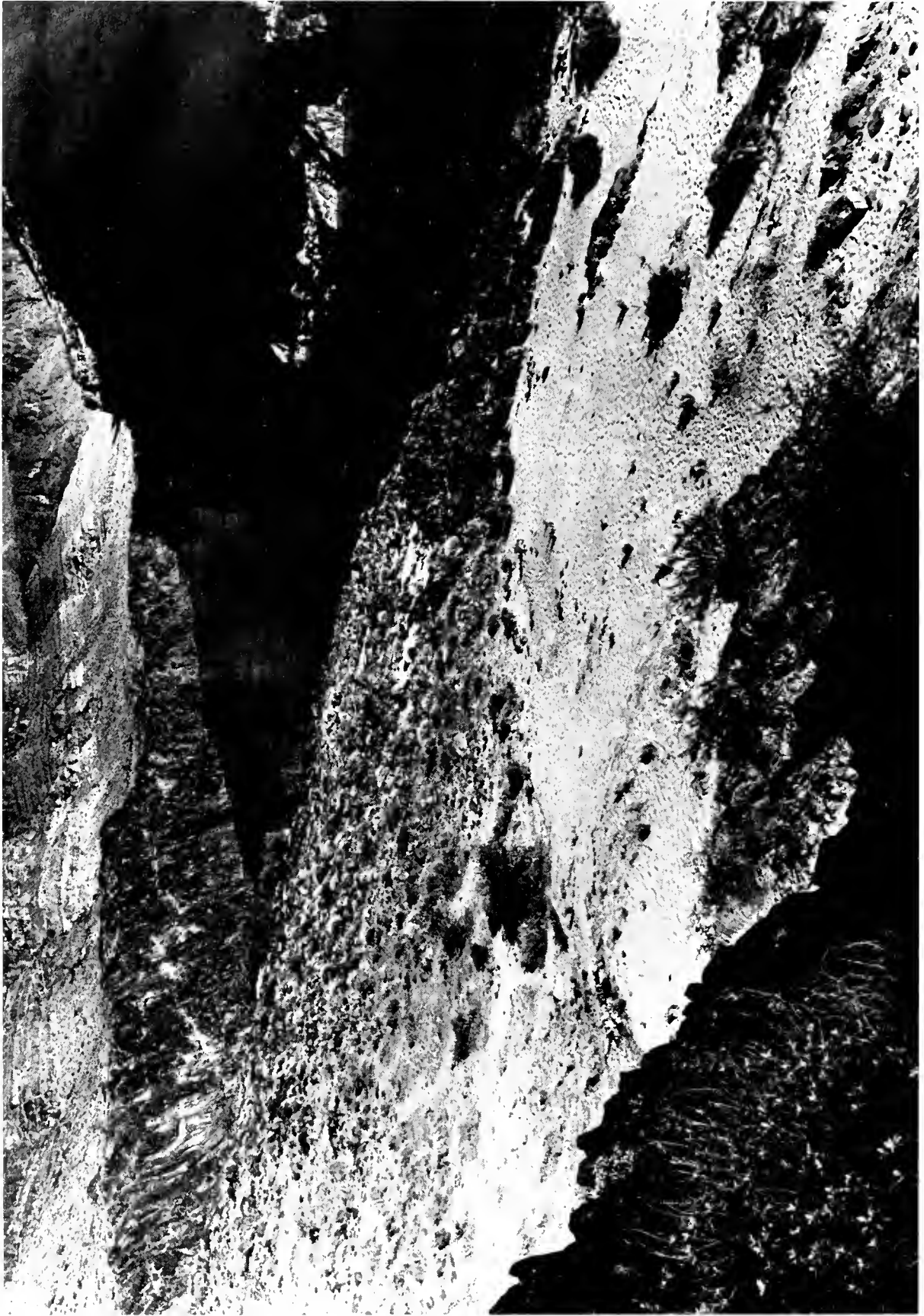


Figure 8. Lower Bass Camp, river mile 108.5, right bank.



Figure 9. Deer Creek Falls, river mile 136.2, left bank.

