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AN ACCOUNT OF THE MAMMALS AND BIRDS
OF THE LOWER COLORADO VALLEY

WITH ESPECIAL REFERENCE TO THE DISTRIBUTIONAL
PROBLEMS PRESENTED

BY
JOSEPH GRINNELL

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(Contribution from the Museum of Vertebrate Zoology of the University of California)

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INTRODUCTION

The southeastern frontier of California lies in the heart of a vast desert region possessing a fauna and flora of notable variety and peculiar specialization of forms. Cutting through the center of this desert area flows the great Colorado River. Politically, this river

marks the southeastern boundary of California, comprising the interval between the Nevada line and the Mexican line, and separates our state from Arizona. Biogeographically, the Colorado River completely bisects the desert area through which it flows, the resultant two divisions with their xerophilous fauna and flora being separated, not only by the stream itself, but also by the riparian strips of more or less width which flank the river immediately on either side.

Two objects were in mind to justify the selection of the Colorado valley for extended field-work in vertebrate zoology: (1) The literature pertaining to the birds and mammals of the region was fragmentary, relatively little work having been published since the early and incomplete reports of Woodhouse (1853), Cooper (1861, 1868, 1869), and Coues (1866). An extended knowledge of the composition of the vertebrate fauna of the southeastern frontier of California was a desideratum. (2) The effect of the Colorado River, with its riparian strips sharply contrasted against the contiguous desert areas, upon the distribution of the animals concerned, promised to provide data of importance relative to the general problem of barriers.

Miss Annie M. Alexander, founder of the California Museum of Vertebrate Zoology, not only warmly approved of the plan to undertake field-work along the lower Colorado River with the above objects in view, but generously provided the necessary cost of the expedition in addition to her regular appropriation for the support of the museum. The plan was carried out in the three months of 1910 from February 15 to May 15, inclusive. The writer took part in the field work in person throughout the entire time, and was assisted by Mr. Frank Stephens, Mr. Joseph Dixon, and Mr. L. Hollister Jones. The party began work at Needles, and proceeded by boat from place to place down the river, the last station being on the California side below Yuma and close to the Mexican line. The locations of the various collecting stations established are given in the itinerary.

The three months' field-work yielded 1,272 specimens of mammals, 1,374 birds, 443 reptiles and amphibians, 22 sets of birds' eggs and nests, a few fishes, and a collection of the more conspicuous plants. All of this material now forms part of the collections of the California Museum of Vertebrate Zoology, except the plants, which are deposited in the Herbarium of the Department of Botany of the University of California, and the few fishes, which are added to the ichthyological collection in the Zoological Department of Leland Stanford Junior University.

The present paper concerns itself with the mammals and birds of the region, and is based upon the collections and field-notes obtained in 1910, as above enumerated. No attempt has been made as yet to work up the reptiles and amphibians, though these promise interesting results. The writer's efforts have been concentrated upon the mammals and birds, with a view to establishing first of all the systematic status of the various included forms; in other words, to determine their relationships with similar species or races of the surrounding regions. Such determination has been performed in a manner wholly satisfactory to the writer in only a part of the critical cases. As must always obtain in work of this sort, lack of material in certain directions often puts abrupt limitations upon investigation.

The obvious principle has been followed, that no generalized treatment of a concrete subject like geographic distribution is justifiable upon any but the soundest basis of systematic analysis.

Because of the close dependence of most mammals and birds upon plants, the latter have an important place in any treatment of animal distribution. The set of plants secured by the Colorado River Expedition has been named by Professor H. M. Hall, of the University of California. Names so provided are used throughout the present paper, particularly in the discussion of associational areas.

My sincere acknowledgements are hereby extended to Professor Charles H. Gilbert, Department of Zoology, Leland Stanford Junior University, and to Professor Charles A. Kofoid, Department of Zoology, University of California, for critical suggestions concerning general considerations; to Professor H. M. Hall, of the University of California, for critical reading of the chapter on associations; and to Messrs. Harry S. Swarth and Walter P. Taylor, fellow staff-members in the California Museum of Vertebrate Zoology, for help from time to time on many points of detail.

ITINERARY

Our party assembled at the town of Needles, California, on the evening of February 14, 1910, and on the following day our first collecting station was established in the river bottom close by.

A scow was constructed for the transportation of our rather bulky outfit, while the skiff purchased, being a much readier means of locomotion, enabled us to traverse the river expeditiously where need be. It was found practicable to divide the party during a portion of the

time, two of the men traveling separately with the skiff and a light outfit. All members of the party were working from the same base, except where indicated otherwise. The current was depended upon almost altogether to carry our boats from station to station.

The following enumeration shows the location of the various stations established from the initial point down the river, the names by which they are designated throughout this report, and the time spent at each. For their location reference should be made to the map (pl. 3).

1. *Needles*, California side; camp in river bottom one-fourth mile east of the railroad station; February 15 to 18.

2. *Five miles below Needles*, California side; camp in river bottom in an air line probably slightly less than four miles south-southeast of Needles; February 18 to 23. In this and some other cases, even where a government map was at hand, the exact location on the flood bottom was indeterminable on the map, because of shifting of the river channel; for it frequently happens that in a single period of high water the topography of the riparian area is profoundly metamorphosed.

3. *Mellen*, Arizona side; camp on narrow mud-bar within one-fourth mile north of the railroad station locally called Topock (=Mellen, on the Needles Special Map, U. S. G. S.); February 23 to March 1. The Santa Fe railroad crosses the Colorado River at this point.

4. *Opposite The Needles*, California side; camp on high bank about one mile northwest of "B. M. 465" of Needles Special Map, U. S. G. S.; March 1 to 8. "The Needles" are a group of sharp-peaked hills chiefly on the Arizona side of the river, and must be remembered as a totally distinct locality from "Needles," the name of the railroad town fifteen miles or more to the northwest.

5. *Foot of The Needles*, Arizona side; this station was worked from the camp on the opposite side of the river. Certain members of the party rowed back and forth morning and evening to tend trap lines; March 4 to 7.

6. *Chemchuevis Valley*, California side; camp in river bottom at lower end of this valley and close to base of hills, probably near "B. M. 438" of Parker quadrangle, U. S. G. S.; March 8 to 11. With this and the succeeding two stations uncertainty exists as to exact location of our base camps. The maps we had at that time were inaccurate. The Parker quadrangle, U. S. G. S., was not issued until 1911.

7. *Lower Chemehuevis Valley*, California side; camp at edge of whirlpool and in mouth of wash emanating from low hills, probably about one mile west-northwest of "B. M. 418" of Parker quadrangle, U. S. G. S.; March 11 to 12.

8. *Above Bill Williams River*, Arizona side; camp in river bottom, probably within two miles above "Steamboat Rock" of Parker quadrangle, U. S. G. S., and hence about eleven miles northwest of the mouth of [Bill] Williams River; March 12 to 15.

9. *Parker*, Arizona side; camp at the new Santa Fe bridge; this was merely an over-night stop, and very little collecting was done; March 15 to 16.

10. *Riverside Mountain*, California side; camp at mouth of wash, close to "B. M. 405" of Parker quadrangle, U. S. G. S.; March 16 to 22.

11, 12. *Above Blythe*, California side. The party separated at Riverside Mountain, Stephens and Jones working along slowly on the lookout for beaver sign and making at least two over-night camps on the way to Ehrenberg. One of these stops, and the one by Grinnell and Dixon, were located some distance apart, in the river bottom adjacent to the mesa on the California side, and within six or eight miles above Blythe. March 22 to 24.

13. *Ehrenberg*, Arizona side; camp in river bottom within one-fourth mile below the town; March 24 to 30.

14, 15, 16. *Below Ehrenberg*, Arizona side, one station, and *near Palo Verde*, California side, two stations. The party again separated, and base camps established at three different points in the river bottom, estimated to be from ten to twenty-five miles below Ehrenberg. The changed course of the river made dependence upon maps impossible. March 28 to April 3.

17, 18. *Opposite Cibola*, California side, two stations; main camp on high bank where river swung against mesa; somewhat above, that is, to the northwest of, rather than directly opposite, Cibola; Stephens and Jones worked from a second station about five miles below the main camp, April 5 to 6. March 31 to April 6.

19. *Ten miles below Cibola*, Arizona side; camp on narrow terrace between river and mesa, about a mile below an adobe ruin; April 6 to 10.

20. *Twenty miles above Picacho*, California side; camp in river bottom opposite Lighthouse Rock, and about a mile below the Draper ranch. In an air line this station was probably somewhat less than twenty miles north of Picacho. April 10 to 17.

21. *Eight miles east of Picacho*, California side; camp in river bottom at lower end of "Charlie's Valley," which in turn is just below Canebrake Cañon. Because of the eastward swing of the river in the vicinity of Picacho, eight miles east of Picacho is also eight miles below Picacho. April 17 to 21.

22. *Five miles above* (or north of) *Laguna*, Arizona side; camp in river bottom near base of first hills above silted-in area; April 21 to 26.

23. *Four miles above* (or north of) *Potholes*, California side; visited April 23, from our camp on the opposite side of the river.

24. *Potholes*, California side; camp in river bottom just below the head-gate; April 26 to 29.

25. *Four miles below Potholes*, California side; camp in river bottom; Grinnell and Dixon; April 29 to May 2.

26. *Five miles northeast of Yuma*, California side; camp in river bottom; Stephens and Jones; April 30 to May 3.

27. *Five miles above (northeast of) Yuma*, California side; camp in river bottom; Grinnell and Dixon; May 2 to 5. This station was but a half-mile or so from the preceding.

28. *Yuma*, Arizona side; camp about half a mile up the Gila River from its mouth, on the shore towards Yuma and within two miles east of that town; Stephens and Jones; May 3 to 7.

29. *Near Pilot Knob*, California side; camp on river bank at site of the old Hanlon Ranch, marked by a group of date palms. This is also the site of the "American Girl Pump," of the Yuma quadrangle, U. S. G. S.; but only rusting machinery and pipes, and a pile of ashes, marked the place at the time of our visit. Grinnell and Dixon; May 5 to 15; Stephens and Jones, May 7 to 15. The season's field-work was concluded on May 15.

As will have been noted, our collecting stations were usually established on alternate sides of the river successively. It proved impossible to propel the heavy scow directly across because of the strong current. In two places, however, a limited amount of collecting was done on exactly opposite sides of the river, this being accomplished through the use of the skiff alone.

From each of the base camps as a center, hunting and trapping were carried on as far radially as proved practicable. It was our effort to test every sort of ground available, that is, each association represented. Three of the four members in the party were constantly engaged in trapping for mammals. Trap lines were run in different directions, usually from the river's edge back to the highest parts of

the desert within reach, generally not farther than two miles from camp.

It was, of course, possible to carry a single day's hunt much farther back on to the desert. A distance of from four to seven miles from the river was occasionally reached in day's tramps, for instance, at Riverside Mountain, twenty miles above Picacho, and at Pilot Knob.

In the nature of the case, our camps were always pitched on the river bank where convenient landings could be made and the boats tied up safely. As is to be expected, the writer now regrets that extended work was not done at certain points scarcely or not at all touched in our 1910 exploration. It would have been a desirable thing to work intensively on directly opposite sides of the river, where it cut through high ground, at three or more points; for example, at The Needles, below Cibola, and at the Laguna Dam.

It must be remembered, however, that we had practically no information to start with, either as to the fauna or local topography along most of the route. We had it all to learn by our own efforts; and only as experience accumulated could the contrasting sets of facts come into relief, thereby directing our enquiries into more productive channels.

DESCRIPTION OF THE COLORADO RIVER

The portion of the Colorado River explored by the 1910 expedition is altogether below the famed Grand Cañon. There is no true "cañon" below the Nevada line, the river flowing through its channel in relatively sober fashion. Yuma is very close to 150 miles in a direct line due south of Needles. While following a general north-to-south course, the many deflections of the river, and especially its meandering through the big valleys, make the distance from Needles to Yuma by the way of the river approximate 285 miles. The altitude of the river at Needles is 460 feet, at Yuma, 125 feet, so that the average fall in this portion of the river is only a little more than one foot per mile.

Two features of the Colorado River are extraordinary, when comparison is made with other streams of the North American continent. (1) The amount of sediment always carried in suspension is very great, so that the flowing waters are quite opaque at all seasons of

the year. (2) There is an enormous increase in the volume of the river at the annual period of high water (see Newell, 1904, pp. 123-161).

The sediment load varies from one-tenth to two and one-tenth per cent, by weight, according to the rate of the current. The latter varies from a maximum of two and one-half miles per hour at low water up to even seven miles per hour at flood time in parts of the channel where conditions are most favorable. While it is probable that the Needles-to-Yuma section of the Colorado River has about reached grade, the extraordinary supply of sediment always fed from above and the ever fluctuating volume of water, result in a continued process of deposition and erosion, going on simultaneously in different parts of the river's channel. At low water deposition exceeds erosion, but at flood time the increased transporting power of the river results in removal of large masses of soil from varying parts of the river bottom.

The flow of the river varies from 4,000 to 100,000 cubic feet per second. The time of lowest water is in midwinter, that of highest flood, in June, at the time of melting snow among the sources of the Colorado River, in the Rocky Mountains. The period of high water is of short duration, about May 15 to July 1, while throughout the year fluctuations of less extent are liable to occur at any time.

The river's course is of two markedly different types: where it flows between rock walls among hills the channel is of fixed location and usually deep and narrow; in the large valleys the river may be broad and shallow, but at any rate of constantly shifting channel. At The Needles the river passes between high hills and the narrow channel thus formed has two sharp bends in it. Such a gorge is locally called a "box cañon," and at certain stages of the river is not without danger to small boats because of whirlpools and jutting reefs of rock. At low water the voyager is astonished at the elevation of the highest water marks on the rock walls above the surface of the river at the low stage.

There is good reason for believing that the river is now aggrading its channel considerably above the apex of the delta where, of course, this process is certainly in progress. At any rate, sedimentation has formed broad flood-bottoms at intervals along the river's course. These, large or small, are very similar in physical and floral features.

The most extensive one of these flood-bottoms is sometimes known as the "Great Valley of the Colorado." The settlements of Blythe,

Ehrenberg, Palo Verde and Cibola are located in it, and considerable activity has of late been directed towards farming the rich bottom lands. But the capriciousness of the river has proven a hindrance to marked development along this line.

Shortly below the point where the river emerges from its rock-confined channel into the broadening valley, meandering begins. The detours of the stream increase in extent towards the lower end of the valley, the channel swinging from side to side in great curves, marked by minor curves along these courses, so that a sort of periodicity of meandering is exhibited. The most notable phenomenon in this connection is the progressive movement of these loops down the valley. The result is that in a short period of years, the major portion of the river's flood-bottom is worked over in the path of this irresistible and continual shifting of the channel.

The effect on the flora is obvious. Only in curves of the valley sheltered by abutting hills are trees given a chance to reach advanced age. The only trees capable of thriving on the unstable portion of the flood-bottom are such as grow rapidly, willows and cottonwood. As the observer floats along the main channel, winding through the great valley, especially during rising water, the destructive process in question is clearly in evidence. On the outside of each curve the river rapidly undercuts the bank, dislodging great masses of the fine sedimentary soil, itself laid down but a few years previously. The overgrowth of comparatively aged willow and cottonwood topples into the stream and is swept away by the swift current. Hundreds of acres may be thus appropriated by the river in a few days and within a short distance.

On the other hand, on the inside of each curve, where the current is slow, and especially during falling stages of the water, the river is rapidly depositing sediment, in other words building up its bank towards the general level of the bottom lands. At the annually recurring periods of high water, when the entire flood bottom is inundated, layers of silt are deposited over the whole, thus tending to establish a uniform level.

The observer, from any appropriate hill-top overlooking the valley, can readily discern the regularly graded heights of tree growth which mark the successive ages of the land on which they grow. The year-old seedlings but a few inches in height form a crescent-shaped belt along the inside of each curve of the river, facing down the valley. Paralleling this and next in position back from the river is dense

two-year-old growth, succeeding which is a stand of still older growth. Because of the progressive trend of the process it is as a rule the oldest growth which becomes subject to the razing action of the river as its loops travel down the valley:

Occasionally cut-offs occur, thus interrupting the symmetry of behavior, and the river quickly establishes a new channel, portions of the old being left as lagoons, though these are usually short-lived because of the rapid sedimentation at recurring times of general overflow. The bottom land immediately adjacent to the channel, where the latter has been fixed for some time, is usually higher than the lateral tracts. The depressions on one or the other side of the flood-bottom are generally drained at the lower end of the valley by a series of sloughs emptying into the main channel just above the constriction of the valley where the hills converge.

At high water these lateral depressions are submerged to a depth of as much as twelve feet, as shown by actual measurement of the upper limit of the mud marks on the tree trunks. Whatever the water touches is discolored by a coat of fine sediment, and one thereby gains at any time of the year an accurate estimate of the depth of inundation in any part of the flood bottom at the previous period of high water (see sectional profiles, figs. A and B).

In some places the overflow depressions have no drainage outlets. After times of flood, the water in them disappears by evaporation, which proceeds at a very rapid rate in this excessively arid and hot region. Areas of alkaline deposits are left, often stretches of bare, baked hard-pan surrounded by concentric belts of halophilous vegetation.

At rather infrequent intervals along the large valleys the river, in swinging, cuts beyond its usual limit and assaults the desert mesa. The process tends to add to the area of the regular flood plain and conduces to the formation of lateral bluffs. It is noteworthy that this aggressive work of the river is much more conspicuous on the *west* side of each valley than on the east side. The law of westward cutting of north-and-south flowing streams in the northern hemisphere, as brought about by the earth's rotation, is thus clearly illustrated in the Needles-to-Yuma section of the Colorado River.

The local use of the terms "first bottom" and "second bottom" in the large valleys is worth adopting in general discussions relative to ranges of animals. The first bottom is the portion of a valley subject to regular overflow, and is clearly marked by the presence of

willows and cottonwood; the second bottom is of sufficiently higher elevation to be chiefly above high-water mark, and is characterized by mesquite, salt-bush, and rank clumps of creosote bush. The second bottom may be altogether wanting, or it may constitute a broad bench-like tract. The surface is often modified by alluvial deposits at the mouths of washes leading down from the adjacent desert, and by wind-blown sands which heap up about bushes, especially along the southeastern borders of the valleys.

The Laguna Dam has had a pronounced modifying influence on the flora and fauna of the vicinity. The dam was built to a height of twelve feet above the mean level of the river at that point at the time of beginning construction. As soon as it was completed (in 1909) the retarded waters above began to deposit silt, and by May, 1910, the valley above had been silted in to a depth determined by the top of the dam. The water level had been raised conspicuously for at least ten miles, and we saw evidences of deepening of the first bottom deposits and slowing of current for fully thirty miles, above the dam. The cottonwoods of the first bottom within eight miles above the dam had all been killed, evidently by the raising of the general surface around their trunks; and the mesquites and other vegetation of the second bottom had all been drowned out, there thus being no trace of second-bottom conditions except for dead stalks. These were replaced by vast mud flats growing up to arrowweed. All this change, of course, involved the birds and mammals of the areas affected, in addition to the plant life.

Below the dam reverse changes took place. The water, having dropped a considerable portion of its sediment above the dam because of the slowing of its current, was able to pick up sediment at a correspondingly accelerated rate below the dam. This, and the fact of a new cut-off having been found by the river in the delta in 1909, thus temporarily shortening its channel, resulted in a deepening of the channel seven feet below the previous level immediately below the dam. Thus the former flood-bottom was, in 1910, far above flood level, and in a way to become good second bottom, with appropriate metamorphosis in vegetation and fauna.

Although these changes were local, and due to man's interference, similar ones, due to natural causes, have doubtless occurred from time to time in various parts of its course in the river's history, thus repeatedly shifting the riparian strips both in position and total width, with corresponding variability in the powers of the river at different

points to act as a barrier to the dispersal of some animals and as a highway of dispersal for others.

The effects of the extraordinary and continuous load of sediment of the Colorado River, together with the inconstancy of its channel, doubtless account directly or indirectly for many of the peculiarities in the fauna. As far as known to the writer, in the Needles-to-Yuma section of the river valley there are no aquatic molluscs or decapod crustaceans, or tailed amphibians. Toads and frogs are present but not abundant. The fish fauna in the main stream is sparse in both species and individuals.

Our party seined at three different points in the main stream. At two of these nothing was caught; in the third, a backwater slough on the Arizona side above Mellen, four sorts of fishes were taken, catfish (*Ameiurus nebulosus*), bony-tail (*Gila elegans*), hump-backed sucker (*Xyrauchen cypho*), and carp (*Cyprinus carpio*). A huge minnow (*Ptychocheilus lucius*), called locally "Colorado salmon," was caught with hook and line in back-water on the California side opposite Cibola, and was plentiful immediately below the Laguna dam, where many were being taken by the Indians living near there. In lateral sloughs and overflow depressions carp and catfish were often observed in numbers, and in these relatively clear waters they were far more accessible to piscivorous animals than in the opaque water of the river itself. It may be said, in conclusion, that the portion of the Colorado River under consideration has relatively a very poor aquatic fauna and flora, and that this poverty has had its effect in limiting the occurrence of vertebrate animals dependent upon such sources of food-supply.

ZONAL AND FAUNAL POSITION OF THE REGION

Two schools of faunistic students are represented among American zoogeographic writers of the present day. One, of which C. H. Merriam (1894, etc.) is the most prominent exponent, sees in temperature the chief controlling cause of distribution, and deals with the ranges of species in terms of "life-zones." The other school, of which C. C. Adams (1905, etc.), A. G. Ruthven (1907), and Spencer Trotter (1912) are active advocates, assigns to temperature but a minor role, looking rather to a composite control, of many factors, resulting in ecologic "associations," of which plants are essential elements, and which are

to be further explained on historical grounds. The two sets of areas thus defined do not by any means correspond. Yet the reviewer cannot fail to note, here and there, places where boundaries coincide, and such coincidences are so frequent as to be suggestive of real concordance in some significant manner. Is it not probable that both schools are approximately correct, the difference in mode of treatment being due to different weights given the different kinds of evidence, or, in other words, to difference in perspective? The opportunity is here taken to attempt to bring into accord the systems of the two schools.

The period of field study up to the present time devoted by the writer to the animal life of the climatically diversified state of California has led him to the recognition of *three distinct orders* of distributional behavior as regards terrestrial vertebrates. These are indicated in the terms: zonal, faunal, and associational.

Every animal is believed to be limited in distribution *zonally* by greater or less degree of temperature, more particularly by that of the reproductive season (see Merriam, 1894). When a number of animals (always in company with many plants similarly restricted) approximately agree in such limitation, they are said to occupy the same life-zone.

The observation of this category of distributional delimitation is particularly easy in an area of great altitudinal diversity like that comprised in the southwestern United States. The writer is led to wonder if those authors who minimize the importance of temperature have ever been privileged to travel, and *carry on field studies*, outside of the relatively uniform eastern half of North America!

Study of any area which varies widely in altitude and hence provides readily appreciable differences in daily temperature from place to place brings conviction of the very great effectiveness of temperature in delimiting the ranges of nearly all species of animals as well as of plants. Particular attention may be called to the results of a biological survey of Mount Shasta (Merriam, 1899).

But temperature is not to be considered the only delimiting factor of environment, though its possible overemphasis by the Merriam school seems to have led some other persons to believe that this view is held. In fact, it becomes evident after a consideration of appropriate data that very many species are kept within geographic bounds in certain directions only by an increasing or decreasing degree of atmospheric *humidity* (see Grinnell and Swarth, 1913, p. 217). By

the plotting of the ranges of many animals as well as of plants, coincidence in this regard is found in so many cases as to warrant the recognition of a number of "faunal areas," on the causative basis of relative uniformity in humidity. It is probable that every species is affected by both orders of geographic control.

As to which is the *more* important, assembled data seem to show that more genera and higher groups are delimited by zonal boundaries than by faunal boundaries (see Merriam, 1892, p. 49, etc.) The arresting power of temperature barriers would therefore seem to be relatively the greater.

In the third category of distributional control there is a conspicuous association of the majority of so-called adaptive structures of animals (often of high taxonomic value) with certain mechanical or physical features of their environment. An animal may thus intimately depend upon certain peculiarities, inorganic or organic, or both, of a given area, and be unable to maintain existence beyond the limits of occurrence of those features of the environment. For instance, *Dipodomys deserti* is delimited by soil of certain texture and depth. Tracts of relatively uniform environmental condition, including their inanimate as well as living elements, are here called *associations*.

The geographical distribution of any animal is correctly diagnosed in terms of each of the above three groupings. In other words, an animal belongs simultaneously to one or more zones, to one or more faunas, and to one or more associations. No one of these groupings can be stated in terms of the other, any more than a person can compute liquids by the peck, or weight in miles. The constituent species within each of these groupings always belong to the other two. To illustrate: the southern white-headed woodpecker inhabits the coniferous forest association of the San Bernardino fauna of the Transition zone; the Abert towhee belongs to the mesquite and quail-brush associations of the Colorado Desert fauna, of the Lower Sonoran zone; the Pacific shrew belongs to the upland riparian association of the northern coast redwood fauna of the Transition and Boreal zones.

Referring now to the region contiguous to the lower Colorado River, we have good reason, both biotic and meteorologic, for assigning it all to one zone, namely, the Lower Sonoran, and to one fauna, the Colorado Desert; but many associations are represented. In other words, the variation in altitude and latitude included is not great enough to bring sufficient modification of the characteristically high temperature to affect profoundly the distribution of the plant and

animal life within the region. Nor is there marked variation in atmospheric humidity, the entire area being swept by air currents of prevailing dryness. To express the situation in a different way, zonal and faunal conditions are remarkably uniform; but associational conditions are varied, as pointed out in the succeeding chapter.

The zonal diagnosis, Lower Sonoran, is based in part upon the presence of the following determinative genera:

MAMMALS	BREEDING BIRDS
Ammospermophilus	Melopelia
Sigmodon	Micropallas
Dipodomys	Geococcyx
Perognathus	Centurus
Pipistrellus	Calypte
Macrotus	Pyrocephalus
	Guiraca
	Phainopepla
	Toxostoma
	Auriparus
	Polioptila

The faunal diagnosis, Colorado Desert, is based in part upon the presence of the following subspecies and species, selected from the entire list as being particularly restricted:

MAMMALS	BREEDING BIRDS
Odocoileus hemionus eremicus	Lophortyx gambeli
Citellus tereticaudus tereticaudus	Otus asio gilmani
Peromyscus eremicus eremicus	Bubo virginianus pallescens
Reithrodontomys megalotis deserti	Dryobates scalaris cactophilus
Neotoma albigula venusta	Centurus uropygialis
Thomomys albatrus	Colaptes chrysoides mearnsi
Dipodomys deserti deserti	Agelaius phoeniceus sonoriensis
Perognathus spinatus spinatus	Melospiza melodia saltonis
Perognathus penicillatus penicillatus	Pipilo aberti
Perognathus intermedius	Piranga rubra cooperi
Lepus californicus deserticola	Vireo belli arizonae
Felis oregonensis browni	Vermivora luciae
Canis ochropus estor	Dendroica aestiva sonorana
Vulpes macrotis arsipus	Toxostoma crissale
Mephitis estor	Polioptila plumbea
Procyon pallidus	
Myotis occultus	
Myotis californicus pallidus	

The picked zonal and faunal "indicators" just named are often found in the same association with other elements seemingly less sensitive to temperature and humidity. Some of the latter, however,

may be present under duress, since their greatest abundance is known to be in adjacent zones or faunas. Thus *Lynx* and *Eptesicus* are much more plentiful in the Upper Sonoran zone or even in the Transition zone; and, on the other hand, *Sigmodon* and *Pyrocephalus* are genera of subtropical abundance. The presence of elements of the latter category was probably what led Merriam at one time (1894, p. 233, footnote, pl. 14) to refer the lower Colorado River Valley to the Tropical zone. All students who employ the life-zone system, now unhesitatingly agree in referring the area in question to the Lower Sonoran zone.

The "western desert tract," of Mearns (1897, pl. 2), is probably similar to the "Colorado Desert fauna" of the present paper. The former term is not considered apropos in the system adopted by the present writer on the ground that an inanimate *area* is designated thereby, rather than an assemblage of living things inhabiting the area.

ASSOCIATIONAL AREAS OF THE REGION

Since the entire region under consideration all belongs to one zone and all to one fauna, according to the definitions of these distributional terms given in the preceding chapter, the study of local distribution in the Colorado River region pertains chiefly to associations. Perhaps nowhere else in America can one find the degree of associational contrast which is presented in the region under consideration. A stream of large volume, with paralleling strips of well-watered bottom land, maintains its course to the sea through what is considered the hottest and most arid desert in the world.

There is nothing to show that the atmosphere is appreciably more humid in the vicinity of the bottom lands or the river itself than upon the open desert. The evaporated moisture is quickly dissipated; that is, it becomes diluted to an imperceptible proportion in the desert air currents. It appears, therefore, that the great floral differences observed between the extreme associations are due primarily to difference in amount of soil water available. There are, of course, such additional factors as varying alkalinity, and shade (see Spaulding, 1909).

It must be understood that the associations here defined are recognized by the writer primarily because of their service in the treatment of animal distribution. Botanists have found it useful to make much

finer analysis (for example, see Spaulding, 1908). A more or less detailed description of the associations observed in our 1910 explorations is herewith offered, as a necessary prelude to further discussion.

In the lists of species, grouped according to apparent associational preferences, all mammals found by our party are included, and all the birds treated in the "General Accounts" except sixteen species, which are of transient occurrence and uncertain forage-ground like swallows, or else so rare as to make even approximate appraisal impossible.

Qualifying terms are appended in each case: whether of exclusive (excl.) occurrence in the association under discussion, or of maximum (max.) abundance, or of minor (min.) abundance. Obviously a species of *exclusive* occurrence is entered in but one of the associational lists, while one marked *max.* in one list is to be found marked *min.* in one or more of the other lists. It is to be taken for granted that in species of easy locomotion, *individuals* may occur in transit across other associations than the one or ones in which it is characteristically present *en masse*.

There is necessarily more or less uncertainty in many cases, and where the doubt is strong, owing to lack of knowledge, a question mark is added. With birds, seasonal occurrence is indicated by the terms: resident (present throughout the year), winter (present throughout the winter, in certain cases including fall and spring also), summer (present during the breeding season, in certain cases including spring and fall also), transient (merely passing through during migration).

RIVER ASSOCIATION

BIRDS

<i>Gavia immer</i> : excl.; winter	<i>Erismatura jamaicensis</i> : excl.; winter
<i>Sterna forsteri</i> : excl.; transient	<i>Chen hyperboreus hyperboreus</i> : excl.; winter
<i>Phalacrocorax auritus alboeiliatus</i> : excl.; winter and transient	<i>Plegadis guarauna</i> : excl.; transient
<i>Pelecanus erythrorhynchos</i> : excl.; winter and transient	<i>Mycteria americana</i> : excl.; summer
<i>Mergus serrator</i> : excl.; winter	<i>Ardea herodias treganzai</i> : excl.; resident
<i>Anas platyrhynchos</i> : excl.; winter	<i>Butorides virescens anthonyi</i> : excl.; transient
<i>Nettion carolinense</i> : excl.; winter	<i>Nycticorax nycticorax naevius</i> : excl.; resident
<i>Querquedula cyanoptera</i> : excl.; transient	<i>Grus canadensis</i> : excl.; winter (?) and transient
<i>Spatula clypeata</i> : excl.; winter	<i>Fulica americana</i> : min.; transient
<i>Dafila acuta</i> : excl.; winter	
<i>Marila affinis</i> : excl.; winter	

Pisobia minutilla: excl.; winter	Sayornis nigricans: excl.; winter
Actitis macularius: excl.; winter	Corvus corax sinuatus: max.; resident
Oxyechus vociferus vociferus: min.; transient	Petrochelidon lunifrons lunifrons: excl.; summer
Circus hudsonius: min.; winter	Stelgidopteryx serripennis: min.; summer
Pandion haliaëtus carolinensis: excl.; transient	Anthus rubescens: excl.; winter
Ceryle alcyon: excl.; transient	

MAMMALS

Castor canadensis frondator: excl.	Procyon pallidus: max.
Ondatra zibethica pallida: max.	

Remarks upon the River Association.—For reasons already explained there is relatively little cryptogamic aquatic flora in the Colorado River. There is therefore little or no food-supply from this source to attract plant-eating ducks. This category of water-birds was, in fact, very sparsely represented.

On the other hand, herons were notably plentiful because of the supply of catfish and carp made abundant at intervals by the drying-up of overflow ponds. While fishes were not abundant in the main stream, they were plentiful in backwater sloughs, where, too, the water was more nearly clear because the sediment had a chance to settle out.

The ornithology of the river appeared to owe its proportionate consistency in large measure to the above two circumstances, namely, poverty in aquatic plant life, and sporadic abundance of certain fishes in the lateral sloughs (see p. 62).

The single carnivorous mammal (*Procyon*) belonging chiefly to the river association was piscivorous in food habits, foraging along mud bars (see pl. 4, fig. 2) and at the margins of overflow ponds and sloughs, as do the herons. The two rodents of the river and larger paralleling sloughs, which are here included as part of the River Association, lived in banks immediately adjacent to the water. The beaver fed chiefly upon bark, twigs and foliage of such willows and cottonwoods as had fallen over into the water through being undermined by the current.

WILLOW-COTTONWOOD ASSOCIATION

BIRDS

- Melopelia asiatica trudeaui*: excl.; summer
Accipiter velox: max.; winter
Accipiter cooperi: excl.; resident
Buteo borealis calurus: min.; resident
Falco sparverius phalaena: min.; resident
Otus asio gilmani: max.; resident
Bubo virginianus pallescens: min.; resident
Dryobates scalaris cactophilus: max.; resident
Sphyrapicus varius nuchalis: min.; winter
Centurus uropygialis: min.; resident
Colaptes cafer collaris: excl.; winter
Colaptes chrysoides mearnsi: min.; resident
Phalaenoptilus nuttalli nuttalli: max.; winter (as a forager only)
Phalaenoptilus nuttalli nitidus: max.; resident (?) (as a forager only)
Chordeiles acutipennis texensis: min.; summer (as a forager only)
Archilochus alexandri: max.; summer
Tyrannus verticalis: excl.; transient
Myiarchus cinerascens cinerascens: min.; transient
Nuttallornis borealis: excl.; transient
Myiochanes richardsoni richardsoni: max.; transient
Empidonax difficilis difficilis: excl.; transient
Empidonax trailli trailli: excl.; summer
Empidonax hammondi: excl.; transient
Empidonax wrighti: excl.; transient
Empidonax griseus: max.; winter
Pyrocephalus rubinus mexicanus: min.; resident
Molothrus ater obscurus: max.; summer
Xanthocephalus xanthocephalus: min.; winter
Agelaius phoeniceus sonoriensis: max.; resident
Icterus cucullatus nelsoni: max.; summer
Icterus bullocki: max.; summer
Zonotrichia leucophrys gambeli: min.; winter
Spizella passerina arizonae: min.; transient (?)
Melospiza melodia fallax: min.; winter
Melospiza melodia saltonis: min.; resident
Melospiza lincolni lincolni: min.; winter
Pipilo aberti: min.; resident
Oreospiza chlorura: max.; transient
Zamelodia melanocephala melanocephala: max.; transient
Guiraca caerulea lazula: min.; summer
Passerina amoena: excl.; transient
Piranga ludoviciana: max.; transient
Piranga rubra cooperi: excl.; summer
Vireosylva gilva swainsoni: max.; transient
Lanius solitarius cassini: max.; transient
Vireo belli arizonae: max.; summer
Vermivora ruficapilla gutturalis: excl.; transient
Vermivora celata celata: max.; winter
Vermivora celata lutescens: excl.; transient
Dendroica aestiva sonorana: excl.; summer
Dendroica aestiva brewsteri: excl.; transient
Dendroica aestiva rubiginosa: excl.; transient
Dendroica auduboni auduboni: max.; winter
Dendroica nigrescens: max.; transient
Dendroica townsendi: max.; transient
Dendroica occidentalis: excl.; transient
Geothlypis trichas scirpicola: min.; resident

<i>Icteria virens longicauda</i> : excl.; summer	<i>Poliophtila caerulea obscura</i> : min.; winter
<i>Wilsonia pusilla pileolata</i> : max.; transient	<i>Hylocichla ustulata ustulata</i> : excl.; transient
<i>Wilsonia pusilla chryseola</i> : min.; transient	<i>Hylocichla guttata guttata</i> : excl.; winter
<i>Troglodytes aedon parkmani</i> : excl.; winter	<i>Planesticus migratorius propinquus</i> : max.; winter
<i>Regulus calendula cineraceus</i> : excl.; winter	

MAMMALS

<i>Odocoileus hemionus eremicus</i> : min. (?)	<i>Urocyon cinereoargenteus scotti</i> : max. (foraged in all other riparian associations)
<i>Peromyscus maniculatus sonoriensis</i> : max.	<i>Mephitis estor</i> : min.
<i>Sigmodon hispidus eremicus</i> : max.	<i>Procyon pallidus</i> : min.
<i>Reithrodontomys megalotis deserti</i> : min.	<i>Antrozous pallidus pallidus</i> : max. (?)
<i>Sylvilagus auduboni arizonae</i> : min.	<i>Myotis occultus</i> : max. (?)
<i>Felis oregonensis browni</i> : max.	<i>Nyctinomus mexicanus</i> : max. (?)

Remarks upon the Willow-Cottonwood Association.—The predominating plants in this association were: willows of at least two species (*Salix nigra* and *Salix fluviatilis*), the cottonwood (*Populus fremonti*), and guatemote (*Baccharis glutinosa*). The latter occurred chiefly as an undergrowth where the willows or cottonwoods had reached large size. Practically all of the area occupied by this association is subject to inundation annually in early summer, of from a few inches to as much as twelve feet. Only such plants as can survive this period of drowning are able to occupy the flood-bottom of the river.

Furthermore, as explained in the general description of the river (p. 59), much of the overflow bottom is subject to destructive erosion through continual changing of the river's channel. By this process all vegetation in its path is swept away at frequent intervals. Only such trees as are of rapid growth are able to maintain a representation on the major part of the bottom lands.

No plants of the willow-cottonwood association (or it may be more briefly referred to as simply the willow association) occurred also on the upland deserts, and conversely no true desert plant occurred in the overflow area. Only one possible exception was observed, the screwbean (*Prosopis pubescens*) which occurred in mixture with willows in a few places, where the flood-bottom was old, that is, had not

been swept by channel-swinging for a long period of years. However, in the vicinity of the Colorado River, we failed to observe the screwbean outside of the willow association, although it is known to occur in the mesquite and even the catelaw associations elsewhere; so that here the screwbean may be considered a restrictedly riparian plant.

One other plant of the willow association requires mention—the cane (*Phragmites communis*), which grows in dense jungles on permanent portions of the river bank from the vicinity of Picaecho down. The tracts of cane are usually narrow, but, as in Canebrake Cañon, below Picaecho, may extend continuously close along the river for miles. At the higher stages of the river the bases of the stalks are submerged, while the drooping ends trail in the water (see pl. 4, fig. 3). A verdant screen on either hand thus intercepts the view of the voyager.

The exogenous vegetation of the willow association is all of it deciduous, so that before the time of leafing-out in early March (see pl. 5, fig. 4) a very different appearance is presented from that later in the season. The spring growth is luxuriant, and accompanying it is a crop of insects which offer prolific food-supply to the abundant bird population of that season. Practically all of the birds listed for the willow association are either insectivorous or raptorial. Graminivorous or spermophilous species are notably absent.

The greater part of the fifty passerine birds listed for this association are transients or winter visitants. Only three are permanent residents. The most notable characteristic summer visitants are: *Dendroica aestiva sonorana*, *Virco belli arizonae*, *Piranga rubra cooperi*, *Archilochus alexandri*, and *Molothrus ater obscurus*.

Since the willow association includes practically the only forest elements in the region, we find here a concentration of dendrophilous birds, other than foliage-feeders, such as woodpeckers and flycatchers. The latter, in particular, are abundant in both species and individuals, and contribute to the great contrast afforded between the life of the riverside and that on the desert which in large part lacks them.

While bird-life is conspicuously more abundant in the willow association than in any one of the desert associations, just the reverse obtains with the mammals. With the exception of the insect-feeding bats, which share with the smaller birds the benefits of the insect supply, there is but one rodent of wide and plentiful occurrence—*Peromyscus maniculatus sonoriensis*. Three other rodents occur locally, notably *Sigmodon*. Otherwise the only mammals of the willow association are far-ranging predators.

The paucity of terrestrial mammals in this association is probably due to the repressive effect of the annual overflow which cannot fail to reduce the food-supply for many days at a time, even if extensive mortality does not directly ensue through drowning of individuals.

As already implied (p. 58), the willow association varies greatly in width in different parts of the river's course. Where the channel is constricted by rock walls, as in the box cañon at The Needles, all trace of it is effaced for many rods. Where the river flows among hills patches of willows in ravine-mouths give detached representations to one or more elements. On the other hand, the broad valleys are occupied chiefly by this association which may then be as much as seven miles wide and continuous for many miles on one side or the other of the meandering channel. Taken by and large, the willow association is the most important one biotically of the entire set of associations dependent upon the presence of the river.

TULE ASSOCIATION

BIRDS

<i>Fulica americana</i> : max.; winter	<i>Melospiza melodia saltonis</i> : min.; resident
<i>Oxyechus vociferus vociferus</i> : max.; winter	<i>Geothlypis trichas scirpicola</i> : max.; resident
<i>Circus hudsonius</i> : max.; winter	<i>Geothlypis trichas occidentalis</i> : min.; transient
<i>Xanthocephalus xanthocephalus</i> : max.; winter	<i>Telmatodytes palustris plesius</i> : excl.; winter
<i>Agelaius phoeniceus sonoriensis</i> : min.; resident	

MAMMALS

<i>Sigmodon hispidus eremicus</i> : min.	<i>Ondatra zibethica pallida</i> : min.
<i>Reithrodontomys megalotis deserti</i> : max.	<i>Procyon pallidus</i> : min.

Remarks upon the Tule Association.—The river's habit of overflow would be expected to result in rather extensive tracts of palustrine flora. As a matter of fact, however, marshes were few and of small size. This was probably due to the rapid rate of evaporation of overflow water so that favoring conditions did not last long, and also to the rapid silting-in of such water basins as ox-bow cut-offs. As a result there were either almost lifeless alkali depressions, or lagoons practically identical in biotic features with the main river. But in a few places there were well-defined palustrine tracts kept wet

throughout the year, chiefly by seepage. These were always located back from the river near the outer edges of the broader valleys, where they were least affected during flood time. They were marked by growths of tules, sedge, and salt-grass, sometimes the latter alone, and were usually surrounded by the arrowweed or willow association (see fig. B). The little open water sometimes attracted a few transient ducks and mudhens, but so far as known no water birds outside of the Ardeidae remain to breed anywhere along the Colorado River.

As may be noted from the list, but few animals were found to frequent the tule association regularly enough to be considered distinctive features of that association. Of these, *Reithrodontomys* was the only mammal finding its center of abundance there.

ARROWWEED ASSOCIATION

BIRDS

<i>Lophortyx gambeli</i> : min.; resident (only as a forager)	<i>Melospiza melodia saltonis</i> : max.; resident
<i>Geococcyx californianus</i> : min.; resi- dent (only as a forager)	<i>Melospiza lincolni lincolni</i> : max.; winter
<i>Astragalinus psaltria hesperophilus</i> : min.; resident	<i>Pipilo maculatus curtatus</i> : max.; winter
<i>Zonotrichia leucophrys leucophrys</i> : min.; winter	<i>Oreospiza chlorura</i> : min.; transient
<i>Zonotrichia leucophrys gambeli</i> : min.; winter	<i>Vireo belli arizonae</i> : min.; summer
<i>Melospiza melodia fallax</i> : max.; win- ter	<i>Vermivora celata celata</i> : min.; win- ter
	<i>Dendroica townsendi</i> : min.; transient
	<i>Oporornis tolmiei</i> : min.; transient

MAMMALS

<i>Peromyscus maniculatus sonoriensis</i> : min.	<i>Sylvilagus auduboni arizonae</i> : min.
<i>Neotoma albigula venusta</i> : min.	<i>Mephitis estor</i> : min.
<i>Perognathus penicillatus penicillatus</i> : min.	<i>Spilogale arizonae arizonae</i> : min. (?)

Remarks upon the Arrowweed Association.—In its purity this association possesses only one conspicuous plant, the arrowweed (*Pluchea sericea*), which, over extensive areas, grows so densely as to occupy the ground to the exclusion of everything else (pl. 5, fig. 5). This belt of arrowweed usually occupies slightly higher ground than does

the willow association, yet not above the high-water mark. It is present quite regularly as a tract along the outer margin of the willow association, often only a few feet in width, but sometimes, as for example near Pilot Knob, as much as two hundred yards in width.

The arrowweed grows to a very uniform height, varying in different places from three to over eight feet; and the slender straight stems stand so close together as effectually to bar rapid progress through the more luxuriant tracts. The plant is of perennial growth, but only during the season of blossoming, April and May, does it appear to be particularly favored by insects. In many places there is mixed willow and arrowweed, in fewer places quail-brush and arrowweed, either combination being evidently more attractive to birds than the arrowweed alone.

The only resident bird finding its maximum abundance in the arrowweed association is the song sparrow (*Melospiza melodia saltonis*). Even here the suspicion is aroused that this association is sought more for cover because of the peculiar manner of growth of the constituent plant, than as a food-producing area. For the song sparrow forages freely into both adjacent associations.

Of mammals, not one can be said to find its maximum abundance in the arrowweed association. The few species regularly trapped there were all more prominent constituents of adjacent associations. There would be little reason for the recognition of the arrowweed association as distinct from the willow association if it were not for its large extent and the conspicuous *absence* from it of a great many of the elements abundant in the latter.

QUAIL-BRUSH ASSOCIATION

BIRDS

<i>Lophortyx gambeli</i> : max.; resident	<i>Pipilo aberti</i> : min.; resident
<i>Zonotrichia leucophrys leucophrys</i> : min.; transient	<i>Oreospiza chlorura</i> : min.; transient
<i>Zonotrichia leucophrys gambeli</i> : max.; winter	<i>Guiraca caerulea lazula</i> : max.; summer
<i>Melospiza melodia fallax</i> : min.; winter	<i>Oporornis tolmiei</i> : max.; transient
<i>Melospiza melodia saltonis</i> : min.; resident	<i>Geothlypis trichas occidentalis</i> : max.; transient
<i>Pipilo maculatus curtatus</i> : min.; winter	<i>Toxostoma crissale</i> : min.; resident
	<i>Poliptila plumbea</i> : min.; resident

MAMMALS

<i>Peromyscus maniculatus sonoriensis</i> : min.	<i>Neotoma albigula venusta</i> : min. <i>Sylvilagus auduboni arizonae</i> : max.
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Remarks upon the Quail-brush Association.—The local hunters at Needles and other towns along the river apply the term quail-brush to *Atriplex lentiformis*, a plant growing in dense clumps three to eight feet in height along the outer margin of the flood-bottom. The belt of this plant is so well marked and continuous, and the important relations borne to certain animals are so evident, that the writer is led to designate it separately by the name quail-brush association (see pl. 6, fig. 6).

Atriplex lentiformis often forms pure growths of a few yards to many rods in width on ground at about the upper limit of the average annual overflow. It was seen by us only in immediate proximity to the flood-bottom, and hence was essentially a riparian element, different from the other species of *Atriplex* inhabiting the region.

The peculiar feature of the quail-brush was its compactly interlacing network of branches, so dense and resistant that a person might throw his whole weight against a thicket only to be hurled back by the elastic rebound. The value of the plant to the animals affecting it consisted pre-eminently in the protecting cover afforded. Quail and cottontail rabbits when frightened took refuge in runways or natural spaces beneath its tangled mass; and bush-inhabiting sparrows of several species seemed to find ideal shelter in it.

Although serving thus as a temporary shelter to animals regularly foraging in other associations, the quail-brush association also provided a safe breeding place for such birds as *Pipilo aberti*, *Guiraca* and *Melospiza*. In places, clumps of quail-brush alternated with mesquites, and here *Toxostoma crissale* found particularly congenial ground.

MESQUITE ASSOCIATION

BIRDS

<i>Lophortyx gambeli</i> : min.; resident	<i>Centurus uropygialis</i> : min.; resident (only as a forager)
<i>Accipiter velox</i> : min.; winter	<i>Myiarchus cinerascens cinerascens</i> : min.; transient
<i>Dryobates scalaris cactophilus</i> : min.; resident (only as a forager?)	<i>Myiochanes richardsoni richardsoni</i> : min.; transient
<i>Sphyrapicus varius nuchalis</i> : max.; winter	

<i>Empidonax griseus</i> : min.; winter	<i>Dendroica auduboni auduboni</i> : min.; winter
<i>Pyrocephalus rubinus mexicanus</i> : max.; resident	<i>Dendroica nigrescens</i> : min.; transient
<i>Molothrus ater obscurus</i> : min.; summer	<i>Wilsonia pusilla pileolata</i> : min.; transient
<i>Astragalinus psaltria hesperophilus</i> : min.; resident	<i>Wilsonia pusilla chryseola</i> : min.; transient
<i>Astragalinus lawrencei</i> : excl.; winter	<i>Oreoscoptes montanus</i> : max.; winter
<i>Zonotrichia leucophrys leucophrys</i> : min.; transient	<i>Mimus polyglottos leucopterus</i> : max.; winter
<i>Zonotrichia leucophrys gambeli</i> : min.; winter	<i>Toxostoma erissale</i> : max.; resident
<i>Spizella passerina arizonae</i> : min.; winter	<i>Heleodytes brunneicapillus couesi</i> : min.; resident
<i>Pipilo aberti</i> : max.; resident	<i>Auriparus flaviceps flaviceps</i> : min.; resident
<i>Piranga ludoviciana</i> : min.; transient	<i>Polioptila caerulea obscura</i> : min.; winter
<i>Phainopepla nitens</i> : max.; resident	<i>Polioptila plumbea</i> : min.; resident
<i>Vireosylva gilva swainsoni</i> : min.; transient	<i>Planesticus migratorius propinquus</i> : min.; winter
<i>Vireo belli arizonae</i> : min.; summer	<i>Sialia mexicana occidentalis</i> : excl.; winter
<i>Vermivora luciae</i> : excl.; summer	

MAMMALS

<i>Odocoileus hemionus eremicus</i> : min.	<i>Sylvilagus auduboni arizonae</i> : min.
<i>Peromyscus maniculatus sonoriensis</i> : min.	<i>Felis oregonensis browni</i> : min. (?)
<i>Neotoma albigula venusta</i> : max.	<i>Lynx eremicus eremicus</i> : max. (?)
<i>Perognathus penicillatus penicillatus</i> : min.	<i>Mephitis estor</i> : max.
	<i>Myotis californicus pallidus</i> : min.

Remarks upon the Mesquite Association.—This association is given the vernacular name of what is perhaps the most widely known plant of the region, the mesquite (*Prosopis juliflora*). Along the Colorado River the mesquite is closely restricted to a rather narrow belt along the outer edge of the riparian area, mostly above the reach of the highest flood water. This belt is of course lacking where hills closely abut upon the river, save at the mouths of ravines. Along the great valleys it forms a nearly continuous tract consisting of straggling clumps or of well-formed, though small, trees, in the latter case sometimes orchard-like in regularity of spacing. At no point did we see mesquites with trunks over eight inches in diameter.

While evidently requiring abundant water at root, submergence of the ground for any length of time kills mesquites, as proven by

the conditions above the Laguna Dam. Here the whole association had been effaced by drowning. On the other hand, the mesquite is unable to exist on the desert proper, even in the larger washes. Only at the mouths of these did scattering examples extend away from the actual river bottom, and then, in the most favored places, for not more than a quarter of a mile.

Man's occupancy of the region has affected the mesquite association more than any other. The great value of the mesquite trunks for fuel has led to its practical disappearance as a tree along much of the lower course of the river. The steamboats which once plied regularly between Needles and Yuma are said to be chiefly responsible for this depletion. Several pumping plants contributed to the demand for fuel. Mesquite trees are very slow of growth; tracts of stumps now mark many areas where luxuriant groves once stood.

A considerable number of low-growing plants find places as elements in the mesquite association, but by far the most important to the animal life is the mesquite itself. This shrub, or tree, provides both shelter and food, the latter through its fruit and foliage (see pl. 6, fig. 7) either directly or by way of insects. The mesquite serves also as the host of a parasitic plant (pl. 6, fig. 6), a species of mistletoe (*Phoradendron californicum*), which when in blossom is visited by myriads of insects, and which produces an abundant and almost continuous crop of berries. Several of the winter and resident birds of the mesquite association depend almost wholly on these mistletoe berries for their food. Notable among these are: *Phainopepla*, *Mimus*, *Orcoptes*, *Planesticus* and *Sialia*.

Four species of breeding birds (*Pipilo aberti*, *Toxostoma crissale*, *Vermivora luciae*, and *Phainopepla nitens*) find in the mesquite association the center of their abundance. One mammal is characteristic of the same association, namely *Neotoma albigula venusta*.

SALTBUSH ASSOCIATION

BIRDS

<i>Lophortyx gambeli</i> : min.; resident	<i>Phalaenoptilus nuttalli nitidus</i> : min.; resident (?)
<i>Zenaidura macroura marginella</i> : max.; winter	<i>Chordeiles acutipennis texensis</i> : min.; summer (only as a forager)
<i>Geococcyx californianus</i> : min.; resident	<i>Sturnella neglecta</i> : excl.; winter
<i>Phalaenoptilus nuttalli nuttalli</i> : min.; winter	<i>Poœetes gramineus confinis</i> : excl.; winter

Passerculus sandwichensis nevadensis: excl.; winter	Amphispiza bilineata deserticola: min.; summer
Passerculus sandwichensis alaudinus: excl.; winter	Amphispiza nevadensis nevadensis: max.; winter
Zonotrichia leucophrys gambeli: min.; winter	Lanius ludovicianus excubitorides: min.; resident (?)
Spizella breweri: max.; winter	Thryomanes bewicki eremophilus: min.; winter

MAMMALS

Citellus tereticaudus tereticaudus: max.	Lepus californicus deserticola: min.
Peromyscus eremicus eremicus: max:	Sylvilagus auduboni arizonae: min.
Thomomys albatius: excl.	Taxidea taxus berlandieri: excl. (?)
Dipodomys deserti deserti: max.	Myotis californicus pallidus: Max. (?)
Dipodomys merriami merriami: min.	Pipistrellus hesperus hesperus: min.
Perognathus penicillatus penicillatus: min.	

Remarks upon the Saltbush Association.—Ranchers in the Colorado River region distinguish two portions in each of the valleys, the "first bottom" and "second bottom." These are of course duplicated in reverse position on opposite sides of the river. The first bottom is the overflow area, and comprises all the associations treated up to this point in the present chapter, from the river to the mesquite association, inclusive. These associations together constitute the riparian belt proper. The second bottom is in the nature of a terrace or bench, and is situated above the reach of high water, extending from the mesquite association desertwards to the base of the mesa bluff.

This second bottom is usually quite level and varies from a mere strip, of few yards in width, to a tract as much as a mile wide. It is for the most part clothed sparsely with xerophytic or halophytic vegetation, a predominating species in which is the saltbush (*Atriplex polycarpa*); hence the name adopted for the association represented.

The soil is almost always of fine sand, often wind-blown. The prevailing westerly winds have caused a growth of sand-dunes on the southeast edges of the second bottom at several points, notably on the Arizona side above Mellen. The driving sand is often arrested about a bush and as the resulting dune grows, so does the bush commensurately. A scrubby form of mesquite may thus constitute the core of a sand-dune. Several small plants are peculiar to these wind-formed hillocks, one of which is the sand verbena (*Abronia villosa*).

Favorable conditions for burrowing here attract heteromyid rodents, notably the large *Dipodomys deserti*. A characteristic assemblage results which might be appropriately called the aeolian sand association. Its peculiarities are not, however, in the writer's mind, sufficient to warrant giving it more than minor recognition. Future finer analysis may possibly justify the separate recognition of the aeolian sand association, especially when the reptiles of the desert at large are taken into consideration.

Elsewhere on the second bottom, depressions frequently occur where rainwater from adjacent desert slopes leaves by evaporation more or less alkali. In cases of excessive deposition, bare white stretches result, without any vegetation at all. On somewhat less alkaline ground there may be tracts of *Spirostachys occidentalis* and *Suaeda suffrutescens*, both being shrubby plants popularly included under the names pickle-weed and iceplant.

But the greater portion of the second bottom, as also a strip leading back along either side of the desert washes, is marked by the saltbush. This *Atriplex* is quite uniform in appearance wherever it grows, forming small but stout-branched bushes seldom more than two feet tall.

The creosote bush (*Larrea divaricata*), although predominating in the next-described association, occurs not infrequently as a minor element in the saltbush association. Sometimes individual plants of *Larrea* reach a very large size (pl. 7, fig. 8), much larger even than on the desert mesa. Where small alluvial fans from the higher adjacent mesa make down on to the second bottom, there is an influx of such plants as the coyote melon (*Cucurbita palmata*), rattle-weed (*Eriogonum inflatum*), unicorn plant, locally called devil's-claw (*Martynia proboscidea*), and sandbur (*Franseria dumosa*), all of which occur on sandy parts of the upper mesa as well. Along shallow washes through the second bottom there are often extensive thickets of *Lycium andersoni*.

In spite of the above indicated variations in floral constitution, there is remarkable homogeneity in the animal life of the saltbush association. In winter it is the preferred forage ground for a number of xerophilous fringillids, as shown in the accompanying list of birds. The generally loose, sandy soil seems to be an attractive feature for burrowing rodents of limited fossorial powers such as *Dipodomys merriami merriami*. These also find abundant food in the residual seeds of numerous small annual plants which for brief periods thrive on

the open ground between the shrubs. One such plant, gathered extensively by *Dipodomys deserti*, is *Achyronychia cooperi*.

It will be noted that the food-relations of the birds and mammals of the saltbush association and of the willow association are quite the reverse of one another; in the latter, *insectivorous* species prevail, in the former *graminivorous* or *spermophilous*.

CREOSOTE ASSOCIATION (MESA)

BIRDS

<i>Chordeiles acutipennis texensis</i> : max.; summer	<i>Amphispiza nevadensis nevadensis</i> : min.; winter
<i>Sayornis sayus sayus</i> : min.; winter	<i>Piranga ludoviciana</i> : min.; transient
<i>Spizella breweri</i> : min.; winter	<i>Salpinctes obsoletus obsoletus</i> : min.; winter
<i>Amphispiza bilineata deserticola</i> : max.; summer	

MAMMALS

<i>Ammospermophilus harrisi harrisi</i> : min. (stony)	<i>Perognathus penicillatus penicillatus</i> : min. (sandy)
<i>Ammospermophilus leucurus leucurus</i> : min. (stony)	<i>Perognathus intermedius</i> : min. (stony)
<i>Citellus tereticaudus tereticaudus</i> : min. (sandy)	<i>Perognathus spinatus spinatus</i> : min. (stony)
<i>Peromyscus eremicus eremicus</i> : min. (sandy)	<i>Lepus californicus deserticola</i> : max.
<i>Thomomys chrysonotus</i> : excl.	<i>Canis ochropus estor</i> : max. (foraged at night practically everywhere else)
<i>Dipodomys deserti deserti</i> : min. (sandy)	<i>Vulpes macrotis arsipus</i> : excl.
<i>Dipodomys merriami merriami</i> : max.	<i>Myotis velifer</i> : max. (?)
<i>Perognathus bombycinus</i> : excl. (sandy)	<i>Eptesicus fuscus</i> : max. (?)
<i>Perognathus formosus</i> : min. (stony)	<i>Macrotus californicus</i> : max. (?)

Remarks upon the Creosote Association (Mesa).—The creosote bush (*Larrea divaricata*) was found to be the most widely distributed shrubby species of all the desert plants (see pl. 10, fig. 14). It occurred in varying abundance from the second bottom and wash-sides to the tops of the highest hills. Only the most rocky hill slopes, and the periodically eroded wash-bottoms, lacked this plant altogether. Yet there were obviously preferred areas of growth, or, still more notable in this connection, areas where the creosote bush grew to the entire exclusion of all other ligneous vegetation. These areas, where

Larrea was at least the most conspicuous plant, occurred mostly on the more level upland desert mesa. The accompanying distinctive assemblage of mammals justifies the recognition of what may therefore be appropriately called a creosote (or mesa) association.

Tongues of typical creosote association often run up from alluvial slopes into the rough hill country, following ravines and terraces. On the other hand, as already noted, the creosote bush and some of its companions in places invade the saltbush association. Along desert washes the two associations may be blended in all particulars to such an extent that definite diagnosis as one or the other is difficult.

As will have been observed from the lists, there are only two breeding birds of the creosote association proper, *Chordeiles acutipennis texensis* and *Amphispiza bilineata deserticola*; and neither of these are abundantly represented. But graminivorous mammals are plentiful in species as well as individuals. Not all the species, however, are found in exactly the same places. As elsewhere shown, identical ground on opposite sides of the river may possess distinct species because of the action of the river as a barrier.

Furthermore, segregation of rodent population on the basis of ability to find or dig safe retreats is evident. The nature of the ground thus bears a controlling relationship. Parts of the desert mesa are swept clean of fine sand by the prevalent winds, the resulting surface consisting of packed gravel, or wind-worn pebbles (pl. 12, fig. 18). Other parts of the desert have a sandy soil; and in places accumulations of sand transported by the wind have grown into sand-dunes, having much the character of those described for the saltbush association on a previous page.

On sandy ground a common small shrub was the sandbur (*Fraseria dumosa*); the rattle-weed (*Eriogonum inflatum*) was ever summoning startled attention; and in the vicinity of Pilot Knob a species of *Ephedra* was common. On stony ground often no other plant was to be seen than the creosote bush; but everywhere remains of short-lived sporadic vegetation gave clue to the source of supply of the seeds upon which depended the rodent population. In the vicinity of Potholes and Pilot Knob the mesa association included scattering clumps of round-stemmed cactus, and ocotilla (*Fouquieria*).

Each of the two physical types of ground here noted, namely, sandy and stony, possesses certain peculiar species of mammals, as well as of plants. This segregation is indicated in the list, and might again serve as basis for recognizing two separate associations, the

sandy creosote, and the stony, or rocky, creosote; but by giving weight to *similarities*, as well as to differences, such distinction could be of but minor rank. Expediency seems to argue against further refinement in the present stage of study. Then, too, no such precise statistical gathering of data as regards the animals has yet been done as would warrant the exercise of such fine analysis.

CATCLAW (OR WASH) ASSOCIATION

BIRDS

Lophortyx gambeli: min.; resident	Zonotrichia leucophrys leucophrys: max.; transient
Zenaidura macroura marginella: min.; winter	Zonotrichia leucophrys gambeli: min.; winter
Bubo virginianus pallescens: max.; resident	Zamelodia melanocephala melanocephala: min.; transient
Geococcyx californianus: max.; resident	Phainopepla nitens: min.; resident
Dryobates scalaris cactophilus: min.; resident	Lanius ludovicianus excubitorides: max.; resident (?)
Phalaenoptilus nuttalli nuttalli: min.; winter	Lanivireo solitarius cassini: min.; transient
Phalaenoptilus nuttalli nitidus: min.; resident	Oreoscoptes montanus: min.; winter
Archilochus alexandri: min.; summer	Mimus polyglottos leucopterus: min.; winter
Calypte costae: min.; summer	Heleodytes brunneicapillus couesi: max.; resident
Myiarchus cinerascens cinerascens: min.; summer	Thryomanes bewickii eremophilus: max.; winter
Icterus cucullatus nelsoni: min.; transient	Auriparus flaviceps flaviceps: max.; resident
Icterus bullocki: min.; transient	Poliophtila caerulea obscura: max.; winter
Carpodacus mexicanus frontalis: max.; resident	Poliophtila plumbea: max.; resident
Astragalinus psaltria hesperophilus: max.; resident	

MAMMALS

Odocoileus hemionus eremicus: max.	Perognathus spinatus spinatus: min.
Peromyscus eremicus eremicus: min.	Lepus californicus deserticola: min.
Dipodomys merriami merriami: min.	Lynx eremicus eremicus: min.
Perognathus formosus: min.	Urocyon cinereoargenteus scotti: min.
Perognathus penicillatus penicillatus: max.	Pipistrellus hesperus hesperus: min.

Remarks upon the Catclaw (or Wash) Association.—Except for the Bill Williams and Gila rivers the Needles-to-Yuma section of the Colorado River receives no tributary stream, save as an immediate

result of the very infrequent local cloud-bursts or severe thunderstorms. Even the two "rivers" named often go completely dry in their lower courses following protracted drouth. At frequent intervals along the valley of the Colorado, well-defined but ordinarily dry water-courses leading down from the adjacent uplands record the existence at some time or other of considerable run-off. Among the hills, deep, steep-sided ravines show the profound effects of erosion, even though, in this era, rains come but rarely. Where the water-course drains a large extent of higher country, enough to furnish a volume of water sufficient to find its way through the mesa to the river, it may occupy a broad valley with low confining banks or bluffs. Such a broad, dry flood plain is called locally a "wash"; and as the biota of such "washes" is quite distinctive the term "wash association" has been suggested (see pl. 7, fig. 9). Since a prevalent plant in its flora is the tenaciously thorny catclaw (*Acacia greggii*), the term catclaw association may be used as an alternative denomination. Both are appropriate terms.

The vegetation of the catclaw association is the most conspicuous of all of the desert associations, for it includes several species which reach the stature of trees. The largest of these is the desert ironwood (*Olneya tesota*) which grows abundantly in all the larger washes on both sides of the river, from the lower Chemehuevis Valley at least to the vicinity of Picacho (pl. 8, fig. 10). The branches are leafy but thorny, forming ideal refuges for certain small birds and locations for their nests. The apparently leafless palo verde (*Parkinsonia torreyana*) is a close companion of the ironwood, and occurs also along the smaller ravines into the hills (see pl. 8, fig. 11; pl. 9, fig. 12). Both the catclaw and the palo verde were found in practically every wash on both sides of the river, from the vicinity of Needles to Pilot Knob. The smoke-bush (*Dalea spinosa*) is a conspicuous element in many of the washes from near Riverside Mountain to Pilot Knob.

As an indication of the size reached by individuals of these truly xerophilous trees the following measurements taken by the writer, are here presented: An ironwood growing in a wash about one-half mile back from the river bottom in lower Chemehuevis Valley, California side of the river, was 90 inches in circumference of trunk two feet above the ground, and had a height of 31 feet. A palo verde nearby was 48 inches in circumference of trunk two feet above the ground, and was 28 feet in height. Another palo verde (pl. 9, fig. 12) growing in a wash on Californian territory four miles north of Pot-

holes, was 60 inches in circumference of trunk two feet above the ground, first branch four feet above the ground, and total height 24 feet.

It is thus apparent that birds of arboreal habit find only in the wash association of the desert a near approach to conditions preferred elsewhere, and this doubtless accounts for the conspicuous transient arboreal element occurring in this association. But the greatly reduced foliage, giving most of the above-named trees the aspect of winter leaflessness, results in close resemblance to brush or shrubbery, as indicated by the prevalence of the brush-inhabiting category of breeding birds affecting them.

The ironwood occasionally harbors clumps of mistletoe (*Phoradendron californicum*) in common with the mesquite of the riparian belt. This accounts for the presence of certain berry-eaters. There are also berry-producing shrubs bordering the washes, notably *Lycium andersoni* and *Lycium parishii*. The former occurs widely as a characteristic member of the catclaw association. The latter, a much larger thicket-forming shrub, was noted only in small washes in the vicinity of Picacho. As already noted, *Atriplex polycarpa* occurs in an extension of the saltbush association leading up along each side of nearly all of the larger washes.

Bird-life is better represented in the catclaw association than in any other of the desert associations. Some of the species are closely adherent to it, being evidently by structure and habits dependent upon the conditions pertaining to thorny brush. But mammals are relatively less numerous. Only one rodent finds its maximum abundance along the washes (*Perognathus penicillatus penicillatus*, see fig. D), and it is possible that even of this species, the metropolis is in the adjacent sandy saltbush tract, and that trapping really waylaid the individuals foraging at large away from their homing places. Times of deluge, even if of rare occurrence, are doubtless accompanied by great mortality of ground-dwelling mammals along these washes. This factor must be one of no small import in determining the biotic constitution on the several levels of the desert surface.

SAGUARO ASSOCIATION

BIRDS

Falco sparverius phalaena: max.; resident	Colaptes chrysoides mearnsi: max.; resident
Otus asio gilmani: min.; resident	Myiarchus cinerascens cinerascens: max.; summer
Micropallas whitneyi: excl.; resident	Carpodacus mexicanus frontalis: min.; resident
Centurus uropygialis: max.; resident	

MAMMALS

(As far as known, same as in creosote association.)

Remarks upon the Saguaro Association.—The conspicuous columns of the giant cactus or saguaro (*Cereus giganteus*) first met our expectant gaze just below the mouth of Bill Williams River. There, on both sides of the Colorado, for a stretch of two miles or more, stood many specimens growing on the hill slopes in full view from the river as we floated by. A landing was made on the California shore, and several saguaros closely examined for nesting sites of birds. We next found these cactuses on the open desert one to three miles east of the river on Arizona territory around Ehrenberg. There were so many here that they formed a distinct tract, extending across the mesas and occupying the interlying washes as well.

Giant cactuses again came to view some ten miles below Picacho, two or three individuals being seen on the California side and many on the Arizona side. Finally, on the mesa on both sides of the river, three to five miles above the Laguna dam, saguaros were plentiful. On the California side from one hundred yards to two miles back from the outer edge of the river bottom were about seventy-five individuals (see pl. 9, figs. 12, 13). Thirty-seven, big and little, were counted by the writer as in sight from one point.

It was gratifying thus to find this unique plant well represented on California ground. For coming with it into the state of California were the several birds listed, an assemblage altogether justifying the designation of a saguaro association. This association is best developed in a large area of southwestern Arizona. The tongue crossing the Colorado River above Laguna and Potholes is undoubtedly an extension of it.

As far as we were able to learn, in other plant elements and in mammals, the saguaro association was here identical with the creosote

association. It is not improbable, however, that further work would disclose the presence of a number of species of both mammals and birds, at least on the Arizona side, not now known so far west.

It is clearly apparent that the critical feature of the saguaro which prescribes its avian dependents is nothing else than the favorable opportunity offered for the excavation of safe retreats in its trunk. And only the two woodpeckers are equipped for making these excavations. So that, without the woodpeckers to make holes, the other birds would be no better off for the presence of the saguaro. As it happens, at least one of the species of woodpeckers (*Centurus uropygialis*) invariably accompanies the cactus.

This is a most interesting form of contingent or incidental interdependence of animal and plant. Since the giant cactus during the greater part of the year produces no fruit and harbors no insect life, it follows that all the birds using its cavities as roosting or nesting places glean their livelihood from the surrounding desert. The latter, as already stated, presents conditions which seem to be practically identical with the creosote association, which is so nearly barren of bird life, and of vast extent beyond the limits of the saguaro. One form of associational restriction is hereby proven, namely, that by dependence upon safe home retreats.

ENCELIA (ROCKY HILLS) ASSOCIATION

BIRDS

<i>Buteo borealis calurus</i> : max.; resident	<i>Spizella passerina arizonae</i> : max.; winter
<i>Falco mexicanus</i> : excl.; resident	<i>Spizella breweri</i> : min.; winter
<i>Bubo virginianus pallascens</i> : min.; resident	<i>Spizella atrogularis</i> : excl.; transient
<i>Aëronautes melanoleucus</i> : excl.; resident	<i>Amphispiza bilineata desertiicola</i> : min.; summer
<i>Calypte costae</i> : max.; summer	<i>Stelgidopteryx serripennis</i> : max.; summer
<i>Sayornis sayus sayus</i> : max.; resident	<i>Salpinctes obsoletus obsoletus</i> : max.; resident
<i>Corvus corax sinuatus</i> : min.; resident	<i>Catherpes mexicanus conspersus</i> : excl.; resident (?)
<i>Carpodacus mexicanus frontalis</i> : min.; resident	
<i>Astragalinus psaltria hesperophilus</i> : min.; resident (?) (as a forager only)	

MAMMALS

<i>Orvis canadensis nelsoni</i> : excl.	<i>Ammospermophilus leucurus leucurus</i> : max.
<i>Ammospermophilus harrisi harrisi</i> : max.	<i>Peromyscus crinitus stephensi</i> : excl.

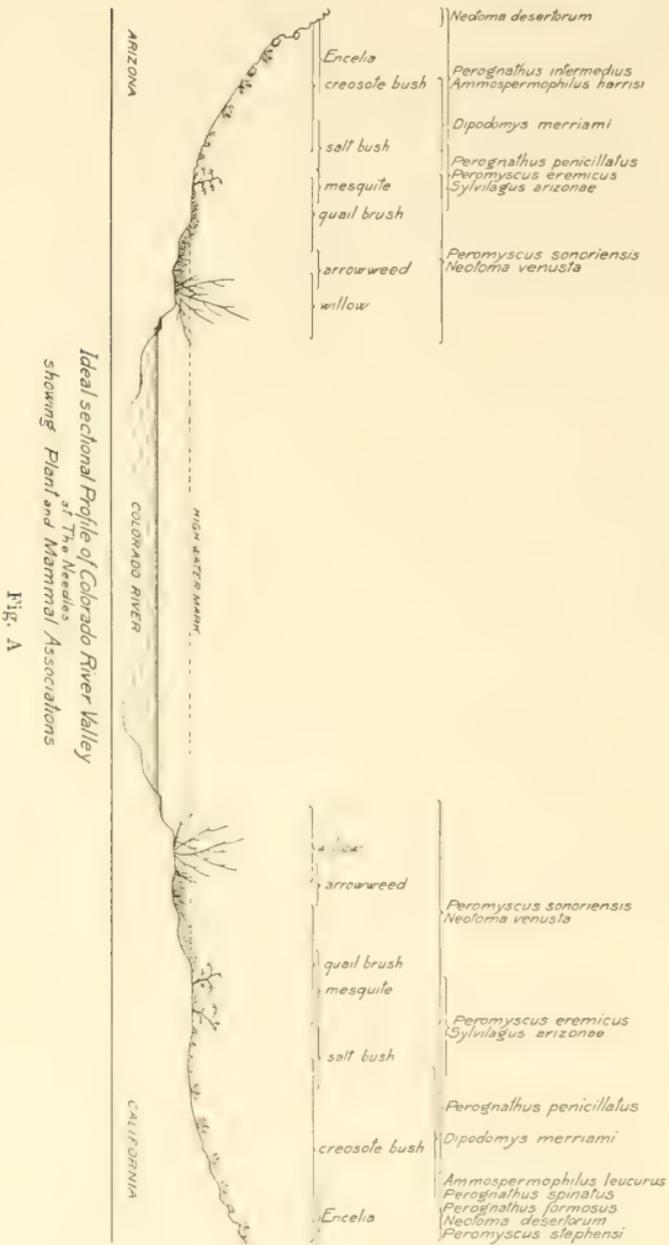
Neotoma intermedia desertorum: excl.	Corynorhinus macrotis pallescens: excl. (?)
Perognathus formosus: max.	Pipistrellus hesperus hesperus: max.
Perognathus intermedius: max.	(foraging everywhere else)
Perognathus spinatus spinatus: max.	

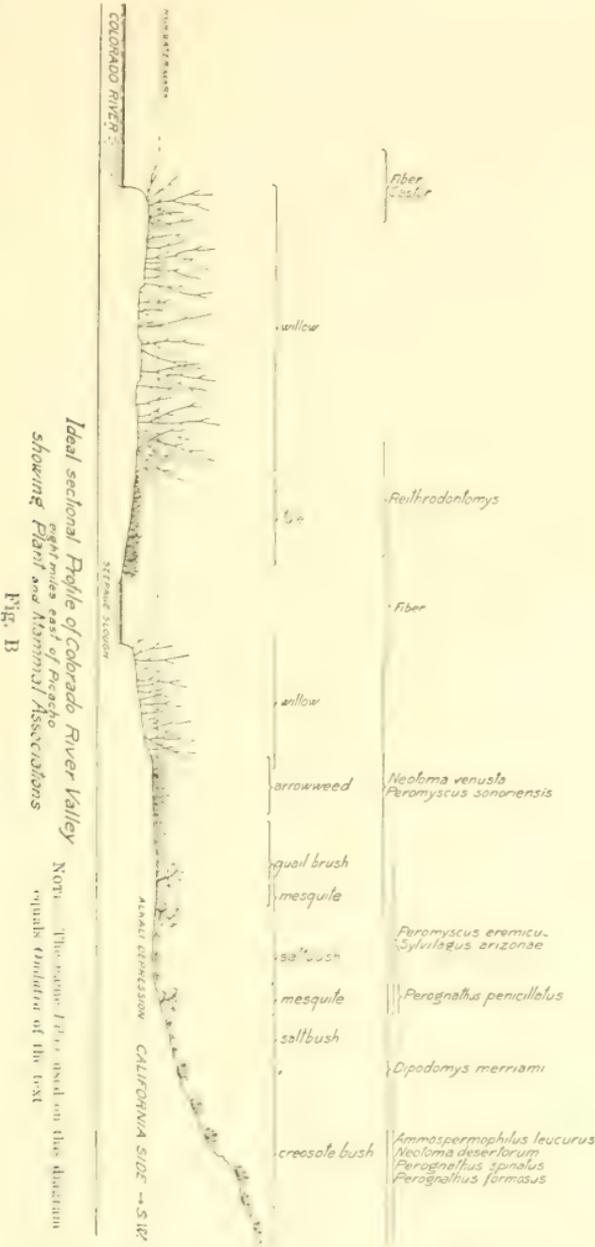
Remarks upon the Encelia (Rocky Hills) Association. None of the hills or "mountains" in the near vicinity of the lower Colorado River is of such great altitude as to bring a reduction in temperature to an extent sufficient to modify its biotic complexion. The tallest of The Needles rises to less than 2,000 feet above the level of the river. In other words, as far as observed, the plants and animals of the hills show no distributional behavior other than as explained on associational grounds.

But the hill country does exhibit a distinctive association of plants and animals, setting them apart sharply from the desert mesa, or the riverside. A conspicuous shrub on the rocky steeps, especially at The Needles, was the dense *Encelia farinosa*, with its light gray foliage, growing on talus slopes and even in crevices of the cliffs (pl. 10, fig. 15). Other plants of the same locality were: *Atriplex confertifolia*, *Larrea divaricata* (sparsely intermixed), *Asclepias subulata* (visited regularly by the Costa hummingbird), *Fagonia californica* (on the hottest slopes of broken rock), *Hyptis emoryi* (a "sage-bush" five to six feet high growing on the sides of ravines and at time of blossoming, in March, frequented by hummingbirds), *Perityle emoryi* (an abundant composite annual, the seeds of which were much sought after in March by fringillids), and *Muhlenbergia debilis* (a grass growing in shaded ravines and providing forage for graminivorous rodents, like *Perognathus*).

While to distant view the hills seemed more barren of vegetation than most of the other associational areas, nearby inspection showed abundant remains of inconspicuous annual plants. This in part would seem to account for the great numbers of mammals present, as shown by our trapping. The additional favorable factor was evidently the abundance and availability of natural retreats afforded in the talus and fractured outcrops.

With insectivorous and raptorial species, such as the swifts and bats, hawks and owls, the rocky hills served merely as home retreats, foraging being doubtless carried to the more productive lowlands.





particularly along the river bottom. Only two insectivorous birds were restricted to the *Encelia* association, namely, the wrens, *Salpinctes obsoletus obsoletus* and *Catherpes mexicanus conspersus*. Both are by structure adapted to gleaning from crevices of rock surfaces after the manner of nuthatches on tree trunks.

GENERAL DISCUSSION OF ASSOCIATIONAL RESTRICTION

From the preceding description of the conditions in the region studied, it is obvious that there are two groupings into which all the designated associations can be classed, namely, riparian and desert. The riparian set of associations includes those which owe their presence to the existence of the river, and is delimited outwardly at the mesquite association (see figs. A and B). The Colorado River apparently exerts no influence beyond the immediate bottom lands, which are affected by the underground water supply. All of the desert set of associations are represented in varying proportion over the vast arid tracts stretching away to the east and west of the river. Often they are discontinuous, but recur again and again in the same fauna with the same constitution.

The riparian associations are thus narrow strips of varying width closely paralleling the river from north to south and persisting practically continuously from the point of emergence of the Colorado River from the Grand Cañon to the Gulf of California. In the broad delta region the riparian associations spread out so that there are great areas of each, doubtless sufficient to be computed by the square mile. It is thus possible to trace the elements severally, of each association, to places of prevalence over considerable areas, even though those elements are, on the upper river, scattered sparsely along a narrow strip. Associational diagnosis of species thus often becomes possible when a knowledge of local conditions alone would be inconclusive. This principle deserves enlarging upon.

There were caught in the same trap-line opposite The Needles both *Peromyscus eremicus eremicus* and *Peromyscus crinitus stephensi*. It might have been impossible to say from the data gathered at that particular point, where the adjacent associations were complexly intermixed, just what sort of ground each species preferred. But trapping previously done in the salt-bush association in the Imperial Valley

showed the presence there of *P. c. eremicus* only, while field-work among the rocky hills in the vicinity of Victorville, on the Mohave Desert, showed *P. c. stephensi* only.

As another illustration, along the Colorado River, *Melospiza melodia saltonis* and *Pipilo aberti* were often found on common ground, although evidently averaging differently in associational preference. To prove beyond doubt what is the true ecologic niche of each, a knowledge of the distribution of each species elsewhere in their respective ranges becomes necessary. In the extensive arrowweed tracts around the west end of Salton Sea, *Melospiza melodia saltonis* is an abundant species while the other bird is absent. In the mesquite belt not far distant to the west, in the vicinity of Martinez and Torres, *Pipilo aberti* is prevalent, and the song sparrow absent. Hence the species of towhee in question may be confidently assigned to the mesquite association, and the subspecies of song sparrow to the arrowweed association.

It is not to be inferred that *all* species behave in this clearcut fashion associationally, any more than that all do so zonally or faunally (see Grinnell and Swarth, 1913, p. 220). At the same time the writer feels fairly sure of adequate grounds for proposing a general law in this regard, namely, that where the faunist happens to meet with a heterogeneous assemblage of biotic elements, not subject to clear associational diagnosis in the restricted locality of first observation, assignment of the species each to a well-defined association becomes possible by tracing out their ranges severally into the adjacent areas.

A concurrent axiom is that if associational analysis is carried far enough, no two species of birds or mammals will be found to occupy precisely the same ecologic niche, though they may apparently do so where their respective associations are represented fragmentarily and in intermixture.

In determining the associational status of mammals we have to deal chiefly with elusive animals, of nocturnal habits, which are hidden away during the day for the most part beyond reach. Trapping is not an altogether certain index to association; for individuals may be caught repeatedly in a trap-line which may not happen to intersect at all the regular forage ground or breeding home of the species. Individuals forage far and wide beyond the limits of their home territory and at the close of the breeding season wander in similar fashion. Some species, including nearly all mammals except xerophilous rodents, regularly travel far for water.

Attention is here called to our records of the capture of pocket mice. An unexpectedly large number of species of the genus *Perognathus* was found to occur in the region traversed. As many as three species were taken in one night in traps placed close together. But by testing many localities and comparing the results we soon came to know where to expect each separate species. The diagrams herewith presented (figs. C-F) show in statistical form the associational preferences of four species of *Perognathus*. Providing the same number of trap-nights (counting one trap set one night as one "trap-night") was

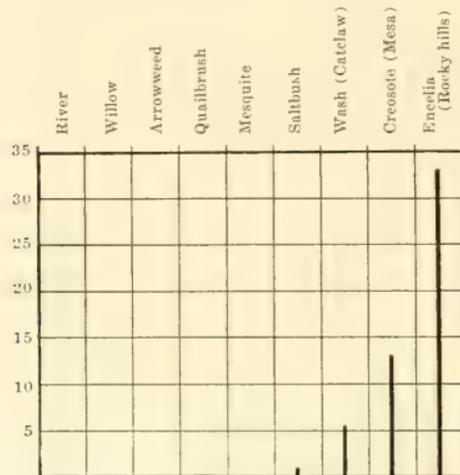


Fig. C. Diagram showing frequency of capture of *Perognathus formosus* in the several associations. There were fifty-three individuals trapped, of which the associational occurrence was satisfactorily recorded.

devoted to each association, this method should be fairly accurate. There will here occur to the reader ways of securing much greater precision in results of field-work in the future. But in fact, as our experience grew, far more effort was expended on ground promising additional specimens of rare species, than on ground already thoroughly exploited.

While a mammal or bird may be closely confined to a narrow territory characterized by certain conspicuous plants, the critical factor or factors of its environment may be quite apart from food requirements. As an illustration, the case of *Dipodomys deserti*

deserti may be cited. This rodent, taking its entire, irregular and discontinuous range into consideration, is closely restricted to those portions of the desert affording a deep surface layer of fine sand. Areas of aeolian sands constitute its typical home territory (see pl. 11, fig. 16). Now, it is quite probably not any peculiarity of food-supply

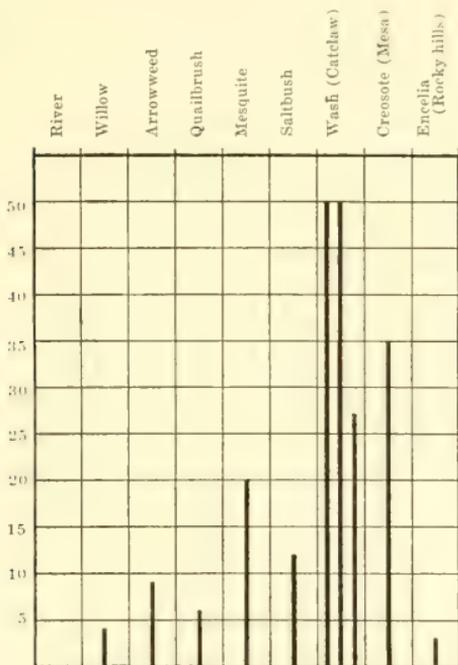


Fig. D. Diagram showing frequency of capture of *Perognathus p. penicillatus* in the several associations. Two hundred and seventeen individuals were taken, of which associational occurrence was definitely recorded. This species is seen to be very widely distributed, yet exhibiting marked preference for certain associations.

attaching to the aeolian sands, which binds the animal to them in this case rather than to the mesa at large; but it is the animal's requirements in the way of retreats for diurnal safety and for breeding. These, by nature of its fossorial limitations, *Dipodomys d. deserti* is unable to construct for itself except in ground easy to burrow into to a depth commensurate with its own large size and in soil with a proper degree of coherence.

In the case of desert quail there is a double need: of daily access to water, plus that for refuges constantly within easy reach in event of the birds being suddenly threatened by an enemy. The quail-brush association affords the ideal shelter. The futile efforts of a coyote or fox to dash in pursuit into such an interlacing thorny branch-work as is afforded by *Atriplex lentiformis* can be imagined!

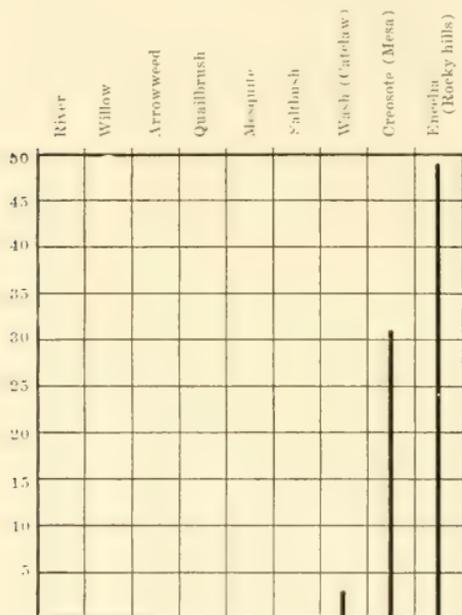


Fig. E. Diagram showing frequency of capture of *Perognathus intermedius* in the several associations. Eighty-three individuals were trapped, of which associational occurrence was definitely recorded.

In these cases and all others it is self-evident that presence of food-supply is the primal associational requisite, whatever other factors may be also essential. And kinds of food produced, with regard to the structural characters of each animal, determine what kinds of associational elements can exist in a locality. An animal having a specialized means of procuring food, like that of a sandpiper, or a woodpecker, or a rock wren, is hemmed in by the bounds outlining the

area in which it is able to get the food necessary for itself by the method which its anatomical structure and psychological equipment prescribe.

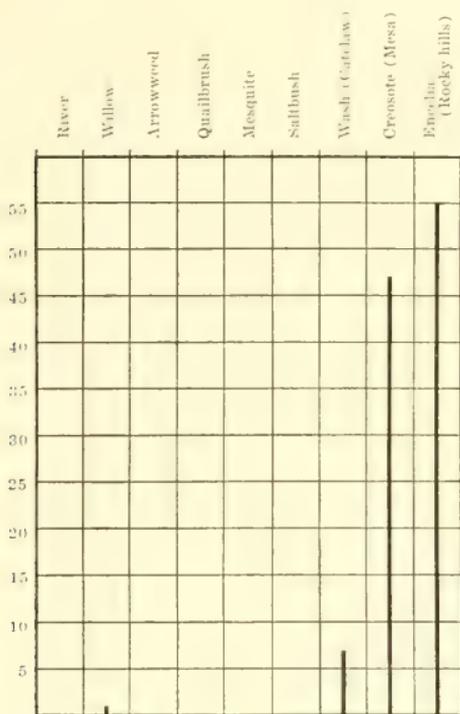


Fig. F. Diagram showing frequency of capture of *Perognathus s. spinatus* in the several associations. One hundred and ten individuals were trapped, of which associational occurrence was satisfactorily recorded. While the associational preference of this species is almost identical with that of *P. intermedius*, the ranges of the two species are wholly distinct, being separated by the Colorado River. Associational preference is also seen to be similar to that of *P. formosus*, which occupies apparently identical ground. But *P. spinatus* belongs to a different subgenus (*Chaetodipus*) from *P. formosus* (subgenus *Perognathus*), hence the two are not nearly related and probably do not come into close ecological competition.

Not infrequent are the cases where food-supply is located in one place, and the refuge or breeding site in another. Animals of such habit are necessarily of relatively great powers of locomotion, and may live regularly in two or more associations situated remotely from

one another. Incidentally all other associations may be crossed, back and forth. *Ardea herodias treganzai* foraged far and wide in the river association, but reared its young in restricted parts of the willow-cottonwood association where lofty trees provided safe nesting sites. *Aëronautes melanoleucus* found safe rendezvous in crevices of cliffs, but foraged far over the lowlands; so also with certain bats. The relations between animals and their environments are manifold and complicated; and these interrelations depend both upon the inherent peculiarities of the entire organism in the case of the animal and upon the physical nature of the environment.

After a consideration of all the birds and mammals mentioned in the present report, as occurring both in the region specifically treated and elsewhere as far as the writer's knowledge goes, associational restriction appears to be governed by the following three factors, of relative importance in the order named.

1. Kind of food-supply afforded, with regard to the inherent structural powers of each of the animals concerned to make it available.
2. Presence of safe breeding-places, adapted to the varying needs of the animals, in other words, depending upon the respective inherent powers of construction, defence and concealment in each species concerned.
3. Presence of places of temporary refuge for individuals, during day time or night time, or while foraging, when hard pressed by predatory enemies, again correlated with the respective inherent powers of defence and concealment of each species involved.

THE COLORADO RIVER AS A HIGHWAY OF DISPERSAL AND CENTER OF DIFFERENTIATION OF SPECIES

According to Gilbert and Scofield (1898, pp. 487, 488) the peculiarities of the fish fauna of the Colorado River bespeak a very long period of absolute isolation. A remarkably high percentage of its fishes are specifically distinct from those of the other river basins of western North America. The same is to be said of the riparian birds and mammals.

So far as known to the present writer, none of the species listed with a star in the following table ranges beyond the confines of the Colorado River basin, including of course its various tributaries and distributaries such as the Gila and New rivers, except sporadically, or as accounted for by distal invasion through passes or along sea-coastal tracts. In other words, the Colorado River has been in existence so long that the conditions imposed by its presence have figured in the differentiation of representative species of several families, both mammalian and avian.

The great age of the Colorado River is indicated geologically by the vast extent and slow rate of the erosion involved in the formation of the Grand Cañon. This time-element is justly inferred to have been an essential condition in the formation of these species.

SPECIES WHICH BELONG TO THE RIPARIAN BELT, AND WHICH ARE THEREFORE
HEMMED IN BY THE PARALLELING DESERT TRACTS. STARRED
SPECIES ARE PECULIAR TO THE COLORADO SUBFAUNA

BREEDING BIRDS

*Agelaius phoeniceus sonoriensis**
*Melospiza melodia saltonis**
*Pipilo aberti**
Guiraca caerulea lazula
Piranga rubra cooperi
*Vireo belli arizonae**
*Vermivora luciae**
*Dendroica aestiva sonorana**
*Toxostoma crissale**

MAMMALS

*Castor canadensis frondator**
Peromyscus maniculatus sonoriensis
*Sigmodon hispidus eremicus**
Reithrodontomys megalotis deserti
*Neotoma albigula venusta**
*Ondatra zibethica pallida**
Mephitis estor
*Procyon pallidus**

It may not be amiss to consider these riparian species somewhat with regard to origin. By confining our attention to the north-and-south valley of the lower Colorado, this becomes, with a knowledge of the general status in North America of each group represented, a com-

paratively simple matter. The axiom holds, that, because of the ever-shifting location geographically of associational, faunal and zonal conditions, every single element or line of descent, now represented in the biota of any one locality must have come either in its present form or in some antecedent one from somewhere else. This is certainly true of all terrestrial life. Elevation and depression have worked like a seesaw in dislocating faunas. The Colorado valley is a trough, hemmed in associationally on either side, and only capable of influx of riparian elements at either end. Therefore the riparian species of the Colorado fauna can have entered the area under consideration from only two directions: from the north and from the south.

Only two species are clearly seen to have entered the Colorado valley from the north: *Castor canadensis frondator*, and *Ondatra zibethica pallida*. The following species or subspecies are believed to have come in from the south: *Pipilo aberti*, *Guiraca caerulea lazula*, *Piranga rubra cooperi*, *Vireo belli arizonae*, *Vermivora luciae*, *Toxostoma crissale*, *Sigmodon hispidus eremicus*, *Neotoma albigula venusta*.

In the remaining seven cases (*Agelaius*, *Melospiza*, *Dendroica*, *Peromyscus*, *Reithrodontomys*, *Mephitis* and *Procyon*) no grounds are apparent to the writer for assigning either one over the other direction of invasion, and this in spite of whatever may be the marked Austral or Boreal distributional affinities of each group concerned. The tide of invasion may in fact in these species have tended in one direction at one period, in the opposite at another; or, as in *Peromyscus maniculatus sonoriensis*, the Colorado valley may have acted continuously as a narrow bridge where have met and mingled descent-lines from both the north and the south.