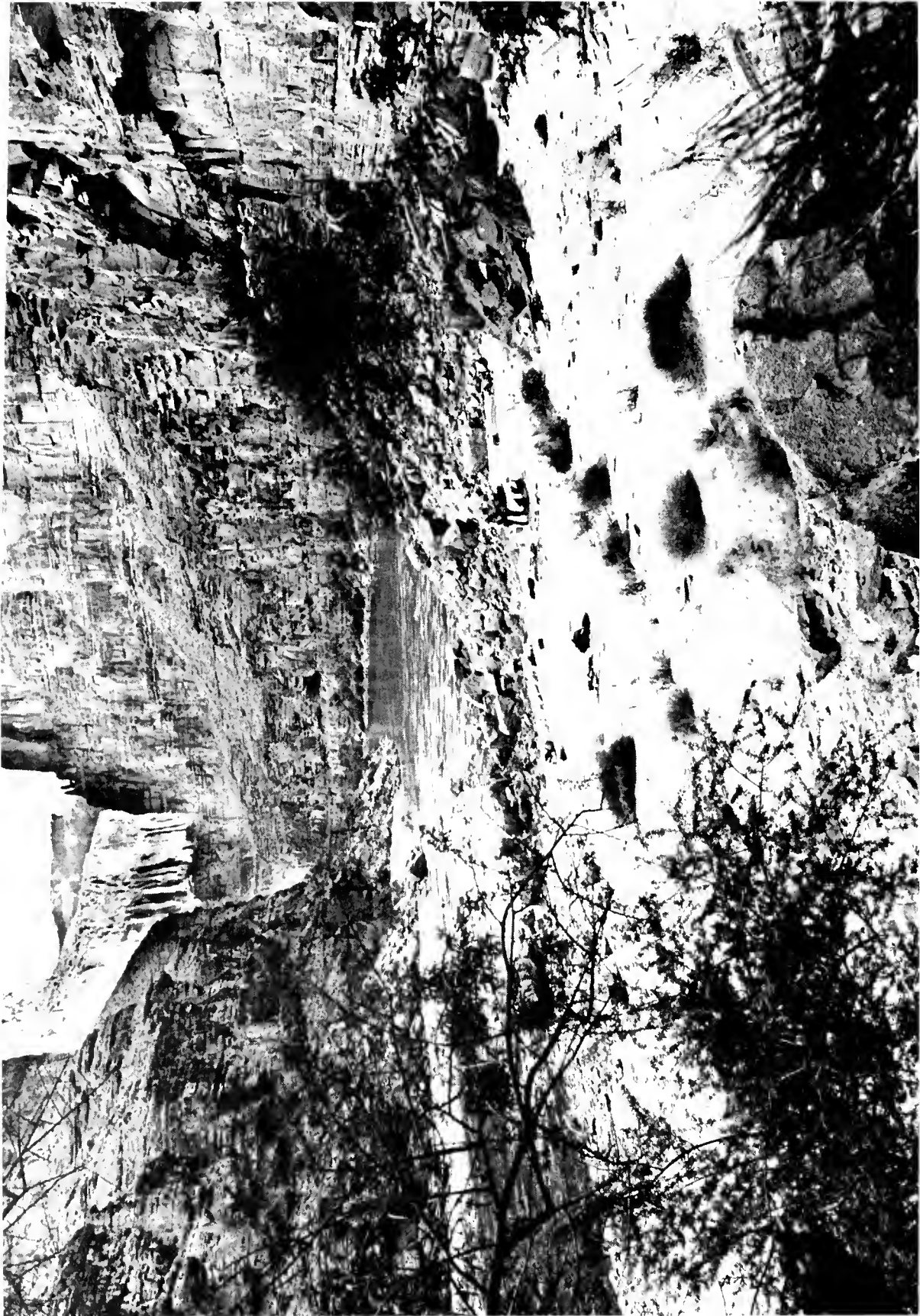


Figure 10. Tuckup Canyon, river mile 164.5, right bank.





Figure 11. Bridge Canyon dam site, river mile 238, left bank.



Figure 12. Scorpion Island, river mile 279.5, left bank, beach and slope of the terrace.