The obvious fact that southern representatives prevail over northern ones is clearly attributable to the present zonal condition obtaining in the region, namely Austral, in its Lower Sonoran division. And evidence elsewhere assembled (Grinnell and Swarth, 1913, p. 383) points towards an increasing temperature throughout the region. This would result in decreasing the favorableness to Boreal forms and increasing the availability of the region for immigration of Austral types. Consideration of the xerophilous vertebrates as well as of the riparian ones leaves little doubt in the writer's mind but that this has been the actual course of events. The northern contingent is on the wane, the southern in the ascendancy.

The query presents itself: is the Colorado fauna *full*? Are all the ecological niches, which are available in this area and which have

occupants in other regions, occupied here? Probably not, for the intervention of barriers has doubtless prevented the invasion of types which, if they could have once gotten there, would have thriven and assumed a place as endemic elements in the fauna. Sporadic incursion, as of migrants among birds, and strays among both birds and mammals, do not appear to the writer to figure in such a process. Rather must it be a progressive invasion of the species *en masse*, acquiring, it may be, adaptive modifications as it proceeds. In other words, the conquering of the land is the combined result of the facilities offered by it plus the relative amenability of each species concerned.

The twelve riparian species and subspecies peculiar to the Colorado fauna vary much in degree of difference from their near relatives which occupy adjacent differentiation areas. These varying degrees of difference might be interpreted as measures of the periods of time elapsed since the entrance into the region of each of the types involved. That this conclusion is poorly grounded is evident upon consideration of the various other elements which must figure in the process of species formation. Among these may be suggested: degree of isolation, divergence of homologous associational conditions in the new region from those in the ancestral, and inherent susceptibility to adaptive modification in each of the species concerned.

In the problem of the origin of the riparian portion of the Colorado fauna we seem to have to do with an accentuated kind of isolation. For, as already asserted, there is such a thing as *more* and *less* isolation. In the region here considered, possessing extreme associational contrast, we find the ordinary geographic, or more properly speaking, physiographic, isolation coupled with associational isolation. In consequence of this extra favorable contingency, differentiation of species may have progressed with particular celerity, with such distinct forms to show for it as *Pipilo aberti*, *Vermivora luciae*, *Toxostoma crissale*, and *Procyon pallidus*.

The axiom has presented itself in this connection that the *more* restricted a species is associationally, that is, the more confined to a narrow range of associational conditions, the more subject it is to the important factor of isolation; hence the more liable to give rise to new incipient strains in different parts of its general range.

An assertion which seems at first glance opposed to the above is: that the *less* restricted a species is associationally, that is, the more *widely* adaptable to varying conditions, the more numerous the chances

for local operation of isolation, because more opportunity for radial dispersion to carry the species into distant localities and under extreme conditions, and for the ultimate interposition of more or less efficient barriers. The factor of distance might here replace the operation of associational restriction in segregating descent-line plexuses.

These are apparently incongruous notions, but the following conception tends to harmonize them; namely, that, granting the three totally different orders of distributionally limiting factors (zonal, faunal and associational), it is probable that different species are restricted *unevenly* with respect to the three; thus a certain wood-rat (*Neotoma intermedia deserta*) is restricted faunally, but ranges widely through zones and associations; a certain wren (*Telmatodytes palustris* and subspecies) is tightly restricted associationally, but ranges widely through faunas and zones; a xerophilous genus of rodents (*Perognathus*) is closely restricted zonally and associationally, but ranges rather widely as to fauna. So that both the above assertions might well be true of a single animal historically and even, in different parts of its range, simultaneously! Certainly the first serves in explanation of the multiplicity of geographic races or species in several widespread groups of birds and mammals.

THE COLORADO RIVER AS A HINDRANCE TO THE DISPERSAL OF SPECIES

Bats and most birds find in the Colorado River no hindrance whatever to individual travel. Freedom of aerial locomotion gives them superiority over any obstruction on the general level of the country they inhabit. It is possible that in a few of the resident birds of limited flight individuals do not regularly cross the main stream, though they readily could do so if such an exigency as that of fire sweeping the bottom lands should drive them to it. *Geococcyx californianus*, *Pipilo aberti* and *Toxostoma crissale* are birds which probably do not often cross the river under normal circumstances.

Among mammals, carnivores are usually of much wider foraging range than rodents. From all the data available it appears that none of the carnivores, not even the cats, are averse to swimming the river if need be. Among rodents, however, our work showed a number of cases in which the Colorado River had effectively checked the distribution of species. The following tables show the situation as regards all the rodents of the region (see also figs. A, B).

RODENTS IN WHICH THE COLORADO RIVER ACTS AS AN ABSOLUTE BARRIER

<i>Association</i>	<i>Arizona side</i>		<i>California side</i>	<i>Association</i>
Encelia and Rocky Creosote	{ Ammospermophilus harrisi harrisi	Colorado River	Ammospermophilus leucurus leucurus	{ Encelia and Rocky Creosote
			Peromyscus crinitus stephensi	{ Encelia
Sandy Creosote	{ Thomomys chrysonotus			
			Thomomys albatrus	{ Saltbush
			Perognathus formosus	{ Encelia and Rocky Creosote
Encelia and Rocky Creosote	{ Perognathus intermedius			
		Perognathus spinatus spinatus	{ Encelia and Rocky Creosote	

RODENTS WHICH OCCUR ON BOTH SIDES OF THE COLORADO RIVER, BUT WHICH SHOW SLIGHT, ALMOST IMPALPABLE, DIFFERENCES ON THE TWO SIDES

	<i>Association</i>
Citellus tereticaudus tereticaudus	Sandy Creosote and Saltbush
Dipodomys deserti deserti	Sandy Creosote and Saltbush
Perognathus penicillatus penicillatus	Saltbush and Sandy Creosote

RODENTS WHICH ARE APPARENTLY IDENTICAL ON THE TWO SIDES OF THE COLORADO RIVER

	<i>Association</i>
Castor canadensis frondator	River
Peromyscus maniculatus sonoriensis	All Riparian
Peromyscus eremicus eremicus	Saltbush and Sandy Creosote
Sigmodon hispidus eremicus	Willow and Tule
Reithrodontomys megalotis deserti	Tule and Willow
Neotoma albigula venusta	Mesquite and other Riparian
Neotoma intermedia desertorum	Encelia
Ondatra zibethica pallida	River
Dipodomys merriami merriami	Saltbush and Sandy Creosote
Perognathus bombycinus	Sandy Creosote
Lepus californicus deserticola	Creosote and Saltbush
Sylvilagus auduboni arizonae	Quailbrush and Mesquite

The fact is apparent that only members of the strictly desert associations are stopped at the river. And of these the species of the *most remote associational position* are, with one exception, *Neotoma intermedia desertorum*, most effectively delimited. Also *degree of isolation* is in a measure commensurate with *amount of difference* between forms of the same genus.

It is pertinent to inquire *how* the Colorado River acts as a barrier to those species affected. It appears that in every one of the eleven cases the animal in question has no need to visit any water-supply. All are species capable of maintaining successful existence without a drop of water other than that obtained by chemical elaboration from their food. In our three months' experience we did not once find evidence that any individual of any of the eleven species in question had visited the river's edge.

Furthermore, to the best of our knowledge, all the species are of limited foraging range. In the case of the two diurnal chipmunks, *Ammospermophilus harrisi harrisi* and *Ammospermophilus leucurus leucurus*, which could be seen, it was seldom that an individual was come upon more than fifty yards from its burrow. In the case of *Perognathus*, which carefully closes the mouths of its burrows for the day, after its night's activity abroad, it was impossible to secure definite information on this score except as afforded by trapping; but the writer's impression is that it, too, does not ordinarily venture many rods from its retreat. Individuals doubtless travel farther at times of rutting, but it is likely that even then the limits of the native association would not be far transgressed.

It is further to be noted that those species finding an insuperable check at the river are all closely confined to one general kind of associational environment, even though two minor associations, as here defined, be occupied. The river *plus* intervening associations of an unfavorable nature constitutes the *total* barrier to the rodents in question.

It is true that the element of distance here implied is reduced to a negligible quantity where hills closely abut upon the river channel. But the major part of the river's course, probably four-fifths of it below the lower end of the Grand Cañon, is through valleys of varying width, occupied by riparian associations most adverse in essential ecological particulars to the species of the upland deserts adjacent.

Along the remaining fifth of the river's course, where the banks rise abruptly and are continuous with the adjacent hill slopes, with

either no trace of riparian tracts or only narrow or interrupted representations, it would seem that chance is afforded for such mammals as the desert chipmunks and pocket mice to encounter the river itself, with all intervening factors removed.

At our base camp (no. 4) at The Needles, our measurements showed the actual width of the stream to be 450 feet at the rather low stage of water obtaining at that time (March 4, 1910). At high water the river could not have been much more than 150 feet wider (see sectional profile, fig. A, and pl. 10, fig. 15). In the box cañon two to three miles below, the width of the river *appeared* to be much less, and, because of the precipitous walls, high water would make little change in width.

The two species of *Ammospermophilus* were *seen* at points only about 850 feet apart in a direct line. All the mammals of the Encelia association, as segregated here on the two sides of the river, were trapped at this station within one thousand feet of one another. The same situation obviously held at several other points along the Colorado River. The sharp separation of the ranges of nearly related vertebrates by a barrier of such narrow width is, to the best of the writer's knowledge, not known elsewhere in North America.

As to the opportunities for crossing the river by such individuals as might get to the water's edge, only speculation is now possible. At times of rising water, riparian mammals are undoubtedly often marooned upon islands and finally forced to swim or to take refuge on floating drift. Practically all the riparian species are known to be able to swim readily, and are probably in ways just mentioned frequently carried from side to side of the river.

The ability of typical desert animals to care for themselves if cast into the water is problematical, though a little experimentation would go far to proving the point one way or the other. Their powers in this line may be inferred to be limited because of the facilities normally lacking for putting such powers into practice. For instance, there is fair probability that a *Reithrodontomys* could safely cross a turbulent stretch of current, where a *Pcrognathus* would perish before any chance of reaching the shore.

Protracted observation along the river brings conviction to the observer that no animal of weak swimming powers is likely to survive many minutes of exposure to the main current. It is a fascinating diversion to watch the course of a stick or log adrift in the stream. Such an object pursues an exceedingly devious course.

It may be carried close under the steep outside bank of an ox-bow swing, only to be directly thrown back towards the opposite shore. Stretches of rough water may be encountered where the object is swamped at the crest of every wave. Or, along rocky parts of the channel, swirls, large and small, arrest its passage. In the most violent of these eddies a twenty-foot log was seen to up-end and sink from sight, to reappear after its total submergence, a hundred yards down stream.

At times of falling water a great deal of drift lodges on mudbars and projecting reefs of rock. It is imaginable that drift logs *might* be reached by individuals, which freed again with subsequently rising water, would carry their passengers until lodged under favoring circumstances on the opposite side of the river. In the account of *Neotoma intermedia desertorum*, the only rodent of the Encelia association not checked by the river, it is suggested that in some such way passage was secured from the California to the Arizona side of the river. This wood rat now bids fair to occupy much appropriate territory in southwestern Arizona not previously possessing an associational homologue, that is a Neotoman representative. *Neotoma* may be looked upon as a more hardy and ecologically less specialized rodent than any of its associational companions. It is certainly much the largest, and is notoriously of aggressive disposition as a forager.

Of the eight species of delimited rodents, not one individual of the hundreds trapped was found on the "wrong" side of the river. As far as they went, then, our efforts furnished no evidence that even an occasional individual does get across. As already shown, there seems to be nothing to attract the upland rodents to the water's edge, so that possibility of securing safe transportation on a log or mass of drift is doubly remote. Now, supposing that a single individual *did* manage to reach the opposite shore, its *species* would not necessarily be established there. In most cases (not, however, with *Peromyscus crinitus stephensi* and *Perognathus formosus*) there is already established an associational homologue, with which even a whole family of the invaders would have to compete, with the chances at least as much against success as favoring it. Hybridization might occur, granted that no sexual antipathy arise, but, whatever the immediate results, it is the impression of the writer that swamping would eventually be likely to wipe out all trace of the invading species. This impression is admittedly based upon fragmentary data which has not been subjected to critical analysis. Whether or not Mendelian behavior in

inheritance of characters obtains among the rodents here concerned is yet to be proven.

Suffice it to say that all the evidence at hand shows the Colorado River to have effectually blocked distribution, in the two directions concerned in the eight cases as listed. While this hindrance to distribution involves the species, it does so through its mechanical action upon the frontier *individuals* of each species. Hypothetically the invaders are severally hurled back or else destroyed outright.

The divergent characters displayed by the upland rodents of the two sides of the Colorado River are, in the mind of the writer, to be best explained on historical grounds. It is not necessary to believe that the specific characters concerned arose in the immediate vicinity of the river, though the circumstance of segregation alone is deemed by some to suffice as a cause of differentiation. The climatic features (zonal and faunal, as well as associational) are identical on the two sides of the river. Rather is it reasonable to presuppose separate and rather remote centers of differentiation, and convergent dispersal through time and space which brought the resulting types to the verge of the river, beyond which they were unable to spread.

It is possible that an arm of the sea continuous with the Gulf of California once extended northward into southern Nevada. A submergence of only 1,000 feet would divide the present desert areas of western Arizona and southern California into two peninsular land masses, which might have served as well-isolated centers of differentiation for various forms which later spread with the elevation of the land until their ranges abutted. Unfortunately for this suggestion, as I am informed by Professor John C. Merriam, geological evidence fails so far to show the existence of such conditions within Pleistocene or even Pliocene times. The suggested explanation must therefore be discarded in our dealing with the differentiation of present-day species and subspecies, especially since even the genera represented and as now restricted are not known to have evolved so early as Miocene.

But another process, recognizable far and wide in dynamic zoogeography, may be called into account without assuming any departure in the past from topographic and climatic conditions as they are today. Comparison of the fauna of the Lower Sonoran plains of south central Arizona with that of the Mohave desert plateau in the same zone, shows two prevalent character combinations among the nearly related component species. The mid-Arizona representatives are usually dark colored and large sized, the reverse appearing to hold in the majority

of the Mohave desert forms. There is considerable floral difference in the two regions, and minor climatic differences are well known. Different environments thus impinge upon the animals in these widely separated centers, and more or less regular blending of conditions occurs between. Although every factor of environment may be identical immediately on the two sides of the Colorado River, the animals now there have undoubtedly descended from ancestral lines which have invaded the territory from the two opposite directions, bringing with them by inheritance the characters developed under the two different sets of conditions.

To express the idea otherwise, from each differentiation area there is an outwardly radiating dispersal of descent-lines, involving time as well as space. This dispersive process is going on now as it has through past time. The eastward-flowing tide of Mohave forms would only be arrested by an insuperable barrier, such as the Colorado River. The westward invading descent-lines from the Arizona center would proceed until stopped by the same barrier. Both sets of forms would find themselves along the Colorado Valley under the same associational, faunal and zonal conditions; but each set is continually receiving by the process of inheritance plus invasion the peculiar characters generated on its own side.

While the Colorado River probably lies in an intermediate position between the Mohave and Arizona faunas, the area of intermediate conditions of environment is probably relatively narrow. This very element of narrowness may be called in to account for the lack of modification displayed by the delimited species of the Colorado River frontiers, for example, in the case of *Ammospermophilus*.

Supposing now that the Colorado River does not serve as an insuperable barrier, nor ever has done so; invasion would have extended from one side to the other as far as associational, faunal or zonal barriers permitted. In animals of wide distribution, intergradation geographically between the remote extremes would in the end be expected to occur. The extremes would not then have differentiated so far, at least in quantity of each character developed, because of inheritance from the opposite type, again involving time and space, concomitantly. Subspecies would have resulted, instead of full species. This condition doubtless obtains in some of the birds, as well as in some of the rodents listed as being the same on the two sides of the river. Take, as an example, *Dipodomys merriami merriami* of south central Arizona, and *Dipodomys merriami simiolus* of the Mohave

desert. Our Colorado River series is fairly intermediate between the extreme types, though the extremes are not so different as are *Ammospermophilus harrisi harrisi* and *Ammospermophilus leucurus leucurus*. As elsewhere explained, the river is believed to be not so much of a barrier to *Dipodomys merriami* as to the forms of *Ammospermophilus*.

The *degree of hindrance*, ranging from the condition, as in the case of *Castor* and *Ondatra*, where the river offers no bar to perfect freedom of crossing, to that where the river is an absolute barrier, as in the case of species of *Perognathus* and *Ammospermophilus*, accords so closely with *degree of difference* in characters developed on the two sides of the river, that adequate ground is afforded for the belief that intervention of barriers is a prime factor in the differentiation of species. And furthermore, it would appear that no two species, in birds and mammals, arise except through geographic segregation.

THE PROBLEM OF BARRIERS WITH REGARD TO BIRDS AND MAMMALS

The geographical range of any species of animal may be likened to a reservoir of water in a cañon. The confining walls are of varying nature. A concrete dam, absolutely impervious, may retain the water at one end. Along either side the basin's walls differ in consistency from place to place. The substratum varies in porosity, at some points impervious like the dam, at others permitting seepage of water to a greater or less distance from the main volume. The water continually presses against its basin walls, as if seeking to enlarge its area. And it may succeed in escaping, by seepage through such portions of its barrier as are pervious or soluble, or by free flow through a gap in the walls, if such offers. The area occupied by the water will extend itself most rapidly along the lines of least resistance.

Every species has a center or centers of abundance in which favoring conditions usually give rise to a rate of reproduction more than sufficient to keep the critical area stocked. A tendency to occupy a larger space results because of competition within the species, and individuals and descent-lines multiply and travel radially, extending those segments of the frontier where least resistance is offered. Such radial dispersal takes place slowly in some directions, more rapidly in others, according to the degree of passability of the opposing bar-

riers. These barriers consist of any sort of conditions less favorable to the existence of the species than those in the center of abundance.

Theoretically, sooner or later and in all directions, every species is absolutely stopped. But as a matter of undoubted fact most barriers are continually shifting, and the adaptability of the animals themselves may be also undergoing continual modification; so that perfect adjustment is beyond the limits of possibility so long as topography and climate keep changing. The ranges of species may thus be constantly shifting. Descent-lines may move about repeatedly over the same general region, like sparks in the soot on the back of a brick fireplace.

Yet, in all of our studies, of but a few years' duration, the time element is reduced almost to a negligible quantity, and we may look upon the areas occupied by each species as, for the time of our observation, fixed. We are thus enabled to compare one with another, and because of the large number of the species, we can infer a good deal as to the nature of barriers in general as regards birds and mammals. It is even conceivable that with sufficient refinement in methods the inquirer may in time find himself able, from a comparative study of the ranges of rodents, for example, to establish the identity of all of the external factors which have to do with the persistence of each species; in other words to analyze the "environmental complex" into its uttermost elements as regards the existing species of rodents in their recent development.

The most obvious kind of barrier to distribution is that consisting of any sort of physical, or mechanical, obstruction. Such obstruction affects directly the *individuals* of a species encountering it, either by stopping their advance, or by destroying outright such as attempt to cross it. As barriers of this nature are to be cited land to purely aquatic mammals, and bodies of water to purely terrestrial, especially xerophilous, mammals. In each case width of the barrier has to do with degree of impassability. Oceans and continents are most perfect and affect a large proportion of the species. The comparatively narrow Colorado River is a barrier of the first rank, but only to a certain few desert rodents, as pointed out in a preceding chapter. Mechanical barriers, where they exist at all, are clearly recognizable.

It is to be observed, however, upon considering the birds and mammals of a whole continent, that by far the greater numbers of species are delimited in range irrespective of any direct dependence upon actual land and water boundaries; more explicitly, their ranges fall

far short of coast lines. The barriers here concerned are intangible but nevertheless powerful. By their action the spread of species, genera, and families is held in check as surely as by any tangible obstruction.

By these invisible barriers the *individual* may not necessarily be stopped at all, as with animals of free locomotion; but the *species* is affected. For example, the mockingbird (*Mimus polyglottos leucop-terus*) in its Californian distribution is closely confined to those parts of the state possessing certain definite climatic features; but vagrant individuals, especially in autumn, occur beyond the limits of these restrictive conditions. Carnivorous mammals are well known to be subject to sporadic wanderings on the part of individuals, but the *species* is kept in set bounds by some potent but invisible set of factors. The very fact that *individuals* are quite capable of temporarily transgressing these bounds and yet do not overstep them *en masse* emphasizes all the more the remarkable potency of this category of barriers as regards species and higher groups.

Our geographic studies lead us to designate among these relatively intangible barriers: (1) increase or decrease in prevailing temperature beyond certain critical limits, according to the species concerned; (2) increase or decrease in prevailing atmospheric humidity beyond certain limits; (3) modification in food-supply and appropriate breeding and foraging ground as regards the inherent structural equipment of each animal considered. In these three sorts of barriers will be recognized the *zonal*, *faunal* and *associational* delimitation as discussed in previous chapters.

CLASSIFICATION OF BARRIERS TO SPECIES AS REGARDS BIRDS AND MAMMALS

Barriers:

A. Tangible (mechanical)

- (a) Land to aquatic species
- (b) Bodies or streams of water to terrestrial species

B. Intangible (non-mechanical)

- (a) Zonal (by temperature)
- (b) Faunal (by atmospheric humidity)
- (c) Associational

- (1) By food-supply
- (2) By breeding places
- (3) By temporary refuges

(Each of these three with regard to the inherent structural characters of each species concerned).

The above categories are believed to include all the factors commonly involved in the checking of the spread of species of birds and mammals. It is possible that inter-specific competition may sometimes occur where associational homologues meet. But even here it becomes a matter of relative associational fitness which determines supremacy and consequent ultimate limits of invasion of the forms concerned.

A mountain range is no barrier at all, *per se*, as frequently alleged. Only as it involves zonal or faunal barriers does it affect distribution. The same is true of a valley or a desert.

As far as contemplation of cases has gone, the writer's experience has led him to believe that the outlines of the ranges of all birds and mammals may be accounted for by one or more of the factors indicated in the above analysis. And as detailed knowledge of the facts of geographical distribution accumulates, the delimiting factors become more and more readily detectable. By such a study, of *comparative distribution*, it seems possible that the ranges of birds and mammals may become subject to satisfactory explanation. The instances included in the list of species discussed in the present paper, when considered in connection with many similar ones, point without exception towards the existence of the set of factors above specified as delimiters.

When considered in its historical bearing, the problem of barriers concerns itself intimately with the origin of species. It is believed by the writer that only through the agency of barriers is the *multiplication of species*, in birds and mammals, brought about.

CHECK-LIST OF THE BIRDS

1. *Gavia immer* (Brünnich)
2. *Sterna forsteri* Nuttall
3. *Phalacrocorax auritus albociliatus* Ridgway
4. *Pelecanus erythrorhynchos* Gmelin
5. *Mergus serrator* Linnaeus
6. *Anas platyrhynchos* Linnaeus
7. *Nettion carolinense* (Gmelin)
8. *Querquedula cyanoptera* (Vieillot)
9. *Spatula clypeata* (Linnaeus)
10. *Dafla acuta* (Linnaeus)
11. *Marila affinis* (Eyton)
12. *Erismatura jamaicensis* (Gmelin)
13. *Chen hyperboreus hyperboreus* (Pallas)
14. *Plegadis guarauna* (Linnaeus)
15. *Mycteria americana* Linnaeus

16. *Ardea herodias treganzai* Court
17. *Herodias egretta* (Gmelin)
18. *Butorides virescens anthonyi* (Mearns)
19. *Nycticorax nycticorax naevius* (Boddaert)
20. *Grus canadensis* (Linnaeus)
21. *Recurvirostra americana* Gmelin
22. *Fulica americana* Gmelin
23. *Pisobia minutilla* (Vieillot)
24. *Actitis macularius* (Linnaeus)
25. *Oxyechus vociferus vociferus* (Linnaeus)
26. *Lophortyx gambeli* Gambel
27. *Zenaidura macroura marginella* (Woodhouse)
28. *Melopelia asiatica trudeaui* (Audubon)
29. *Cathartes aura septentrionalis* Wied
30. *Circus hudsonius* (Linnaeus)
31. *Accipiter velox* (Wilson)
32. *Accipiter cooperi* (Bonaparte)
33. *Buteo borealis calurus* Cassin
34. *Falco mexicanus* Schlegel
35. *Falco columbarius richardsoni* Ridgway
36. *Falco sparverius phalaena* (Lesson)
37. *Pandion haliaëtus carolinensis* (Gmelin)
38. *Aluco pratincola* (Bonaparte)
39. *Otus asio gilmani* Swarth
40. *Bubo virginianus pallescens* Stone
41. *Micropallas whitneyi* (Cooper)
42. *Geococcyx californianus* (Lesson)
43. *Ceryle alcyon* (Linnaeus)
44. *Dryobates scalaris caetophilus* Oberholser
45. *Sphyrapicus varius nuchalis* Baird
46. *Centurus uropygialis* Baird
47. *Colaptes cafer collaris* Vigors
48. *Colaptes chrysoides mearnsi* Ridgway
49. *Phalaenoptilus nuttalli nuttalli* (Audubon)
50. *Phalaenoptilus nuttalli nitidus* Brewster
51. *Chordeiles acutipennis texensis* Lawrence
52. *Chaetura vauxi* (Townsend)
53. *Aëronautes melanoleucus* (Baird)
54. *Archibuteo alexandri* (Bourcier & Mulsant)
55. *Calypte costae* (Bourcier)
56. *Tyrannus verticalis* Say
57. *Myiarchus cinerascens cinerascens* (Lawrence)
58. *Sayornis sayus sayus* (Bonaparte)
59. *Sayornis nigricans* (Swainson)
60. *Nuttallornis borealis* (Swainson)
61. *Myiochanes richardsoni richardsoni* (Swainson)
62. *Empidonax difficilis difficilis* Baird
63. *Empidonax trailli trailli* (Audubon)
64. *Empidonax hammondi* (Xantus)
65. *Empidonax wrighti* Baird
66. *Empidonax griseus* Brewster
67. *Pyrocephalus rubinus mexicanus* Selater

68. *Corvus corax sinuatus* Wagler
69. *Molothrus ater obscurus* (Gmelin)
70. *Xanthocephalus xanthocephalus* (Bonaparte)
71. *Agelaius phoeniceus sonoriensis* Ridgway
72. *Sturnella neglecta* Audubon
73. *Icterus cucullatus nelsoni* Ridgway
74. *Icterus bullocki* (Swainson)
75. *Euphagus cyanocephalus* (Wagler)
76. *Carpodacus mexicanus frontalis* (Say)
77. *Astragalinus psaltria hesperophilus* Oberholser
78. *Astragalinus lawrencei* (Cassin)
79. *Passer domesticus* Linnaeus
80. *Poæcetes gramineus confinis* Baird
81. *Passerculus sandwichensis nevadensis* Grinnell
82. *Passerculus sandwichensis alaudinus* Bonaparte
83. *Chondestes grammacus strigatus* Swainson
84. *Zonotrichia leucophrys leucophrys* (Forster)
85. *Zonotrichia leucophrys gambeli* (Nuttall)
86. *Spizella passerina arizonae* Coes
87. *Spizella breweri* Cassin
88. *Spizella atrogularis* (Cabanis)
89. *Junco oreganus thurberi* Anthony
90. *Amphispiza bilineata deserticola* Ridgway
91. *Amphispiza nevadensis nevadensis* (Ridgway)
92. *Melospiza melodia fallax* (Baird)
93. *Melospiza melodia saltonis* Grinnell
94. *Melospiza lincolni lincolni* (Audubon)
95. *Pipilo maculatus curtatus* Grinnell
96. *Pipilo aberti* Baird
97. *Oreospiza chlorura* (Audubon)
98. *Zamelodia melanocephala melanocephala* (Swainson)
99. *Guiraca caerulea lazula* (Lesson)
100. *Passerina amoena* (Say)
101. *Calamospiza melanocorys* Stejneger
102. *Piranga ludoviciana* (Wilson)
103. *Piranga rubra cooperi* Ridgway
104. *Petrochelidon lunifrons lunifrons* (Say)
105. *Hirundo erythrogastra* Boddaert
106. *Iridoprocne bicolor* (Vieillot)
107. *Tachycineta thalassina lepida* Mearns
108. *Stelgidopteryx serripennis* (Audubon)
109. *Bombycilla garrula* (Linnaeus)
110. *Phainopepla nitens* (Swainson)
111. *Lanius ludovicianus excubitorides* Swainson
112. *Vireosylva gilva swainsoni* (Baird)
113. *Lanivireo solitarius cassini* (Xantus)
114. *Vireo belli arizonae* Ridgway
115. *Vermivora luciae* (Cooper)
116. *Vermivora ruficapilla gutturalis* (Ridgway)
117. *Vermivora celata celata* (Say)
118. *Vermivora celata lutescens* (Ridgway)
119. *Dendroica aestiva sonorana* Brewster

120. *Dendroica aestiva brewsteri* Grinnell
121. *Dendroica aestiva rubiginosa* (Pallas)
122. *Dendroica auduboni auduboni* (Townsend)
123. *Dendroica nigrescens* (Townsend)
124. *Dendroica townsendi* (Townsend)
125. *Dendroica occidentalis* (Townsend)
126. *Oporornis tolmiei* (Townsend)
127. *Geothlypis trichas scirpicola* Grinnell
128. *Geothlypis trichas occidentalis* Brewster
129. *Icteria virens longicauda* Lawrence
130. *Wilsonia pusilla pileolata* (Pallas)
131. *Wilsonia pusilla chryseola* Ridgway
132. *Anthus rubescens* (Tunstall)
133. *Oreoscoptes montanus* (Townsend)
134. *Mimus polyglottos leucopterus* (Vigors)
135. *Toxostoma crissale* Henry
136. *Heleodytes brunneicapillus couesi* (Sharpe)
137. *Salpinctes obsoletus obsoletus* (Say)
138. *Catherpes mexicanus conspersus* Ridgway
139. *Thryomanes bewicki eremophilus* Oberholser
140. *Troglodytes aëdon parkmani* Audubon
141. *Telmatodytes palustris plesius* (Oberholser)
142. *Auriparus flaviceps flaviceps* (Sundevall)
143. *Regulus calendula cineraceus* Grinnell
144. *Polioptila caerulea obscura* Ridgway
145. *Polioptila plumbea* (Baird)
146. *Hylocichla ustulata ustulata* (Nuttall)
147. *Hylocichla guttata guttata* (Pallas)
148. *Hylocichla guttata nanus* (Audubon)
149. *Planesticus migratorius propinquus* (Ridgway)
150. *Sialia mexicana occidentalis* Townsend

GENERAL ACCOUNTS OF THE BIRDS:

RECORD OF SPECIMENS, DISTRIBUTION, VARIATION, BIOGRAPHICAL NOTES

Gavia immer (Brünnich)

Common Loon

There is in the Museum an adult-plumaged female specimen (no. 6403) of this species taken (probably by W. W. Holder) at "Mineral City in Colorado River" (=Ehrenberg) April 4, 1864.

Sterna forsteri Nuttall

Forster Tern

Adult male (no. 12616), secured May 4 at the mouth of the Gila River, Arizona, near Yuma; clearly a transient.

Phalacrocorax auritus albociliatus Ridgway

Farallon Cormorant

Cormorants were not noted until the vicinity of Laguna Dam was reached, and then only in small numbers. April 24 one was seen at an overflow pond on the California side above Potholes; and on the same date a small flock was observed in the distance flying up the river, close over the water. Four individuals were seen below Potholes, April 29.

A lone individual (no. 12617) was shot on the river, nearest the California shore, five miles northeast of Yuma, May 2. In this specimen the anterior lower parts forward to the chin are light drab with numerous black feathers scattered uniformly through; naked portion of gular pouch bright orange yellow; wing 322 mm., tail 164, tarsus 65, middle toe with claw 100, culmen 56, depth of bill at base 17.7. Although immature, this bird is unequivocally referable to *P. a. albociliatus*.

Pelecanus erythrorhynchos Gmelin

White Pelican

Although reported to be extremely numerous at times along the river, we saw only stragglers. One was seen March 22 on a mud bar in the river above Blythe; April 3 one was noted opposite Cibola flying down the river.

Mergus serrator Linnaeus

Red-breasted Merganser

February 18 two small flocks were seen a few miles below Needles; March 8 three individuals flew past our boat as we entered Chemehuevis Valley.

Anas platyrhynchos Linnaeus

Mallard

Encountered sparingly: a pair found at a lagoon in Chemehuevis Valley, March 10, and female adult (no. 12618) secured; two seen at a tule pond near Ehrenberg March 25; two seen in flight along the river within two miles above Yuma, May 5.

Nettion carolinense (Gmelin)

Green-winged Teal

Most numerous of the ducks wintering in the region. One of two females (nos. 12619, 12620) taken from a small flock February 26 near Mellen has scattered through the plumage of the lower surface from chin to crissum many feathers, the exposed terminal portions of which are brightly stained with a rusty color. The species was further noted in Chemehuevis Valley March 10, near Riverside Mountain March 17, and opposite Cibola April 4.

Querquedula cyanoptera (Vieillot)

Cinnamon Teal

An adult female (no. 12621) taken on the California side opposite Cibola April 3.

Spatula clypeata (Linnaeus)

Shoveler

Four observed on a mud bar opposite Cibola, April 4; one obtained: female adult, no. 12622.

Dafila acuta (Linnaeus)

Pintail

One obtained March 10 in Chemehuevis Valley: adult female, no. 12623.

Marila affinis (Eyton)

Lesser Scaup Duck

Two large flocks seen flying up the river above Ehrenberg March 24; one noted on a mud bar opposite Cibola April 4.

***Erismatura jamaicensis* (Gmelin)**

Ruddy Duck

Four noted on a sand bar in the river four miles above the Laguna Dam, April 23; one secured: immature male, no. 12624.

***Chen hyperboreus hyperboreus* (Pallas)**

Lesser Snow Goose

February 16 two small flocks were seen at Needles flying south; February 23 a flock was met with on a mud bar on the California side between Needles and Mellen.

***Plegadis guarauna* (Linnaeus)**

White-faced Glossy Ibis

A dozen seen May 5 flying down the river along the Arizona shore four miles above Yuma.

***Mycteria americana* Linnaeus**

Wood Ibis

A flock of twelve individuals seen April 21 flying up the river, at a point about four miles above the Laguna Dam. Said by residents of the region to occur abundantly along the river at the present time, just as recorded in the '60's by Coues (1866, p. 96) and Cooper (1869, p. 481).

***Ardea herodias treganzai* Court**

Pallid Blue Heron

Abundant resident along the whole course of the river as far as explored. Nesting colonies were observed in trees at many points through the large valleys; and one group of nests was noted on a pinnacle of rock in the narrow cañon just below The Needles. Ordinarily nests were placed in the tips of the largest cottonwoods in the neighborhood. Special predilection was evinced for dead trees standing close to the river. This would seem to be because of the clear fly-way afforded to and from the nests; and because of the more extensive outlook possible. But there were in this region drawbacks to these advantages.

In a number of places the river was rapidly undercutting the outside curve of its bank, on which stood occupied nest trees. Though

we did not witness such a catastrophe in the few minutes consumed in floating by such places, many trees were on the verge of toppling; the annual mortality from this local condition alone must be large. Evidently the herons have failed to grasp the situation, and cling to old habits, even though these entail considerable annual loss. The area in which this destruction occurs is so small compared with the entire range of the pallid blue heron, and the proportion of the local birds which suffer disaster to their nests is also so small, that the contingency in question has not effected any change in the habits of the birds.

Ten miles below Ehrenberg, on the California bank of the river, was a colony which was visited on March 30. There were approximately thirty nests, one to three per tree, which were unquestionably occupied, besides others in various stages of construction or dilapidation. The place had evidently been inhabited for at least one year previously. One nest, situated forty feet above the ground in a cottonwood, contained three fresh eggs. The time of laying in this region is thus indicated.

Inspection of the nests of a colony on the Arizona side four miles above Laguna, April 25, showed young perhaps one-third grown. They could be seen from the ground clambering about the nest platforms. Another colony, on the Arizona shore five miles northeast of Yuma, passed May 2, showed young appearing conspicuously above the nest rims, and their hoarse calls were to be heard to a considerable distance.

Along the whole course of the river, save in the rock-walled box cañons, blue herons were almost continually in sight. Their chief foraging grounds were the mud bars traversed by shallow diversions of the river. The habit of the river of having frequent periods of falling water, even when, as in the spring, the aggregate tendency is to rise, results in the stranding of many fishes in the shallow overflows as the water seeps away or evaporates. This frequently recurring supply of fish appears to be the chief source of food of all the species of herons occurring in the region. The stomach of one blue heron contained a semi-liquid mass of fish, identifiable from the large-sized scales as carp; another contained a large catfish. One stomach was empty save for a single grasshopper leg; this gives a clue as to an emergency diet, when the river is rising rapidly. It may be remarked that the opacity of the moving water of the main stream is so complete as effectually to prevent fishing here by piscivorous birds in the usual manner.

Twelve specimens of this heron were secured, two (nos. 12625, 12626) from the California side near Riverside Mountain, one (no. 12627) from the Arizona side at Ehrenberg, and nine (nos. 12628–12636) from the California side about ten miles below Ehrenberg. In the accompanying table of measurements of the fourteen apparently mature specimens a wide variation will be noted. While the largest individuals of the series are males, some females are larger than some males. I find nothing to indicate that size increases with age, though this might fairly be expected. The average of the series accords closely with the measurements given by Court (1908, p. 292) for *Ardea herodias treganzai* (except as resulting from obviously different methods of measuring, as with middle toe).

The status of the great blue herons residing in California west of the Sierran divide has been recently settled by Oberholser (1912, p. 550). As compared with these all of the Colorado River skins are markedly pale throughout, with reduction in extent of dark areas. Bills straw yellow, darkening on culmen, not "black," as stated by Court (1908, p. 291).

The weights of two freshly killed males were 5½ and 5¾ pounds, of two females 5 pounds each.

MEASUREMENTS IN MILLIMETERS OF *ARDEA HERODIAS TREGANZAI*
FROM THE LOWER COLORADO RIVER AND VICINITY

Museum No.	Sex	Wing	Tail	Tarsus	Middle Toe and Claw	Culmen	Depth of Bill
12625	♂	493	186	193	132	157	28.0
12626	♂	462	162	165	123	142	26.0
12627 ¹	♀	441	164	172	120	142	25.0
12628	♂	488	192	178	128	143	28.0
12629	♀	442	168	167	121	143	26.0
12630	♀	468	172	166	114	140	26.5
12631	♂	466	169	180	129	149	26.8
12632	♀	465	175	173	116	136	26.0
12633	♂	478	176	180	126	150	28.4
12634	♂	492	184	190	129	154	29.0
12635	♀	453	167	162	121	141	25.6
12636	♀	445	172	158	118	144	25.8
1070 ²	♀	450	170	169	114	150	25.0
8041 ³	♂	445	174	175	124	141	28.0
Averages		463	174	173	122.5	145	26.7

¹The plumage of this specimen is not in full breeding condition, and the bird may not have been full grown, in respect to flight feathers especially.

²Pelican Island, Salton Sea, Calif., April 20, 1908.

³Silsbee, Imperial Co., Calif., April 4, 1909.

***Herodias egretta* (Gmelin)**

American Egret

Met with only in one place, the recently silted-in area above the Laguna Dam. About five miles north of Laguna, on the Arizona side and about one half mile back from the river, were extensive shallow lagoons sprinkled with numerous water-killed mesquites. Here herons found seclusion and feeding grounds. April 22 to 25 we frequently saw individuals of the egret, to the number of three at one time; but because of the deep mud and water we were unable to stalk them. Usually they were seen in flight from one portion of the bog to another; one, however, was seen perched on a dead mesquite, preening.

We were told that in summer, after the overflow begins subsiding, there is a large influx of white herons and ibises from the south. This would appear to be accounted for by the abundant food-supply in the way of fish left in the drying ponds as the river lowers. This constitutes a local condition, therefore, serving to modify the seasonal movements of these birds.

There is in the Museum a skin (no. 4492) taken by J. G. Cooper at Fort Mohave, January 9, 1861.

***Butorides virescens anthonyi* (Mearns)**

Anthony Green Heron

First seen April 24, five miles above Laguna. Thenceforth common all along the river below, and up to the time of our departure, May 15. As far as observed up to the latter date the species was still in migration. We found no evidences of breeding. Seven specimens were taken, nos. 12645-12651, from Potholes, near Yuma, and near Pilot Knob, all on the California side.

***Nycticorax nycticorax naevius* (Boddaert)**

Black-crowned Night Heron

Eight specimens secured (nos. 12637-12644). Three, taken March 25 and April 20, are immatures in the streaked plumage; the rest are in more or less perfect adult plumage.

Since one individual was seen February 18, near The Needles, it is probable that the species winters in the region, though sparingly.

March 16 one was seen below Parker. March 25 about fifty night herons were found at a tule pond below Ehrenberg. Of these, approximately forty were in the streaked immature plumage, only the relatively small remaining proportion being fully adult-plumaged birds. Farther down the river the species was common, being often startled from diurnal roosting places in the willows bordering the river. Individuals were not seen stalking fish during the day, as did the blue herons; but their activity about sloughs and mud bars began with the dusk of evening, and, as indicated by their voices, continued all night.

Among the adult specimens are some, no. 12643 in particular, which are extremely pale, almost pure white beneath, with the outer surfaces of the closed wings very light lavender. These are noticeably paler than the few specimens at hand from elsewhere. We found no indication, however, that the species occurs in the region otherwise than as a migrant and winter sojourner.

There is in the Museum an immature specimen (no. 4496) taken by J. G. Cooper at Fort Mohave, March 12, 1861.

Grus canadensis (Linnaeus)

Little Brown Crane

Cranes were seen daily, March 1 to 8, in northward flight past The Needles. A large flock spent the night of March 9 on a mud bar in the river at the lower end of Chemehuevis Valley. This roosting ground was about midway between the high wooded banks of the river, and about two hundred yards from either bank. The cranes had thus selected a place which could not be approached except in the open, and were evidently on their guard all night. They were just opposite our camp; every now and then something would disturb them and a chorus of sonorous calls and wing-flappings would ensue for a minute or more.

It is believed that these migrating cranes are more likely to have been *Grus canadensis* than *Grus mexicana*. I believe the latter to be far less common, especially of late years, than generally supposed.

Recurvirostra americana Gmelin

Avocet

There is in the Museum a skin, no. 7069, taken probably by W. W. Holder, at "Mineral City" (=Ehrenberg), February 12, 1864.

Fulica americana Gmelin

Coot

Noted but sparingly: Six seen on a tule pond below Ehrenberg, March 25. Several noted along margins of the main river near Pilot Knob, May 9 to 15; here they found concealment among the overhanging masses of cane trailing in the water. Two specimens taken, nos. 12652, 12653.

Pisobia minutilla (Vieillot)

Least Sandpiper

A band of eight seen February 24, and another of a dozen February 27, on the Arizona shore a mile above Mellen; they were at the margin of an overflow pond. About a dozen were found similarly on the California side eight miles east of Picacho. Two specimens, nos. 12654, 12655, were secured there April 20.

Actitis macularius (Linnaeus)

Spotted Sandpiper

Frequently observed all along the river, on both sides, practically throughout the period of our work. First seen, two individuals, February 18, a little below Needles; last seen, six individuals, May 9, near Pilot Knob. In spite of the lateness of the last date, there was no evidence leading to the belief that the species breeds in the region. Two specimens, nos. 12656, 12657, taken March 20 near Riverside Mountain and March 31 near Pato Verde, are in winter plumage; a third, no. 12658, taken May 1, four miles below Potholes, is in full summer plumage.

Oxyechus vociferus vociferus (Linnaeus)

Killdeer

Noted sparingly, not more than a pair at one time, but at a number of points and almost throughout the season: Above Mellen, February 23; above Bill Williams River, March 14; near Riverside Mountain, March 17; opposite Cibola, April 1; eight miles east of Picacho, April 19; four miles above Potholes, April 23; five miles above Lag-

una, April 26; Potholes, April 28; five miles northeast of Yuma, May 2. In the last four cases the behavior of the birds at the time aroused the supposition that they were nesting in the respective vicinities. But recalling the tattler-like actions of the killdeer on occasions at other seasons, I do not now consider the evidence at all conclusive. Two killdeers were preserved, nos. 12659, 12660.

Lophortyx gambeli Gambel

Desert Quail

Desert quail were numerous on both sides of the river almost continuously down to the Picacho region. Below this they were notably scarce, in fact apparently wanting at several of our stations. A few were seen at Pilot Knob. Along the whole course of the river the quail are close associates of the mesquite and quail-brush (*Atriplex lentiformis*). They also forage widely on the adjacent desert, especially up the washes lined with catclaw and ironwood. But in all cases the river is their base, as they apparently need to drink both morning and evening. Stomachs of birds shot contained masses of mistletoe berries, and, at the time the mesquites were just coming into leaf, quantities of the tender green foliage of this plant. Nineteen specimens of the desert quail were preserved, nos. 12661-12679. The combined weight of three males shot February 21, five miles south of Needles, was sixteen ounces; of three females fifteen ounces.

There are in the Museum four skins (nos. 4446-4449) taken by J. G. Cooper at Fort Mohave in 1861.

Zenaidura macroura marginella (Woodhouse)

Western Mourning Dove

First seen February 25, on the Arizona side above Mellen; a flock of about seventy-five were scattered out feeding on the ground among the creosote and bushes of *Atriplex polycarpa*. Doves were not again noted until March 18, near Riverside Mountain; but thenceforth they were seen at nearly every station, and sometimes in considerable numbers. As elsewhere in desert regions, doves visited the water at dusk, arriving from a distance over the mesas. Up to May 13 in the vicinity of Pilot Knob, the species was still in evidence; it is probably resident in the region.

Four specimens were secured, nos. 12680-12683.

Melopelia asiatica trudeaui (Audubon)

White-winged Dove

First noted on the California side at Potholes, where, on April 29, one was heard in a willow thicket and finally secured (no. 12684, ♂). At our station on the California side, five miles northeast of Yuma, the species was common. The hoarse note, so characteristic of this dove, was to be heard at almost any hour of the day from the dense woods close to the river. As many as three were heard at one time from as many directions. Careful stalking usually resulted in discovering the performer among the uppermost branches, usually dead ones, of the largest cottonwood in the vicinity, surrounded by dense living willow and cottonwood timber. The crop of one shot here May 5 (no. 12685, ♂) contained thirty-three watermelon seeds and one muskmelon seed. In the bottom lands on both sides of the river in the vicinity of Pilot Knob white-winged doves were common. One was taken on the California side May 12 (no. 12686, ♀). This species is here a strict adherent to the willow association.

Cathartes aura septentrionalis Wied

Turkey Vulture

First seen, near Mellen, February 25; thenceforth of daily note everywhere we went, both in the river bottom and far out over the desert. Last observed May 13 at Pilot Knob. We were continually bothered in our mammal trapping by these birds. Wherever meat bait was used and the steel traps left out during the day unsprung, no matter how far back under thick bushes these were placed, and so concealing the setting from view, the turkey buzzards were almost certain to get caught. Fully two dozen were thus captured, and, being seldom severely injured, were usually released. One, no. 12687, was saved as a skin, and two more, nos. 12712, 12713, as skeletons. Another specimen in the Museum, a skin (no. 5937), was taken probably by W. W. Holder at "Mineral City" (=Ehrenberg), March 10, 1864.

Circus hudsonius (Linnaeus)

Marsh Hawk

February 23 an adult was seen on the Arizona side and an immature on the California side, both between Needles and Mellen. April 2 a marsh hawk flew north along the California side opposite Cibola.

Accipiter velox (Wilson)

Sharp-shinned Hawk

Apparently a common winter visitant to the Colorado River bottom, adhering closely to the willow belt. Seen in the vicinity of Needles, February 16, 20, and 21; at Mellen, February 24; in Chemehuevis Valley March 9; ten miles south of Cibola April 8; twenty miles above Picacho, April 14 and 16; and five miles above Laguna April 24. The latter date probably indicates about the time of departure. Two specimens were obtained, nos. 12690, 12691.

There is also in the Museum a skin (no. 4380) taken by J. G. Cooper at Fort Mohave, January 4, 1861.

Accipiter cooperi (Bonaparte)

Cooper Hawk

Seen in February and March; to our surprise this proved to be also a breeding species of the region. It was confined almost altogether to the timbered bottom lands. Definite points and dates of observation were: Mellen, February 26; above Bill Williams River, March 13; eight miles east of Picacho, April 19; four miles north of Potholes, April 23; five miles north of Laguna, April 24; Potholes, April 29; and five miles northeast of Yuma, May 3.

On April 19 a female bird (no. 12693), with two eggs, was secured on the California side eight miles east of Picacho. The nesting site was in a tract of tall willows, free from undergrowth, and closely paralleled by the river on one hand and an open mud flat on the other. The nest tree was relatively slender and leaning, its top about on a level with the crowns of the rest of the grove in the vicinity, and stood fifty yards from the river's edge. The nest was about twenty-five feet above the ground, lodged among the branches of the willow near its top, and was a small, loosely constructed platform composed wholly of dry willow twigs. The two eggs it contained were fresh. Although the female bird had already begun to sit closely, as we were able to determine because the nesting site happened to be only a few yards from our camp at this place, the set was incomplete. Dissection of the bird showed that two more eggs would have been laid.

One of the eggs of the set (Mus. no. 765) has sparse speckling of liver brown about the large end; both have equivocal nest stains; otherwise they are very pale Nile blue. They are *small*, measuring

in millimeters 45.0 by 37.2 and 45.6 by 36.5. The average for the species, as given by Bendire (1892, p. 195), is 49.0 by 38.5. This is another instance of diminution in the size of the eggs in the southern part of the range of a species. It is not paralleled in this case by decrease in size of the birds themselves. The three specimens of Cooper hawk obtained from the Colorado Valley (nos. 12692-12694) are in no respect smaller than individuals taken in the breeding season in the Transition zone, where large eggs are laid. The explanation possibly lies in the demands of the developing embryo for a larger supply of heat-producing food in the colder zone. Even though this species incubates closely, the temperature of the egg after deposition is doubtless affected to some extent by that of the outside air.

There is in the Museum an immature female specimen of this hawk (no. 4378) taken by J. G. Cooper at Fort Mohave, April 27, 1861.

***Buteo borealis calurus* Cassin**

Western Red-tailed Hawk

This hawk proved to be regularly distributed along the valley of the Colorado, both in its timbered portions and where it cut through mountains. Yet the species was not nearly as numerously represented anywhere along the river as it is ordinarily on the Pacific slope of California. Exact places of observation were: five miles below Needles; both sides of the river at The Needles; above Bill Williams River; Ehrenberg; ten miles below Cibola; twenty miles north of Picacho; four miles south of Potholes. All adults seen by us closely enough for determination in this regard, were in the light phase of plumage coloration. There is, however, in the Museum an adult female specimen (no. 4372) taken by J. G. Cooper at Fort Mohave, April 3, 1861, which is distinctly in the dark phase. There is also a specimen (no. 4373), same place and collector, taken March 7, 1861, which is in immature plumage, and at least as heavily marked as skins in like stage from the California coast region.

***Falco mexicanus* Schlegel**

Prairie Falcon

Two pairs were seen along the steep rock wall of the cañon immediately below the mouth of Bill Williams River. An evident aerie was noted some 200 feet above the water in a hole near the top of the face of a cliff.

Falco columbarius richardsoni Ridgway

Richardson Pigeon Hawk

There is in the Museum a female specimen (no. 4388) taken by J. G. Cooper at Fort Mohave, January 21, 1861.

Falco sparverius phalaena (Lesson)

Desert Sparrow Hawk

First noted March 31, two flying north over the river ten miles below Ehrenberg. Next observed April 15, twenty miles above Picacho. Otherwise found only in the saguaro belt on both sides of the river within five miles above the Laguna Dam. Here the species found favorable nesting sites in the deserted burrows in the giant cactuses, made by gilded flickers and Gila woodpeckers. A set of five eggs, in which incubation was far advanced, was found eleven feet above the ground in an eighteen-foot saguaro on the California side, April 23. An elf owl was taken at the same time from a hole in the opposite side of the trunk. The excavation in which the hawk's eggs were laid, opened to the south.

The only specimen secured by the expedition was an adult female (no. 12689) shot among the saguaros on the Arizona side of the river five miles above Laguna, April 22. This bird is markedly different from any one of a series of twenty-seven adult females from California, Nevada, Washington, Alaska, and the western United States generally, which series I would call *Falco sparverius sparverius*. Yet it does not accord, particularly in size, with Mearns's characterization (1892, p. 263) of *Falco sparverius deserticola*. As compared with average examples of *sparverius*, as represented in the series referred to, the specimen in question is decidedly smaller, except bill: wing 178, tail 113, tarsus 34, middle toe and claw 31, bill from nostril 11, culmen from cere 12, depth of bill 9.4; the browns of the upper and under surfaces are more reddish, the brown area on top of head very broad and pure cinnamon-rufous without trace of plumbeous shaft-streaks, the plumbeous of head reduced to narrow frontal and superciliary tracts continuous with one another, shaft-streaks of pectoral region narrow, barrings on dorsum very narrow, the widest only 3 mm. instead of 7.

It will thus be seen that in all essential respects this specimen meets with the description of *Falco sparverius peninsularis* Mearns (1892, p. 267), of the southern extremity of Baja California. Mearns expressly states in this connection that all of the sparrow hawks examined by him from the southern borders of California and Arizona are of the large "deserticolus" type. I might dispose of the peculiar Colorado River example by referring it to *peninsularis* without further ado. But I do not consider this a reasonable course, unless later acquisition of numerous specimens should show that the sparrow-hawk of the saguaro belt here and that of Lower California is normally like the one in hand and hence different from that of the surrounding regions. This I now doubt, preferring rather to consider the bird in question as an extreme of individual variation in the direction of *peninsularis*, but to be identified with the obvious geographic stock-form, *F. sparverius sparverius* (or *F. s. phalaena* Lesson [= *F. s. deserticola* Mearns], if a southwestern desert form be considered different from *sparverius* proper of the north and east).

There is in the Museum a male specimen (no. 4390) taken by J. G. Cooper at Fort Mohave, December 24, 1860. This may or may not have been a winter visitant. But it, too, is small as though possibly representative of a resident race. It measures: wing 175, tail 111, tarsus 31.0, middle toe and claw 31.3, bill from nostril 10.5, culmen from cere 11.1, depth of bill 9.2. In coloration this specimen, also, has the black markings of the mantle reduced to mere indications.

***Pandion haliaëtus carolinensis* (Gmelin)**

Osprey

One specimen (female, no 12688) taken April 17 on the California side of the river seven miles east of Picacho. Another seen flying over the river a mile or so above Yuma, May 5. Evidently a migrant through the region.

***Aluco pratincola* (Bonaparte)**

Barn Owl

Feathers of a barn owl were seen on the California side at Riverside Mountain. Its presence was nowhere else detected until we reached our last station near Pilot Knob. Here in a low bluff on

the California side, where the river swings northwest against the mesa, a nesting site was located as we floated past on May 5. The place was revisited on May 10, and the hole in the partly cemented gravel face, fifteen feet above the water, was ascertained to contain four downy young. Two of these were preserved (nos. 12695, 13979).

Otus asio gilmani Swarth

Saguaro Screech Owl

The widespread presence of screech owls was brought to our attention by their notes heard almost nightly and at nearly every one of our camps from Needles all the way down the river, clear to Pilot Knob. The birds appeared to occur both in the willow and cottonwood timber close along the river, and out on the desert. They were heard from the precipitous sides of The Needles, the numerous crannies in the rock walls of which may have afforded the birds daytime concealment. At Mellen, Arizona, February 27, a female screech owl (no. 12696) was captured in a trap set near the house of a wood-rat (*Neotoma albigula venusta*) under a mesquite and baited with portions of a wood-rat found partly eaten in the same trap the night before.

On the California side, twenty miles north of Picacho, April 16, one (no. 12697) was shot at night in a willow when giving the characteristic deep-toned succession of mellow notes; it proved to be a male.

April 23, on the California side four miles above Potholes, two were taken from holes in giant cactuses. A male (no. 12698) was taken from an otherwise empty cavity ten feet above the ground. A female (no. 12699) occupied a cavity nine feet above the ground. This hole was rather small, evidently originally excavated by the Gila woodpecker; but it held besides the old owl, three newly-hatched young (preserved as alcoholics, nos. 13976-13978), and the fresh, headless bodies of four mammals: two *Perognathus penicillatus penicillatus*, one *Dipodomys merriami merriami*, and one *Peromyscus maniculatus sonoriensis*.

The four adults specified above, together with a fifth in the Museum (no. 4395) taken by J. G. Cooper at Fort Mohave, February 24, 1861, are all typical of the subspecies *gilmani* as described by Swarth (1910, p. 1).

Bubo virginianus pallescens Stone

Western Horned Owl

The hooting of horned owls was heard almost nightly at every one of our camps, from Needles to Pilot Knob. The birds themselves were occasionally seen flying overhead at dusk, and twice, on the California side at Riverside Mountain and opposite Cibola, were flushed in the daytime from dense ironwood trees in desert washes back from the river. Three specimens were shot (nos. 12702-12704). These are markedly pale, as compared with *Bubo virginianus pacificus* of the coastal slope of southern California, and in their characters closely approximate specimens from central Arizona which in turn have been referred to *B. v. pallescens* (see Oberholser, 1904, p. 182).

Micropallas whitneyi (Cooper)

Elf Owl

The elf owl was detected only in the belt of saguaros which extends across the Colorado Valley within six miles above the Laguna Dam. The numerous excavations in the trunks of these great cactuses evidently furnish desirable diurnal retreats for owls of size small enough to render them usable. By chopping into many of the perforated saguaros we succeeded in capturing two of this species, nos. 12700 and 12701. The latter was taken on the Arizona side, April 22, from a hole twelve feet above the ground. The cactus in which it was located was a single column thirty-one feet high and twenty-six inches in diameter. In the same trunk, four and one-half feet higher up, was an occupied nest of the gilded flicker. The other bird was taken April 23 on the California side four miles above Potholes. The cavity occupied in this instance was twelve feet above the ground in a three-branched saguaro eighteen feet tall and twenty-six inches in diameter.

In the same trunk one foot lower, but opening on the opposite side, was a cavity occupied by a sparrow hawk and its five eggs. Both owls were females, and each showed signs of immediate breeding. In one case dissection disclosed five large ova of graded size, the largest being an apparently full-sized yolk.

The locality where our California specimen was secured is some two miles west of the river and not far from the old Senator Mine. It is in a valley leading down from the hills and locally known as

the Senator Mine Basin. It was doubtless in the limited tract of saguaros here that Brown (1904, p. 46) found the species nesting on May 17, 1903, and secured two sets of four eggs each. We noted the old scars on the largest cactuses where holes had been chopped into, years before our visit. Brown's was the first authentic record of the elf owl for California. But Cooper found the species on the Arizona side of the river, near Fort Mohave, whence on April 26, 1861, he secured the type, now in the National Museum, though at one time the property of the State of California (see Cooper, 1870, p. 443).

***Geococcyx californianus* (Lesson)**

Roadrunner

Safely to be considered a common resident of the whole region traversed. Noted at every collecting station on either side of the river, from Needles to Pilot Knob. Noted with equal frequency on the upland mesas and hills, and on the first bottom even to the water's edge. The peculiar notes were on several occasions heard from opposite shores as we floated along, as though birds were answering one another from across the water.

Two examples came into our possession through being caught in meat-baited steel traps set for carnivorous mammals. The stomach of a roadrunner obtained at Needles contained remains of beetles and one half-grown lizard (*Cnemidophorus*).

The five specimens secured by us (nos. 12705-12709), and another (no. 4369) taken by J. G. Cooper at Fort Mohave, March 26, 1861, give a uniform impression at first glance of paleness, as compared with roadrunners from the Pacific slopes of southern and central California. This paleness consists in an apparent greater average extent of white markings and particularly in the whitening of the buffy lower surface and a paling of the buffy margins of the dorsal feathers. The Pacific slope series, however, includes specimens taken at all seasons of the year, and it becomes apparent at once that the deepest buffy specimens in it are those in the freshest (that is, fall) plumage. The variation in the Pacific series in this respect is great, and leads to the conclusion that the paleness of the buffy tints of the Colorado desert series, which are February to May examples, is not altogether intrinsic, but

due in part at least to an extreme amount of fading. This does not, however, account for the average greater extent of white areas on the individual feathers of the desert birds. But this feature is too variable in both series to be satisfactorily defined.

It is of course a remarkable exception if the roadrunner, a terrestrial, permanently resident bird of all the areas it inhabits, should not show some geographic color peculiarities. Indeed it is all the more strange that it does not show conspicuous differences in color tone in the arid and subhumid areas it occupies, when we observe the markedly different color tones exhibited by the thrashers, towhees, spermophiles, and jack rabbits of the same areas, these being also terrestrial animals.

The roadrunner's failure to conform to the rule offers a problem for those who would explain animal coloration wholly on the grounds of physiological response to meteorological conditions, irrespective of adaptive value.

***Ceryle alcyon* (Linnaeus)**

Belted Kingfisher

Our observations would indicate that this species occurred only as a migrant through the region. The first individual was noted April 6 on the California side below Cibola; another was seen on the seventh on the Arizona side ten miles below Cibola. In both these cases, and also subsequently, the birds were perched on snags intently watching the muddy current. But the futility of their scrutiny was apparent in that at no time was a kingfisher seen to plunge into the water in the characteristic fashion of the species when capturing a fish; the opacity of the mud-laden water was most certainly unfavorable to this mode of securing fish. Kingfishers, but one at a time, were seen April 19, eight miles east of Picacho; May 3, five miles northeast of Yuma; and May 5, near Pilot Knob.

There was not the least doubt in any of these instances that the bird seen was the large belted kingfisher and not the little Texas green kingfisher. Coues's oftquoted statement (1866, p. 59) that he observed the latter species "at several points on the Colorado River between Forts Mohave and Yuma" in the autumn of 1865 remains unconfirmed by any later observation.

Dryobates scalaris cactophilus Oberholser

Cactus Woodpecker

Common resident of the willow and mesquite associations along the whole of the explored portion of the river. In but one place was the species seen outside of the riparian strip. The exceptional case was on the Arizona side above Mellen, where several individuals were seen over a mile up the Sacramento Wash, affecting dead or sickly palo verde trees. At Needles, February 17 and the few days following, this woodpecker was common in certain portions of the river bottom, where, however, its habit of working near the ground in young growth, together with its winter quietude, rendered it very inconspicuous. Within a month later, those seen along down the river had become noisy, and the presence of the species was readily detected, even as we floated along from one station to another.

On April 11, on the California shore twenty miles north of Picacho, a nest was found situated twelve feet above the ground in a willow stub, the upper part of which was dead and centrally decayed. The excavation freshly made in this by the birds opened on the under side of this slanting terminal section. There were three eggs on the point of hatching, and one newly hatched young, showing the date of egg-laying to have been toward the last of March.

On the California side below Potholes parts of the willow area had been burned over as a preliminary to clearing the land. The woodpeckers here were much discolored ventrally by contact with charred tree trunks, yet they appeared to be thriving quite as well as if arrayed purely in their normal colors.

Fourteen specimens of the Texas woodpecker were secured, nos. 12714-12727. Besides these there are in the Museum six skins (nos. 4315-4320) taken by J. G. Cooper at Fort Mohave, December 31, 1860, and in January and February, 1861; and another taken at "Mineral City" (=Ehrenberg) March 10, 1864, collector not recorded.

For the use of the name *cactophilus* in replacing the older name *bairdi*, formerly in general use for this woodpecker, see Oberholser (1911, p. 152).

Sphyrapicus varius nuchalis Baird

Red-naped Sapsucker

Evidently a winter visitant to the Colorado Valley, where we found it for a time common among the willow thickets. Localities of capture

were: the immediate vicinity of Needles, opposite The Needles, and Lower Chemehuevis Valley. At the first two places several were seen that were not also taken; at the latter point but the one, taken March 11, was noted. This probably indicates the approximate date of departure from the region, as we saw none thereafter. Willows were the trees attacked by this woodpecker; but in one case a single large mesquite, and only this one out of many in the vicinity, had been selected for bleeding, and its main trunk and larger branches were plentifully bored. I visited this tree many times during the space of three days, March 2 to 4, opposite The Needles, and invariably found a sapsucker working about the borings. I shot two of the birds at this mesquite, and there was still one there the last time I visited the tree, although I had never seen but one at a time there.

The five specimens secured (nos. 12728-12732), all from the California side, are characteristic of the subspecies.

There is a skin in the Museum, no. 4312, taken by J. G. Cooper at Fort Mohave, February 20, 1861.

***Centurus uropygialis* Baird**

Gila Woodpecker

A common and characteristic resident the whole length of the region, from Needles to the vicinity of Yuma. Found at every station on both sides of the river. While regularly present in the willows and cottonwoods of the river bottom, the species occurred also up the desert washes a mile or more from the edge of the riparian strip. This was the case on the Arizona side above Mellen, and on the California side opposite Cibola, and on the Arizona side ten miles below Cibola. At the latter two points Gila woodpeckers were feeding on mistletoe berries in the ironwoods. At the last named place, an excavation fifty-four inches above the ground in a dead broken-off branch of a palo verde contained a single fresh egg, April 7. The nest cavity appeared to be an old one, perhaps dug out the year previous. On the California side twenty miles above Picacho a nest was found twenty-five feet above the ground in a broken-topped living willow, the core of which was rotten. There were three small young, April 15.

The Gila woodpecker was one of the birds conspicuously associated with the giant cactus. Where a scattering growth of this plant reached nearly to the river on the Arizona side east of Ehrenberg, several of these birds were encountered far out on the mesa and many of the

larger cactuses contained from one to four holes each. At the date they were examined, March 27, egg-laying had not yet commenced.

Where the better defined belt of saguaros meets the Colorado above the Laguna Dam, with well represented tracts on both sides of the river, the Gila woodpecker abounded. The availability of satisfactory sites would therefore seem to be the prime factor in governing the local distribution of this species. For the cactus itself certainly would not seem to afford food, except during the fruiting season, or other attractions.

In this vicinity nests were found in saguaros as follows: On the Arizona side, five miles above Laguna, April 24, a set of three fresh eggs, twelve feet above the ground; on the California side, four miles above Potholes, April 23, nest (not investigated) twenty-four feet above the ground; another nest, same place and date, fourteen feet above the ground, with four small young.

In the same vicinity Gila woodpeckers were nesting also in dead cottonwoods in the river bottom. The birds appeared to find favorable foraging grounds both in the riparian tracts and out on the desert.

A series of twenty-three adult specimens was taken, nos. 12733-12755.

There are five other skins in the Museum, nos. 4330-4334, taken at Fort Mohave by J. G. Cooper, December 24 and 25, 1860, and February 4 and March 12, 1861. It is to be remarked that not an iota of difference, save as is accountable for by extraneous causes, is observable between the Cooper birds obtained fifty years ago and the freshly obtained material. Considering the rather intricate color pattern and the opportunity thus afforded for the detection of determinate or any other sort of variation, this is indicative of constancy of characters under natural conditions through a long series of generations.

Colaptes cafer collaris Vigors

Red-shafted Flicker

Evidently a common winter visitant. Noted daily the third week of February in the willow timber of the river bottom below Needles, and early in March in the narrower willow association on both sides of the river opposite The Needles; likewise in Chemehuevis Valley. The last individual of the species observed, was shot in the willows on

the California side near Riverside Mountain, March 16. Five specimens in all were secured, as listed in the table presented under the discussion of *Colaptes chrysoides mearnsi*.

There is in the Museum another skin (no. 4325) taken by J. G. Cooper at Fort Mohave March 12, 1861.

***Colaptes chrysoides mearnsi* Ridgway**

Mearns Gilded Flicker

Detected by our party only in a restricted area within six miles north of Laguna Dam. This area of occurrence coincided with the westward extension across the Colorado Valley at this point of a belt of the giant cactus, or saguaro. Here this woodpecker was fairly common, probably as a permanent resident. While closely restricted on the desert to the saguaro belt, at least two pairs were nesting in dead cottonwood stumps in the drowned-out area of the river bottom. A nesting hole located here was eighteen feet above the ground, in a large stub. It is probable that the species occurs, or has occurred in the past, along the bottom timber up and down the river, though not seen by us. The year 1910 may have been one of a series of unfavorable years when the range of the species was retracting through dying-off of the frontier individuals. We saw near Pilot Knob and at several places above Pieacho excavations in willows and cottonwoods, which were too large for the Gila woodpecker, and in all probability were made some years before by gilded flickers. Moreover, the Museum contains two of Cooper's specimens, taken at Fort Mohave, considerably above Needles, February 23 and April 2, 1861 (nos. 4328, 4329). Cooper (1870, p. 411) found "two pairs" there, in cottonwoods.

Nests of the gilded flicker were found by us, in the saguaro belt above referred to, as follows: On the Arizona side, April 22, excavation sixteen and one-half feet above the ground in cactus thirty-one feet high, contained two fresh eggs; April 24, excavation twenty feet above the ground, not investigated. On the California side, April 23, excavation ten and one-third feet above the ground, in cactus twenty-eight feet high, contained one infertile egg and two small young. The two parent birds taken with the latter had their gullets distended with a mass of small black ants and ant larvae. It was in this same place that Brown (1904, p. 46) found a nest of this bird in 1903.

Of the five specimens secured by us only one has the shafts and under surfaces of the wings and tail yellow as in the two Cooper specimens from Fort Mohave. Reference to literature shows that this yellowness is generally supposed to be a constant character of *chrysoides*. In fact I find but four recorded exceptions: Brewster (1883, p. 25) mentions a specimen taken at Tucson, Arizona, as "having the yellow of the wings and tail replaced by orange, while the shafts of many of the feathers show an even stronger reddish cast, those of the rectrices at their bases being especially deep in color." Brewster remarks further that "this departure from the normal coloring undeniably narrows the gap which separates *chrysoides* from *mexicanus* [= *collaris*], but it may be merely a chance reversion, or, what is perhaps still more likely, the specimen in question may be a hybrid." Coues (1903, p. 602) observes that "gradation between this form [*chrysoides*] and *C. mexicanus* [= *collaris*] has not yet been observed."

Swarth (1905, p. 27) discusses at length an aberrant specimen from the Papago Indian Reservation, Arizona, evidently in the same category as Brewster's. Swarth considers this a hybrid between *chrysoides* and *collaris*, although he goes on to say that he found these two species in that region "breeding almost side by side, practically without mixing," and this seems strange "when we consider the extensive hybridization that takes place in the northwest, where *collaris* and *luteus* come together."

Breninger (1898, p. 13) reports two supposed hybrids between the "gilded" and "red-shafted" flickers. But these are probably of the same nature as Brewster's and Swarth's.

The abnormal appearance of four out of five of the flickers collected by us on the lower Colorado, and the circumstance that this abnormality consists in a redness approximating the color of corresponding areas in *collaris*, led us to conclude at the time that we had there found *chrysoides* and *collaris* hybridizing. The chief characters of the specimens in question are shown in an accompanying table; also the corresponding characters of those examples of *collaris* taken by us in the Colorado Valley. The latter, it should be emphasized, are believed to have been winter visitants to the region, and not representative of the breeding species.

No. 12761, male of typical yellow *chrysoides*, and no. 12762, female with under surfaces of wings and tail coral red, were a mated pair, the parents of the young found in a saguaro on the California side. These young, preserved as alcoholics, are in too early a stage for the

colors in the rudiments of their feathers to be ascertained. Nos. 12763 and 12764, both with reddish coloration, were a mated pair taken in the overflow bottom on the Arizona side. No. 12765, of reddish type, was taken on the desert on the Arizona side.

The salient fact shown by this comparative examination is that *in all other characters* the specimens aberrant in color of wings and tail, are perfectly typical of *chrysoides* (that is, of its subspecies *mearnsi*). None of the phenomena consequent upon hybridization is evinced in other particulars, such as general size, proportional dimensions, extent of dorsal barring, colors of body and head. In all these characters there is no nearer approach of the red-shafted *chrysoides* to *collaris*, than of the yellow-shafted *chrysoides*.

My conclusion is that the strain of *chrysoides* occurring at the present time in the lower Colorado Valley shows proneness to replacement of yellow by red, without there having been any interbreeding with another species. This may be accounted for chemico-physiologically, as in the case of the linnet of the Hawaiian Islands, where, however, the change has been from red to yellow. (See Grinnell, 1911, p. 191.) According to this idea there has been some cause, germinal or somatic, affecting the oxidation of the basic chromagen, so that in the critical instance the process is going beyond the stage of yellow-production and reaches the red-production stage. The phenomenon at the present time may be purely sporadic; on the other hand it may be an incipency of a character which, beginning in this center of differentiation, may become fixed and heritable over a larger area, thus constituting the arising of a new species. The flickers collected were only a few out of the large population which probably occupies the extensive tract of saguaros widening out to the eastward of the river in Arizona. Observation in the same region at successive times in the future will afford data indicative of the real significance of the phenomenon.

It is quite evident that the aberrant examples described by Brewster and by Swarth from central Arizona, as referred to above, are of the same nature as the Colorado Valley specimens. The chances are that they were not hybrids. So far as shown by the literature at hand, no unquestioned hybrids have been found between *chrysoides* (or any of its subspecies) and *collaris* or *cafer*.

MEASUREMENTS IN MILLIMETERS AND COLOR FEATURES OF *COLAPTES*
CHRYSOIDES MEARNSI FROM THE COLORADO VALLEY

No.	Sex	Wing	Tail	Culmen	Dorsal barring	Color of lower surface of wings and tail	Whole top of head to level of eyes	Throat, fore-neck and sides of head
12761	♂	152	100	40	barely indicated	chrome ² yellow	bright cinnamon	clear gray, no. 9
12762	♀	145	87	35	distinct but reduced	pale coral red	bright cinnamon	clear gray, no. 9
12763	♂	147	91	35	slightly indicated	pale saturn red	bright cinnamon	clear gray, no. 9
12764	♀	149	88	34	well-defined though narrow	pale coral red	bright cinnamon	clear gray, no. 9
12765	♀	142	93	36	well-defined though narrow	pale coral red	bright cinnamon	clear gray, no. 9
4328 ¹	♀	154	94	38	narrow but distinct	chrome yellow	bright cinnamon	clear gray, no. 9
4329 ¹	♀	147	91	37	well-defined though narrow	chrome yellow	bright cinnamon	clear gray, no. 9

¹ Cooper's Fort Mohave specimens.² Color names from Ridgway's *Nomenclature of Colors*, 1886.
 MEASUREMENTS IN MILLIMETERS AND COLOR FEATURES OF *COLAPTES*
CAFER COLLARIS FROM THE COLORADO VALLEY

No.	Sex	Wing	Tail	Culmen	Dorsal barring	Color of lower surface of wings and tail	Top of head between lighter super- ciliary areas	Throat, fore-neck and sides of head
12756	♀	161	110	37	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12757	♂	165	108	39	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12758	♂	161	109	—	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12759	♂	165	111	41	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6
12760	♂	170	113	38	broad and conspicuous	deep coral red	broccoli brown	clear gray, no. 6

Phalaenoptilus nuttalli nuttalli (Audubon)
Nuttall Poor-will

Phalaenoptilus nuttalli nitidus Brewster
Frosted Poor-will

Poor-wills were first noted the evening of February 28 at Mellen; then March 3, at The Needles; thenceforth at every one of our stations all the way down the river to Pilot Knob, May 12. The mellow call was heard practically every night when the wind was not blowing. As with the nighthawks, the poor-wills appeared to spend the day out on the desert. One individual was flushed near Ehrenberg from the stony surface of a wash in the shade of a palo verde. In the evening the birds appeared at dusk in the river bottom, alighting in characteristic fashion on spaces of bare ground or in roads, not infrequently on mud bars in the river, or skimming low over the water itself. Their proneness to alight on the wet mud at the edge of the water was evidenced by the packed balls of mud firmly dried on the toes of several of the birds shot. In the evening of April 19, eight miles east of Pieacho, fully a dozen poor-wills were observed. There was a lot of broken-down fencing close to the river near our camp at this point; the birds congregated here as a basis for foraging and consociating, resting on the posts as well as on the prostrate poles, evidently in preference to alighting on the sticky mud of an overflow depression on the one hand or the river margin on the other.

The series of eighteen specimens of this bird secured at once aroused inquiry because of the large range displayed in size and pattern of coloration. Even in the field, as the specimens were collected, conspicuous differences were noted and the suspicion aroused that really two subspecies were represented, one being the resident breeding form, the other a winter visitant. The first clue to discrimination came through observing the state of activity of the reproductive organs. Of two birds shot the same evening at Riverside Mountain, one, no. 12780, with testes small, was relatively large, dark, and coarsely marked; the other, no. 12781, with testes very large, was small in general size, narrow-barred, and notably pale. In five other birds, field examination showed the same relative state of affairs (see accompanying tables). It is of course regrettable that state of reproductive activity was not recorded of all the poor-wills taken.

The seven birds, dissected in the field by the writer, would seem to provide adequate basis for the conclusion that two races were repre-

sented, in spite of the fact that of the remainder of the series it is difficult to allocate certain examples with one or the other category. This has finally been done, however, as shown in the tables. The first character employed for separation, and the only one holding throughout the present series, is the style of black marking on the medial scapulars. In the resident form, for which I am using the name *nitidus*, these markings are narrow and more V-shaped or hastate; in the presumably migratory form, which I am calling *nutalli*, these markings are broad, sagittate to rhomboid. I am inclined, however, to believe that this character, like the others pointed out beyond, will be found to fail in some cases; for a skin at hand from the Huachuca Mountains, Arizona (no. 10324), is otherwise good *nitidus* as here understood, but the scapular markings are broadly rhomboid. In the Colorado series, believed to represent two forms, any of the remaining characters are not separately diagnostic in every case. But the series is found divisible with fair precision as indicated in the tables, by an aggregate of characters.

Besides the scapular marks above specified, the black barring across the primaries averages narrower in *nitidus* than in *nutalli*, and their transverse trend is zigzag in the former, more squarely defined in the latter. The transverse dark barring on the posterior lower surface averages narrower again in *nitidus*, coarser in *nutalli*. The ground-color, whitish or hoary, is not only more extended in *nitidus* but of a clearer white tone. In general size *nitidus* is distinctly the smaller, and it appears to have a more rounded wing, indicative of less extended migratory flight.

While in each of these characters variation leads from one extreme to the other, there are clearly two modes. The theory suggests itself as accounting for this, that there are two unstable phases in the poor-will, irrespective of locality, sex or age, a condition which has been verified in the case of certain owls. But the facts as here presented militate against either that idea or the contention that the paleness develops with individual senility. All the above characters are paralleled in such birds as are represented by races occupying the deserts on the one hand and the more northern and less arid regions on the other. Some of the *nutalli* examples are precisely like poor-wills in the Museum collected from Humboldt County, Nevada. No skins examined from anywhere north of the Colorado Valley show characters of *nitidus*.

The inference is that the *nuttalli* of the Colorado Valley are winter visitants from the Great Basin region. That these, however, are identical with typical *nuttalli*, described from South Dakota (according to A. O. U. *Check-List*, 1910, p. 197), is problematical. I have had no opportunity for comparison of relevant material. Neither is there assurance that the Colorado Valley *nitidus* is typical of the form bearing that name and described from the Nueces River, southern Texas (Brewster, 1887, p. 147). In the original description of the latter, restriction of dark markings and general paleness are emphasized characters, which are in accord with the Colorado Valley *nitidus*. Ridgway (1887, p. 588) adds the character of small size. The difference in facial mottling, mentioned by both of the authors just cited, is not clearly in evidence in the Colorado Valley material.

It is to be remarked that *Phalaenoptilus nuttalli californicus*, represented by specimens from central and southern California west of the desert divide, is well differentiated from both of the forms here pointed out. Three races of the poor-will thus occur within the state of California, and as there are good grounds for believing that *P. n. nuttalli* summers east of the Sierran divide in northeastern California, all three probably breed within the limits of the state.

In this connection sixty-seven adult-plumaged poor-wills have been examined.

LIST AND DIMENSIONS IN MILLIMETERS OF *PHALAENOPTILUS NUTTALLI*
NUTTALLI FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	9th primary exceeds 10th by	Wing formula
12780	♂ ¹	Riverside Mt., Calif. side	Mar. 18	145.5	89.0	5.5	9-8-10-7
12785	♂ ¹	Opposite Cibola, Calif. side	Apr. 2	140.0	88.2	too worn	.....
12791	♂ ¹	8 mi. E. Picacho, Calif. side	Apr. 18	136.3	84.0	too worn	.....
12777	♂	Chemehuevis Val., Calif. side	Mar. 10	133.8	80.3	4.7	9-8-10-7
12788	♂	10 mi. S. Cibola, Ariz. side	Apr. 7	142.4	82.0	too worn	.....
12783	♂	Ehrenberg, Ariz. side	Mar. 27	144.3	82.0	7.4	9-8-7-10
		Average of the males,		140.4	84.2	5.9	
12790	♀ ¹	8 mi. E. Picacho, Calif. side	Apr. 18	138.1	82.5	7.5	9-8-7-10
12789	♀	20 mi. N. Picacho, Calif. side	Apr. 10	144.2	82.5	7.1	9-8-7-10
12784	♀	Opposite Cibola, Calif. side	Mar. 31	142.7	85.6	8.7	9-8-7-10
12779	♀	Riverside Mt., Calif. side	Mar. 18	139.0	80.0	4.7	9-8-7-10
12776	♀	Chemehuevis Val., Calif. side	Mar. 10	138.0	85.0	5.2	9-8-10-7
12793	♀	5 mi. N. Laguna, Ariz. side	Apr. 22	141.0	81.2	5.5	9-8-7-10
		Average of the females		140.5	82.8	6.4	
		Average of the 12 specimens		140.4	83.5	6.2	

¹ Dissection showed reproductive organs to be inactive.

LIST AND DIMENSIONS IN MILLIMETERS OF *PHALAENOPTILUS NUTTALLI*
NITIDUS FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	9th primary exceeds 10th by	Wing formula
12781	♂ ¹	Riverside Mt., Calif. side	Mar. 18	132.8	79.8	7.9	9-8-7-10
12786	♂ ¹	Opposite Cibola, Calif. side	Apr. 2	135.4	82.8	6.0	8-9-7-10
12787	♂	Opposite Cibola, Calif. side	Apr. 3	133.1	83.7	5.7	9-8-7-10
12778	♂	Above Bill Williams River, Ariz. side	Mar. 14	140.3	82.1	10.0	9-8-7-10
		Average of the males,		135.4	82.1	7.4	
12782	♀	Above Blythe, Calif. side	Mar. 23	130.7	77.3	5.2	9-8-7-10
12792	♀ ¹	8 mi. E. Picacho, Calif. side	Apr. 19	131.9	77.0	6.5	8-9-7-10
		Average of the females,		131.3	77.1	5.8	
		Average of the 6 specimens,		134.0	80.3	6.9	

¹ Dissection showed reproductive organs to be much enlarged.

***Chordeiles acutipennis texensis* Lawrence**

Texas Nighthawk

First seen on March 9, on the California side in Chemehuevis Valley—one individual at dusk flying north. Next, March 27, on the Arizona side at Ehrenberg. Thereafter common at all stations, appearing each evening at dusk over the river and its flood plain. Not observed anywhere in the riparian strips during the day, but often flushed from the desert floor, usually from the scanty shade of a creosote bush.

A specimen shot on the Arizona side five miles above Laguna, April 24, had a spine-cushion of a cactus firmly stuck into the right carpal joint. This impediment, evidently picked up from the ground some time previously, had proven so serious a handicap as to result in the bird's emaciated bodily condition. It would probably have resulted finally in the death of the bird, as the spines were deeply imbedded in the tissues. Accidents of this sort may not be infrequent and thus introduce an additional factor into the economy of desert bird-life.

Near Pilot Knob, May 8, a Texas nighthawk was flushed from its complement of two fresh eggs. These lay on bare gravel between pebbles in the shade of a creosote bush on the hot glaring mesa. They are of the size and type of coloration usual with this species.

The eight skins preserved, nos. 12766-12773, show no peculiarities as compared with specimens from the San Diego and San Joaquin

districts of California. It is quite possible that the species is a comparatively recent invader of the latter regions, hailing originally from the more arid deserts, with which its pale coloration would appear to associate it most closely.

There are in the Museum two skins (nos. 4185, 4186) taken by J. G. Cooper at Fort Mohave, April 23 and May 23, 1861.

Chaetura vauxi (Townsend)

Vaux Swift

Appeared as a migrant. First seen at Potholes. April 29, two individuals; next, one, on the following day, four miles south of Potholes. Very many were observed May 4 along the California side five miles northeast of Yuma; these were flying in a general northerly direction across the woods and river, irrespective of the local trend of the latter. May 5 a flock was seen at the mouth of the Gila, near Yuma. May 9 the last was seen, a single individual among cliff swallows near Pilot Knob. Two specimens secured, nos. 12774, 12775.

Aëronautes melanoleucus (Baird)

White-throated Swift

Observed as follows: March 1 and 5, on the Arizona side among The Needles, seen to enter a slanting crack in the face of the cliff; April 4, on a precipitous mountain peak about five miles west of the river opposite Cibola, seen to enter and leave a crevice in the rock wall; April 19, eight miles east of Picacho, flying overhead; May 2, four miles south of Potholes, overhead. Not more than two individuals were noted at any of the above localities.

Archilochus alexandri (Bourcier and Mulsant)

Black-chinned Hummingbird

First noted March 3, one of each sex, on the California side opposite The Needles; next March 7, several on the Arizona side at the foot of The Needles. Here they were feeding about the flowering bushes of *Lycium andersoni*. Noted on the California side in the lower Chemehuevis Valley, March 9, one specimen; several on the Arizona side above Bill Williams River, March 13 and 14; several at River-

side Mountain, March 17 to 21. At our station above Blythe, March 22 and 23, this hummer was for the first time numerous, both males and females occurring along the desert edge of the riparian bottom, feeding among bushes of *Lycium andersoni*. At Ehrenberg the last week of March and opposite Cibola the first week in April, the species was abundant in the desert washes, feeding about the profusely blossoming palo verdes. Noted at all stations below the latter point, though in lesser numbers.

The males were more seldom seen, and the females became closely restricted to the willow strip along the river, in which association we were convinced that this was the only species of hummingbird breeding. The males were not seen in the willows, but only in the mesquite association and up the desert washes. The females foraged everywhere except on the desert mesa, but nested exclusively in the willows. Nest-building was in progress April 12, on the California side twenty miles north of Picacho. Nests, each with two small young, were found April 18 and 20, on the same side eight miles east of Picacho. Many full-grown young-of-the-year were feeding about the lavender flowers

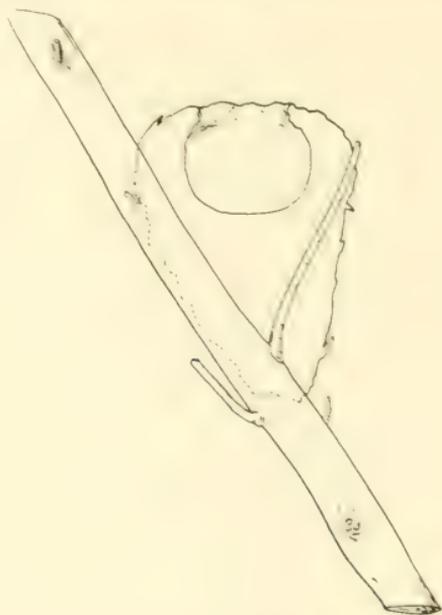


Fig. G. Vertical sectional diagram of nest (no. 769) of *Archilochus alexandri*. Note position as regards supporting stalk, and construction of rim (see text, p. 145). $\times \frac{2}{3}$.

of ironwoods in washes near Pilot Knob, May 13. The breeding season of this hummingbird in this region is thus definitely indicated and shows itself to be just about one month earlier than on the Pacific slope of southern California.

Of the nests above referred to, one was placed eight feet above the ground on a dead willow twig, in a close-set grove of tall willows. The other was four feet above the ground on a slanting dead stalk of arrowweed beneath a large spreading willow. In structure and composition the nests are of the compact type peculiar to this species as compared with those of the Costa. The body of the nest in one (no. 769) is closely felted cottonwood and willow down. The whole outer surface is closely beset with small yellow and green leaves gathered where dried, on the lower portions of arrowweed stalks, and attached with web. A conspicuous feature is the extreme constriction of the rim, as shown in the accompanying sectional diagram (fig. G). Even if the supporting stalk were bent down to a horizontal position, there would be no likelihood of eggs or young falling out, because of the depth of the cavity and narrowing of the neck at the top. This maximum in complexity of construction, accompanying, as it does, situation upon a tall, slender, and easily swayed stalk, shows marked adaptation in the habits of the bird to meet the special conditions imposed by its nesting site.

The four newly hatched young (numbered 13985, 13986) are of interest in one particular in that they show a double row of down filaments along the dorsal tract, thus indicating the presence of a partial natal plumage, which plumage has been supposed to be unrepresented in the Trochilidae.

Eighteen adult examples of the black-chinned hummingbird were preserved, nos. 12794-12811.

There is also in the Museum a skin (no. 5882) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 20, 1864.

***Calypte costae* (Bourcier)**

Costa Hummingbird

First seen February 26, a male flying northward near Mellen, Arizona. Next noted March 1, opposite The Needles, and for the *andersoni* which were at this time profusely laden with flowers. A succeeding week very common along ravines on both sides of the river at The Needles. They were feeding about the spiny bushes of *Lycium andersoni* which were at this time profusely laden with flowers. A

tall-stalked milkweed (*Asclepias subulata*) growing high among the precipitous peaks was also an attraction; so, too, a sage (*Hyptis emoryi*). The latter was about the only shrub growing on the walls of steep-sided gulches at Riverside Mountain, and here two old nests of the Costa hummingbird were found on horizontally projecting or drooping branches of the plant. Another nest found March 16 was five feet above the bed of a wash and contained two eggs; on the 19th the eggs were hatched.

This hummingbird was pre-eminently a desert species; it was only casually noted even as a forager within the riparian set of associations. It was thus complementary in its local distribution to *Archilochus alexandri*. It was more abundant in the early part of the season than later. This may have been due to local variation in favoring conditions as we traversed the region; or it is quite likely that the males and, as soon as able, the young and females largely departed from the desert floor to seek feeding grounds on the higher desert ranges.

Besides the localities mentioned above, the Costa hummingbird was noted in Chemehuevis Valley, above Bill Williams River, opposite Cibola, twenty miles above Picacho, and at Pilot Knob. At the latter point, May 13, full grown juvenals were feeding about flowering ironwoods.

Seventeen adult specimens of the species were obtained, nos. 12812-12828.

Tyrannus verticalis Say

Western Kingbird

First seen, two individuals, March 24, at Ehrenberg; next, three individuals, March 29, at the same place; thereafter noted frequently at various points down the river. On the Arizona side five miles above Laguna, where there were many dead cottonwoods, many kingbirds were to be seen in pairs May 25; and their behavior led me to suspect them to be about to nest. The same condition held in the river bottom on the California side four miles below Potholes. No actual nests were seen, however. Many individuals believed to be in migration were seen at Pilot Knob, May 12. Seven specimens of this bird were taken, nos. 12829-12835.

There is also in the Museum a skin (no. 4295) taken by J. G. Cooper at Fort Mohave April 25, 1861.

***Myiarchus cinerascens cinerascens* (Lawrence)**

Ash-throated Flycatcher

Our capture of an example of this flycatcher as early as February 19 in a willow tract on the California side five miles below Needles, would appear to indicate that the species winters in the region. This idea is further borne out by Cooper's observation (1870, p. 317) that he encountered an individual at Fort Mohave January 15. On March 8 in the willow groves in Chemehuevis Valley we saw three ash-throated flycatchers; on March 9, two. Thenceforth the species was noted regularly. It was common above Bill Williams River, affecting a tract of mesquites as well as the willows; also at Riverside Mountain and above Blythe. At Ehrenberg, besides scattered individuals, several pairs were encountered March 27 in the saguaro belt back on the mesa; in each case the birds had obvious claims on some old woodpecker hole in a huge cactus trunk. Opposite Cibola and ten miles below Cibola individuals were seen to enter rotted-out cavities in iron-woods.

The species was less common at our stations twenty miles north of and eight miles east of Picacho. But in the saguaro belt on both sides of the river and within five miles above the Laguna Dam the ash-throated flycatcher was one of the characteristic breeding birds. The woodpecker holes in the giant cactuses are pre-eminently suited to these birds as nesting sites. A nest on the Arizona side was chopped out April 21 and found to contain one fresh egg. The nest cavity was five feet above the ground, and was bedded with a mass of burro hair and duck feathers. Another nest, found on the California side, April 23, was twelve feet above the ground in a cavity fourteen inches deep; composed of a closely packed mass of rabbit fur; there were four eggs in which incubation was well along.

Ash-throated flycatchers were further observed, though more sparingly, at our stations at Potholes, four miles south of Potholes, five miles northeast of Yuma, and at Pilot Knob.

A specimen (no. 4293) is in the Museum taken by J. G. Cooper at Fort Mohave April 13, 1861.

Our series of twenty-five specimens (nos. 12836-12860) was secured as a result of an unsuccessful attempt to detect the presence of some one of the Mexican forms which come regularly into southern Arizona. While it is probable that this series includes transient individuals, it is not possible to pick them out, and the majority are, for certain,

breeding birds. I cannot discern in the series as a whole any departure from the characters of *M. c. cinerascens* of the coast slope of California. The accompanying table shows the size and range of variation in certain respects of the Colorado Valley birds.