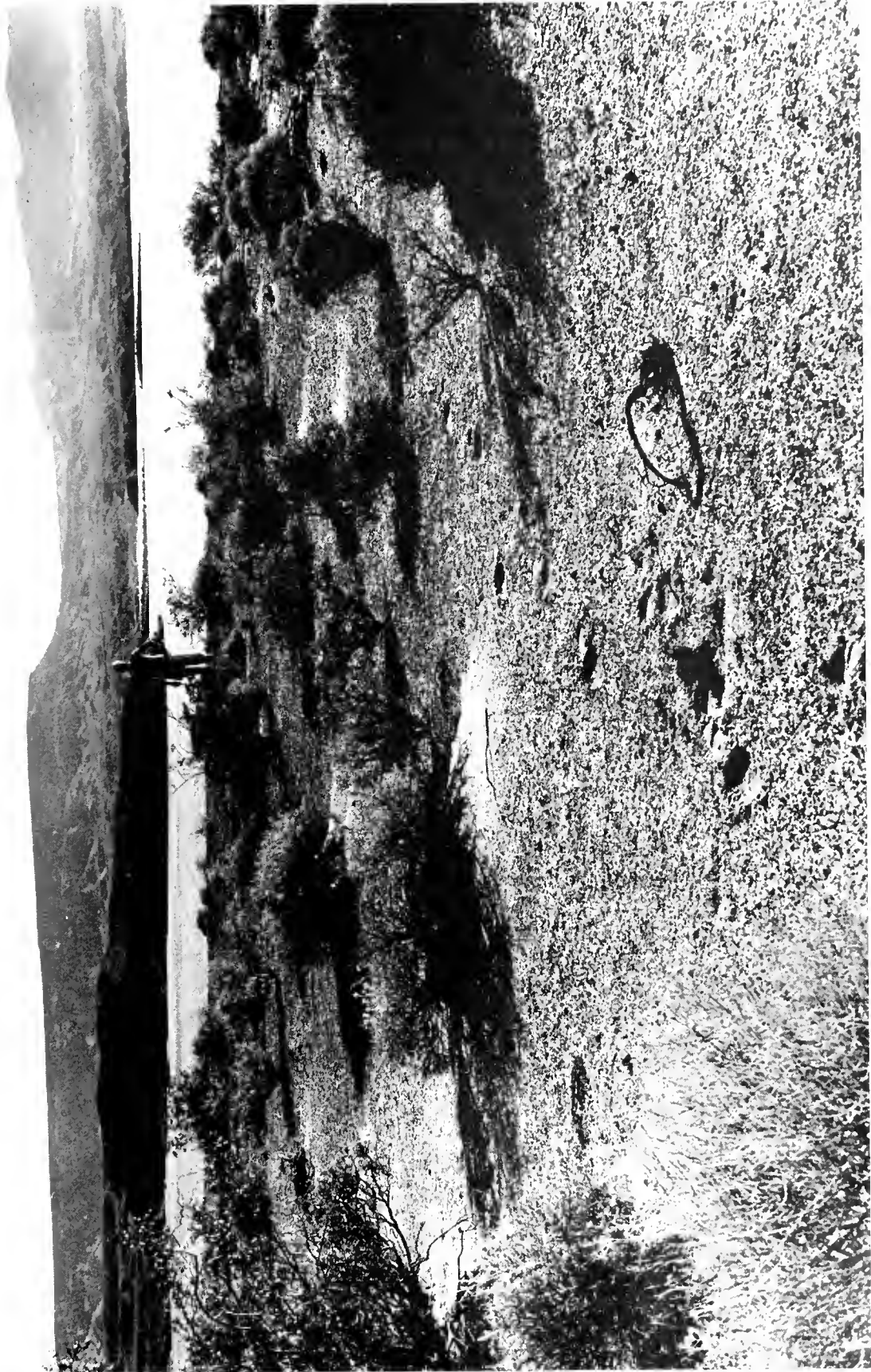


Figure 13. Scorpion Island, river mile 279.5, left bank, top of the terrace.







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