MEASUREMENTS¹ IN MILLIMETERS OF A SERIES OF *MYIARCHUS CINERASCENS CINERASCENS* TAKEN IN THE COLORADO VALLEY FROM NEEDLES TO YUMA, FEBRUARY 19 TO MAY 9, 1910

Males					Females				
No.	Wing	Tail	Culmen	Width of bill at nostrils	No.	Wing	Tail	Culmen	Width of bill at nostrils
12837	103.0	95.0	17.8	7.6	12836	93.0	87.0	16.4	8.0
12838	100.0	91.5	17.2	7.9	12846	92.5	85.5	17.0	7.7
12839	99.3	92.5	17.4	7.7	12847	93.5	85.0	16.7	7.1
12840	101.3	92.0	17.8	8.0	12849	97.7	89.3	17.2	7.7
12841	102.5	93.0	16.9	7.6	12852	92.2	82.7	17.5	7.4
12842	98.4	89.0	18.2	7.5	12853	94.0	84.7	16.9	8.0
12843	99.5	90.0	18.0	7.7	12855	91.7	83.8	17.6	7.2
12844	101.6	95.0	18.7	8.1	12856	92.3	85.3	17.8	7.7
12845	102.3	92.3	18.0	7.8	12857	96.0	88.4	18.4	7.8
12848	98.4	89.2	17.5	7.7	12859	94.0	88.5	17.8	7.3
12850	101.6	91.9	18.0	7.6	12860	95.5	87.2	18.0	7.2
12851	98.0	92.0	17.2	7.4	Average	93.8	86.1	17.4	7.6
12854	98.5	92.2	18.2	8.3	Maximum	97.7	89.3	18.4	8.0
12858	102.0	93.1	19.7	7.4	Minimum	91.7	82.7	16.4	7.1
Average	100.5	92.0	17.9	7.7	Mid-point of Range	94.7	86.0	17.4	7.5
Maximum	103.0	95.0	18.7	8.3	Variation				
Minimum	98.0	89.0	16.9	7.4	either side	3 1/4%	3 3/8%	5 3/4%	6%
Mid point of Range	100.5	92.0	17.8	7.8	of mid-point				
Variation either side of mid-point					2 1/2%	3 1/4%	5%	5 3/4%	

¹ See text under *Molothrus ater obscurus*, p. 157.

The table shows also the decided sexual difference in size in this species, and further that in both sexes there is greater variation in the size and relative narrowness of the bill, than in wing and tail length. Incidentally it would appear that females are subject to greater variation than males. All of the birds whose measurements are presented are comparable as regards stage of plumage wear and age; they are, at youngest, birds of the previous year.

Sayornis sayus sayus (Bonaparte)

Say Phoebe

In February and early March this species was met with in small numbers out on the desert mesas as well as on the lower slopes of the hills. But it was not found in the wooded bottom lands of the broader valleys nor along the river banks except where the rocky hills abutted close upon the water. The bird was evidently wintering in the region, as the several individuals seen in the town of Needles upon our arrival there, February 15, were much smoke-begrimed, showing that their plumage had been exposed to the local conditions for some considerable time.

The Say phoebe was further noted at Mellen, among The Needles, and above Bill Williams River, on the Arizona side; and, on the California side, opposite The Needles. As the season advanced this species was met with only sparingly and in the vicinity of nesting sites. A pair was noted at Ehrenberg March 28, flying about some adobe ruins. On the California side opposite Cibola, April 3, a pair was found in a steep-sided ravine two miles back from the river. A last year's nest, of usual construction and containing one dried egg, was found on a narrow shelf of rock itself a part of an overhanging conglomerate wall. A single bird was noted ten miles south of Cibola near some adobe ruins. Another was taken April 12 among the hills twenty miles north of Picacho. The species was last seen at Potholes, where one was observed on a telephone wire near the head works of the canal, April 29. Seven specimens were preserved, nos. 12861-12867.

Sayornis nigricans (Swainson)

Black Phoebe

Met with only during the early part of the season, and only close along the river, where it was fairly common. Favorite perches were tips of snags on mud bars, or twigs of trees fallen over into the river through undercutting of the bank. The species was noted at Needles, five miles below Needles, at Mellen, on both sides of the river in the vicinity of The Needles, in Chemehuevis Valley, at Riverside Mountain, and at Ehrenberg. One, the last noted, was seen on the California side opposite Cibola, April 5. As far as it goes, the evidence would seem to show that the black phoebe is only a winter visitant in the Colorado Valley. Five specimens were preserved, nos. 12868-12872.

Nuttallornis borealis (Swainson)

Olive-sided Flycatcher

One seen May 6 perched at the top of a willow stub in bottom land on the California side near Pilot Knob. Two seen near the same place, May 10. Undoubtedly migrants.

Myiochanes richardsoni richardsoni (Swainson)

Western Wood Pewee

First observed April 20, when a male was secured on the California side, eight miles east of Picacho. Next noted at Potholes, April 29; thenceforth in small numbers nearly every day, at the stations four miles south of Potholes, five miles northeast of Yuma, and at Pilot Knob. Most numerous at the latter point, May 6 to 12, where as elsewhere they were closely confined to the willow bottoms. Evidently only a migrant through the region. Eight specimens taken, nos. 12918-12925.

There are also in the Museum three skins (nos. 4305-4307) taken by J. G. Cooper at Fort Mohave, May 21 and 22, 1861.

Empidonax difficilis difficilis Baird

Western Flycatcher

First noted April 3, on the California side opposite Cibola, observed almost daily thereafter throughout the trip, the last being seen the day we left, May 15. Still, there is no evidence to indicate that the species remains to breed anywhere in the region. The migration appeared not to have reached its height until the second week of May when, in the willows of the bottom lands on both sides near Pilot Knob, western flycatchers were continually in evidence, through their unmistakable notes.

The fourteen skins preserved (nos. 12896-12909) are representative of the following localities: Arizona side: ten miles below Cibola, five miles north of Laguna; California side: opposite Cibola, eight miles east of Picacho, four miles south of Potholes, Pilot Knob. One specimen (no. 12909) is aberrant in that the lower surface has a peculiar blanched appearance, the sides of the belly and crissum being

distinctly whitish. This results in a casual similarity to *E. trailli*; all of the other characters are normal for *difficilis*, however.

There is also in the Museum a skin (no. 4302) taken by J. G. Cooper at Fort Mohave, May 20, 1861.

***Empidonax trailli trailli* (Audubon)**

Traill Flycatcher

First detected April 28 and 29, when several were discovered in a tract of willows on the California side within a mile below Potholes. There were several of the birds, keeping in the upper foliage of the trees on ground overflowed from the adjacent canal to a depth of two feet or less.

On the same side of the river five miles northeast of Yuma several Traill flycatchers were observed May 4 and 5 close along a rapidly filling slough lined with willows. On both sides of the river in the vicinity of Pilot Knob the species was frequently observed up to the date of our departure, May 15. The birds were never detected away from dense willow growths close to the water, just such a type of locality as is chosen elsewhere for nesting ground. This fact and the behavior of the birds led me to believe that they would nest in the vicinity. If so, this is the only *Empidonax* to breed in the lower Colorado Valley. Two specimens taken, nos. 12910, 12911, both males, are quite like more northern and western breeding birds.

***Empidonax hammondi* (Xantus)**

Hammond Flycatcher

First observed April 3, on the California side opposite Cibola; next April 6, at the same place; thereafter almost daily all along down the river, usually in the mid-branches of large willows. Thirteen specimens taken (nos. 12883-12895) from: Arizona side: ten miles below Cibola; California side: opposite Cibola, twenty miles above Pieacho, eight miles below Pieacho, Potholes, Pilot Knob. At the latter point the species was noted up to and including May 11. It appears that the species is only a transient through the region.

Empidonax wrighti Baird

Wright Flycatcher

In only one instance was the presence of this species ascertained, and the specimen secured happened to be the first *Empidonax* taken: no. 12873, male, shot from the upper branches of a willow in the then leafless first-bottom timber, on the California side, five miles south of Needles, February 19.

In spite of the largely increased extent of material illustrating this genus, the relative characters of *Empidonax griseus*, *Empidonax wrighti*, and *Empidonax hammondi* remain somewhat subtle. It would seem that *wrighti*, as I now recognize it, is much less common in the southwest even as a transient than formerly supposed, since out of the thirty-nine examples of the genus taken by our Colorado expedition but one is referable to *wrighti*.

To show upon what characters I base the discrimination of the *wrighti* example in the present case, a comparison with a picked average specimen of *hammondi* and of *griseus* is here given. All are males of apparently equal age and stage of plumage wear, this being very slight. The color differences are minute: *hammondi* is slatiest, *griseus* ashiest, *wrighti* intermediate; *wrighti* is greenest dorsally and pectorally; the outer web of outer tail-feather is distinctly white nearly to its tip in *griseus*, grayish white in *wrighti*, and but slightly paler than rest of feather in *hammondi*. The lower mandible is entirely blackish brown externally, in *hammondi*, dull or lighter brownish in *wrighti*, while in *griseus* it is blackish brown at tip and abruptly straw yellow for its basal two-thirds, brightest along the rami.

COMPARATIVE MEASUREMENTS IN MILLIMETERS OF THREE CLOSELY
RELATED SPECIES OF *EMPIDONAX* OCCURRING TOGETHER
IN SPRING IN THE COLORADO VALLEY

	No.	Sex	Wing	Tail	Tarsus	Exposed culmen	Bill from nostril	Width of bill at base	Depth of bill	Width of outer rectrix (at widest portion)	Interval between tips of lateral and central rec- trices in closed tail
<i>E. hammondi</i>	12894	♂	69.3	56.1	15.0	8.8	7.0	5.4	3.3	7.6	4.1
<i>E. wrighti</i>	12873	♂	71.0	61.8	18.4	10.1	8.1	6.0	2.9	8.3	3.5
<i>E. griseus</i>	12879	♂	72.0	59.2	18.8	12.9	10.0	6.5	4.6	8.6	0.9

The above are the measurements and features of coloration which I find of diagnostic value, in discriminating these three flycatchers. They apply satisfactorily to the transient flycatchers of Arizona and California. But the breeding ranges of these forms west of the Rockies are still imperfectly made out and there is undoubtedly extensive confusion in the literature.

***Empidonax griseus* Brewster**

Gray Flycatcher

With very little doubt this flycatcher is a winter visitant; but it was nowhere common. The first one noted was shot February 22, on the California side five miles below Needles. The next was secured March 10, also on the California side, in Chemehuevis Valley. Three were taken on the California side near Riverside Mountain; two on the same side opposite Cibola; and two on the Arizona side ten miles below Cibola. The last two were taken April 6 and 7. Nothing more was seen of the species after the latter date. Of the nine examples secured by us (nos. 12874-12882) all are males. This may be indicative of separate areas of wintering for the two sexes, or at least that those individuals wintering farthest north are males.

Two specimens (nos. 4300, 4301) taken by J. G. Cooper at Fort Mohave, April 11 and 27, 1861, are also males.

***Pyrocephalus rubinus mexicanus* Selater**

Vermilion Flycatcher

An adult male seen at Needles, California, February 14. A few, not more than six in all, noted March 27 to 29 in the vicinity of Ehrenberg, Arizona, where they remained in the sparse mesquite growth at the margin of the bottom farthest from the river. Fairly common April 1 to 5 on the California side opposite Cibola, where closely confined to a narrow strip of mesquite close to the river and along a lagoon. Here a nest was found, April 2, containing three eggs in which incubation was far advanced. It was fifty-four inches above the ground, saddled on the bare forking branch of a dead mesquite standing in an open area thirty-five yards from the river bank.

The nest (no. 767) is slight in bulk, but firmly constructed, mainly of straight short dry twigs held together and to the large supporting

branches with much cobweb; the rather shallow cavity (48 mm. wide by 17 deep) is lined with plant fibers, a few horse and cow hairs, and, most liberally, with down feathers from the desert quail. In spite of the absence of foliage on the tree, the nest was difficult to see even from a distance of fifteen feet, because of its small height above the branches on which it rested, and because its outer surface of gray twigs blended admirably with the striately shredded bark of the dead branches. One large branch extended above the nest, and gave partial protection from the sun, and certain other small branches may have helped some; but the sitting bird must have been compelled to endure the direct and intense sunshine a good part of the day. The nest was discovered only by flushing the bird, which sat very closely, and returned promptly when the intruder left the immediate vicinity. Only the female was seen on or close to the nest. The far more brilliantly colored male remained at a distance of twenty to fifty yards from the nest, selecting conspicuous perches on dead mesquites, from which it sallied forth after passing insects in ordinary flycatcher fashion. It sang musically early in the morning before sunrise, the song resembling somewhat that of the black phoebe, though of greater length and not so loud.

The nest and pair of birds were finally collected. The abdominal surface area of the female was found to be conspicuously modified for incubatory function, the skin being greatly thickened owing to the subcutaneous vascular development. The male had no such feature. This must have been an exceptionally early laying for the species in this vicinity, as other females taken showed no signs of breeding.

The vermilion flycatcher was next noted on the Arizona side five miles above Laguna, where it was fairly common on overflow land among drowned and living cottonwoods and dead mesquites. On the California side, four miles below Potholes, the species proved to be one of the most numerous of the birds present. Here the valley widens out; much land is being reclaimed for farming, and intersecting irrigation ditches supplied from the Laguna Dam conduct water throughout the region. There is much waste land as yet, and burning has killed many of the cottonwoods. In this sort of locality the vermilion flycatchers were found to be far more numerous than anywhere else; it would appear that here is a native bird of the Colorado Valley which will greatly augment in numbers with the settling of the region.

A peculiarity of the bird which impressed me was that by apparent preference it avoided green foliage, almost invariably perching on

dead branches or exposed tree-tips, where the brilliant colors of the male rendered each individual most conspicuous. Yet this same sort of perch, because of its being a good vantage point from which to get the widest survey for passing insects, was also preferred by the other flycatchers, such as wood pewees and western kingbirds. No instance came under my observation of the conspicuousness of the male vermilion flycatcher causing it to be molested save by human hunters.

A half-grown juvenal was taken May 2 at this last station. The species was seen nowhere else than as above stated. Eighteen specimens were secured (nos. 12938-12955).

Corvus corax sinuatus Wagler

Western Raven

Ravens were to be seen at practically every point of observation along our route from Needles to Pilot Knob. They were always noted singly or paired and were usually quiet. No young of the season were observed up to the time of our departure from the region. Ravens came to notice most frequently along the river as we floated down the swift current. Our boat was sometimes quietly carried into close proximity to an unwitting raven as it foraged for fish on some sand bar.

At a heronry on the California side, ten miles below Ehrenberg, a pair of ravens was observed circling close over some nests which had just been deserted by the startled herons. Nearby, a dead cottonwood stub had under it a number of broken heron egg shells which doubtless betokened a source of the ravens' food supply. The stomach of one of the ravens shot contained only some mammal hair and one spider.

In each of the three ravens secured the "concealed" grayish white of the hind neck is much whiter and more extended than in ravens from California west of the desert divide. In the latter it is ordinarily distinctly light gray; in the Colorado River birds it is so much lighter as to give a first impression of pure white contrasted with the black surface-plumage when the feathers are parted. In fact this impression was so vivid that for a time in the field we thought we had secured examples of *Corvus cryptoleucus*. But comparison of skins shows the concealed white of *cryptoleucus* to be actually much more snowy. And there is, of course, no difficulty in distinguishing *sinuatus* from *cryptoleucus* when measurements are compared, the former being very much the larger (see accompanying table).

The Colorado River ravens, as shown by the accompanying table, are of the usual *sinuatus* dimensions. The whitening of the basal or down portions of the nuchal feathers in desert representatives of the *corax* group would seem to be a modification in the direction of the condition as it finds its extreme in *cryptoleucus*, and probably because of coming under the same conditions. But no use of the feature is apparent.

MEASUREMENTS IN MILLIMETERS OF *CORVUS CORAX SINUATUS*
FROM THE COLORADO VALLEY

No.	Sex	Locality	Date	Wing	Tail	Tarsus	Middle-toe and-claw	Culmen	Bill from nostril	Gonys	Depth of bill at base
12914	♂	Riverside Mt., Calif.	Mar. 16	440	242	70.0	60.0	74.0	52.5	36.3	25.8
12913	♂	10 m. S. Ehrenberg, Calif.	Mar. 30	414	222	66.8	59.5	69.2	50.1	34.3	25.1
12912	♂	10 m. S. Cibola, Ariz.	Apr. 7	381	224	64.8	61.7	67.4	48.0	33.0	26.2
4367 ¹	♀	Fort Mohave, Ariz.	Jan. 6	410	212	64.7	58.2	65.6	45.3	31.9	24.2
4368 ¹	♀	Fort Mohave, Ariz.	Jan. 6	423	221	65.8	59.0	68.9	49.0	32.9	25.3

¹ Collected by J. G. Cooper in 1861.

***Molothrus ater obscurus* (Gmelin)**

Dwarf Cowbird

Cowbirds were first seen when we reached Ehrenberg, March 25. Here, on the Arizona side, flocks aggregating approximately one hundred individuals were staying close about the town. They were either roosting quietly in mesquites among the adobe ruins, or flying about in compact, unanimously acting flocks, or feeding in company with other blackbirds in cattle pens. In one case a bunch of fully forty were feeding close together on the ground in a calf corral, all with uptilted tails and quivering bodies, a mannerism peculiar to the species. They were eating millet seeds, and the crops of those taken were crammed with this material. One flock was seen flying north along the California side opposite Ehrenberg. On the same side, opposite Cibola, during the first week of April a number were seen, now in pairs haunting the bottom lands close to the river.

The species was next seen April 17 on the California side twenty miles north of Picacho at the Draper ranch, four individuals; then eight miles east of Picacho, April 20, a small flock. On the Arizona side again, five miles north of Laguna, April 24 to 27, several pairs

were seen among cottonwoods. On the California side, from the vicinity of Potholes south all along the river to the Mexican line, the species was numerous throughout the bottom lands. Here up to May 15 cowbirds were to be seen usually in pairs frequenting the densest willow tracts, as well as foraging on the mud bars at the water's edge. When prospecting in thickets near the ground they were usually quiet and gave the impression of sneaking, as if intentionally planning to avoid observation. But when affecting the taller tree tops and open places, they kept flying about actively, often intently pursuing one another, and giving frequent voice to an attenuated squeal. The species confines itself strictly to the river bottom: none were seen out on the desert, even in flight overhead.

Fifty-three skins of the dwarf cowbird were obtained, nos. 12956-13008.

In addition to these there are in the Museum two skins, one (no. 4347) taken by J. G. Cooper at Fort Mohave, April 4, 1861, and another (no. 5963), of unknown collector, from "Mineral City" (=Ehrenberg), April 20, 1864.

The acquisition of so large a series of *Molothrus ater obscurus* (previously sparingly represented in collections) from so limited an area, warrants a detailed examination of its characters. The fifty-three specimens are all comparable, as far as age is determinable, and are in comparatively unabraded plumage. The variations in measurements are therefore intrinsic, except, of course, for an indefinite but small amount of error which seems unavoidable. Although but four dimensions are presented, it is believed that these are a close index to any other correlated features that could be selected for measurement. And the ones adopted would appear to be capable of more exact determination than, for example, length of body and wing expanse.

The wing is measured, according to prevalent custom, from the bend of the carpus in closed wing to tip of longest primary; but even here a slight error may result from the mode in which the wing has been "set" in drying, that is, according to the sharpness of the curve along its outer edge. The tail is measured from the point between the insertions of the median rectrices into the uropygium to the tip of the longest rectrix in "closed" tail; and here too the proximal point from which to measure is not quite satisfactory. The culmen is rather more accurate of measurement in the cowbirds because it is a well-defined ridge coming to an end rather abruptly on the forehead. The depth of bill is most unsatisfactory because of the liability to slight separation

or abnormal closeness of the mandibles incurred in drying, and because of the conical shape of the beak. The method of taking the measurement here presented is to secure with calipers the diameter of the bill from the highest point on the culmen along a line through the nostril. This does not, therefore, take into account the *extreme* base of the lower mandible, where it is difficult to find any constant point from which to measure.

It will be noted from the tables that, in both sexes, the average is practically identical with the mid-point of range; that the wing length is least variable; that males are more variable than females; that the bill of the female is relatively shorter and thicker than that of the male, and its shape is much more constant; that in the male the variation in the shape of the bill involves length much more than depth, so that a wide range in degree of slenderness results, rather than in actual volume; that in matter of general size of body (using the wing and tail length as an index) females are nine per cent smaller than males.

Previously (1909, p. 281) the writer has given a table of measurements of the then available specimens of *Molothrus ater obscurus*. There were eleven males, from Arizona and southeastern California. Comparison with the dimensions of thirty-one other males as here presented shows remarkably close accord in all particulars save one, due to depth of bill being taken to extreme base of lower mandible instead of through nostril. It is of interest to note that among the entire series of fifty-three cowbirds from the lower Colorado River there is not one showing any closer approach to the Nevada form, *Molothrus ater artemisiae*, than in the smaller series above referred to and used originally for comparison. The apparent absence of *M. a. artemisiae* from the Colorado Valley as a migrant is contrary to previous ideas as to its route of migration to and from the Great Basin region. But what other route may be followed is still a matter of conjecture.

As regards color the Colorado series is remarkably uniform, except in one respect: the steely reflections of the dark body plumage in the male vary from deep violet to bronzy. This variation is exhibited similarly in *M. a. artemisiae* and in *M. a. ater*. In *obscurus*, however, the brownness of the head averages perceptibly paler than in the Atlantic race, *ater*. It is in the female that *obscurus* shows marked color characters as compared with *ater*; and this has apparently been overlooked in current descriptive works (as, for instance, by Ridg-

way, 1902, p. 210). The entire plumage in *obscurus* is very much paler than in *ater*. The former is drab throughout, slightly paler ventrally and very much paler, more clay color, on the throat; the narrow dusky shaft-streaks on the dorsum, chest and sides are clearly indicated. The female of the eastern form is dark slaty hair brown with less abruptly contrasted grayish throat.

MEASUREMENTS¹ IN MILLIMETERS OF THIRTY-ONE MALES OF
MOLOTHRUS ATER OBSCURUS FROM THE LOWER
COLORADO VALLEY

No.	Wing	Tail	Culmen	Depth of bill at nostril	Ratio % of depth of bill to culmen
12960	96.8	65.3	15.5	8.5	55
12961	97.8	64.7	15.2	8.7	57
12962	96.5	63.8	16.0	8.3	55
12963	102.3	68.3	15.3	8.6	56
12964	100.7	69.6	14.8	8.2	55
12965	100.4	66.4	16.2	8.4	52
12966	101.0	67.5	16.0	8.5	53
12967	103.3	66.7	16.0	8.8	55
12968	98.7	64.5	15.5	8.4	54
12969	97.3	65.0	15.7	8.0	51
12970	100.9	66.4	16.6	8.4	51
12971	101.4	66.0	16.5	8.7	53
12972	103.0	69.6	15.8	8.5	54
12976	100.0	67.4	16.0	8.4	52
12979	100.8	65.5	15.6	8.3	53
12981	98.5	69.3	16.1	8.6	53
12986	102.6	69.9	16.5	8.5	52
12987	103.7	68.5	15.9	8.4	53
12988	98.9	64.7	15.6	8.0	51
12989	96.7	66.2	16.1	8.2	51
12990	99.8	67.0	16.9	8.3	49
12992	103.1	70.5	17.0	8.4	49
12993	97.4	66.2	17.1	8.2	48
12995	101.3	70.0	17.0	8.2	48
12998	103.2	69.4	16.0	8.0	50
13000	99.4	64.6	17.3	8.6	50
13001	101.1	67.0	16.8	8.1	48
13005	102.5	70.0	15.7	8.4	53
13006	102.0	69.7	17.2	8.1	47
13007	99.1	63.6	16.4	8.3	51
13008	97.0	67.0	16.0	8.1	51
Average	100.2	67.1	16.1	8.4	52
Maximum	103.7	70.5	17.3	8.8	57
Minimum	96.5	63.6	14.8	8.0	47
Mid-point of Range	100.1	67.0	16.1	8.4	52
Variation on either side of mid-point	} 3.6%	} 5%	} 7.4%	} 4.8%	} 10%

¹ See text, pp. 157-158.

MEASUREMENTS IN MILLIMETERS OF TWENTY-TWO FEMALES OF
MOLOTHRUS ATER OBSCURUS FROM THE LOWER
COLORADO VALLEY

No.	Wing	Tail	Culmen	Depth of bill at nostril	Ratio % of depth of bill to culmen
12956	90.5	59.6	14.7	8.0	54
12957	91.7	60.3	15.0	8.4	56
12958	89.8	59.9	14.0	8.0	57
12959	91.9	61.3	15.1	8.3	55
12973	88.8	60.3	14.5	7.8	54
12974	89.2	58.0	14.4	7.7	53
12975	89.7	59.7	14.5	8.0	55
12977	92.3	58.6	14.6	7.8	53
12978	89.0	59.7	14.8	7.9	53
12980	91.8	62.0	14.6	8.1	55
12982	89.0	59.5	15.2	8.0	53
12983	91.1	60.3	14.4	7.7	53
12984	91.4	61.6	15.0	8.0	53
12985	92.9	63.7	.....¹	7.5	.
12991	94.6	65.0	14.9	8.2	55
12994	90.4	62.9	.....¹	.....¹	.....
12996	91.6	59.3	14.8	7.7	52
12997	92.7	62.0	15.4	7.8	51
12999	93.4	63.3	15.0	8.1	54
13002	89.0	59.0	14.7	8.0	54
13003	93.0	59.5	15.0	8.3	55
13004	93.3	59.8	14.9	8.2	55
Average	91.2	60.7	14.8	8.0	54
Maximum	94.6	63.7	15.4	8.4	57
Minimum	88.8	58.0	14.0	7.5	51
Mid-point of Range	91.7	60.8	14.7	8.0	54
Variation on either side of mid-point	} 3.2%	} 4.6%	} 4.8%	} 5.6%	} 5.5%

¹ Defective.

***Xanthocephalus xanthocephalus* (Bonaparte)**

Yellow-headed Blackbird

The single specimen secured, an adult male (no. 12915), was shot from a flock of cowbirds at Ehrenberg, Arizona, March 28. No others of the species were seen at that point. But on April 24, on the Arizona side five miles north of Laguna, a male and two females were seen overhead flying south. And on May 5, on the California side four miles south of Potholes, a small flock of yellow-headed blackbirds was seen flying north along the river bank.

There is in the Museum an adult male (no. 4346) taken by J. G. Cooper at Fort Mohave March 31, 1861; and another skin (no. 5959) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 8, 1864. The species is probably a regular winter visitant to the Colorado Valley.

Agelaius phoeniceus sonoriensis Ridgway

Sonora Red-winged Blackbird

First seen March 6, when a large flock was encountered flying north along the Arizona shore at the foot of The Needles. Next noted at Ehrenberg, Arizona, during the week beginning March 24. Here not more than fifteen individuals all told were staying close about the town, associated with the cowbirds and Brewer blackbirds which foraged in the cattle corrals. On the same side of the river, ten miles below Cibola, April 7, four individuals were seen in flight up the river. Several small flocks came to notice at our station on the California side eight miles east of Picacho, April 18 to 20. On both sides of the river above Laguna and at Potholes, April 22 to 29, many were seen, mostly in pairs or small flocks pursuing their way up the river. It was observed in nearly every instance that these presumably migrating birds, instead of taking a more direct route northward up the valley, closely followed the river bank even when through the meandering of the stream this course was sinuous in the extreme.

At Potholes and below, evidence was unmistakable that red-wings were preparing to nest, though no nests had been built as yet up to the time of our examination. At one place in particular, on the California side of the river, about five miles northeast of Yuma, a large colony had evidently settled for breeding purposes. Here in the late afternoon of May 2, on the inside of a large bend of the river, we were afforded opportunity of securing a good series of specimens and of observing the behavior of the birds. The males were by themselves, spaced out, and perched at the tips of willow saplings in an extensive dense tract of these on ground which at a little higher stage of the rapidly rising river would have been wholly inundated. The male birds were singing continually, and displaying themselves conspicuously in short circling flights, but each one behaving independently of any other. The females on the other hand were quietly foraging on the ground in close flocks in a much younger growth of

willow seedlings some three hundred yards off. The inference was that the males had selected the appropriate site for the location of nests, but that pairing off had not yet occurred. Here, as with many other birds of the Colorado Valley, it was evident that nesting time is deferred until the period of highest water, which custom doubtless obviates danger of destruction of nests through flooding. Elsewhere in the Austral zone red-winged blackbirds are caring for broods of young at so late a date as May 2.

The species was common near Pilot Knob flying back and forth overhead, evidently between breeding and feeding grounds somewhere in the vicinity. Nowhere was it seen outside of the confines of the river flood plain, so that the desert mesa forms the practical barrier to its farther spread laterally.

Thirty-three specimens were preserved, nos. 13009-13041.

The red-winged blackbirds of the Colorado Valley show themselves to be markedly different from those of the Pacific slope of southern California. The latter are *Agelaius phoeniceus neutralis* Ridgway; the former are here referred to *Agelaius phoeniceus sonoriensis*, following Ridgway's last diagnosis (1902, p. 337). Although the type locality of *sonoriensis* is stated by Ridgway (1902, p. 338) to be Mazatlan, Arizona had previously been fixed as type locality by Nelson (1900, p. 126), and the A. O. U. *Check-List* (1910, p. 233) further specifies *Camp Grant*, Arizona. I have no Mexican material for comparison.

The Colorado Valley form, as compared with *neutralis*, has the bill in both sexes very much longer and slenderer. In some of the males this feature is extraordinarily pronounced: the culmen, gonys and lateral outlines are all concave, resulting in an acicular sharpness of the bill. An opposite variation, however, leads to a moderately pointed bill in six out of twenty-six males, which can be matched by picked examples of *neutralis*. These *neutralis*-like males are all but one obviously immature. It is possible, of course, that some of these may actually be transient or casual visitants of *neutralis*. But it appears to me now as more likely that they are individual extremes of the locally native form, which in the material at hand varies towards them.

The six females collected are all conspicuously different in coloration, as well as in shape of bill, from *neutralis*. They have the coloration ascribed to *sonoriensis*, the black streaking below being much narrower and more distinctly contrasted against the extended white ground; also dorsally and on the sides of the head the pale edgings

of the feathers are much lighter and more extensive. In the males no color peculiarities are apparent.

There is in the Museum a skin (no. 4350) taken by J. G. Cooper at Fort Mohave, January 13, 1861. It is a male, obviously immature. It has a markedly thick bill and much dark rusty on the back. While probably not referable to *sonoriensis*, I am not able to place it satisfactorily. It possibly represents some northern race which winters in the region.

***Sturnella neglecta* Audubon**

Western Meadowlark

Numerous February 15 to 18 on the first bottom close to the river at Needles, California. Here there had been some attempt to induce the growth of a coarse pasture grass by irrigation, and the resulting cleared field scantily clothed with grass formed the chief local attraction for the meadowlarks. A few were seen February 22 five miles below Needles on a section of mesa by the river. Three individuals were seen on some grass land on the Arizona side, above the mouth of Bill Williams River March 13 and 14; and a lone individual was shot April 22 on the Arizona side five miles north of Laguna. Twelve specimens were secured (nos. 12926-12937), all but one near Needles.

There is in the Museum a skin (no. 4359) taken by J. G. Cooper at Fort Mohave January 1, 1861; and another, without date, from "Mineral City" (=Ehrenberg) taken by W. W. Holder.

***Icterus cucullatus nelsoni* Ridgway**

Arizona Hooded Oriole

Common and breeding about the site of the old Hanlon ranch on the California side near Pilot Knob. Here these birds affected primarily the large date palms which afforded characteristic nesting sites. One nest was noted suspended in a mistletoe clump in the cottonwood above the ruins of the American Girl pump. One hooded oriole was discovered far up a wash on the mesa, sipping nectar in company with hummingbirds in a profusely blossoming ironwood. Six of these orioles were secured May 6 to 14, nos. 13055-13060. Elsewhere the species was observed twice on the Arizona side, one seen April 26 five miles north of Laguna, and one heard April 9, ten miles below Cibola; and once on the California side, one heard April 11, twenty miles north of Picacho.

Icterus bullocki (Swainson)

Bullock Oriole

Nests of this species were conspicuous in the taller willows early in the season while the trees were yet leafless, all along the river from Needles down. The first birds to appear were noted on the California side opposite Cibola, April 5. There were five of them, all males, feeding about the blossoms of palo verde trees. From this date on, almost daily, and at every station, the species was noted in increasing numbers, until at Potholes the last of April, and elsewhere down the river to Pilot Knob, this was one of the numerous and characteristic birds of the willow-cottonwood association. Fourteen examples were preserved, nos. 13041-13054. Another specimen in the Museum (no. 4342), an adult male, was taken by J. G. Cooper at Fort Mohave April 3, 1861.

Although there are doubtless breeding individuals among these, as well as probable transients, I am unable to find any differences by which the Colorado Valley birds may be distinguished from those of western California or northern Nevada.

Euphagus cyanocephalus (Wagler)

Brewer Blackbird

Common about the town of Needles, California, February 15, where they were foraging indifferently along the railroad tracks and in the streets. Very many were seen similarly in the town of Parker, Arizona, March 16. Small flocks, aggregating about forty individuals, were noted at Ehrenberg, Arizona, March 24 to 29, and two secured (nos. 12916, 12917). Here the birds were usually mingled with the flocks of cowbirds feeding in chicken yards and cow pens.

There are four skins in the Museum (nos. 4355-4358) taken by J. G. Cooper at Fort Mohave January 4, 1861. Evidently a winter visitant in the Colorado Valley.

Carpodacus mexicanus frontalis (Say)

California Linnet

Locally common all along our route, from Needles to the vicinity of Yuma. Large flocks were foraging over the Sacramento Wash on the Arizona side near Mellen the last week in February. Elsewhere

only small companies were noted, either on the river bottom proper or out on the desert. As the season advanced linnets were more frequently noted in pairs, often along the deep, narrow ravines and precipitous hillsides where the mountains reached the neighborhood of the river. Nests with eggs were found ensconced among the tangled, sharp-pointed twigs of old smoke-bushes on desert washes both at Riverside Mountain, March 18, and Ehrenberg, March 26. Four miles below Potholes the birds were common on the bottom lands, affecting especially those cottonwood trees laden with mistletoe clumps. Five miles above Laguna, a linnet's nest was found in a cavity in the side of the main shaft of a saguaro. Twenty miles north of Picacho a nest with small young was found April 14 on the thorny upper branch of an ironwood.

The series of twenty-eight skins secured (nos. 13061-13088) shows the desert linnets to be in no perceptible way different from those of the coast region of California.

There is in the Museum a skin (no. 4169) taken by J. G. Cooper at Fort Mohave, January 26, 1861.

***Astragalinus psaltria hesperophilus* Oberholser**

Green-backed Goldfinch

More or less common all along the river; evidently resident. First noted on the California side opposite The Needles, several, March 2. On the Arizona side at the foot of The Needles, March 4 to 6, large flocks were congregated in the central portions of extensive dense mesquite thickets where, perched from three to four feet above the ground, they were certainly safe from marauders; here they sang volubly in chorus until dusk settled. During the day they were scattered out over the hills feeding on the flower-heads of *Perityle emoryi*. California side, at Chemehuevis Valley; common, both in the palo verde washes back on the mesa, and in the mesquites and willows near the river; noted similarly, still in flocks, at Riverside Mountain, March 16 to 20, and above Blythe, March 23. On the Arizona side in the vicinity of Ehrenberg there were but few noted, and these only in pairs along the mesa margin of the river bottom; on March 25 two partially constructed nests were found each four feet above the ground in arrowweeds.

Goldfinches of this species were henceforth noted in small numbers as follows: opposite Cibola, ten miles below Cibola, twenty miles north of Picacho, eight miles east of Picacho (full grown young taken), four miles below Potholes and near Pilot Knob (family of young). Twenty-five specimens were taken, nos. 13091-13115. These are identical with the form inhabiting the Pacific slope of California. Of the sixteen males in the series, not one is of the *arizonae* or *mexicanus* type of coloration, that is, with unusual extensions of black in the plumage.

Astragalinus lawrencei (Cassin)

Lawrence Goldfinch

Observed only on the California side at Riverside Mountain, March 17: a flock of eight was discovered in the upper branches of a dead mesquite on the verge of the river bank, singing and calling in characteristic fashion. Two were procured, nos. 13089-13090.

A single specimen (no. 4164) is in the Museum, taken by J. G. Cooper at Fort Mohave January 28, 1861. The species is probably a winter visitant to the Colorado Valley, though not in abundance.

Passer domesticus Linnaeus

English Sparrow

Several dozen were apparently well established in the station park and about the railroad yards of Needles. They had their retreats in the palms and eucalyptus by the station. One lone individual was seen in some willows on the Arizona side half a mile above the railroad station at Mellen, February 24.

Poœetes gramineus confinis Baird

Western Vesper Sparrow

Met with in but two places: on the California side, in Chemehuevis Valley, where a specimen, no. 13124, was secured March 10; and on the Arizona side, above Bill Williams River, March 12 and 13, where three specimens were taken, nos. 13125-13127. A few others were seen in the latter locality, where they were all found in a growth of tall coarse grass paralleling the mesquite belt.

There is in the Museum a skin (no. 4155) taken by J. G. Cooper at Fort Mohave, March 6, 1861. This sparrow probably occurs in the region throughout the winter.

***Passerculus sandwichensis nevadensis* Grinnell**

Nevada Savannah Sparrow

Four Savannah sparrows referable to this form were taken: no. 13116, California side, opposite The Needles, March 3 (the only one of the genus seen here); nos. 13117, 13118, Arizona side, above mouth of Bill Williams River, March 13; and no. 13119, Arizona side, five miles north of Laguna, April 22.

***Passerculus sandwichensis alaudinus* Bonaparte**

Western Savannah Sparrow

Five specimens secured, all on the Arizona side: nos. 13120, 13121, above Bill Williams River, March 13, and nos. 13122, 13123, 13128, five miles north of Laguna, April 22. At both places small areas of grassy land on the river bottom back near the mesa afforded the attraction to the species. The last-mentioned specimen is so nearly an intermediate in all characters between *P. s. alaudinus* and *P. s. nevadensis* as to be allocated uncertainly with one or the other. At least six Savannah sparrows were observed in a tract of low herbage lying near the river, five miles northeast of Yuma, May 2; these were the last to be noted.

***Chondestes grammacus strigatus* Swainson**

Western Lark Sparrow

One specimen taken (no. 13129) at edge of bottom near mesa on California side at base of Riverside Mountain, March 17. Not otherwise seen by our party.

***Zonotrichia leucophrys leucophrys* (Forster)**

White-crowned Sparrow

Appeared in the region only as a transient. First noted in Cheme-huevis Valley, California side, March 11, when an adult female (no. 13130) in worn winter plumage was shot from a flock of *Z. l. gambeli*. This must have been an exceptionally early arrival, or possibly a stray sojourner through the winter. For no more were identified with certainty until April 11, when a male (no. 13131) was taken on the California side, twenty miles north of Pieacho. This bird is in the midst of the first prenuptial molt, as is also another (male, no. 13133)

taken April 18, eight miles east of Picacho. Another (female, no. 13132) taken on the same date and at the same place, and one (male, no. 13134) secured April 21, on the Arizona side five miles north of Laguna, have nearly or quite completed the prenuptial molt (whether first or later, I am not able to judge).

From April 16 to 26 many crown sparrows of this form were observed closely enough to make identity certain. They sometimes formed scattering companies in brush along desert washes; or, in company with *Zonotrichia leucophrys gambeli*, they invaded the mesquite and arrowweed associations nearer the river. None were seen after April 26. It would appear that molting and migration occur simultaneously. Still there is nothing inconsistent with utility in this. For the prenuptial (or spring) molt in this sparrow, as with *gambeli*, is only partial; the flight feathers (primaries, secondaries and rectrices) are not involved, save that, in case any have been lost by accident, new ones grow in at this time.

Zonotrichia leucophrys gambeli (Nuttall)

Intermediate Sparrow

A winter visitant to the region in large numbers, occurring in scattered flocks with greatest frequency along the river, in the mesquite, quail-brush and salt-bush associations. Thence they were to be found up the brushy margins of desert washes at least as far as two miles from the river. Although often found foraging over open ground, these sparrows appeared never to venture so far from dense bushes but that they could on alarm find quick shelter.

In the vicinity of the railroad station at Needles many intermediate sparrows were to be observed at all times of the day foraging over the tracks, often beneath trains, where they appeared to find plenty to eat in the grain and refuse sifting from the cars. These birds had evidently been in the neighborhood all winter, for those shot February 15 and 16 had their plumage begrimed by coal dust to such an extent in some cases that the birds at a distance appeared to be of a uniform deep plumbeous color. No birds of such extraneous peculiarity were observed farther than two miles from the station, perhaps showing habitual close adherence to a local feeding ground selected upon arrival in the fall.

To enumerate localities of occurrence would be to list every place explored along down the river to the collecting station on the Arizona side five miles north of Laguna. By the time we reached this point, April 21, intermediate sparrows had become notably fewer in numbers than immediately before. Still there were several to be seen each day in the arrowweed and willow thickets until the 26th of April, when the last for the season were seen at the same place, and one, a female, taken.

There is in the Museum a skin (no. 4177) taken by J. G. Cooper at Fort Mohave, January 26, 1861.

Of thirty individual specimens shot before the completion of the prenuptial molt, April 15, fifteen are in the brown-and-gray-crowned first winter plumage. As there was, as far as I know, no intention of selecting adults in preference to immatures, these figures probably give an approximate proportion of birds-of-the-year at that season (February 15 to April 15) that is, fifty per cent.

The whole series taken, thirty-four specimens (nos. 13136-13169), serves well to indicate the period occupied in the prenuptial molt. The earliest individual showing molt, adult female, March 27 (no. 13160), shows many new feathers unsheathing in the mid-dorsal and pectoral tracts. An immature of the same date (male, no. 13161) shows a few unsheathing feathers in the mid-dorsal region only. An adult male, April 6 (no. 13162), is well along toward completion of the molt, though many old feathers persist in the capital region. It is of course to be remembered that the prenuptial molt does not involve any of the flight feathers, or, in this species, the wing and tail coverts.

That the molt program is not exactly simultaneous in all individuals is shown by an adult female (no. 13163) taken April 7, in which no sign of molt is apparent. An immature (male, no. 13165), April 10, is in the midst of the molt all over the body. In another specimen (female, no. 13166), April 18, of age not with certainty recognized, the molt is approaching completion. In the remaining three specimens, females, April 20, 24, and 26, feather growth in all the tracts involved is evidently complete, though in each individual a few old abraded feathers still remain in the post-auricular and pectoral regions.

It would thus appear that the spring molt occupies a period of not to exceed twenty-five days. Because of lack of uniformity in date of inception in different individuals or rate of the process, this is probably somewhat more than the time occupied in any one individual. The nuptial dress differs in color from the adult winter plumage in

the clearer ash of the anterior lower parts, in the darker clay color of the flanks, the clearer white of the belly, and the decidedly darker tone of the dorsal streaking, sepia rather than bay.

***Spizella passerina arizonae* Coues**

Western Chipping Sparrow

A single example noted February 20, on the California side, five miles below Needles. On the Arizona side, among the precipitous hills constituting The Needles, a large scattering flock was seen March 5. The birds were foraging among the sparse creosote and *Encelia* bushes on the steep slopes. Thereafter observed on the California side in Chemehuevis Valley, at Riverside Mountain, Blythe, opposite Cibola and eight miles east of Pieacho (last April 18), and on the Arizona side above Bill Williams River, at Ehrenberg, and ten miles below Cibola. At all of these points chipping sparrows were frequently met with, either in the bushy ravines among desert hills, or in the brush of the different associations paralleling the river.

I had concluded after seeing none for many days after April 18, that the species had left the region about that time. But as a matter of surprise the species was found once again on April 30 and May 1, on the California side four miles south of Potholes. Here the birds were notably common in the newly settled bottom land characterized by open fields, groves of mistletoe-laden cottonwoods and intersected by irrigation canals. They were in full song, and not in flocks as were the last previously seen, but in pairs, on or near the ground; or the males were singing alone from the bare upper branches of fire-killed trees. The two males shot had their testes greatly enlarged. Thus all the evidence obtained indicates that the species was breeding. Yet no nest was actually found, and the previously unknown occurrence of the species in so low a life-zone brings an element of probability that these individuals were merely tarrying late in the region before leaving for breeding grounds in a higher zone. Moreover the specimens secured differ in neither coloration, general size, nor proportions from breeding birds from the Sierras and northward. The breeding of the chipping sparrow on the lower Colorado is problematical; if a fact, it is a remarkable instance of extreme range of a species through zones from low Lower Sonoran to Canadian, inclusive.

Thirty specimens were obtained by us (nos. 13170-13199) and these show the time of the partial prenuptial molt to occupy some-

what less than one month (in different individuals, March 9 to April 3). The prenuptial molt in *Spizella passerina arizonae* involves in both sexes and apparently all ages, only the capital tracts, and, perhaps in only a few individuals, part of the pectoral region. This is apparently the same condition of affairs found in *Spizella passerina passerina*, of eastern North America, as described by Dwight (1900, p. 199).

Since there are in the Museum two skins (nos. 4160, 4161) taken by J. G. Cooper at Fort Mohave, December 24, 1860, it is evident that the western chipping sparrow passes the winter in the Colorado Valley.

***Spizella breweri* Cassin**

Brewer Sparrow

Since this sparrow was noted as early as February 19, when it was common a few miles south of Needles, a fair inference is that it is a winter sojourner in the region. At any rate, from the above date on until the middle of April, scattering flocks were of frequent note at all our collecting stations, on either side of the river, down to a point on the California side four miles north of Potholes. Here several individuals were seen April 23, the last for the season. As with the chipping sparrow, with which the Brewer sparrow was not infrequently associated, the latter occurred both on the desert uplands and along the river bottom lands. The preferred feeding grounds were probably on the desert, the river being visited only for water.

The series of specimens of *Spizella breweri* secured (nos. 13201-13226) shows that there is a partial prenuptial molt, beginning (as shown by no. 13219, a male) as early as March 11, and continuing at least until March 27. This molt, however, is very limited in extent, involving only the chin and throat in addition to replacement of a part of the feathers of the crown, particularly anteriorly, and the chest. There is a scarcely discernible change in color, resulting in slightly whiter throat and clearer ash and clay color on the crown, certainly not enough to warrant the molt from the standpoint of color significance. Neither does the very small amount of wear which the specimens in hand up to the first of March appear to have incurred, seem sufficient to make a spring molt imperative. Yet the latter would appear the best explanation, restricted area of replacement pointing towards relative importance of the process. A spring molt may have

been more essential as a renewal of worn plumage formerly than at the present time.

Cooper, in at least three places (1861, p. 122; 1869, p. 475; 1870a, p. 75) made record of *Spizella pallida* from Fort Mohave. He states that two specimens were secured. In the second citation Cooper even emphasized that it was "not *S. Breweri*" he had. A little later (1870b, p. 209) he for the first time gives *Spizella breweri* from Fort Mohave, then without mention of *S. pallida*. It always seemed probable, therefore, that Cooper's "*pallida*," although quoted freely by other authors, was really a misidentification of *breweri*. There are no Cooper specimens of *Spizella* in the Museum of Vertebrate Zoology bearing either name. At my request Dr. C. W. Richmond kindly looked into the matter at the United States National Museum. He writes me that there is a specimen of *Spizella breweri*, so identified by Ridgway and now no. 208619, labeled in Cooper's handwriting "*Spizella pallida*," and taken by him at Fort Mohave, April 2, 1861. This is evidently one of the skins upon which Cooper's record of *pallida* was originally based, so that there is now no doubt but that *breweri* was the species really involved. Needless to say, *Spizella pallida* is not known from any station in this latitude so far west.

***Spizella atrogularis* (Cabanis)**

Black-chinned Sparrow

California side opposite The Needles, in a ravine among the hills, March 3, male taken (no. 13200); the only one of the species seen on our whole trip.

***Junco oreganus thurberi* Anthony**

Sierra Junco

In willow bottom, on California side at base of Riverside Mountain March 17, female taken (no. 13135); the only junco of any sort seen by us anywhere in the region.

There is a well-preserved skin in the Museum (no. 4143) taken by J. G. Cooper at Fort Mohave, December 24, 1860, and as stated by Cooper (1870, p. 200) a few probably winter regularly in the Colorado Valley.

***Amphispiza bilineata deserticola* Ridgway**

Desert Sparrow

This is a bird of the upland deserts; not one was seen in the riparian belt. Around the base of Riverside Mountain, March 21, several were noted. On the desert back of Ehrenberg, Arizona, March 27, a few were seen; on the California side, opposite Cibola, April 3, a pair was located in a ravine, where they appeared to have established a nesting site; and on the Arizona side ten miles south of Cibola, April 9, two birds were noted in full song. Three skins were obtained, nos. 13324-13326.

There are also in the Museum two skins (nos. 4135, 4136) taken by J. G. Cooper at Fort Mohave, March 18 and April 4, 1861.

***Amphispiza nevadensis nevadensis* (Ridgway)**

Nevada Sage Sparrow

Common early in the season on the desert, especially in the salt-bush and sandy creosote associations. On the California side five miles south of Needles, and on the Arizona side above Mellen, February 20 to 28, many were observed. Their habit of skulking along the ground among the close-set bushes doubtless often resulted in their eluding observation.

Although intermediate sparrows occupied the same sort of ground and were present in much larger numbers, the two species kept in separate companies. The sage sparrows were prone to space themselves out much farther apart than *Zonotrichia*, and flushed singly rather than nearly simultaneously.

Many sage sparrows were observed on both sides of the river at The Needles, March 1 to 5. Nine specimens preserved, nos. 13227-13235.

There is also in the Museum a skin (no. 4137) taken by J. G. Cooper at Fort Mohave, January 26, 1861. That the species winters in the region is therefore practically established.

***Melospiza melodia fallax* (Baird)**

Rocky Mountain Song Sparrow

Common as a winter visitant to the riparian associations. Five miles below Needles on the California side, on both sides of the river at The Needles, on the Arizona side above Bill Williams River, and

at Riverside Mountain, on the California side, the presence of this song sparrow was established by the taking of specimens. The last capture for the season was made at the last-named station, March 17. The ten specimens secured (nos. 13236-13245) are quite uniform in characters and are so exactly like birds from northern Nevada as to leave no doubt as to the source of those individuals of *fallax* visiting the Colorado Valley in winter.

Song sparrows were very often heard when it proved impossible to rout them out from the dense arrowweed thickets in which they took refuge. It thus happened that the identity of most of the song sparrow population known to occur in a locality could not be ascertained. Judging from specimens shot, up to the middle of March, there were about as many *fallax* as *saltonis*. After this time *fallax* had departed from the region for its summer home, and the resident form, *saltonis*, was the only song sparrow remaining. No difference in habits or notes was detected between the two forms, and they appeared to possess identical preferences in regard to feeding grounds and cover. Both often ventured a few yards into open grassy or weedy places occasionally found adjoining the quail-brush belt; and both forms occurred through the willows to the water's edge, where, especially at early morning or late evening, they foraged among drift or through root tangles.

The name *montana* of Henshaw (1884, p. 224) is here considered synonymous with the older *fallax*, of Baird (1854). The latter has been shown to be incorrectly employed for the "desert" song sparrow resident along the Gila and Colorado rivers (see Grinnell, 1909, p. 269), and I now fail to see good grounds for recognizing two song sparrows from the Rocky Mountain region.

Melospiza melodia saltonis Grinnell

Salton Sink Song Sparrow

This was the form of song sparrow resident along the Colorado River. Song sparrows were noted in the vicinity of every one of our collecting stations from Needles and Mellen to Pilot Knob. Through the big valleys, as we floated along near shore especially in April and May, we were often almost continuously within hearing of them. The presence of *fallax* early in the season renders somewhat uncertain the occurrence of *saltonis* at the two points (Needles and Mellen) where

no specimens of it were actually secured. But elsewhere abundant material testifies to its status.

The occurrence of this sparrow appeared to be correlated closely with the extent of the arrowweed association, or of the almost as attractive young willow growth. The lower ends of the large valleys thus appeared to offer the best conditions. A series of lagoons below Ehrenberg margined with tules and surrounded by arrowweed was notable for its song sparrow population, as was also the "drowned-out" area just above the Laguna dam. Below Potholes, in a growth of mixed cane and young willow, song sparrows were notably numerous; also wherever there was a pure growth of cane, as along "Cane-brake Cañon" and on the California bank near Pilot Knob.

All the above areas are yearly subjected to overflow, and this may be held to account for the fact that even up to May 15 not a single new nest or young bird of this species was found. In the vicinity of Salton Sink young have been taken as early as March 30, and are common by the middle of April. It would appear that the birds have in the former region habitually come to defer their nesting time until after the high-water period, the last of May and early June. It was further observed that most of the old nests (which were considered with fair certainty to have belonged to song sparrows) were in arrowweeds or willows above the highest mud mark. The coating of mud on vegetation up to a regular height was indicative of the previous summer's flood level. So that, again, the song sparrows have here accommodated themselves to the extraordinary conditions by building their nests much higher above the ground than is usual elsewhere.

The fifty-one specimens (nos. 13246-13296) of *Melospiza melodia saltonis* obtained by our party, together with three other skins (nos. 4178-4180) taken by J. G. Cooper at Fort Mohave in January, 1861, are in no perceptible degree different from the topotype series from Salton Sink. (See Grinnell, 1909, p. 268.) The larger series now available increases the range of variation in all characters, but not so much that any single specimen, even when considered by itself, would raise a question as to its identity. The Colorado Valley birds, as far as I am able to judge, are not in the least divergent towards *fallax*, it being understood that the latter name applies to the Rocky Mountain song sparrow. It would appear that *saltonis* is very sharply defined both geographically and specifically. It is of further note that Cooper's specimens, taken fifty years ago, are identical with the average *saltonis* as it is today.

Melospiza lincolni lincolni (Audubon)

Lincoln Sparrow

First observed February 26 at Mellen; this is not indicative, however, that the species had not been present all winter in suitable places. Indeed, it seems quite probable that at least a portion of those individuals encountered later had wintered in the Colorado Valley. Very common the first week in March on both sides of the river in the vicinity of The Needles; also in lower Chemehuevis Valley and above Bill Williams River up to March 15; then, in reduced numbers, at Riverside Mountain and Ehrenberg, at the latter point up to March 29. Finally one was taken opposite Cibola April 5, and the last for the season April 7, ten miles below Cibola. At all these points the Lincoln sparrows were confined to the riparian belt, where they affected brush and nearby grass patches, especially at the outer margin of the arrowweed association. They were usually found in close company with song sparrows, though not in the least gregarious; in fact, many were shot by mistake as flushed singly from low herbage, during our pursuit of song sparrows.

Among the twenty-seven specimens (nos. 13297-13323) constituting the series of Lincoln sparrows preserved, much variation is displayed. Most of the specimens are quite typical of *Melospiza lincolni lincolni* as breeding in the Sierra Nevada and Rocky Mountains; but several (six in particular, nos. 13301, 13304, 13311, 13313, 13320, 13322) vary strongly in the direction of *Melospiza lincolni gracilis* (= *M. l. striata* of the A. O. U. *Check-List*, 1910, p. 276). The peculiarities of these lie in the slightly smaller bill, shorter wing and broader black streaking, especially on the dorsum. None, however, are quite like extreme *gracilis*, and this fact, together with the presence in the series of various intermediates, would seem to indicate that the Colorado specimens did not any of them hail from breeding stations in the coast belt proper (Sitkan district) but perhaps from an interlying area towards the interior. This is the more probable, too, in consideration of the fact that in no case was any strictly humid coast belt subspecies found wintering in the Colorado Valley. Possibly the Lincoln sparrows breeding in the northern Rocky Mountain region are subject to greater variation especially towards darkening, and so the dark (and incidentally smaller) Colorado Valley examples may not be essentially *gracilis*. Material is lacking to demonstrate their status satisfactorily.

Pipilo maculatus curtatus Grinnell

Nevada Towhee

Occurred in the river bottom only, and even there not in large numbers. One was seen on the California side near Needles, February 17, and another was taken on the same side five miles below Needles, February 20. One was secured and others heard on the California side of the river in the lower Chemehuevis Valley, March 9. One was heard on the Arizona side at Parker, March 15. And individuals were heard, and one finally secured, March 17, on the California side near Riverside Mountain. In nearly all cases the birds kept close to the arrowweed and quail-brush associations, from within which it was difficult to see them or drive them out, though they were readily heard.

As none was seen after March 29, when two were routed out of an arrowweed thicket near Ehrenberg, this bird is doubtless to be considered only a winter visitant to the region. Careful examination of the three specimens obtained (nos. 13337-13339) showed them to be unlike the *P. m. montanus* resident in the mountains to the eastward in Arizona, and yet quite different from the *P. m. megalonyx* resident in the southern Sierran and San Diegan districts of California. Casting about for comparable specimens disclosed the fact that Colorado River birds were practically identical with examples representing a previously unnamed form, inhabiting in summer portions of the Great Basin region at least of northern Nevada, eastern Oregon and north-eastern California. The Colorado Valley birds were thus evidently winter visitants from this region and not from any nearer locality, as far as known (see Grinnell, 1911, p. 309).

Pipilo aberti Baird

Abert Towhee

Abundant resident of the riparian strip along both sides of the river with scarcely a break the whole way from Needles to the Mexican line. Of the four recognized riparian associations—willow, arrowweed, quail-brush and mesquite—the latter two were the ones for which preference was most often shown. Although foraging a few yards outwardly from the mesquite belt, in no instance were these birds found to have followed up the desert washes away from the

river, although the lines of catclaw or palo verde would seem to offer congenial cover. The Abert towhee seems to be closely bound to the vicinity of water, in spite of its evident adaptation in color and structure to a region of desert conditions.

Although we were camped almost continually within the riparian strip, we saw no evidences of the nesting of this species until April 27, on which date near Potholes a half-grown juvenal was found. This, however, appeared to be exceptional, as many adults in pairs were to be seen. A juvenal was taken near Pilot Knob, May 14, where, again, there were no further evidences of nesting. In 1908, Museum collectors found the Abert towhee around the northwest end of Salton Sea, where nests were found plentifully in April; and in the same locality in 1911, Van Rossem (1911, p. 136) found eggs March 20 and 21. It would appear that the Abert towhee, as in the case of the song sparrow, has along the Colorado River deferred its regular time of nesting until relatively late in the season, so as to avoid the period of rising floods.

A series of forty-six specimens (nos. 13340-13385) obtained by the present expedition shows striking uniformity in external characters; that is, individual variation both in respect to color and size lies within very narrow limits. Taking a single feature: twenty-two adult males show a wing length of 89.9 to 95.1 millimeters. The average is 92.3, the mid-point of the range is 92.5, and the variation each side of the mid-point is but 2.8 per cent. In twenty-one adult females the average wing length is 86.8 millimeters; the extremes are 83.0 and 89.4, the mid-point of the range is 86.2, and the variation on either side of the mid-point is 3.7 per cent.

Three specimens are in the Museum (nos. 4115-4117) taken by J. G. Cooper at Fort Mohave, February 19 and April 4 and 24, 1861.

***Oreospiza chlorura* (Audubon)**

Green-tailed Towhee

First seen March 14, on the Arizona side above Bill Williams River, one or two individuals; next April 7, on the same side ten miles below Cibola, two seen; then April 15, on the California side twenty miles north of Picaecho, several; two were seen April 26 on the Arizona side, five miles north of Laguna; and one, on the California side, May 4, five miles northeast of Yuna, and May 8 and 10, one

each day, near Pilot Knob. In all these cases the birds were in the riparian tract, in willows, arrowweed or quail-brush. Although not numerous, the species is clearly a well-established transient through the region.

Five specimens secured, nos. 13332-13336, April 7 to 24, show no sign of even a partial prenuptial molt; if such is actually lacking, the species in this respect resembles *Pipilo* rather than *Zonotrichia*, again showing the affinities of *Orcospiza* to be nearer to the former genus than to the latter.

Two specimens are in the Museum (nos. 4123, 4124) collected by J. G. Cooper at Fort Mohave, February 13 and March 11, 1861.

Zamelodia melanocephala melanocephala (Swainson)

Black-headed Grosbeak

First observed April 12 on the California side twenty miles north of Picacho, one male; next April 25, eight miles east of Picacho, two males; then April 25, five miles north of Laguna, two males. May 4, on the California side five miles northeast of Yuma, many were observed, apparently as a result of arrested migration; for the previous afternoon and all night, as well as on the day of observation, a strong west wind, laden with dust, was blowing across the desert. The black-headed grosbeaks in company with several other transient species were restlessly foraging through the sheltering willow timber of the river bottom. During the succeeding week, practically until we left the region, the species was numerous. On May 13, especially, another windy day, around the east and north bases of Pilot Knob many black-headed grosbeaks were observed towards evening roving out over the desert in companies, as if preparing for through flight.

The above observations, in addition to the fact that dissection of specimens taken showed no signs of immediate breeding, leads to the conclusion that the species occurs in the region only as a transient. A peculiar thing was the late arrival here, as compared with that on the Pacific slope of southern California; in fact, the greater part of the migration appeared to take place here in early May, while the black-headed grosbeaks of the other region had arrived a full month previously and in the majority of cases already had nests and eggs. It would appear likely that the grosbeaks passing through the Colorado Valley are not bound for the Pacific Coast region, but rather to

the Great Basin and northern Rocky Mountain region, where the spring of the Transition zone dawns much later in the season, forcing a much later nesting season.

This idea is further borne out by a comparison of specimens. Breeding birds from the Pacific Coast, selected as being fully adult, are smaller throughout, with particularly less tumid bill than the Colorado Valley birds of obvious maturity. The latter, however, in these particulars, as well as in certain points of coloration, as extent of black on head and extra amount of white on wings and tail, are almost exact counterparts of breeding birds in the Museum collection from the Pine Forest Mountains of northern Nevada. The May birds of the Colorado Valley were thus evidently bound for the elevated interior to the northward. The differences above referred to, as exhibited between Pacific Coast black-headed grosbeaks and those of the Rocky Mountain plateau, would appear to warrant recognition in nomenclature, if for no other reason than to serve in designating their separate course of migration. Ridgway (1901, p. 619) presents data showing the differences in size and proportions, and also (*l. c.*, p. 617) refers to one of the color differences. But he does not consider the races so distinguished worthy of naming. His synonymy (*l. c.*, p. 620) would appear to show that the Rocky Mountain race should probably be called *Zamelodia melanocephala melanocephala* (Swainson) while the Pacific Coast race should bear the name *Zamelodia melanocephala capitalis* (Baird).

Eleven examples of the black-headed grosbeak were secured on the Colorado expedition, nos. 13433-13443. Among these is an aberrancy: No. 13439 is a male of otherwise full plumage, except for the tail, in which there is one old full-length, sticky and bedraggled feather, and ten short feathers, newly unsheathing; this unusual condition at this season was probably induced by loss of tail-feathers through some accident.

***Guiraca caerulea lazula* (Lesson)**

Arizona Blue Grosbeak

First seen May 1, four miles below Potholes, two males; the next day one male. Common at our station on the California side five miles northeast of Yuma, May 3 and 4, as also on both sides of the river in the vicinity of Pilot Knob. Observed here up to the time of our departure, May 15. There was reason to believe that this Lower

Sonoran species was preparing to breed in the river bottom: none were seen outside of the willow and arrowweed associations, and here, especially in clumpy tracts of willow, the males were present and in full song, spaced out over the appropriate territory as if settled for the nesting season. Females were doubtless present also, but only one was seen, probably because of their extremely retiring mood during the season of courtship.

The eight specimens secured (nos. 13444-13451) all on the California side of the river at the three stations above named, together with one more (no. 4132) taken by J. G. Cooper at Fort Mohave, May 6, 1861, are all of the large-billed race inhabiting southern Arizona. They differ markedly from the race summering in central and southern California west of the Sierran divide, in much larger and more tumid bill. (See Grinnell, 1911, p. 163).

***Passerina amoena* (Say)**

Lazuli Bunting

First seen, one of each sex, April 11, twenty miles above Pieacho; next, a few examples April 24 and 25, five miles above Laguna; then April 29 at Potholes, and almost daily thereafter at all points to the vicinity of Pilot Knob where last seen May 8. In all cases the birds were observed in the riparian bottom, usually in willows close to the river. There was no evidence of breeding, and the probabilities are that the lazuli bunting occurs in the region merely as a transient. Four examples were preserved, nos. 13390-13393.

There is a specimen in the Museum (no. 4157) taken May 20, 1861, by J. G. Cooper at Fort Mohave. Two of the five specimens have larger bills than any breeding bird at hand from the Pacific slope of California. This might be interpreted as being a parallel to the case with the black-headed grosbeaks, the Colorado River buntings being migratory to the Great Basin region. The material at hand, however, is insufficient to elevate the supposition to even a probability. And apparently there is, besides, a wide range of variation of the characters in question.

***Calamospiza melanocorys* Stejneger**

Lark Bunting

On March 8, on the California side opposite The Needles, a flock of a dozen lark buntings alighted in the tops of some tall willows close

to the river. Four were shot, nos. 13327-13330, all proving to be males in winter plumage. In these the lower parts are irregularly blotched with black. Two more were seen the same day in a willow on the California side a few miles below, in Blankinship Valley. A solitary female (no. 13331) was secured ten miles below Cibola, on the Arizona side, April 8. This bird was perched upon the wall of an adobe ruin on a spur of the mesa abutting upon the river.

Piranga ludoviciana (Wilson)

Western Tanager

Common as a migrant. First seen, a male, on the Arizona side five miles above Laguna, April 25; another male noted there the next day. Several were seen at Potholes, April 29, and four miles south of Potholes, May 1.

Five miles northeast of Yuma, on the California side, May 4, a very conspicuous arrested migration was in evidence among many species of transient birds. A heavy westerly wind blew all day, and the thick willow and cottonwood growth close to the river furnished both shelter and forage. Western tanagers were present in large numbers. I counted twenty in sight at one moment, flying serially along the edge of the woods. In the vicinity of Pilot Knob, up to May 15, this species was numerous, both on the bottom lands, and out on the desert. On the 7th and 13th, many western tanagers, singly and in pairs, were seen flying to the northwest low over the desert mesa north of Pilot Knob, frequently alighting for a moment in creosote bushes or ocotillos before resuming their transit. Eight specimens of this tanager were obtained, nos. 13415-13422.

Piranga rubra cooperi Ridgway

Cooper Tanager

First seen April 20 on the California side of the river eight miles east of Picacho: a single full-plumaged male which was secured. It attracted attention through its typical tanager call note, "prtitit"; but the bird was difficult to discern in spite of its brilliant red attire, amid the vivid green of the new foliage of the willow thicket in which it ensconced itself.

The species was next observed April 30 and May 1 in the bottom lands four miles below Potholes (in California), and then, on the same side of the river, five miles northeast of Yuma, May 3 and 4. At each of these places a dozen or more individuals were seen. On both sides of the river in the vicinity of Pilot Knob, May 5 to 15, this tanager was frequently observed. While the call note was closely similar to that of the western tanager, present as a migrant in numbers at the same time, the song was quite different, being a clear, full-toned warble more nearly like that of the black-headed grosbeak, yet with an individuality of its own.

The Cooper tanager, as far as our observations went, is strictly confined to the willow association. Not one bird was seen even so far from this association as the mesquite belt. The species is evidently a regular summer visitant.

The ten specimens secured, nos. 13423-13432, are all males. One of these was thought to be a female until dissected, as it is in a greenish-yellow phase of coloration. However, there are scattering pale reddish feathers in nearly every feather tract, though there is no indication that any molt is in actual progress. This is probably a case of arrested molt.

The notable absence of female specimens in our series resulted in spite of our greater effort to secure that sex. It was not that the males were more conspicuous, though this may have been a factor against that sex, but that the females were at this season extremely wary. As a pair was approached the female was always first to take alarm. I was repeatedly able to distinguish females at a distance as soon as males, in some cases sooner, after having located the pair by their notes. The red of the male appeared to be neutralized by the shimmering green of the surrounding foliage, so that the male was no more quickly discerned than the female. The male, however, was far more conspicuous in flight across open spaces.

There are in the Museum two skins (nos. 4202, 4203) taken by J. G. Cooper at Fort Mohave, April 29, 1861.

***Petrochelidon lunifrons lunifrons* (Say)**

Cliff Swallow

This swallow is evidently a common breeding species along the Colorado River wherever appropriate nesting sites are afforded. But we found the birds remarkably late in arriving and in nest-building.

Many cliffs, from the vicinity of The Needles on down the river, were seen with remains of nests adhering to their faces in rows or patches. The first birds noted were a very few flying high overhead near Riverside Mountain, March 17. Next seen near Ehrenberg, March 26. Several were seen April 12 coursing over the river and bottom lands twenty miles north of Picacho. Not noted again until May 5, when at Yuma a large colony was seen constructing nests on the steep rocks on the Arizona side near the prison. The birds were gathering mud at the edge of the river on the California side, thronging back and forth over the unusually narrow channel at this point.

On the California side in the vicinity of Pilot Knob two large nesting colonies were in evidence. One was on a sandstone bluff of some twenty-five feet height past which the main current of the river swung with exceptional speed. Here the nests were attached, to the number of ninety-seven, mostly as yet incomplete, to the irregularly eroded surface of the rock from ten to twenty feet above the surface of the river at its present stage—evidently above the reach of the highest level at flood time. Four of the finished nests were investigated on May 9 and found to contain in two cases three fresh eggs, in two cases one fresh egg.

On the same day, sixteen of the birds were shot for specimens. The skiff was repeatedly rowed out from shore a little below the colony, and as it was swept down stream by the current was pulled back again by means of a long rope manipulated by a man on shore. Those swallows flying nearest the boat upstream in front of the colony were shot at, so that the dead birds would float past within reach. Of the sixteen secured, fifteen were males. There is no way that I know of to determine sex until the birds are in hand. This would seem to indicate that the females at this time in the breeding season are most retiring, and that the males are the ones to make demonstrations of alarm when the colony is invaded by an enemy.

The other colony located had taken possession of the concrete walls in the head-gates of the Imperial Canal at Andrade. The nests were being constructed in crowded rows in the lateral upper corners beneath the woodwork bridging the piers. The birds were gathering mud at the margin of the canal nearby, alight with uplifted wings. Four shot were all males.

The superintendent of the canal, stationed at Andrade, complained that the swallows proved a nuisance by dirtying up the painted wood-

work. He had tried to drive them away repeatedly in previous years by destroying their nests. But the birds persisted in returning. Last year he had procured a quantity of poisoned wheat and spread it out on nearby ground, without, however, bringing any perceptible results!

Our nineteen specimens, nos. 13396-13414, show slight peculiarities as compared with examples from central California and Illinois. They are smaller: wing 100.0 to 108.0, averaging 103.2 mm. (see Ridgway, 1904, p. 48); the frontal light patch is cinnamon instead of whitish; the feathers of the dorsum are more conspicuously edged with clear white; the belly is whiter. These differences are indicative of the probable fact that the cliff swallows of the lower Colorado Valley are near in derivation to the forms in Mexico, particularly *Petrochelidon lunifrons tachina* Oberholser, which is recorded north on the east side of the Mexican plateau to southern Texas.

Hirundo erythrogastra Boddaert

Barn Swallow

Observed but once: one, evidently a migrant, flying overhead at Potholes, April 29.

Iridoprocne bicolor (Vieillot)

Tree Swallow

Recognized but once: March 23 a small number were noted flying back and forth over the second bottom on the California side at our collecting station above Blythe. One specimen taken, no. 13394. Evidently only a transient through the region.

Tachycineta thalassina lepida Mearns

Northern Violet-green Swallow

First noted March 4 opposite The Needles. No birds were actually seen; but a tumult of the characteristic twitterings high overhead belonged unmistakably to this swallow. The sky was dazzlingly bright so that small objects at but a moderate distance were invisible. Next seen with certainty, ten or so, on the Arizona side, March 7; then above Bill Williams, March 13. A few violet-green swallows were seen above Blythe March 23, in company with other swallows; simi-

larly at Ehrenberg, March 26 and 28; two seen opposite Cibola, April 5; and a few ten miles south of Cibola, April 8. One specimen taken, no. 13395. The species occurs in the region as a transient only.

***Stelgidopteryx serripennis* (Audubon)**

Rough-winged Swallow

First noted February 20, three individuals, five miles below Needles on the California side; next noted at Mellen, Arizona, February 23, thenceforth observed daily and at every station all the way down the river to Pilot Knob. This swallow forages alike over the river and flood-plain, and out over the desert where I saw it as far as I went (opposite Cibola fully six miles from the river). At Ehrenberg, March 24 to 29, many rough-winged swallows were to be seen close about the old adobe houses. They roosted by the half-dozen on wires stretched overhead for drying meat. Rafter holes in the walls, up under the thatches of those houses still possessing roofs, would appear to offer attractive nesting sites for these swallows. Individuals were seen flying up to such openings, though actual nest-building had not yet commenced.

Back in the hills, two to five miles west of the river and twenty miles north of Picacho, one or two pairs were noted in nearly every ravine. April 16 a nesting site was located in a naturally eroded hole in the face of a conglomerate wall. The cavity was too deep and too small to investigate. But the actions of the birds plainly indicated that it held either eggs or young.

At a number of places below Picacho, and down to Pilot Knob, nesting holes of rough-winged swallows were observed in banks, but always above flood level. In no case did we see birds attempting to nest in banks subject to undercutting or overflow, although these would appear to be in some cases otherwise quite suitable, suggesting extraordinary powers of anticipatory "discrimination" on the part of the birds. Near Pilot Knob, May 14, a nest burrow was found in the wall of a wash meeting the river at right angles, and only some fifty feet from the brink of the main bank. This burrow was about eight feet above the floor of the wash; the terminal cavity was found to contain one fresh egg. Twenty-six specimens of this swallow were secured, nos. 13452-13477.

Bombycilla garrula (Linnaeus)

Bohemian Waxwing

Known from the region only from the female specimen, now no. 4207 in this Museum, taken by J. G. Cooper at Fort Mohave, January 10, 1861.

Phainopepla nitens (Swainson)

Phainopepla

Everything indicated that this bird was common as a permanent resident of the region. It was, however, closely restricted to two narrow belts paralleling the river, one on each side; namely as constituting the mesquite association. The close coincidence of the range of the bird with the plant association in question was here clearly due solely to the preferred food afforded in constant and abundant quantity by the berries of the mistletoe parasitic upon the mesquite. Judging from experience elsewhere, there is reason to believe that the phainopepla would have availed itself of edible berries in whatever part of the region these might have been produced. Yet the fact remained that in the Colorado Valley the bird's presence and distribution was remarkably controlled by those of the mesquite; where there were no mesquites, as at our station near Pilot Knob, not a phainopepla was seen; where the mesquite had amassed itself into an extensive belt, the birds abounded.

In certain places, as on the Arizona side above Mellen, and on the California side opposite Cibola, this bird was, within the riparian strip, the most abundant single species. In such localities the birds overflowed in small numbers a little way up contiguous desert washes, foraging about palo verdes or ironwoods, which latter plant occasionally bore mistletoe clumps.

The phainopepla nested earlier than most of the resident birds of the region. Bob-tailed young out of the nest were seen April 12 on the California side, twenty miles above Picacho. April 5, on the same side opposite Cibola, two nests were found, each containing two eggs nearly hatched. In one of these cases the nest was eight feet above the ground on a branch of an ironwood; in the other, sixty-two inches above the ground on a mesquite limb. A nest with three fresh eggs found April 11 at the first-named locality, was seven feet above the

ground in a mesquite. These situations are representative of the average predilections of the species in other regions.

Thirty-two specimens of the phainopepla were preserved, nos. 13478-13509. There are in the Museum five specimens (nos. 4196-4200) taken by J. G. Cooper at Fort Mohave, December 24, 1860, and January 17 to April 13, 1861.

Lanius ludovicianus excubitorides Swainson

White-rumped Shrike

Shrikes proved unexpectedly scarce in the region explored. In spite of our special exertions, only four specimens were secured, nos. 13386-13389. Besides these, there are two more in the Museum (nos. 4205, 4206) taken at Fort Mohave by J. G. Cooper, April 18, 1861, and December 26, 1860. The six specimens show much variation among themselves, and not enough of uniformity in any one character to suffice for recognition, as I had anticipated, of a Lower Sonoran form of the *excubitorides* type different from an Upper Sonoran or Transition one. It is quite possible that some of the variation exhibited, as in degree of paleness and size and outline of bill, may be due to the fact that in the series some individuals were resident birds and others winter visitants from the Great Basin region. At any rate, the small series is inadequate as a basis for any satisfactory study of subspecific status. I am therefore including all under the name *excubitorides*, with the suggestion that it will probably be found after more extensive collections are worked over that further subspecific separation will have to be made.

Our first specimen was taken February 15 at Needles, and like several other birds of that neighborhood, the plumage was seriously discolored by coal smoke. Another was taken five miles below Needles, February 22, and one additional pair seen there. A pair was seen on the Arizona side near Mellen, February 24 and 27. Next noted at Ehrenberg, where a lone individual was secured March 28; next on the same side five miles above Laguna, where one was taken April 24. Last seen May 15 near Hanlon Junction, just north of Pilot Knob. In all these cases, the shrikes were in desert washes from a half-mile to two miles from the margin of the riparian belt. As usual they chose the most open ground productive of an adequate food-supply.

Vireosylva gilva swainsoni (Baird)

Western Warbling Vireo

First noted April 1, opposite Cibola. Thenceforth of almost daily observation at all our stations from there to Pilot Knob, where still common May 14. At times numerous in the willows; a few noted in the mesquite belt. Evidently a plentiful migrant through the region. Fourteen specimens taken, nos. 13537-13550.

Lanivireo solitarius cassini (Xantus)

Cassin Vireo

Occurred only in April and as a transient. First seen on the 7th of that month on the Arizona side ten miles below Cibola. One was found on the 9th singing volubly from an ironwood in a desert wash; all the rest seen were in the willow belt. On the California side, twenty miles above Picacho, several were noted April 10 and 11. Thereafter none were seen anywhere. Four specimens, nos. 13533-13536.

There is also in the Museum a skin (no. 4247) taken by J. G. Cooper at Fort Mohave, May 14, 1861.

Vireo belli arizonae Ridgway

Arizona Least Vireo

First detected early in the morning of March 8, on the California shore opposite The Needles. Heard repeatedly the same day from both banks as we floated down to lower Chemehuevis Valley. Nests, a year or more old, were seen both in the vicinity of The Needles and above, and the inference was that the species arrived throughout the region in full force on the above date. Thenceforth the species was met with at all stations all the way down the river, being one of the most characteristic avifaunal elements in the riparian strip. The bird foraged in all of the component associations, but was perhaps best represented in the willow association, especially where there was an undergrowth of guatemote (*Baccharis glutinosa*).

On the Arizona side above Bill Williams River, March 14, I was able to make some observations on local distribution. Here the willow association was narrow but well defined, and the vireos were closely confined to it. A singing male occupied each segment of about 200 yards in this belt, just about the same spacing as the Lucy warbler

in the adjacent mesquite belt. Each pair of vireos was closely delimited in its forage beat by that of its neighbor. Each pair in its own area actively resented encroachment by others of its own species. The vireos worked a rather low zone of foliage, from the ground up to a height of six or eight feet, just about the same, again, as in the case of the Lucy warbler. It is of interest to note that the Sonora yellow warblers, which arrived much later, after the willows had leaved out, were spaced much closer, but foraged through a greater *depth* of verdure, from the summits of the willows to within five or six feet of the ground. The vireo's domain was but slightly impinged upon.

At Ehrenberg, Arizona, a newly started nest was found, March 29. It was at this date about half completed, and was attached to the forking stalk of a guatemote five feet above the ground. It would appear that many nests meet with disaster from their being built, as they so often are, in openings between thickets. These openings serve as passage ways for browsing cattle, which as they crowd through, force the supporting branches aside and demolish the nests. Evidence of a number of instances of this type of catastrophe came to notice. A partly completed nest found on the California side near Pilot Knob, May 12, the owners being seen in the vicinity, would, together with the previous instance, indicate a length of breeding season of at least six weeks. Repeated trials, following such common accidents as the above, may account for this.

A nest found April 24 on the Arizona side, five miles above Laguna, was located three and one-half feet above the ground on a horizontal willow branch, beneath and darkly shaded by several small willow trees growing close together at the margin of an overflow slough. The nest preserved (no. 759), is of normal construction for vireos of this genus. The chief constituents are weathered mesquite and willow bark strips and spiderweb and cocoons; the inner lining is of fine round grass stems and shreds of dry grass blades. The eggs, four in number, were advanced about one-third in the process of incubation. The egg-shells are pure white, dotted very sparsely about the large ends with bay and hazel.

The series of twenty-three adult specimens taken (nos. 13510-13532) establishes clearly the identity of the Colorado Valley birds with *Vireo belli arizonae* of south central Arizona. The range of this geographic race is thus carried over into the confines of California along the southeastern frontier of the state.

***Vermivora luciae* (Cooper)**

Lucy Warbler

First seen March 10, on the California side in lower Chemehuevis Valley; there were three individuals foraging quietly in company with Audubon warblers and ruby-crowned kinglets in the sunlit summits of willows. The one shot was a male. The Lucy warbler is undoubtedly absent from the region in winter, and the above observation indicates approximately the date of its arrival.

Next noted March 14 on the Arizona side above Bill Williams River. Here, at least four males were located in mesquites, and as they were in full song and spaced apart, had doubtless settled upon breeding locations. The song is unmistakable, as far as all other birds of southern California and Arizona are concerned. It resembles the song of the Sonora yellow warbler in length and frequency of utterance and somewhat in quality, but with a distinct hurried and lisping effect reminding one of the song of the Lazuli bunting.

On the California side, both at Riverside Mountain and above Blythe, Lucy warblers were numerous, and very closely confined to the narrow belt of mesquite. The singing males, each representing the forage area and nesting site of a pair, were spaced out very uniformly, so that an estimated strip of about 200 yards in length belonged to each. The birds foraged out to a limited extent from the mesquites towards the river into the arrowweed and willows, and away from the river at the mouths of washes into the ironwoods and palo verdes. But the metropolis was always most emphatically the mesquites. At this time, March 18 to 23, the mesquites were just coming into leaf, and the new yellow-green foliage was prolific of insect life and formed both a productive food-source and an excellent cover for a low-foliage feeder, such as the Lucy warbler pre-eminently is.

At Ehrenberg, Arizona, the last week of March, the species was common, as also on the California side opposite Cibola the first week of April, and on the Arizona side, again, ten miles below Cibola. At the latter point a nest, nearly completed, was found April 8. It rested upon a loosened skein of bark on the under side of a slanting mesquite trunk, and was five feet above the ground.

On the California side the Lucy warbler was fairly common in the vicinity of our stations twenty miles above and eight miles east of Picacho, at both points being closely adherent to the mesquite strip.

Not one was observed anywhere below the last-named station, and this fact we ascribed to the lack of mesquite at the remainder of the points visited, this wood having been cut out for fuel.

It was a particularly gratifying circumstance that a nest of the Luey warbler was found by us on California territory, thus adding a species to the state list of breeding birds. As above implied, individuals were encountered in fair numbers at our station twenty miles above Picacho. Here, as usual, they affected the mesquite belt, but strangely enough the nest found was situated in a nearly dead ironwood, at the base of a hill rising abruptly from the river bottom. This tree (see pl. 12, fig. 19) evidently owed its failing condition to the rising water level in the ground in which it grew, a circumstance as fatal to an ironwood, as it is, up to a certain degree, propitious to a mesquite. There were young mesquites in the immediate vicinity.

The nest was built thirty-five inches above the ground in the crotch where a steeply inclined branch sprang from the main trunk, which was here about one foot in diameter. The nest was sheltered from above by a two-inch strip of loosened bark and an outstanding twig. The nest was thus practically within a closed cavity save for an approach in one direction, as shown in the photograph (pl. 13, fig. 20). This falls within the known predilection of the species elsewhere, as in the upper Gila Valley of south central Arizona (Gilman, 1909, p. 168), where out of "twenty-three nests observed, twelve were in natural cavities, four under loose bark, four in woodpecker holes, and three in verdin's nests."

The nest in question was evidently a relining of a previous year's structure, the latter being distinguishable by its compactness and admixture of dried mud, as if it had been sifted full of wind-blown dust and then drenched by heavy rain. There was no evidence that the tree had been submerged to this depth. The new portions of the nest (no. 754) are loosely formed of various feathers (mostly down-feathers of desert quail), mingled with weathered shreds of grass. There is a scanty lining of fine hairs. The cavity of the nest is 45 mm. across, by 22 mm. deep.

The three eggs, taken April 12, were considerably incubated, and thus constituted a full complement. The shells are pure white, with a fine and abundant speckling of vinaceous, vinaceous-cinnamon and cinnamon-rufous, chiefly in an agglomerated ring about the large ends. Some of the markings nearest the pole at the large end are

splotchy rather than punctulate. The eggs are rounded-ovate and measure in millimeters 14.0 by 11.7, 14.6 by 11.8, and 14.0 by 11.6. Only the female parent was observed in the vicinity of the nest and, as noted by Gilman, there was a notable lack of expressed anxiety. The bird merely remained among distant mesquites, uttering an occasional faint, one-syllabled alarm note.

Twenty-five specimens of this warbler were obtained, nos. 13579-13603.

The Lucy warbler was originally discovered at Fort Mohave, which is on the Arizona side of the river. Its describer, J. G. Cooper (1861, p. 120), remarks as follows: "This bird was common at Fort Mojave, near Lat. 35°, in the Colorado Valley, where it arrived about March 25th, and remained until I left there, the twenty-eighth of May. I saw none along the Mojave river, on the route westward. I collected five male specimens and one female."

Two of Cooper's specimens are in the Museum collection: female, no. 4266, April 5, 1861; male, no. 4267, April 11, 1861. These may with propriety be considered co-types, at least. Although no single specimen had been designated as type, Ridgway (1902, p. 474) indicates that a specimen which he considers the type is in the United States National Museum; this is probably one of the five males referred to by Cooper. Both our specimens have the original label, on faded blue note-paper, giving full data, entirely in Cooper's own handwriting. The female has "luciae, n.s. Cooper" in one corner in the same faded ink as on the rest of the label, except that both specimens have "luciae, J. G. C." interlined in blacker ink, just beneath the original "Helminthophaga," evidently inscribed by Cooper at some later time.

***Vermivora ruficapilla gutturalis* (Ridgway)**

Calaveras Warbler

First noted April 7 to 9, on the Arizona side of the river, ten miles below Cibola. Here they were not uncommon in the upper foliage of blossoming willows. Next observed on the opposite side, twenty miles north of Picacho, April 11, with similar mode of occurrence; then five miles above Laguna, April 25, and at Potholes, April 29. Here, and four miles south of Potholes, up to May 2, this was one of the commonest warblers. One was seen five miles northeast of Yuma, May 3; and in the vicinity of Pilot Knob, May 6 to 15, a few were

seen daily. The species was thus well represented as a migrant through the region.

Twelve specimens were taken, nos. 13551-13562. No. 13522, an adult male, shows conspicuously a character not mentioned in text descriptions, namely, a mixture of long, fine, black hairs (filoplumes) in plumage of sides and especially the flanks. Examination of appropriate series of specimens shows this character to be possessed in varying degrees, even in female first-winter plumage, by both *Vermivora ruficapilla gutturalis* and *V. r. ruficapilla*, but not by other members of the genus.

Vermivora celata celata (Say)

Orange-crowned Warbler

Apparently the only member of the genus present in the Colorado Valley through the winter. That it does winter here is quite apparent from its being observed by us almost daily during the latter part of February, and early March, whenever we were at work in favorable localities. Later its identity was obscured by the arrival of its close relative, *Vermivora cclata lutescens*, which, as a migrant, outnumbered *V. c. cclata*.

The orange-crowned warbler was closely confined to the riparian strip, where it foraged singly at a low level in the tangle of underbrush in the willow association, or, less often, in the arrowweed thickets. Its presence was betrayed as a rule through the sharp, single call note. Though usually repeated at not infrequent intervals, this clue was not always alone sufficient for the discernment of the bird, because of the impenetrability of its cover.

The first bird was seen in the river bottom near Needles, February 17. On the 20th, five miles below Needles, a specimen (no. 13574) was secured. Although observed frequently, no more were obtained until April 8, when one (no. 13575) was taken on the Arizona shore, ten miles below Cibola. On the California side, eight miles east of Picacho, another (no. 13576) was taken April 20. And two examples were secured on the same side near Pilot Knob, May 9 and 14 (nos. 13577, 13578).

These five specimens are unequivocally *cclata*, save that one shows a slight but notable aberrancy. This is no. 13577, a male, in which the grayness characteristic of *celata* pervades the plumage as usual,

except facially, where it is replaced on the chin, lores, superciliary line, lower eyelid and fore part of auriculars with the clear greenish yellow peculiar to *V. c. lutescens*. This abrupt replacement is bilaterally uniform and so conspicuously in evidence as to suggest the style of coloration in the yellow-faced gray-bodied verdin. It is probable that the warbler in question is a hybrid between *V. c. celata* and *V. c. lutescens*, having been bred in a region where the ranges of these two forms meet. Such a locality is Prince William Sound, Alaska (see Grinnell, 1910, p. 409).

***Vermivora celata lutescens* (Ridgway)**

Lutescent Warbler

Common as a migrant, chiefly in April and May. Two specimens taken February 23 and 28 at Mellen, Arizona, may have been wintering in the region; no more were encountered until March 29, at Ehrenberg, when two in full song came to notice; thereafter the species was observed almost daily, though not in numbers. The willow strips formed the main forage-ground. The last specimen was taken May 7, on the California side near Pilot Knob.

The eleven specimens preserved (nos. 13563-13573) are varyingly grayer than breeding birds (May and June) from the Pacific Coast. But it is clear that a slight ashy obscuration in some degree accounts for the duller yellow of the early spring birds. The underlying yellow of the male appears just as intense in February and March examples as in June birds. Wear removes most or all of the ashy feather tips.

***Dendroica aestiva sonorana* Brewster**

Sonora Yellow Warbler

First encountered April 8, a single adult male, on the Arizona side ten miles below Cibola; next noted April 10, two in song on the California side, twenty miles north of Picacho; many on the morning of the 17th near the same place. When we reached our station on the California side eight miles east of Picacho, April 17, Sonora yellow warblers were abundant. As this was a particularly favorable locality, more so than the last, it is fair to infer that the species had arrived in force some days previously. Even so, the first appearance of yellow warblers along the Colorado River was later than the usual date of

arrival of the closely related *Dendroica aestiva brewsteri* at the same latitude in the San Diegan district of southern California; and this in spite of the lower zone of the Colorado Valley.

The Sonora yellow warblers were abundant at all suitable places along down the river from Picacho, the stations being indicated in the accompanying table of measurements. They adhered closely to the willow association, the mode of their forage zone lying somewhere in the crown foliage of the willows and cottonwoods, the height above the ground of course varying with the stature of the trees. The females were hard to locate, but the incessant song of the male birds rendered the latter easy to detect. Observation on April 19 in a very extensive willow tract in "Charlie's Valley," eight miles east of Picacho, showed them to be regularly spaced out through the top foliage at an estimated frequency of four per acre. Thus, at this point, a quarter of an acre, with a depth of perhaps twelve feet of foliage, was the forage allowance of each nesting pair of warblers. This was a greater congestion of warbler population than in most places, because of the evident unusual favorableness of the environs.

At another place, five miles above Yuma, May 3, there was only one singing male to two acres of willows. With a minimum of 640 yellow warblers to the square mile, their aggregate numbers in the Colorado Valley must reach an enormous total, considering the vast area of first bottom. Since there is in the Museum collection a female specimen (no. 4265) of *Dendroica aestiva sonora* taken by Cooper May 4, 1861, at Fort Mohave, it is reasonable to suppose that this form breeds north in uniform abundance along the valley to the Nevada line. In spite of the numbers of the birds, we failed to run across nests. This may, however, have been due to nesting being deferred until later than the middle of May.

The series obtained of this warbler (forty-seven specimens, nos. 13604-13650) provides so much material of a bird not heretofore adequately represented in our collections, that a rather detailed examination of its characters seems warranted. Furthermore, so many examples of one species of migratory bird from so limited an area, and taken practically within a month's time at one season, would seem to be a basis from which to obtain a fair idea of normal variation.

Referring first to the accompanying table of measurements, it will be noticed in the males that the average and the mid-point of the range practically coincide; that the variation in the six respects varies

from six to nine per cent on either side of the mid-point; that the wing length is most constant; that in average dimensions females are smaller than males *except* that the bills in the former are slightly the larger.

Although little more than three weeks apart in time of capture, the May birds are distinctly more worn than those of April 18. This undoubtedly accounts for the slight lessening in wing length, and also modification in wing formula, as exhibited bottomwards in the appropriate columns. In obtaining the wing formula as given, the primaries are numbered consecutively from the carpal joint distally. The numbers are arranged in order of relative length of the primaries, the first given being the longest; thus 8-7-6-9-5-4-3-2-1 means that the eighth primary is longest, the seventh next in length, and so on. Since in this bird the primaries proximally from number 5 in all individuals decrease in length with regularity, only the variable (outer) portion of the formula is given. The variation in wing formula as shown in the table *appears* to be greater than it really is, for in most cases 6, 7, and 8 are very nearly of a length, 9 being proportionally shorter but in no case as short as 5. Eight and 7 are most frequently of greatest length.

In coloration the females are paler, being more ashy and less yellow than in either *D. aestiva aestiva* or *D. aestiva brewsteri*. The males, on the other hand, have the yellow more intense and extensive, involving the whole head and back, and represented on the wings and tail by much broader edgings. The green mantle of *brewsteri* is represented in *sonorana* by a more restricted area of dull yellow, the whole head and rump being brightly yellow. The yellow of the crown is often tinged strongly with chestnut, and the dorsum is streaked narrowly with a darker tone of the same color. The underparts are even more narrowly chestnut-streaked than in *brewsteri*. Variation in the latter respect is considerable, from a case where the ventral streaking is scarcely perceptible to the opposite extreme, where the streaking is about as well defined as in average *brewsteri*.

Sonorana, as shown by the present series, is an easily recognized form, in spite of its great range in individual variation. For, among so many characters, where one fails, others are left to hold to.

MEASUREMENTS IN MILLIMETERS OF *DENDROICA AESTIV. SONOR. INJ.* FROM THE LOWER
COLORADO VALLEY

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Hind toe with claw	Bill from nostril	Gonyx	Wing formula ²
13604	♂	10 mi. S. Cibola, Ariz. side	Apr. 8	64.7	46.6	19.0	11.0	7.8	7.2	8-7-6-9-5
13605	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.3	44.1	18.4	11.0	7.4	7.1	7-8-6-9-5
13606	♂	8 mi. E. Picacho, Calif. side	Apr. 18	62.4	47.0	18.0	11.4	7.7	7.0	8-7-9-6-5
13607	♂	8 mi. E. Picacho, Calif. side	Apr. 18	62.5	48.6	18.8	11.1	8.4	7.7	7-8-6-9-5
13608	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.3	45.0	18.4	10.0	8.0	6.9	.....³
13609	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.1	46.4	17.1	10.0	7.3	6.6	7-8-6-9-5
13610	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.5	45.7	18.5	11.3	8.2	7.5	9-8-7-6-5
13611	♂	8 mi. E. Picacho, Calif. side	Apr. 19	61.2	44.9	17.3	10.0	7.7	6.7	8-7-6-9-5
13612	♂	8 mi. E. Picacho, Calif. side	Apr. 19	60.9	45.0	17.8	11.2	7.8	6.9	7-8-6-9-5
13613	♂	8 mi. E. Picacho, Calif. side	Apr. 20	61.4	44.5	18.3	10.1	7.5	7.0	8-7-6-9-5
13614	♂	8 mi. E. Picacho, Calif. side	Apr. 20	62.5	45.0	18.8	10.4	7.7	7.0	8-7-6-9-5
13615	♂	8 mi. E. Picacho, Calif. side	Apr. 20	60.5	44.0	17.7	10.0	7.9	7.1	7-8-6-9-5
13616	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.3	45.5	18.9	11.0	8.2	7.5	8-7-6-9-5
13617	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.9	47.1	19.0	10.0	7.8	7.1	7-8-6-9-5
13618	♂	8 mi. E. Picacho, Calif. side	Apr. 18	60.6	45.2	18.5	10.4	7.7	7.2	8-7-6-9-5
13619	♂	8 mi. E. Picacho, Calif. side	Apr. 20	63.0	44.8	18.0	10.1	8.0	7.2	8-7-9-6-5
13620	♂	5 mi. N. Laguna, Ariz. side	Apr. 26	63.0	45.7	17.8	10.5	7.8	7.0	7-8-6-9-5
13621	♂	5 mi. N. Laguna, Ariz. side	Apr. 24	63.4	46.0	18.4	9.8	7.5	7.0	8-7-6-9-5
13622	♂	5 mi. N. Laguna, Ariz. side	Apr. 25	62.8	47.2	18.9	10.2	7.5	6.8	8-7-6-9-5
13623	♂	5 mi. N. Laguna, Ariz. side	Apr. 26	61.3	44.8	18.0	11.3	7.6	6.7	7-6-8-9-5
13624	♂	4 mi. N. Potholes, Calif. side	Apr. 23	63.5	47.0	17.9	11.0	7.3	....⁸	7-8-9-6-5
13625	♂	Potholes, Calif. side	Apr. 27	64.6	47.1	19.2	11.0	7.8	7.5	8-7-6-9-5
13626	♂	Potholes, Calif. side	Apr. 27	62.8	47.0	18.8	10.3	7.4	7.0	7-8-6-9-5
13627	♂	Potholes, Calif. side	Apr. 27	62.7	45.0	17.9	10.7	7.6	7.0	8-7-6-9-5
13628	♂	Potholes, Calif. side	Apr. 27	63.7	46.1	18.6	11.0	7.5	7.3	7-8-6-9-5
13629	♂	Potholes, Calif. side	Apr. 28	62.4	44.1	19.0	10.8	7.8	7.3	8-7-6-9-5
13630	♂	Potholes, Calif. side	Apr. 29	58.4	41.7	18.0	10.6	7.3	7.0	8-7-6-9-5

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Hind toe with claw	Bill from nostril	Gonyx	Wing formula ²
13631	♂	1 mi. S. Potholes, Calif. side	Apr. 30	62.2	47.5	17.7	9.7	7.4	7.0	8 7 6-9 5
13632	♂	4 mi. S. Potholes, Calif. side	May 1	63.2	46.0	18.8	11.5	7.7	7.2	7-8 9-6 5
13633	♂	1 mi. S. Potholes, Calif. side	May 2	63.1	46.0	18.0	10.3	7.6	7.0	8-7 6-9-5
13634	♂	4 mi. S. Potholes, Calif. side	Apr. 30	61.3	45.5	17.6	11.0	7.7	7.0	8-7 6-9-5
13635	♂	5 mi. N.E. Yuma, Calif. side	May 3	57.3	40.2	18.4	11.1	7.3	7.0	8-7 6-9 5
13636	♂	Near Pilot Knob, Calif. side	May 6	59.3	43.0	18.5	10.5	7.8	7.1	8 7 6 9 5
13637	♂	Near Pilot Knob, Calif. side	May 6	63.5	45.7	18.0	10.1	7.7	7.6	8 7 6 9 5
13638	♂	Near Pilot Knob, Calif. side	May 6	61.6	45.4	18.7	10.4	8.0	7.6	8 7 6 9 5
13639	♂	Near Pilot Knob, Calif. side	May 8	58.0	41.0	16.8	10.4	7.6	7.0	
13640	♂	Near Pilot Knob, Calif. side	May 9	58.0	40.8	18.0	11.3	8.2	7.3	
13641	♂	Near Pilot Knob, Calif. side	May 11	59.0	42.0	17.0	9.7	7.4	7.0	7 8 9 6 5
13642	♂	Near Pilot Knob, Calif. side	May 12	60.3	42.3	18.4	11.2	7.4	7.1	8 7 9 6 5
13643	♂	Near Pilot Knob, Calif. side	May 14	58.2	44.5	18.8	10.8	7.8	7.1	8 7 9 6 5
13644	♂	Near Pilot Knob, Calif. side	May 7	57.4	41.4	18.6	10.6	7.9	6.9	8 7 9 6 5
		Average of the 41 ♂♂		61.5	44.9	18.2	10.6	7.7	7.1	
		Maximum		64.7	48.6	19.2	11.5	8.4	7.7	
		Minimum		57.3	40.2	16.8	9.7	7.3	6.6	
		Mid-point of the range		61.0	44.4	18.0	10.6	7.8	7.1	
		Percent variation on either side of mid-point		6.0	9.0	6.6	8.5	7.0	7.7	
13632	♀	4 mi. S. Potholes, Calif. side	May 1	59.3	43.2	18.6	11.3	8.1	7.3	9 8 7 6 5
13635	♀	4 mi. S. Potholes, Calif. side	May 2	60.8	43.6	18.0	11.0	7.9	7.4	7 6 8 9 5
13637	♀	1 mi. S. Potholes, Calif. side	May 1	58.8	43.0	19.3	10.7		6.7	8 7 9 6 5
13645	♀	Near Pilot Knob, Calif. side	May 12	55.0	39.6	17.6	10.7	7.6	7.5	9 8 7 6 5
13648	♀	Near Pilot Knob, Calif. side	May 6	60.0	43.0	17.5	10.8	8.3	7.5	8 7 9 6 5
13650	♀	Near Pilot Knob, Calif. side	May 11	57.8	42.0	18.1	10.4	8.1	7.6	8 7 9 6 5
		Average of the 6 ♀♀		58.6	42.1	18.2	10.8	8.0	7.3	

¹ See text, pages 157, 196. ² See text, page 197. ³ Defective.

***Dendroica aestiva brewsteri* Grinnell**

California Yellow Warbler

Appeared as a migrant through the willow bottom, individuals at large being distinguished from the breeding *D. a. sonorana* by their silence. Five specimens taken, nos. 13653-13657, bear locality and date as follows: Male, California side, twenty miles north of Picacho, April 12; male and female, same side, five miles northeast of Yuma, May 4; male and female, same side, near Pilot Knob, May 9 and 6, respectively.

***Dendroica aestiva rubiginosa* (Pallas)**

Alaska Yellow Warbler

A late migrant along the willows, secured only on the California side near Pilot Knob; two specimens: male, no. 13651, May 9; female, no. 13652, May 14.

***Dendroica auduboni auduboni* (Townsend)**

Audubon Warbler

Varyingly common as a winter visitant or transient on either side of the river from the first day of our work, February 15, and from our first station, Needles, until the last day of our work at our last station, May 15, at Pilot Knob. Full-plumaged males were still noted on the latter date, which would indicate unexpectedly late migration. The species was seldom noted outside of the willow association, and then only a short distance away, in the mesquite or a little beyond. Twenty-five specimens were taken, nos. 13658-13682.

There is also in the Museum a skin (no. 4257) taken by J. G. Cooper at Fort Mohave, February 24, 1861.

***Dendroica nigrescens* (Townsend)**

Black-throated Gray Warbler

First seen April 2, on the California side opposite Cibola, a solitary female. Next seen on the Arizona side ten miles below Cibola April 9, a male; then more frequently, sometimes in small droves with other warblers, twenty miles north of Picacho, eight miles east of Picacho, five miles north of Laguna, four miles south of Potholes and at Pilot Knob. The last one was noted at the latter place May 9. The species

was noted all along only in willows or mesquites. Seven specimens taken, nos. 13683-13689. Evidently occurs through the region as a migrant only.

Dendroica townsendi (Townsend)

Townsend Warbler

First noted April 26, on the Arizona side five miles north of Laguna, two seen and another secured. At Potholes, April 28 and 29, fully twenty-five were noted; four miles south of Potholes May 2 one was taken, and another five miles northeast of Yuma, May 4. In the vicinity of Pilot Knob several were seen May 13 and 14. At every other place the birds were exclusively in the willows, but here they were in arrowweed as well. Evidently a transient. Nine specimens taken, nos. 13690-13698.

Dendroica occidentalis (Townsend)

Hermit Warbler

First observed, a male, April 20, on the California side, eight miles east of Picacho; next, a male, on the Arizona side five miles north of Laguna, April 25; then at Potholes on the 28th and 29th, several; five miles northeast of Yuma, May 3, a male; and near Pilot Knob, May 9, a female. A through migrant. Six specimens taken, nos. 13699-13704.

Oporornis tolmiei (Townsend)

Tolmie Warbler

First noted, a male, April 12, on the California side of the river, twenty miles north of Picacho. Next observed, in numbers, both sexes, April 25 and 26, on the Arizona side five miles above Laguna. Then, on the California side, almost daily in varying numbers, at Potholes, four miles below Potholes, five miles northeast of Yuma, and in the vicinity of Pilot Knob. The species was still common in the latter locality, May 14.

In all the above places, the species adhered closely to the arrowweed and quailbrush associations, frequently visiting the water's edge through the willows, especially during midday. The brush associa-

tions are preferred doubtless because nearest like their summer associational habitat. Ten specimens taken, nos. 13705-13714.

There is also in the Museum a skin (no. 4255) taken by J. G. Cooper at Fort Mohave, April 24, 1861.

***Geothlypis trichas scirpicola* Grinnell**

Tule Yellowthroat

A cursory glance at the sixteen specimens of yellowthroats obtained shows clearly that as regards size and color two diverse types are represented. Observation in the field showed that there were two categories as regards behavior. And these two assortments, as far as data justifies, appear to coincide; namely, the smaller, grayer and duller birds were quiet, and doubtless migrating, while the larger, more brightly colored birds were in full song, evidently the breeding subspecies. Both forms were found in the densest available cover, the resident birds, however, being always met with in the immediate vicinity of water, while some of the migratory individuals were in quail-brush on the second bottom many rods from the river or nearest slough. It was, of course, impossible to distinguish the forms by appearance in the field; in fact, some of the specimens themselves are only with difficulty and some uncertainty placed in one or the other category.

After an independent study of the Museum's series of yellowthroats from the western United States, British Columbia and Alaska, I have arrived at the same conclusions as expressed by Swarth (1912, p. 72). These conclusions are that there is no recognizable Pacific coast race (*arizcla*), the name *occidentalis* applying rightly to all breeding yellowthroats of North America west of the great plains, except those of the San Francisco Bay region (*G. t. sinuosa*) and those of southern California and Arizona (*G. t. scirpicola*).

The breeding males of the Colorado Valley agree with those of southern Arizona and the San Diego district in southern California, and differ from *occidentalis* in large size throughout, and in brighter coloration. The latter feature consists in a deeper toned yellow below and an extension of this yellow posteriorly to include the abdominal area; in brighter yellow of the crissum; in the flanks being washed with a darker tone of clay color; in the dorsum being pervaded with golden yellow instead of being of a grayish cast, as in *occidentalis*; and in the grayish area on the head bordering the black mask posteriorly

being very broad, tending to cover in some cases the whole pileum, though becoming concealed beneath an olive wash posteriorly, and with a mixture of yellow.

Extreme examples of *scirpicola* are conspicuously different from the nearest approach to it in appearance among many specimens of *occidentalis* from Nevada, northern California, British Columbia and southeastern Alaska. But among the considerable number of specimens from the range of *scirpicola*, there are some which have so far defied every effort to distinguish them satisfactorily from *occidentalis*. The problem is complicated by the fact that there are yellowthroats moving through the range of *scirpicola* at the same season that the resident birds are nesting, that is, until the last week in April at least.

The twelve Colorado Valley examples referred to *scirpicola* (characterized by Grinnell, 1901, p. 65) are listed in an accompanying table to show locality and date of capture, and measurements. One specimen, no. 13723, deserves special comment because of an extraordinary aberrancy in coloration: the whole throat is clear, intense cadmium yellow, in marked contrast with the normal canary yellow of the chest and remaining lower parts; otherwise the bird is like the average. This extra intensification towards orange, though over a restricted area, is probably a color change of significance along the same line as discussed in this paper under *Colaptes chrysoides*.

The tule yellowthroat was closely restricted to dense vegetation growing close beside or over water. Tules bordering sloughs formed

MEASUREMENTS IN MILLIMETERS OF *GEOTHLYPIS TRICHAS SCIRPICOLA*
FROM THE COLORADO VALLEY

Mus. No.	Sex	Locality	Date	Wing	Tail	Tarsus	Culmen
13720	♂	Riverside Mt., Calif. side	Mar. 18	57.7	54.5	20.0	11.1
13721	♂	Riverside Mt., Calif. side	Mar. 20	56.5	52.8	20.3	11.0
13723	♂	Ehrenberg, Ariz. side	Mar. 29	55.1	53.3	19.7	11.8
13728	♂	5 mi. N. Laguna, Ariz. side	Apr. 25	53.9	50.5	20.9	11.5
13729	♂	4 mi. S Potholes, Calif. side	May 2	57.0	52.1	20.0	11.2
13731	♂	5 mi. N.E. Yuma, Calif. side	May 4	54.2	51.2	20.4	.....
13732	♂	5 mi. N.E. Yuma, Calif. side	May 3	58.6	56.7	20.2	11.6
13733	♂	5 mi. N.E. Yuma, Calif. side	May 4	57.3	53.6	20.5	12.1
13734	♂	Near Pilot Knob, Calif. side	May 6	58.9	56.6	.....	11.8
13735	♂	Near Pilot Knob, Calif. side	May 14	57.5	55.0	20.8	12.0
		Average of the males,		56.6	53.6	20.3	11.5
13725	♀	Opposite Cibola, Calif. side	Apr. 1	53.5	49.5	19.8	11.9
13730	♀	4 mi. S. Potholes, Calif. side	May 2	54.8	49.3	20.2	11.7

the usual habitat. Occasionally dense growths of very young willows, being then similar in habit to tules, offered the proper conditions. Along the lower course of the river, thickets of cane which clothed the abrupt banks were the chief resort. Where tules failed, as near Pilot Knob, this was the only accepted cover. On April 17, as we floated through Canebrake Cañon, three to seven miles below Picacho, the songs of yellowthroats were heard almost continually. Here they were inhabiting the jungles of cane which grew down into the river along both shores. Unfortunately we did not have the time to devote to search for nests, and information in regard to breeding habits is lacking.

***Geothlypis trichas occidentalis* Brewster**

Western Yellowthroat

Occurred as a migrant along the valley, as noted under the preceding heading. The four specimens taken and referred to this subspecies are all males, and were obtained as follows: No. 13722, Blythe, California side, March 23; 13724, ten miles below Cibola, Arizona side, April 9; 13726, 13727, twenty miles north of Picacho, California side, April 11 and 12. These migrants were quite likely bound for the Great Basin to the northward, being indistinguishable from specimens from northern Nevada.

***Icteria virens longicauda* Lawrence**

Long-tailed Chat

First seen April 25, above Laguna, one individual; three in the same place the next day. On the 27th, at Potholes, several were seen; and thenceforth, at Potholes and four miles below, five miles northeast of Yuma, and on both sides of the river in the vicinity of Pilot Knob, chats were abundant. Twenty-four specimens were taken, nos. 13769-13792.

There is in the Museum a skin (no. 6423) taken by J. G. Cooper at Fort Mohave, April 25, 1861.

This bird was everywhere closely confined to the willow association, at any rate never seen beyond the arrowweed. In point of actual numbers, they were probably not so numerous as yellow warblers or song sparrows; but in volume of noise they exceeded all other birds combined. These chats of the Colorado possess an amazingly large vocabulary in imitation of other sounds. On May 3 a few minutes of

attention to a single individual was enough for unmistakable recognition of notes or songs of Abert towhee, flicker, kingfisher, Bullock oriole, and tanager. The chat is here a far better mocker than the mockingbird itself.

***Wilsonia pusilla pileolata* (Pallas)**

Alaska Pileolated Warbler

Appeared commonly as a migrant through the riparian strip. Sixteen specimens (nos. 13736-13751) were taken, from April 19 to May 12, inclusive, representing the following localities: California side, eight miles east of Picacho, April 19 and 20; Arizona side, five miles north of Laguna, April 21, 24 and 25; California side at Potholes, April 27; same side, four miles south of Potholes, May 1 and 2; same side, five miles northeast of Yuma, May 4; same side near Pilot Knob, May 8 and 12.

***Wilsonia pusilla chryseola* Ridgway**

Golden Pileolated Warbler

Common as a migrant, through the riparian strip. First seen March 9 and 10, one each day, on the California side in Chemehuevis Valley. Next noted March 20, one taken, near Riverside Mountain; thenceforth of almost daily observation in suitable places at nearly all stations until May 2, when the last one with certainty identified was taken on the California side four miles below Potholes. Intermediate points and dates of capture were: California side above Blythe, March 23; Arizona side below Ehrenberg, March 26; ten miles below Cibola, Arizona side, April 7, 8 and 9; California side twenty miles north of Picacho, April 11 and 12; same side, eight miles east of Picacho, April 18 and 20; Arizona side, five miles above Laguna, April 25 and 26; four miles below Potholes, April 30, as well as May 2, as noted above. The series of specimens taken consists of seventeen examples (nos. 13752-13768).

At times pileolated warblers were numerous in tracts of willow, but since it was impossible to distinguish between the race *pileolata* and the race *chryseola* without shooting, the proportion present of these two forms between April 19 and May 2 could not be judged. All individuals shot were, however, preserved. Between these dates, thirteen *pileolata* were taken and seven *chryseola*. This proportion, nearly

two to one, for this period may therefore be near the truth. But it is further observable from the data presented that *pileolata* was a later migrant through this region than *chryseola*.

Anthus rubescens (Tunstall)

Pipit

At the time of our arrival at Needles, February 15, pipits were numerous close along the river, both on the grassy areas near the Indian camp and on the mud bars at the water's edge. They were thenceforth observed through March at many points along the river on both sides, especially when we were floating down from station to station. They were still common the first week of April, opposite Cibola. But none were seen later than April 8, when a single bird was noted flying up river, ten miles below Cibola.

Five specimens taken, nos. 13715-13719.

Oreoscoptes montanus (Townsend)

Sage Thrasher

Observed only on March 23 and April 2 and 3, so probably a transient purely. On the first specified date three were noted on the California side, above Blythe. On the latter two days fully a dozen were encountered on the same side opposite Cibola. In each case the birds adhered closely to mistletoe-bearing mesquite and ironwood, the latter extending up the desert washes. Four specimens taken, nos. 13793-13796.

Mimus polyglottos leucopterus (Vigors)

Western Mockingbird

Common early in the season all along the river on both sides. Almost exclusively confined to the mesquite belt and to the ironwoods a short distance up washes, especially where these trees were laden with mistletoe. The berries of this parasite appeared to be the chief or only food of the mockingbird.

Mockingbirds were especially common the last week in February in company with robins, bluebirds, and phainopeplas in the mesquite belt near Mellen, Arizona. The day (March 15) we floated down from our last station above the mouth of Bill Williams River to Parker, we heard the singing of mockingbirds from either side of the

Colorado River at frequent intervals all along. At Riverside Mountain and above Blythe, on the California side, they were still common. A few were noted the first week in April on the California side opposite Cibola. Three individuals were seen on the Arizona side ten miles below Cibola, April 9, and the last for the season were noted April 19, eight miles east of Picacho. Nine specimens of the mocking-bird were secured (nos. 13797-13805), one on this latest day.

There were no indications, either through dissection or judging from the behavior of the many birds observed, that the species nests in the region. It appears most probable that the species is only a winter visitant from the higher Upper Sonoran Zone to the northward in eastern California and southern Nevada.

***Toxostoma crissale* Henry**

Crissal Thrasher

A very characteristic element of the fauna of the Colorado bottom along the whole portion of its course explored by us. All evidence shows that it was a permanent resident, and closely restricted at all times to the outermost riparian association, namely the mesquite belt. Wherever this belt was strongly represented, the presence of crissal thrashers was to be recognized through their song or call note. But it was a difficult matter to shoot specimens, as the birds were ever alert, and kept close to or upon the ground beneath dense cover. Locally the thrashers were found foraging among catclaws and ironwoods up desert washes within a mile of the river bottom, and in some places they had temporarily forsaken the mesquites and invaded the willow tracts. The total absence of mesquite in any section of the river valley, however, was a sure indication of the absence of thrashers.

The species was noted at the following localities: California side, five miles below Needles; Arizona side, above Mellen (more numerous than at any other point); both sides of the river in the vicinity of The Needles; Arizona side above Bill Williams River; California side at Riverside Mountain, above Blythe, opposite Cibola, twenty miles above Picacho, and eight miles east of Picacho; Arizona side, five miles above Laguna; and California side in the vicinity of Pilot Knob. Mellen was the only station where definite indications of breeding were found. A female taken February 24 showed conclusively that incubation was in process; and another contained large ova. Still no young-of-the-year were encountered during the succeeding two and one-half months.

Twelve specimens of the crissal thrasher were preserved, nos. 13806-13817.

There is also a specimen in the Museum (no. 4226) taken by J. G. Cooper at Fort Mohave, January 2, 1861; and another (no. 6112) taken by W. W. Holder at "Mineral City" (=Ehrenberg) March 20, 1864.

Heleodytes brunneicapillus couesi (Sharpe)

Cactus Wren

Met with in small numbers at most of the collecting stations. Where desert washes led down to the river bottom, cactus wrens occurred locally in the mesquite belt; but otherwise the species was restricted to the neighborhood of tracts of ironwood, catclaw, and cactus back from the river. In other words, it was a desert species, not properly a member of the riparian assemblage.

This wren was evidently resident wherever found, as nests were always to be seen in the vicinity. Specific points of occurrence were: in the Sacramento Wash near Mellen; both sides of the river in the vicinity of The Needles; Arizona side above Bill Williams River; California side at Riverside Mountain; and same side above Blythe, opposite Cibola, twenty miles above Picacho, eight miles east of Picacho and four miles north of Potholes. At the latter place in a wash in the giant cactus belt, about two miles back from the river, a nest was found April 23 containing four eggs in which incubation was far advanced. The nest was of usual construction, and was situated five feet above the ground in a dense cholla cactus. Other nests were seen at different points, in ironwood, palo verde and mesquite.

Nine specimens of the cactus wren were taken, nos. 13818-13826.

Salpinctes obsoletus obsoletus (Say)

Rock Wren

Up to the middle of March common widely on the desert mesas as well as among hills. Noted at every station from the vicinity of Needles and Mellen south to Riverside Mountain. Thenceforth observed only in pairs in restricted localities affording appropriate nesting sites. On the California side opposite Cibola, April 3, a pair of rock wrens were found in a ravine about two miles from the river. Their nest was located in a hole in the rock wall of a gully, only about five feet from the bed. The floor of the opening, and also of some

adjacent cavities, was paved with flat pieces of stone about an inch in diameter. The nest itself was out of reach. Several rock wrens were observed among the hills twenty miles north of Picacho. On April 16 a bird was observed to fly into a cranny with a bill full of insects, thus indicating young at this date. A bird taken on the hillside near Potholes, April 27, showed evidences that the breeding season was past.

Five specimens were secured (nos. 13841-13845).

There are also in the Museum two skins (nos. 4277, 4278) taken by J. G. Cooper at Fort Mohave, January 31 and February 10, 1861.

***Catherpes mexicanus conspersus* Ridgway**

Cañon Wren

Observed only where precipitous rock walls furnished the ideal environs for the species, and only sparingly then. At least three pairs were located on the river side of the pinnacles constituting The Needles, and one specimen obtained March 5. Another pair was observed on the California side opposite. The song was heard repeatedly as we passed through the whirlpool cañon just below The Needles. Again met with in deep, narrow ravines in some red conglomerate hills above Bill Williams River, where one example was taken March 15 and another seen. From the cañon walls on either side of the river in its course immediately below the mouth of Bill Williams River, the song of this wren came often to our ears as we drifted along.

March 17 and 18 cañon wrens were heard in ravines well up on Riverside Mountain. As none were seen after the latter date, although other favorable localities were visited, it is possible that the species is only a winter visitant to the region from the higher desert ranges in the Death Valley region. Still it is known to breed in similar localities in the same life-zone elsewhere.

The two examples secured (nos. 13848, 13849) are doubtfully referred to *conspersus*. Lack of material prevents a satisfactory study of the case.

***Thryomanes bewicki eremophilus* Oberholser**

Desert Bewick Wren

Common as a winter visitant to the region. Observed chiefly in the sparse brush margining the washes leading down from the desert interior. The catclaw and larger creosote bushes appeared to afford

both productive foraging grounds and safe retreats. It was rarely that this wren was seen near the river, and then only as far as the salt-bush belt. The range of the western house wren in the willow association appeared to be not at all impinged upon by that of the desert Bewick wren. This again shows the local dissociation of birds of the same or nearly the same habits, even in their winter habitats. It is to be inferred that there are inherent preferences of the two species for cover of the two different sorts.

The desert Bewick wren was observed on the California side five miles below Needles, opposite The Needles, and in the lower Chemehuevis Valley; on the Arizona side in the vicinity of Mellen, at the foot of The Needles, and above Bill Williams River. At least one specimen was secured at each of the above points. The last for the season were observed March 21 at Riverside Mountain. The series of nine specimens (nos. 13827-13835) are uniform in their exhibition of the characters assigned to this race by its original describer (Oberholser, 1898, p. 427). The great length of tail alone serves to distinguish *Thryomanes bewicki cremophilus* from any of the other seven forms of *bewicki* occurring within the state of California (Grinnell, 1910, p. 309). The Colorado Valley birds are with a high degree of probability visitants from a summer habitat lying on the higher desert mountains in the vicinity of Death Valley, California and Nevada, where this form has been recorded as breeding (Oberholser, 1898, p. 429).

There are in the Museum three skins (nos. 4280-4282) of this wren taken by J. G. Cooper at Fort Mohave, January 1, March 6 and 21, 1861.

Troglodytes aëdon parkmani Audubon

Western House Wren

Common as a winter visitant to the river bottom only, and even here confined almost exclusively to the willow association. Not one individual was seen anywhere on the desert proper. The species was noted in the willow thickets near Needles, February 15, and thenceforth at all stations, on both sides of the river, until the last of March. At Ehrenberg but one was noted (and obtained) March 29. The last for the season was seen April 9, a single individual, in a pile of drift on the river bank on the Arizona side ten miles below Cibola.

Five specimens preserved (nos. 13836-13840).

There is also a skin in the Museum (no. 4287) taken by J. G. Cooper at Fort Mohave, January 22, 1861.

As there are no known characters by which to recognize house wrens breeding in the Great Basin region from those on the Pacific coastal slope, there is no way of deciding where those individuals wintering in the Colorado Valley come from. But it is most likely that they hail from the interior somewhere, as do practically all of those birds where this point can be definitely determined.

Telmatodytes palustris plesius (Oberholser)

Western Marsh Wren

Observed only in dense but low vegetation such as tules, along lagoons in the river bottom. A single example was seen and secured (no. 13846) on the California side at the lower end of Chemehuevis Valley, March 11. Near Riverside Mountain March 17 several were seen, and one secured (no. 13847). On the Arizona side a mile or so below Ehrenberg, March 25 to 29, there were many around a series of ponds. Nothing was seen of the species after the latter date. Since no old nests or other indications of breeding were detected, it is not to be presumed that marsh wrens are more than winter visitants to the Colorado Valley.

Auriparus flaviceps flaviceps (Sundevall)

Verdin

The most numerous and widespread resident species of bird in the whole region. The only essential condition for the presence of this species appeared to be stiff-twigged thorny bushes or trees of some sort. This requisite was met with in a variety of situations, as in the screwbeans of the first bottom, mesquites of the second bottom, and catelaw, ironwood, palo verde and daleas of the desert washes. The birds appeared to have already paired off by the latter half of February; each pair had a particular beat or forage area, focussing at one or more nests. Nests were occupied, at least as roosting places, throughout the season, and as nests were not constructed in other than the thorny bushes above named, the local range of the species was predetermined. While the birds were often seen in willows, arrowweed, and even low shrubs of *Atriplex* and sandburr, these were

always within a limited radius of nests. As far as observation went, these birds do not need to visit water; some were met with as much as three miles away from the river up desert washes.

Nests containing eggs or young were found as follows: April 5, California side opposite Cibola, eggs four, incubation advanced; April 7, Arizona side ten miles below Cibola, eggs four, incubation far advanced; same date and place, three eggs incubated and one newly hatched young; same date and place, eggs five, incubation nearly complete; April 11, California side, twenty miles above Picacho, eggs four, incubation advanced; April 12, same place, three small young and one egg about to hatch; April 22, on the Arizona side five miles above Laguna, a brood of two-thirds grown young was encountered. The breeding period thus would appear to be of remarkable uniformity among all individuals of the species.

The above six nests varied from 38 to 96 inches above the ground, averaging 69 inches. These, of the usual firm-walled, globular type and constructed of stiff, thorny twigs, with the laterally placed opening scarcely larger than the diameter of the bird, would thus appear admirably adapted for the exclusion of the parasitic cowbird, of much greater size, as well as a defence against depredators of various sorts. I can see no other reason for so specialized a structure. Yet the plumbeous gnatcatcher, occupying almost an identical range, and with *open* nests, lays the same number of eggs, as though it were no more subject to fatalities than the verdin. This is true also of the Sonora yellow warbler (see Brown, 1903, p. 47).

A series of twenty-four verdins was taken, nos. 13922-13945. Two of our specimens, taken at Needles February 15 and 16, are much discolored with coal soot.

Besides these, there are in the Museum collection five specimens (nos. 4238-4242) taken in 1861 by J. G. Cooper at Fort Mohave. The dates of capture are: February 19, March 9, 15 and 30, and April 5. These old skins are perceptibly paler than the freshly obtained specimens, most probably due to their having been exposed to strong light in a show case at some time or other.

Regulus calendula cineraceus Grinnell

Ashy Kinglet

Evidently a characteristic winter visitant, as it was one of the commonest birds of the willow bottom in the vicinity of Needles at the time of our arrival in the region, February 15. It was thenceforth

noted regularly down along the river until the first week in April, when it became scarce; the last one noted was secured April 18, on the California side eight miles east of Picacho, this being the only individual seen at this point. The other localities of capture, lying between the two above-named, are as follows: on the California side: opposite The Needles, Chemehuevis Valley, Riverside Mountain, Blythe, opposite Cibola, twenty miles north of Picacho; on the Arizona side: Mellen, foot of The Needles, Ehrenberg, ten miles south of Cibola. In all these places the kinglets were seldom seen outside of the willow association.

The series of twenty-four specimens obtained, nos. 13946-13969, is uniform in its exhibition of the characters assigned to *Regulus calendula cineraceus* (see Grinnell, 1904, p. 25). As compared with examples from eastern North America, they are distinctly more ashy-hued anteriorly both above and below. Especially is this peculiarity marked over the top and sides of the head. There is a slightly greater general size in the case of the southwestern race. It is therefore probable that the Colorado River birds are visitants from the mountains of the southwest, whence kinglets of the same characters have been secured in summer, rather than from the forests of the far north.

There is also in the Museum a skin (no. 4272) taken by J. G. Cooper at Fort Mohave, January 18, 1861.

***Polioptila caerulea obscura* Ridgway**

Western Gnatcatcher

First seen at Needles, February 16; thenceforth noted regularly at all stations along down the river until April 6, when the last were noted ten miles below Cibola. As the specimens taken the first week in April, when *Polioptila plumbea* was nesting, showed no signs of immediate breeding, it seems probable that the western gnatcatcher is only a winter sojourner in the Colorado Valley. It occurred chiefly in the bushes lining the desert washes leading back from the river; a few individuals were met with in the mesquite and willow associations.

The series of thirteen skins preserved (nos. 13874-13886) represent the following localities: California side, five miles south of Needles; both sides of the river at The Needles; California side at Riverside Mountain and opposite Cibola; and Arizona side, ten miles below Cibola.

There is also in the Museum collection a skin (no. 4216) taken by J. G. Cooper at Fort Mohave, March 26, 1861.

The spring molt (which involves only the body plumage) is well along in the bird (a male) of the latter date and in birds of April 4, 5 and 6 appears to be nearly or quite complete. In the females of these dates there is, however, a want of clearness and continuity in the gray of the dorsum and pileum, and upon close examination this is found to be due to an interrupted and irregular replacement of feathers. This results in a mixture of new clear gray feathers and worn ashy ones.

Of the April birds there are six females and one male. The latter (no. 13882), in comparison with series of *Polioptila caerulea obscura* from western California, has an extraordinary amount of black on the forehead, there being a frontal band of an approximate width of five millimeters, with a conspicuous extension posteriorly over each eye. Moreover, two of the females (nos. 13880, 13881) show a distinct supra-loral black line on each side, the two lines converging and meeting over the base of the culmen. This tendency to blackness on the crown may characterize a race wintering in the Colorado Valley and breeding in the Upper Sonoran zone of desert mountains to the northward. Material is not at hand to permit following up the matter.

***Polioptila plumbea* (Baird)**

Plumbeous Gnatcatcher

A common resident along the whole line of exploration from Needles to the Mexican line. The series of thirty-five specimens secured (nos. 13887-13921) represents the following localities: California side, at Needles and five miles below Needles; Arizona side, above Mellen and at the foot of The Needles; California side in Chemehuevis Valley, at Riverside Mountain and above Blythe; Arizona side, at Ehrenberg; California side, opposite Cibola, twenty miles above Picacho, eight miles east of Picacho, and near Pilot Knob.

There are also in the Museum two skins (nos. 4219, 4220) taken by J. G. Cooper at Fort Mohave, February 19 and March 19, 1861.

The desert wash association, with its catclaw, palo verde, ironwood and smaller woody and stiff-twiggged plants, was the preferred habitat of this bird, though it occurred also in the *Atriplex* and mesquite belts along the river, even straying occasionally into the arrowweeds and

willows. It did not, however, seem to visit water, and so its presence did not at all depend upon the proximity of the river.

April 19, on the California side, eight miles east of Picacho, a nest was found in a smoke-bush (*Dalea*). It was four feet above the ground, of usual structure, and contained five small young. April 23, on the same side, four miles above Potholes, a brood of nearly grown young was flitting about at large. The breeding time in this region is thus indicated.

***Hylocichla ustulata ustulata* (Nuttall)**

Russet-backed Thrush

As elsewhere in the west this bird proved to be a late arrival. The first individuals were noted May 4 and 5, five miles northeast of Yuma, one each day. On both sides of the river in the vicinity of Pilot Knob, May 9 to 15, the species was of frequent observation, chiefly at daybreak in the willows close along the river. One was seen, however, in a rocky ravine on Pilot Knob itself, towards late evening of the 14th. The species is most certainly only a transient through the region. The three specimens taken (nos. 13850-13852) are unequivocally referable to *H. u. ustulata*.

***Hylocichla guttata guttata* (Pallas)**

Alaska Hermit Thrush

Hermit thrushes proved not to be characteristic winter visitors, as expected, and they were rare even as migrants. Unmistakable notes of one were heard at daybreak from a willow thicket in Chemehuevis Valley, March 9. Heard again similarly, ten miles below Ehrenberg, March 31. A single individual secured (no. 13853) on the California side twenty miles north of Picacho, April 10. This bird, the last of the species noted, was in a dense willow growth close to the river. The specimen is identical, in size and coloration, with examples of this race from the Prince William Sound region of Alaska.

***Hylocichla guttata nanus* (Audubon)**

Dwarf Hermit Thrush

There is in the Museum a skin (no. 6432) taken by J. G. Cooper at Fort Mohave, January 25, 1861. Although obviously faded on its ventral surface, by size and dorsal color this specimen is distinctly referable to *nanus*.

Planesticus migratorius propinquus (Ridgway)

Western Robin

Fairly common as a winter visitant to the bottom lands. Often met with in the dense willow woods, on the ground foraging for insects in the layers of dead leaves. Also one of the regular feeders on mistletoe berries. At Needles, California, February 17, several individuals were seen hopping about on the grass in the railway parking. On the Arizona side above Mellen a number were found among the mistletoes of the mesquites, February 23 to 31. A few were encountered on each side of the river at The Needles, March 1 to 7. One was seen March 14, on the Arizona side above Bill Williams River; a few on the California side at Riverside Mountain, March 17 to 21; several on the same side opposite Cibola, April 1 to 5; and one, the last noted, on the Arizona side, ten miles below Cibola, April 7.

Seven specimens secured, nos. 13854-13860.

There is also in the Museum a skin (no. 4224) taken by J. G. Cooper at Fort Mohave, March 7, 1861.

Sialia mexicana occidentalis Townsend

Western Bluebird

Common, as a winter visitant, feeding in flocks on mistletoe berries wherever these were obtainable, usually in the mesquite belt. Numerous at Needles, California, and immediately below, February 14 to 22; at and above Mellen, Arizona, February 23 and 31; and on both sides of the river at The Needles, March 1 to 7. The species was last seen, a very few, March 13, on the Arizona side above Bill Williams River.

There is a skin (no. 4212) in the Museum taken by J. G. Cooper at Fort Mohave, February 22, 1861.

The thirteen specimens secured by us (nos. 13861-13873) are not exactly typical of *S. m. occidentalis*, as occurring in the northwest coast district of the United States. Yet I do not find grounds for allocating them with *S. m. bairdi*, of the Rocky Mountain area, nor with *S. m. anabetae* of northern Lower California. They are very much like birds from the Sierra Nevada, and I have little doubt are winter visitants to the Colorado Valley from there. Sierra Nevada birds are customarily referred to *S. m. occidentalis*, and at present I cannot do anything better than employ this name for the specimens in hand. Coloration furnishes characters difficult to weigh properly,

because of much seasonal variation in tone of browns and blues through fading and abrasion, and because of wide individual variation in extent of chestnut areas. General size, too, is an inconstant feature (see Grinnell and Swarth, 1913, p. 318).

CHECK-LIST OF MAMMALS

1. *Ovis canadensis nelsoni* Merriam
2. *Odocoileus hemionus eremicus* (Mearns)
3. *Ammospermophilus harrisi harrisi* (Audubon and Bachman)
4. *Ammospermophilus leucurus leucurus* (Merriam)
5. *Citellus tereticaudus tereticaudus* (Baird)
6. *Castor canadensis frondator* Mearns
7. *Peromyscus maniculatus sonoriensis* (Le Conte)
8. *Peromyscus crinitus stephensi* Mearns
9. *Peromyscus eremicus eremicus* (Baird)
10. *Sigmodon hispidus eremicus* Mearns
11. *Reithrodontomys megalotis deserti* J. A. Allen
12. *Neotoma albigula venusta* True
13. *Neotoma intermedia desertorum* Merriam
14. *Ondatra zibethica pallida* (Mearns)
15. *Thomomys chrysonotus* Grinnell
16. *Thomomys albatus* Grinnell
17. *Dipodomys deserti deserti* Stephens
18. *Dipodomys merriami merriami* Mearns
19. *Perognathus bombycinus* Osgood
20. *Perognathus formosus* Merriam
21. *Perognathus penicillatus penicillatus* Woodhouse
22. *Perognathus intermedius* Merriam
23. *Perognathus spinatus spinatus* Merriam
24. *Lepus californicus deserticola* Mearns
25. *Sylvilagus auduboni arizonae* (J. A. Allen)
26. *Felis oregonensis browni* Merriam
27. *Lynx eremicus eremicus* Mearns
28. *Canis ochropus estor* Merriam
29. *Vulpes macrotis arsipus* Elliot
30. *Urocyon cinereoargenteus scotti* Mearns
31. *Mephitis estor* Merriam
32. *Spilogale arizonae arizonae* Mearns
33. *Taxidea taxus berlandieri* Baird
34. *Procyon pallidus* Merriam
35. *Corynorhinus macrotis pallescens* Miller
36. *Antrozous pallidus pallidus* (Le Conte)
37. *Myotis occultus* Hollister
38. *Myotis californicus pallidus* Stephens
39. *Myotis velifer* (J. A. Allen)
40. *Pipistrellus hesperus hesperus* (H. Allen)
41. *Eptesicus fuscus* (Beauvois)
42. *Nyctinomus mexicanus* Sausure
43. *Macrotus californicus* Baird

GENERAL ACCOUNTS OF THE MAMMALS: LOCAL
DISTRIBUTION, VARIATION, HABITS**Ovis canadensis nelsoni** Merriam

Desert Bighorn

Mountain sheep still occur in parts of the country on both sides of the river. Among The Needles, on the Arizona side, March 5, fresh feces and footprints showed plainly where a band of at least five had been grazing. The point of this occurrence was not more than half a mile from the river and 300 feet in elevation above it.

We were assured of the existence of a flock of fully thirty-five sheep on the Arizona side east of Cibola. These sheep were reported to visit regularly certain springs in the Chocolate Mountains.

On the California side, as we were informed, sheep used to range over Riverside Mountain, but they have not been seen there of late years, probably because of the mining activity in that vicinity. Prospectors told us that they had always taken every opportunity to obtain "fresh meat" wherever they might be in the desert hills; and as the camps of the prospectors are usually made at the water holes which the sheep depend upon in the long, dry seasons, it is not difficult to account for the disappearance of sheep in a mineralized region!

West of the river, 16 to 22 miles above Picacho, we found sheep to be quite common. At least five had been killed within the previous year by residents along the river. Two of these were shot from a rancher's house and within a few hundred yards of the river, which here flows between steep hills, with relatively little bottomland intervening. This, by the way, is in the near vicinity of Lighthouse Rock, and in the sketch of the river including this landmark, given in Ives' *Report upon the Colorado River of the West* (1861, page 52, figure 7), two unmistakable bighorns are portrayed at the water's edge.

We learned nothing to indicate that the sheep in this neighborhood ever visit the river for water at the present time. There are springs back in the hills to which the sheep regularly resort. We saw five sheep, and secured two, a ewe (no. 10588) and a male lamb (no. 10589). These were found about three miles west of the river among rough hills.

There is a possibility that the bighorns on the Arizona side of the Colorado differ slightly from those on the California side. The latter unquestionably belong to the race *nelsoni*. Mearns (1907, p. 240) describes a race (*Ovis canadensis gaillardi*) from the Gila Mountains, Yuma County, Arizona. This locality is less than seventy-five miles from the locality near Cibola where sheep are known to occur, and if *gaillardi* is a really distinct form the sheep of Cibola are perhaps referable to it rather than to *nelsoni*.

***Odocoileus hemionus eremicus* (Mearns)**

Burro Deer

No trace of deer was found by us anywhere, nor had anyone we talked with seen deer along the Colorado within four years. We were told of their occurrence in numbers many years before, when they were to be found both in the river bottom and back through certain desert ranges, where there are springs which the deer could visit regularly for water.

In August, 1902, Mr. Frank Stephens saw two deer on the California side of the river west of Cibola. The animals were jumped from a wash among ironwood trees and made off across a wash. Sign was fairly plentiful, and deer were said to be common at that time on both sides of the river.

Members of our party in 1910 looked over the same ground closely without finding sign. The rapid settlement of the river bottom around Palo Verde probably accounts for the disappearance of deer throughout that section. At the Draper ranch twenty miles above Picacho a single old buck had been seen "about" five years previously.

***Ammospermophilus harrisi harrisi* (Audubon and Bachman)**

Harris Ground Squirrel

Twenty-six specimens secured, from localities all on the Arizona side of the river, as follows: Mellen, 18; foot of The Needles, 1; above Bill Williams River, 2; Ehrenberg, 3; 10 miles below Cibola, 2. None was seen at any locality where not also taken, so that the species appears not to occur near the river along its course below Cibola. Our work shows, further, an extreme associational restriction, namely, to rupestrine conditions as furnished in the rough hills and on those parts of the desert mesa where the wind keeps the weathered detritus

removed, leaving a surface of firmly packed gravel or pebbles. The burrows of the Harris ground squirrel are most often to be found opening out beneath a creosote bush (see pl. 12, fig. 18), which plant occurs throughout the range of the squirrel. Up to the last date of capture, April 9, no young had been observed, although on March 5, at Mellen, a female taken contained six embryos.

In no instance was this rodent found to have strayed on to any part of the river bottom, even on to the edge of the sandy second bottom. But where the river passed among the steep-sided hills, as at

LIST AND MEASUREMENTS IN MILLIMETERS OF *AMMOSPERMOPHILUS HARRISI HARRISI* FROM THE ARIZONA SIDE OF THE COLORADO RIVER

Mus. No.	Sex	Locality	Date, 1910	Total length	Tail vertebrae	Hind foot	Ear	Occipito-nasal length of skull	Zygomatic width
10531	♀	Near Mellen	Feb. 25	225	70	39	5	38.8	22.0
10532	♂	Near Mellen	Feb. 26	246	85	40	5	40.4	23.7
10533	♂	Near Mellen	Feb. 27	226	84	40	8	39.3	22.5
10534	♀	Near Mellen	Feb. 27	217	76	39	8	38.5	22.0
10535	♂	Near Mellen	Feb. 27	232	70	40	..	39.4	22.6
10536	♀	Near Mellen	Feb. 27	215	70	38	..	38.4	22.1
10537	♂	Near Mellen	Feb. 27	222	66	37	..	38.5	22.2
10538	♀	Near Mellen	Feb. 27	225	70	40	..	39.7	22.5
10539	♂	Near Mellen	Feb. 27	224	68	39	..	40.8	23.5
10540	♂	Near Mellen	Feb. 27	243	80	40	..	40.1	22.5
10541	♀	Near Mellen	Feb. 28	205 ¹	50 ¹	39	..	38.7	22.5
10542	♀	Near Mellen	Feb. 28	230	70	38	..	39.1	23.0
10543	♂	Near Mellen	Feb. 28	220	68	36	..	.....	22.1
10544	♂	Near Mellen	Feb. 28	220	67	38	..	38.5	23.2
10545	♂	Near Mellen	Mar. 1	230	70	38	..	40.1	23.4
10546	♂	Near Mellen	Feb. 28	220	77	38	7	38.3	22.4
10547	♀	Near Mellen	Feb. 28	219	78	39	7	38.6	22.6
10548	♀	Foot of The Needles	Mar. 5	230	86	38	8	38.5	22.4
10549	♀	Above Bill Williams River	Mar. 13	230	70	38	..	.....	22.5
10550	♀	Above Bill Williams River	Mar. 15	235	73	38	..	.....	22.8
10551	♀	Ehrenberg	Mar. 25	220	70	39	..	39.2	23.0
10552	♂	Ehrenberg	Mar. 26	223	75	40	..	39.5	22.8
10553	♀	Ehrenberg	Mar. 29	240	75	41	..	39.8	22.8
10554	♀	10 miles below Cibola	Apr. 8	225	72	38	..	39.8	23.4
10555	♂	10 miles below Cibola	Apr. 9	225	72	38	..	40.2	22.5
		Average of the 24 adults		227	73.4	38.7	6.9	39.3	22.7

¹ Not averaged, tail defective

The Needles, *harrisi* was observed as close as within one hundred yards of the water's edge. The animals did not, however, even here, show the least disposition to visit the water for any purpose whatever; so that the chances of being transported across to the opposite shore are practically nil. That in this part of the range of *harrisi* the Colorado River is the limiting barrier is a fact beyond question. There is a persistent statement in literature (for example, Elliot, 1905, p. 97) to the effect that *harrisi* occurs in California; but I am not cognizant of any basis for this assertion and I doubt its correctness.

Two races of *Ammospermophilus harrisi* have been distinguished within the state of Arizona. Mearns (1896, p. 444, and 1907, pp. 303-309) has characterized a form *A. h. saxicola* from extreme southwestern Arizona, thus restricting *harrisi* proper to central Arizona. I fail to find grounds, either in tone of coloration or relative length of tail, to warrant separate recognition of the Colorado River series from the animal of the vicinity of Tucson. Even Mearns' own tables of measurements do not bear out the size characters of his *saxicola*, which name might be expected to be usable for our specimens. The measurements of the Colorado Valley series are given herewith, as is also a table showing comparison with the near-related form *leucurus*, of the opposite side of the river (see pp. 220, 223).

***Ammospermophilus leucurus leucurus* (Merriam)**

Antelope Ground Squirrel

Seventeen specimens obtained, all on the California side: 5 miles below Needles, 1; opposite The Needles, 5; Chemehuevis Valley, 2; Riverside Mountain, 1; opposite Cibola, 2; twenty miles above Picacho, 4; eight miles east of Picacho, 2. This rodent was not notably numerous anywhere, and was closely restricted to rocky or gravelly ground, chiefly among hills. It occupied the same ecologic niche on the California side that *harrisi* did on the Arizona side; and where the hills closely abutted upon the river, as at The Needles, the two species existed in places not more than three hundred yards apart, but with the river between. In no case was there any evidence of crossing; all individuals captured or seen were unquestionably one form or the other, and always appropriately segregated as regards the river.

No young of *leucurus* were taken; but a female taken five miles south of Needles, February 20, contained eight embryos, and another

taken at Chemehuevis Valley, March 11, contained five embryos. It is notable that the weather on the first date was very cold for the region. It seems to be a rule among the Sciuridae of the Colorado desert area that the young-of-the-year are well grown long before the period of intense summer heat.

Ammospermophilus l. leucurus and *A. h. harrisi* are perfectly distinct but closely related species. The following comparative table serves to show the differences between them, which differences must not be overemphasized as contrasted with the close general resemblances.

AMMOSPERMOPHILUS L. LEUCURUS	AMMOSPERMOPHILUS H. HARRISI
General size slightly less; body 149.4 mm.	General size greater; body 153.6 mm.
Tail relatively shorter, 44 per cent of body.	Tail relatively long, 48 per cent of body.
Audital bullae slightly smaller.	Audital bullae slightly higher, more inflated.
External ear slightly larger, 7.1 mm	External ear slightly smaller, 6.9 mm.
General coloration paler above, less brown more gray.	General coloration darker, distinctly brownish dorsally.
White side-stripes more conspicuous.	White side-stripes narrower and not so long.
Tail beneath pure white.	Tail beneath grizzled gray.
Tail carried appressed over the rump, displaying under surface conspicuously as if there were a white rump patch.	Tail carried vertically or inclined backward or forward, but showing no conspicuous white.
Tail often rapidly vibrated from side to side, causing the white to flicker	Tail often waved or jerked in fore-and-aft arc.

In the matter of audital bullae, *harrisi* parallels *Thomomys chrysonotus*, in the increased size of bullae on the Arizona side of the river. A curious anomaly appears in the reverse proportion in the size of the external ear in the two squirrels, *leucurus* of the California side having larger ears than *harrisi*. There are similar reverse ratios between ears and bullae in certain southern California *Perognathus*.

The most striking difference between *Ammospermophilus harrisi* and *A. leucurus* is, as noted in the table, in the color of the under surface of the tail and in the manner of carrying this appendage. It may be inferred that the musculature connected with the tail is quite differently developed in the two species, together, of course, with correlated nervous and circulatory differences.

The range of *harrisi* is practically restricted to Arizona and parts of Sonora. The range of *leucurus* and its geographic races almost completely surrounds that of *harrisi*. But, as far as I know, the ranges of the two nowhere overlap, nor has there been found any case of hybridization between the two. It is certain that only the existence of the Colorado River keeps the ranges of the two separate in this segment of their respective peripheries. What would have happened if the river had not served as an absolute barrier is, of course, wholly conjectural. But there is no doubt in my mind that in such event both the ranges and the characters of the two forms would be far different from what they now are.

LIST AND MEASUREMENTS IN MILLIMETERS OF *AMMOSPERMOPHILUS*
LEUCURUS LEUCURUS, FROM THE CALIFORNIA SIDE OF
THE COLORADO RIVER

Mus. no.	Sex	Locality	Date	Total length	Tail vertebrae	Hind foot	Ear	Occipito-nasal length of skull	Zygomatic width
10556	♀	5 miles below Needles	Feb. 20	177 ¹	40 ¹	35.5	7	36.8	20.8
10557	♂	Opposite The Needles	Mar. 2	220	60	35	..	37.3	22.7
10558	♀	Opposite The Needles	Mar. 2	222	65	38	..	39.1	21.3
10559	♂	Opposite The Needles	Mar. 2	218	65	38	..	38.2	22.6
10560	♂	Opposite The Needles	Mar. 3	220	60	38	..	37.8	22.9
10561	♀	Opposite The Needles	Mar. 7	215	60	40	..	37.3	21.4
10562	♂	Chemehuevis Valley	Mar. 11	221	76	38	7	38.5	22.9
10563	♀	Riverside Mountain	Mar. 20	225	67	39	..	.....	23.2
10564	♀	Opposite Cibola	Apr. 4	235	75	38	..	.....	.....
10565	♀	Opposite Cibola	Apr. 5	190 ¹	43 ¹	40	9	39.0	22.3
10566	♀	20 miles above Picacho	Apr. 12	220	76	37	7	37.9	22.2
10567	♀	20 miles above Picacho	Apr. 13	220	67	37	..	39.2	.....
10568	♂	20 miles above Picacho	Apr. 13	215	60	38	..	40.0	23.1
10569	♀	20 miles above Picacho	Apr. 15	194	61	34	6	36.4	21.1
10570	♀	Chemehuevis Valley	Mar. 11	200	62	37	7	37.4	22.9
10571	♀	8 miles east of Picacho	Apr. 20	210	60	37	..	.....	22.2
10572	♂	8 miles east of Picacho	Apr. 21	220	70	39	..	38.0	22.2
		Average of the 17 adults		215	65.6	37.5	7.1	38.0	22.1

¹ Not averaged; tail defective.

Citellus tereticaudus tereticaudus (Baird)

Round-tailed Ground Squirrel

Fairly common at intervals from Needles to the Mexican line. Sixteen specimens were collected (nos. 10637-10651, 10722) on both sides of the river, as follows: California side: five miles below Needles 1, opposite Cibola 2, near Pilot Knob 4; Arizona side: at Mellen 5, five miles northeast of Laguna 3. The species was seen at no other places, and the inference is to be drawn that it is of quite interrupted distribution. This is explained when its associational position is taken account of.

Citellus tereticaudus is a sand-dwelling mammal, resembling in its preferences *Dipodomys deserti*, *Peromyscus eremicus* and *Perognathus penicillatus*. The squirrel, however, is even more restricted than either of these, for a rather large extent of arenaceous territory seems to be necessary to support a representation. Where the second bottom was broad, with accumulations of wind-drifted sand about the scattering *Atriplex* and creosote bushes, *tereticaudus* was best represented. Such a place was afforded on the Arizona side above Mellen. On the desert mesa similar conditions were rare, but where they did occur to any extent, as near Pilot Knob, the round-tailed ground squirrels were usually in evidence. The burrows open up among the stems of partly buried bushes, the animals foraging out over the bare intervals where seeds from annual plants are found sifted into the surface sand.

No young were seen by our party; but two females taken opposite Cibola, April 3 and 4, contained six and four embryos respectively. There are in the Museum two half-grown young (no. 7767, 7768) taken by Charles L. Camp at Needles, July 15 and 19, 1909.

The series of *Citellus tereticaudus*, when segregated into two groups according to the side of the river from which the individuals were obtained, shows appreciable diversity in external features. The specimens from the Arizona side are distinctly darker, more brownish than those from the opposite (California) side, even where obtained within but a very few miles of one another. This diversity in color is most marked at Needles, less so lower down the river. It would appear that the case is quite comparable to that in *Perognathus penicillatus*, where the darkest individuals hail from the east side of the river north of The Needles.

In measurements of the two groups, the Arizona-side examples of *tereticaudus* are shorter-tailed, as shown in the following comparison. Average of eight adults from the Arizona side as compared with average of seven adults from the California side (in parenthesis) is: total length, 234.1 (240.6); tail vertebrae, 76 (88.3); hind foot, 35.1 (35.5); ratio, tail to body, 48 per cent (58 per cent). These measurements of the California side examples are close to those of many others of the Colorado Desert west of the river. The shortness of tail is fairly well borne out in the measurements of *Citellus tereticaudus* from east of the river along the Mexican line as given by Mearns (1907, p. 338). The present series, however, is inadequate to settle the point satisfactorily.

It will be observed that in relative darkness of the Arizona side examples, we have here a parallel to the case in *Ammospermophilus*, while in ratio of tail to body the reverse relationships are presented. The degree of difference exhibited in *Citellus*, even if actual, is very slight as compared with the differences between *Ammospermophilus h. harrisi* and *A. l. leucurus*.

Castor canadensis frondator Mearns

Sonora Beaver

Signs of beavers were seen at many places along the river through the big valleys, from near Riverside Mountain to Pilot Knob. We heard of their occurrence also above Needles. At the present time, however, beavers are scarce along the Colorado River, this being said to be due to the unrelenting pursuit of them by professional trappers. Various evidences of the late presence of trappers were seen by us below Ehrenberg.

Very little of the beaver sign seen during our cruise of the river was fresh. The first noted was on the California side near the base of Riverside Mountain, March 16. Many young cottonwoods had been felled at the edge or within twelve feet of the main river channel, where its bank sloped steeply into deep water. The trees had been cut off about one foot above the ground and all felled down-stream, or, rather, diagonally, down-stream and towards the river. The largest cottonwood was fourteen inches in diameter where cut, the next two seven inches in diameter. Other cuttings were noted down to willow shoots one-half inch in diameter.

A stick "house" was located at the edge of the river a short distance below these cuttings. It resembled a mass of drift caught among the snags resulting from the undercutting of the timbered bank. This house was three and one-half feet in height, by fourteen and sixteen feet in two diameters on the ground. It consisted of small branches and broken saplings from the driftwood of the river and some brush dragged in from the land side. A little earth and dead leaves had been worked into the interstices. Less than a dozen beaver-cut sticks were in evidence in the whole structure. There were no fresh signs in or around this house. But a recently used "slide" was found on the bank a few yards off.

Opposite Riverside Mountain, and below Ehrenberg in at least two places, beaver cuttings were found on the Arizona side. And on the California side from near Ehrenberg to below Palo Verde considerable work was noted. In one place bark had been stripped within a day or two from a cottonwood sapling lying in the water, where it had recently fallen as a result of undermining by the river.

It was thought that the continual undercutting of its timbered banks by the river itself, thus precipitating many green trees into the water, provided an immediate food-supply for the beavers, so that even if present in numbers they would gain an easy living without themselves having to fell trees. It is possible, too, that the habitually unsettled behavior of the river accounts for the loss of the dam-building propensity, or at least for its futility on the part of the beavers of the Colorado Valley. We saw no signs anywhere of dams such as are reported by Mearns (1907, pp. 354-358) as occurring on the Verde River, Arizona, a tributary of the Gila, which in turn flows into the Colorado.

A used "house" located at the margin of a slough near Palo Verde was cut into by Stephens and Jones on April 3. It proved to be three feet in height and twelve feet across at the base. It consisted of branches and small saplings cut by the beavers when in full leaf, and laid compactly. The mass was eight inches thick over the nest cavity. The interior space was two and one-half feet high by four to five feet across. At one side the bank had been dug away to make the floor comparatively level, as the house was built on a sloping bank near its top. There was an under-water entrance at one side, and an opening through the wall above ground. A fresh willow sapling had been hauled through this opening butt first. The beds were merely hollows in the earth floor.

On both sides of the river in the vicinity of Pilot Knob there was considerable beaver sign, consisting of well-beaten trails up the banks, foot and tail prints, and cut willow saplings. At all points where prospects seemed at all favorable, traps were set, but our nearest approach to success was the securing of a front foot (no. 10731) in a trap on the Arizona shore opposite Pilot Knob. The shore sloped so gently at this place that the trap could not be set in water deep enough to insure drowning of the victim and yet occupy a position anywhere near the foot of the used slide. The animal had evidently pulled loose.

Further troubles in our efforts to trap beavers resulted from the continual rising or falling of the river and from the heavy deposit of silt. The latter so rapidly filled in the steel traps (Newhouse nos. 3 and 4), even when set upon broad strips of bark and staked out two feet or so from the actual bank, that beaver or any other animals could walk upon them without setting them off.

At the last trapping place, the lowering of the water repeatedly exposed both the traps and stakes, but tracks showed that during the night a beaver had gone past, nevertheless, indicating no particular shyness or suspicion.

From the reports given us by different people along the river, it is probable that beavers were abundant in suitable parts of its course up to a few years ago. As many as 250 skins are said to have been taken in a single year by one trapper. With observance of the protective laws now in force in both Arizona and California there is a chance for beavers to become sufficiently plentiful again to warrant a brief open season each year when the fur is prime. I see no reason why the Colorado River should not produce a regular output of skins, provided the number taken annually be adjusted to the rate of increase.

***Peromyscus maniculatus sonoriensis* (Le Conte)**

Sonora White-footed Mouse

An abundant inhabitant of the bottomlands everywhere, this in spite of the annual overflow which might be expected to drown out a mammal of this non-aquatic genus.

The 65 specimens secured (nos. 10100-10164) represent the following localities: California side: five miles below Needles, opposite The Needles, Chemehuevis Valley, at Riverside Mountain, above Ehrenberg, near Palo Verde, eight miles below Picacho, four miles south of

Potholes, five miles northeast of Yuma, and near Pilot Knob; Arizona side: Mellen, Ehrenberg, twenty-five miles below Ehrenberg, five miles northeast of Laguna, near Yuma.

The species thus proved to be regularly distributed all along the Colorado Valley. Yet we failed to trap it anywhere on the nearby desert outside of the mesquite belt. In other words, this *Peromyscus* has appropriated the river bottom, which, in turn, is tabooed by the two desert species of the region, *cremicus* and *stephensi*. It is to be inferred that *sonoriensis* used the Colorado Valley as a highway of immigration through the region, and found it suitable for permanent occupancy. The *maniculatus* division of the genus *Peromyscus* is notorious for its success as an invader. Single subspecies representative of this group range through the habitats of dozens of other species of small rodents, from the hottest, Lower Sonoran, Colorado desert to the Boreal zone on the San Bernardino Mountains. It is thus a remarkably hardy animal; yet, as far as known, it nowhere thrives to the total exclusion of other small rodents, save in the case of slightly different subspecies on certain islands.

The aggressiveness of *Peromyscus m. sonoriensis* was illustrated by our experience along the Colorado. It was the only wild mammal which found its way on to our boats; individuals were twice routed out of the cargo of supplies on the scow. This boat was most of the time moored alongside the shore, either touching the bank at one corner, or with a gangplank out, so that any venturesome animal could easily go aboard.

At a point five miles northeast of Yuma, Sonora white-footed mice were trapped April 30 on a river bar covered with a very young growth of willow. This was at a time when the rising water had already cut the place off from connection with the main shore. Footprints of mice were plentiful on the dry, fine silt on the higher part of the island thus formed. In several other places this rodent was trapped on portions of the flood-bottom elevated in such a degree that they would have been first cut off from the shore as the water rose and then set adrift. In some of these cases safety could have been secured by swimming short distances through relatively quiet water, or by taking refuge on floating drift. It is highly probable that in the rush of flood waters a large mortality must annually occur.

It is probable also that the paucity of snakes and other enemies in the flood-bottom gives this mouse relative immunity from those dangers which beset the small mammals out on the desert; so that

sonoriensis can stand the fatalities due to the river's irregular habits and still maintain a large population, without any modification in birth rate.

Mice of the *Peromyscus maniculatus* group are known to be much more prolific than *Perognathus* or *Dipodomys*, not so much because of the larger litters but because there are several litters each year in the first-named rodent, and only one as a rule in the last two. On the Colorado the results of our collecting give but little information as to the breeding of *P. m. sonoriensis*. A female taken March 25 contained five embryos; one taken May 5 contained three embryos.

***Peromyscus crinitus stephensi* Mearns**

Stephens Cañon Mouse

As judged from the results of our three months' trapping, this was the least numerous of the smaller rodents of the region. Only thirteen specimens were procured, apportioned by locality as follows: Opposite The Needles, five (nos. 9978-9982); above Ehrenberg, one (no. 9983); twenty miles above Picacho, two (nos. 9984, 9985); Pot-holes, two (nos. 9986, 9987); Pilot Knob, three (nos. 9988-9990).

All of these localities are on the California side of the river. It would thus appear that in its lower course the river forms an absolute barrier to the eastward spread of this mouse. Yet it has been taken on the Arizona side of the Colorado, whence, considerably above Fort Mohave, Osgood (1909, p. 233) has recorded three specimens.

The associational preferences of this mouse are most pronounced. All of the specimens were captured near or among rocks in ravines or on steep hillsides. It is thus a rupicoline species with much the same associational exclusiveness as *Perognathus spinatus*. As in the case of the latter, each mountain mass probably possesses its more or less completely isolated colony of these mice, separated from its neighboring colony by the uninhabited interval of level mesa or valley.

***Peromyscus eremicus eremicus* (Baird)**

Desert White-footed Mouse

The series of 109 specimens of this mouse (nos. 9991-10099) are representative of the following localities: Arizona side: Mellen, foot of The Needles, above Bill Williams River, Ehrenberg, twenty-five miles below Ehrenberg, ten miles below Cibola, five miles north of Laguna, and Yuma; California side: opposite The Needles, Chemehuevis Valley,

Riverside Mountain, Palo Verde, opposite Cibola, twenty miles above Picacho, eight miles below Picacho, Potholes, five miles above Yuma, and Pilot Knob.

The wide occurrence of *Peromyscus eremicus* through the region is thus indicated. Yet our trapping showed distinct associational preferences. The overflow bottom is evidently rarely invaded, there being but slight overlapping of the habitat of *Peromyscus maniculatus sonoriensis*; and the rocky hills and mesas are eschewed, so that in this direction the domain of *Peromyscus crinitus stephensi* is seldom encroached upon. *P. eremicus* was found in greatest numbers on arenaceous alluvium *not* included in the overflow area of the river bottom. It was present on the second bottom outside the mesquite belt, and along desert washes leading down from the interior; also on the desert mesa where wind-blown accumulations of fine sand afforded the same sort of ground, that is, ground of a fine but loose consistency, easy to burrow into.

The breeding season of the desert white-footed mouse, as indicated by the following dates, covers at least three months. Nearly or quite full-grown, blue-pelaged young were taken as early as March 2, and from then on at increasingly frequent intervals until the last of April. Females were taken March 5 with three embryos, March 8 with three embryos, April 13 with four embryos and April 19 with four embryos.

***Sigmodon hispidus eremicus* Mearns**

Western Desert Cotton Rat

This rodent proved to be strictly riparian in its associational preferences, and, furthermore, was found only along the lower course of the river, below Ehrenberg. It belongs to a southern zone, tropical or semi-tropical, and is one of the lowest zonal elements entering the region; moreover, it has not pressed its way far up the river.

I should judge its habits and food requirements to be closely similar to those of *Microtus*, of cooler regions. But as far as known, the ranges of *Sigmodon* and *Microtus* do not quite meet anywhere. Certainly there are no *Microtus* in the Colorado River bottom as low down as Needles. *Sigmodon* thus has a clear right of way, from a competitive standpoint.

The three localities of capture are all on the California side; yet there is every reason to suppose that cotton rats occur on the Arizona side as well, being surely as readily able to swim as harvest mice.

In the bottomlands a few miles below Palo Verde, cotton rats were found in apparent abundance March 31 to April 3. They were here inhabiting a tule patch at the edge of a slough and a dense patch of seedling willows adjacent. There were no runways in evidence, but a dozen or more little piles of cut willow twigs were found lying on the ground one to four feet from the edge of the water.

The twigs were from four to eight inches in length with teeth-cuts at each end, and there were from half a dozen to twenty of these twigs in a pile. A few bits of tule stems were found in one place, and in another a rather thick green tule stem was nearly eaten through. The stomach of one of the rats taken contained a finely masticated mass of material judged to be tule stem.

Five miles northeast of Yuma, *Sigmodon* was found April 30 to May 3 inhabiting a tract of wire-grass bordering a back-water slough near the river, and flanked by young willow growth. Near Pilot Knob, May 10, specimens were caught in thickets of cane surrounded by dense arrowweed.

A half-grown young one was caught on the last named date. A gravid female was caught on April 30.

The weight of one of the largest males taken (no. 10626) was eight ounces; that of a smaller male (no. 10632), though quite adult, $4\frac{1}{2}$ ounces. A very great range in size is also shown from the accompanying table of measurements, which lists all of the specimens taken by the expedition. So great is the discrepancy between nos. 10626 and 10627, and other apparently fully adult males in our series, that the existence of two distinct species was at first suspected. The two large examples referred to present measurements far above any of the specimens listed by Mearns (1907, p. 453), and some twenty per cent above the typical size of the race *eremicus* as given by Bailey (1902, p. 107). There are also apparent other differences concurrent with the great size, namely, rather coarser pelage, greater hairiness of tail, and a faintly pinkish cast to the coloration on the rump and sides.

I sent specimens illustrating this state of affairs to Mr. Vernon Bailey, who gives it as his opinion that the differences are due to age; in this genus "old males often outgrow the bounds of specific characters." In support of this contention, that the extremes are conspecific, is the consideration of geographical probabilities: to-wit, that experience teaches that it is not to be expected that two closely related species in a genus exist together in exactly the same locality.

LIST AND MEASUREMENTS IN MILLIMETERS OF *SIGMODON HISPIDUS EREMITUS* FROM THE
CALIFORNIA SIDE OF THE LOWER COLORADO RIVER

Mus. no.	Sex	Age	Locality	Date	Length	Tail	Hind foot	Ear	Body with head	Basilar length of tessel	Length of nasal	Zygomatic breadth	Mastoid breadth	Alveolar length of upper molar series
10626	♂	ad.	Palo Verde	Mar. 31	327	146	33	22	181	.....	15.3	.....	16.0	6.7
10627	♂	ad.	Palo Verde	Apr. 3	335	138	36	22	197	33.4	16.0	23.4	16.8	7.0
10628	♂	ad.	Palo Verde	Apr. 3	211 +	56 +	34	20	155	28.2	13.8	20.9	14.3	6.7
10629	♀	ad.	5 mi. N.E. Yuma	Apr. 30	252	122	31	18	130	26.7	13.0	18.9	.....	6.2
10630	♂	ad.	5 mi. N.E. Yuma	Apr. 30	243	106	31	17	137	.....	12.1	.....	.....	6.3
10631	♀	ad.	5 mi. N.E. Yuma	Apr. 30	246	106	30	17	140	25.8	12.8	19.5	13.5	6.1
10632	♂	ad.	5 mi. N.E. Yuma	May 1	291	130	34	18	161	29.8	14.1	20.7	14.5	6.2
10633	♂	ad.	5 mi. N.E. Yuma	May 2	246	128	32	17	118	.....	13.3	.....	.....	6.4
10634	♀	ad.	5 mi. N.E. Yuma	May 3	280	131	32	20	149	27.7	13.2	19.6	13.7	6.5
10635	♂	ad.	Pilot Knob	May 10	292 +	60 +	31	17	142	27.6	13.5	19.6	13.8	6.5
10636	♂	juv.	Pilot Knob	May 10	190	91	28	15	99	.....	.....	.....	.....	.....
10715	♂	ad.	Pilot Knob	May 10	290	135	33	18	155	29.5	13.6	20.1	14.7	6.4

On the other hand, these aberrant examples might be recognized as mutants, that is, variants of phylogenetic significance though not geographically isolated. After going over the ground, I lean personally towards the notion of the existence of an exceptionally wide range in ordinary fluctuational variation, as accounting for the extremes in question. This is coupled with the inadequacy of the material available, so that the distinctions are emphasized. With large series more nearly normal frequency would be expected.

In this connection it may be pointed out that an alleged race, *Sigmodon hispidus arizonae* Mearns (see Bailey, 1902, p. 108), has been described from Fort Verde, Yavapai County, Arizona, with characters close to those appertaining to the Colorado River giants in question. In size these two specimens from the Colorado equal or exceed that of the type of *arizonae*, so that the existence of a separate race based on size is questionable.

Reithrodontomys megalotis deserti J. A. Allen

Desert Harvest Mouse

This rodent was confined strictly to the riparian strips. Although not found by us above Ehrenberg, it probably does occur in suitable environs as far up the Colorado as these are afforded, that is, up to the steep-walled cañons above Fort Mohave. Specimens were trapped close to the water's edge, usually in grassy places adjacent to tracts of willows. In some cases these mice were on islands cut off by channels from connection with the shore. In practically all cases the ground they occupied would at high water be entirely submerged, so that the mice would either have to swim to higher ground or take refuge in the willows and drift piles. Doubtless they swim freely and are also swept back and forth across the river channels at flood time.

Twenty-one specimens were preserved (nos. 10165-10185). The localities of capture were: Arizona side: Ehrenberg, five miles north of Laguna, and Yuma; California side: near Palo Verde, and five miles northeast of Yuma. Young over half grown were taken May 2, and on the same day a female containing five embryos.

Neotoma albigula venusta True

Colorado Valley Wood Rat

This species of wood-rat was in distribution the exact associational complement of *Neotoma intermedia desertorum*: it was restricted to

the riparian strips, and no evidence was forthcoming of its occurrence out on the desert mesa, in the hills, or even up the desert washes. As compared with rodents of the desert proper this species might for the sake of emphasis be termed semi-aquatic, for it was trapped within a few feet of the main river, and its tracks were noted on fresh mud at the water's edge. Individuals were caught on willow-grown islands, which were subject to submergence with rising water, so that the animals would be forced to live in trees or take to water. No signs of nests were observed in trees anywhere, and it seems reasonable to suppose that these wood rats voluntarily swim narrow channels, especially when pressed by hunger.

Although foraging widely over the bottomlands, the permanent abodes of these rats appeared to be chiefly located at the lateral rims of the riparian belts, just at the upper reach of high water. This, too, marked the belt of mesquites, so that the mesquite association can be confidently assigned as the distinctive habitat of *Neotoma a. venusta*.

At no point did we find the "enormous nests" of this species described by Mearns (1907, p. 474) as found by him below Yuma. His name, *Neotoma cumulator*, for this species was selected on this account. A few small stick houses were found by us in the mesquite strip above Mellen, and nests of similar scant proportions, at other places down the river. In all cases the rats appeared to have ready access to subterranean burrows. At the mouth of the Gila River, near Yuma, many burrows were found in a tract of guatemote without trace of stick nests, and a number of the animals were caught. It is quite possible that recurring unusually high flooding discourages the rats in the portion of their range explored by us from amassing much material, since it is subject to being floated off.

We found small young as early as February 24 and 25 at Mellen, and from that date on to May 5, near Yuma. It is probable that the breeding season is just about closed by the time the annual overflow begins, so that young as well as adults are able to seek safety for the brief period of exile by assuming arboreal habits or swimming to higher ground.

The series of 68 specimens of *Neotoma albigula venusta* obtained (nos. 10463-10530) represent localities of capture as follows: California side: near Riverside Mountain, 2; Palo Verde, 2; twenty miles above Picacho, 8; eight miles below Picacho, 2; five miles northeast of Yuma, 8; Pilot Knob, 3. Arizona side: Mellen, 12; Ehrenberg, 3; twenty-five miles below Ehrenberg, 1; ten miles below Cibola, 7; five

miles northeast Laguna, 6; near Yuma, 14. Two adult males from twenty miles above Picacho and near Yuma weighed nine ounces each; an adult female from the former station weighed seven ounces.

No differences are observable between the specimens from the two sides of the river. The river is evidently in scarcely any degree a barrier to distribution in this species. Rather has the Colorado bottom served as a highway of invasion for the species from its center of distribution, which is manifestly to the southward, the desert on either side acting as confining walls. An examination of the series of specimens shows an apparent slight decrease in size up the river, that is, away from the assumed center of dispersal. But since there is also continued, though diminished, growth of individuals with age, and because of the few examples from any one of the uppermost stations, this direction in variation up the river is not to be considered as established. Much more material is needed.

***Neotoma intermedia desertorum* Merriam**

Desert Wood Rat

The 41 specimens taken (nos. 10424-10462, 10716, 10717) indicate stations of occurrence as follows: California side: opposite The Needles, 3 specimens; Riverside Mountain, 2; opposite Cibola, 1; twenty miles above Picacho, 13; eight miles below Picacho, 3; Potholes, 2; Pilot Knob, 11. Arizona side: foot of The Needles, 3; above Bill Williams River, 1; ten miles below Cibola, 2.

None of our specimens was trapped within the riparian strips; all were taken on the desert proper, though at The Needles, where because of the abrupt rock walls the riparian element is in places reduced to a mere nearly vertical band, desert wood-rats or signs of them were found within a few yards of the river on the opposite sides.

Here scanty accumulations of sticks were observed in crevices among loose boulders on hillsides or in clefts of the walls of ravines. At Riverside Mountain, some two miles back from the bottomlands, nests of large size were noted among boulders; this was true, too, at Pilot Knob, where also sign was seen and the rats themselves caught around clumps of desert tea far out on the mesa.

Fifteen of the specimens taken at the different stations are young of varying sizes. Two very small young of 172 and 167 mm. length, respectively, were trapped March 6 and 7 at The Needles, indicating early breeding. Others nearly as small were taken at Pilot Knob, May

10; so that there is not such constancy in breeding time in this species as in certain other rodents of the region.

A careful comparison of the six specimens secured from the Arizona side with the much larger series from the California side, shows both cranially and as regards external features, no tangible differences which might be expected to occur (and do occur in other cases) in a mammal of the desert proper and whose range is divided by the Colorado River.

It appears that this species of wood-rat has not previously been found to the east of the Colorado River (see Goldman, 1910, pp. 76, 77). In fact, in his revision of the genus *Neotoma*, Goldman, in discussion of *Neotoma lepida* and its subspecies *stephensi* (which are forms not dissimilar to *desertorum*), states (1910, p. 80) that "the ranges of the two [*lepida* and *desertorum*] are completely separated by the effective barrier of the Colorado River." While the results of our work detract from this statement as to fact, the implication remains the same, namely, that the Colorado River may have been at one time of prime service in effecting the isolation of the *lepida* stock, particularly in the upper (northeastern) course of the river (see Goldman's map, p. 77).

I sent my Arizona-side examples of *desertorum* to Mr. Goldman with the request that he examine them closely and give his opinion as to their possible approach in characters to *N. l. stephensi*. The latter form is, by the way, the nearest wood-rat of the same group recorded from east of the river, its nearest station being (Goldman, 1910, p. 80) the Hualpai Mountains, Arizona, only about fifty miles east of The Needles. Mr. Goldman replied that my specimens were "typical *desertorum*," and hence not bearing any significant resemblance to *stephensi*.

It would appear, therefore, that the *desertorum*, as found by us on the Arizona side of the Colorado at the three stations named, is of probably direct and relatively recent descent from the stock on the California side. While this wood-rat does not inhabit the river bottomlands, as does *Neotoma a. venusta*, it is quite possible that individuals forage down to the water's edge where the riparian strip is reduced in width or practically wanting, as at The Needles. In event of rats becoming marooned on drift-rafts at periods of rising water such animals would be in a position to be ferried across the river; for it is not unlikely that such rafts would be carried by the swerving currents to opposite banks. No matter where such waifs should be landed they

would, ultimately, barring accidents, tend to reach the same sort of environs they were used to, namely, the rocky hill slopes.

While such a series of propitious events is in but a remote degree possible, it appears to me the most logical way of explaining the extension of the range of *desertorum* across the Colorado to the Arizona side. As above intimated, this occurrence, if a fact, does not militate against Goldman's hypothesis that *lepida* and *desertorum* may have been held apart by the Colorado River, and are still so held apart in most of its course.

***Ondatra zibethica pallida* (Mearns)**

Pallid Muskrat

Evidence, hearsay and direct, indicates the presence of muskrats all along the Colorado River, from above Needles to below the Mexican line. They occur both in the main stream and in the various diverging sloughs of the big valleys. Our nine specimens (nos. 10652-10660) were all secured on the California side of the main stream, three near Palo Verde and six near Pilot Knob.

No signs of houses were seen anywhere, the muskrats appearing to resort entirely to holes in banks where the current was sluggish. Near Palo Verde, April 1, a system of burrows was dug out by Stephens and Jones. This system of holes was in the bank of a tule-bordered slough about a half mile above its confluence with the main river. The entrances all opened considerably beneath the surface of the water at its level at the time. From these the burrows sloped upwards as they extended back from the slough, until those parts farthest from the water were two to three feet above its level at that stage.

Some green tule stems were found in the passage-ways. One of the blind leads was filled in with packed tule stems, mostly dead ones, but moist and crushed. The regular nests consisted of dry tule stems, some of them shredded, and laid two to three inches deep. Some of the short blind leads showed fresh claw scratches in the earth at their ends. The passage-ways were ordinarily five inches in diameter, in places more, and usually kept near the surface of the ground, following its irregularities pretty closely. In places there was not more than three inches of earth above the burrow, and there was seldom as much as a foot. The system was in fact discovered by one of the party's stepping upon a thin place and breaking through.

The impression gained from a survey of the uncovered burrows was that the excavator had at the beginning burrowed up from the

slough five to eight feet, then gone back a third of the way and started a branch to the water for another entrance. After finishing that, it had come half way back on the branch and dug another branch from it inland, then a branch from that to the water again. Roughly speaking, a series of connected Y's thus resulted, with ends alternately in the water and in the bank landwards. It would appear as though such a plan of runways were well adapted to eluding enemies, both terrestrial and aquatic. An adult male and two two-thirds-grown young were trapped in the entrance burrows.

In the vicinity of Pilot Knob the muskrats were living along the steep northern bank of the main river, where the water was overhung by a dense growth of cane. A number of willow branches sagging into the water and drift logs caught in the tangle of cane (pl. 4, fig. 3) showed themselves to be the nightly rendezvous of muskrats. On these, at the farthest projecting portions, and usually not over four inches above the surface of the water, capsule-shaped pellets of excrement to the number of three to a dozen or more marked the perching places of the rats. This excrement was usually fresh, as the logs would go awash with the frequent cross-river winds. Number 0 steel traps set on these logs without attempt at concealment, either with or without bait (apple or potato), caught five adult muskrats, May 10 to 14. Four out of the five were drowned, the traps being provided with chains which in turn were nailed to the logs. A half-grown youngster was shot on the latter date as it swam among some trailing cane stalks.

Muskrats have recently invaded the Imperial Valley along the irrigation canals leading from the Colorado River. I visited this valley in February, 1912, and was told there that the California Development Company found it necessary to hire men to shoot and trap muskrats because of the damage done in burrowing through the levees. The rats even follow the smaller ditches out into the farms at Calexico, Heber, and El Centro. At Calexico, February 8, I obtained a fresh specimen shot by a boy on a farm close by, on the California side of the Mexican boundary.

The entire series of ten specimens of the pallid muskrat in the Museum displays the now well-known features peculiar to the race represented, namely, small size, pale color and relatively scanty pelage (see Mearns, 1907, p. 495). The weights of the five full-grown male animals were: 31, 24, 21, 26, and 27 ounces, respectively; average 26 ounces.

Thomomys chrysonotus Grinnell

Ehrenberg Pocket Gopher

The only place on the Arizona side of the river where gopher sign was seen was on the mesa within two miles back from Ehrenberg. Here two sets of mounds were found on low sandy ridges and a single gopher caught from a burrow, March 27. This specimen is a male, young adult (no. 10617) and proved so different from any previously described race of gopher as to warrant making it the basis of a new specific name (see Grinnell, 1912, p. 174). This is evidently an upland species, that is, not riparian, and its nearest relationships are suggested to be with forms to the east and north rather than with *T. perpallidus* or *T. albatrus* of the desert region west of the river.

Thomomys albatrus Grinnell

Imperial Valley Pocket Gopher

At only one station on the California side of the river did we find any sign of gophers. This was at our last camp, east of Pilot Knob, where on the site of the old Hanlon Ranch several sets of workings were located, and eight specimens taken (nos. 10618-10625), May 7 to 10. Four of the animals were young, not more than half grown.

These workings were all on the first bottom just at the outer margin of the arrowweed association, in ground barely reached at the highest level of overflow. The absence of gophers in the greater portion of the Colorado bottom is reasonably explained by the occurrence of the yearly overflow which would drown them out. The colonies invading the river bottom do so only at points which they reach from some more favorable center of distribution back from the river.

As already shown (Grinnell, 1912, p. 172), our gophers from the Pilot Knob station belong to the species occupying the alluvial delta region including Imperial Valley, which species is distinct from both the one represented on the Arizona side at Ehrenberg (*Thomomys chrysonotus*) and the one of the western end of the Colorado desert, at Palm Springs (*Thomomys perpallidus*).

The characters distinguishing *albatrus* from *chrysonotus* cannot be reasonably considered as due alone to the action of the river as a barrier, for the former species belongs to a different association (saltbush) from the latter which, as far as known, adheres to the

creosote association. Thus the two species *might* exist on the same side of the river, with complementary ranges. Still, as far as known, neither species occurs on the opposite side of the river, the river thus serving as the factor of absolute delimitation in the respective cases. It is probable that the two species had latterly a separate course of origin, having been derived from distantly located stocks.

Dipodomys deserti deserti Stephens

Big Desert Kangaroo Rat

The thirty-nine specimens secured were preserved as follows: nos. 10352-10381, skins with skulls; nos. 10708, 10709, complete skeletons; nos. 10724-10730, alcoholics. The following localities are represented: Arizona side: Mellen, 23; Ehrenberg, 2; twenty-five miles below Ehrenberg, 1; five miles northeast of Laguna, 3. California side: Riverside Mountain, 1; near Pilot Knob, 9.

This rat shows strong preferences for the aeolian sand association. It was found present practically wherever such accumulations reached an extent of an acre or more of sufficient depth to contain the burrows. This essential depth was seen to be at least a foot. Because of the limited powers of digging, as shown both by weak incisors and small front feet and claws, only such loose and fine-grained substratum could be occupied by this rodent. The packed floor of the mesa or the hardpan of the hillsides was uninhabitable.

The presence of this *Dipodomys* could always readily be recognized by means of conspicuous burrows, the mouths of which were usually at all times open. The looseness of the ground in which the burrows are dug results in their frequent caving in when men or horses walk over them. When the wind had not acted to efface them, the tracks of the rats could be plainly seen on the surrounding sand surface (pl. 11, figs. 16, 17). These tracks showed imprints of the hind feet and tails, indicating the tripedal mode of ambulation characterizing the Heteromyidae.

The associational restriction of this large kangaroo rat gives the impression that it possesses a colonial habit. But it was observed that where proper conditions were continuous, as at the north base of Pilot Knob, the local distribution over the suitable area was practically uninterrupted. The burrows occur in small groups, each group probably representing but a single home center and occupied at times by a single adult, at others by an adult pair, and at others by adult and

young. Tracks were to be seen far and wide between the scattering groups of burrows.

At Mellen, February 25, specimens of *Dipodomys deserti* trapped had their cheek-pouches filled with the minute blossoms and stem ends of *Achyronychia cooperi*, an inconspicuous plant growing prostrate upon the surface of the broad, sandy intervals between the creosote and *Atriplex polycarpa* bushes (pl. 11, fig. 16).

The series of specimens from Mellen, on the Arizona side at the north, is faintly darker in color dorsally on an average than the series from near Pilot Knob on the California side at the south. Otherwise I can see no differences between specimens from the two sides of the river.

Like *Peromyscus eremicus* and *Perognathus penicillatus*, *Dipodomys deserti* inhabits the second bottom in places along the river, though much less continuously than these smaller rodents. Doubtless, as with them, individuals occasionally forage on to the first bottom, and thus run the chance of being transferred from one side of the river to the other by means suggested in other parts of this paper.

***Dipodomys merriami merriami* Mearns**

Merriam Kangaroo Rat

A series of 168 specimens of this small kangaroo rat were preserved, and besides these many were discarded. The Museum numbers are: 10186-10351 (skins with skulls), 10710-10712 (skeletons), 10733-10741 (alcoholics). The following localities are represented: Arizona side: Mellen, 18; foot of The Needles, 6; above Bill Williams River, 6; Ehrenberg, 10; twenty-five miles below Ehrenberg, 3; ten miles below Cibola, 8; five miles northeast of Laguna, 12; Yuna, 2. California side: five miles below Needles, 3; opposite The Needles, 4; Chemehuevis Valley, 10; near Riverside Mountain, 6; above Blythe, 3; opposite Cibola, 19; twenty miles north of Picacho, 21; eight miles below Picacho, 12; Potholes, 5; Pilot Knob, 20.

As indicated above, this was a widespread and abundant desert rodent, being taken in nearly every line of traps outside of the overflow bottom. Its greatest abundance occurred on sandy ground adjacent to desert washes, on tracts of aeolian sands on the desert mesa, and on the second bottom paralleling the river on either side through the broad valleys, but wholly above the reach of the highest floods. In a number of cases specimens were trapped on the packed

ground of the upper mesa, and occasionally on rocky hillsides. These instances probably show great extent in foraging radius, the home burrows being in the softer ground of neighboring ravine bottoms or in depressions where sand could lodge. For, as far as observed, the burrows are always dug by the animals themselves, and their burrowing powers are weak.

Their small size, however, does not require anywhere near the depth of workable soil that the huge *D. deserti* needs. Probably the far greater restriction in distribution of the latter species compared with that of *D. merriami* is determined by this difference in depth of soil required.

The burrows of *D. merriami* are not easy to locate, as the entrances are left smoothly closed during the day. But where the fine wind-laid sand composed the surface of the ground, the hind foot and tail tracks showed clearly the routes taken by the rats to and from their burrows.

The breeding season is at its height in April, though the following dates show considerable latitude. Females with embryos were taken on February 19, March 5 and 6, April 1 to 4, 19 and 21, and May 8. On each of the above dates but one animal is concerned, except during the period from April 1 to 4, when observations were made upon at least ten, and April 19, upon two. In sixteen cases there were two foetuses, in two cases three.

The above data indicate a relatively slow rate of reproduction: but one litter per year is raised and there are seldom more than two young to a litter. This indicates a much safer existence, individually, for this kangaroo rat than for the ground squirrels and white-footed mice of the same habitat. In the case of these latter rodents litters consist of four to eight young, and in some species, at least, two or more litters are born each year. Kangaroo rats must be relatively very successful in escaping the numerous enemies that assail the rodent population of the desert.

The writer finds it impossible to refer the Colorado River series of *Dipodomys merriami*, as a whole, to the subspecies *D. m. simiolus* (type locality, Palm Springs, on the western arm of the Colorado Desert), as might have been expected. The material shows great range in variation; some of the specimens, particularly in the series from the lower course of the river, are, it is true, very close to *simiolus*. On the other hand many, especially from the Arizona side of the river above Ehrenberg, are not with certainty distinguishable from near-totypes of *D. m. merriami*, from south-central Arizona. It proves,

however, impossible to assort the series into two subspecies on any satisfactory basis, and, since the average appears nearest *D. m. merriami*, all are placed under this name.

***Perognathus bombycinus* Osgood**

Yuma Pocket Mouse

Twenty-five specimens were procured (nos. 9956-9977, 10742-10744), three being preserved as alcoholics, and the rest as skins-with-skulls. Only two localities are represented, near Ehrenberg on the Arizona side of the river, where eighteen specimens were caught March 25 to 30, and near Pilot Knob on the California side of the river, where seven were taken May 7 to 15. Those at Ehrenberg were caught on areas of wind-blown sand, especially where heaped about the bases of creosote bushes, on the mesa a mile or more back from the river. At Pilot Knob the species was found on aeolian sand accumulations and in shallow sandy washes on the desert mesa.

In all cases *Perognathus bombycinus* was found on common ground with *Dipodomys deserti*, *Dipodomys merriami*, *Peromyscus eremicus*, and *Perognathus penicillatus*. The five rodents named thus have very similar associational preferences. While *Perognathus bombycinus* was not found by us as near the river as the second bottom (as were all the other rodents named) it is fair to assume that it may so occur where conditions favor. And like the others of the same association, transfer of individuals from side to side is likely to have taken place at intervals in the past. This might be advanced as a reason for the close similarity of the representations of *bombycinus* on the two sides of the river.

The original description of *Perognathus bombycinus* (Osgood, 1907, pp. 19, 20) was based on a single specimen from Yuma, Arizona, and two from just over the Mexican line in Sonora. Our present series bears out to the dot the cranial characters assigned by Osgood, namely, as compared with *Perognathus panamintinus bangsi*, enormously inflated audital bullae and mastoids, the latter conspicuously protuberant posteriorly, and narrow interparietal. Externally our specimens of *bombycinus* are distinguishable from *bangsi* in their very pale coloration, which consists in lighter ground color (dilute pinkish buff) and almost obsolete black tipplings to the hairs dorsally. Although, as compared with *bangsi*, *bombycinus* has greatly enlarged audital bullae, the external ear is not of appreciably greater size.

The measurements of twenty adult males from our series are, averages and extremes: total length 139 mm. (130-149), tail vertebrae 79 (70-85), hind foot 18.5 (17-19.5).

I am unable to find any differences between the specimens from Ehrenberg and those from Pilot Knob, the species being thus identical on the two sides of the river. We found no traces of pocket mice of this group anywhere else along the river. Osgood (1907, p. 20), however, records typical *bangsi* from Needles, California. It is quite possible that there is a hiatus between the ranges of *bangsi* and *bombycinus*. At any rate, among the large series of *bangsi* in the Museum from the Mohave desert and from the west side of the Colorado desert from San Gorgonio Pass to the Mexican line, there is no individual showing close enough approach in characters to *bombycinus* to warrant classing it as an intermediate. Although the affinities of *bombycinus* are clearly with the *panamintinus* group, there is good evidence for carrying the former as a full species.

Curiously, only one out of the entire twenty-five *bombycinus* taken was a female. This, and the fact that no young-of-the-year were found, would seem to show that up to May 15 the breeding season had not yet begun. For experience with other rodents in different places indicates that as soon as the young are born the females forage abroad actively, and are then caught in at least equal proportions to the males.

***Perognathus formosus* Merriam**

Long-tailed Pocket Mouse

A series of 44 specimens was obtained, 40 skins-with-skulls (nos. 9652-9691) and 4 alcoholics (nos. 10794-10797). These were taken exclusively on the California side of the river and represent localities as follows: five miles below Needles, 6; opposite The Needles, 12; Chemehuevis Valley, 8; Riverside Mountain, 5; near Blythe, 1; Pot-holes, 5; Pilot Knob, 7.

The known range of this species is thus carried southeast along the west side of the Colorado River to the Mexican line (see Osgood, 1900, pp. 40, 41). The distribution is not, however, continuous, for marked restriction is shown to hilly country and rough mesas. The immediate valley of the Colorado is avoided, as also the broad, flat and low desert depressions between the mountain ranges.

Yet within the rough country trapping showed that *Perognathus formosus* occurred most frequently upon the narrow strips of loose.

sandy soil along ravine bottoms or along washes cutting the elevated mesas. This closer associational phase of occurrence is significant on comparison with the local distribution of *Perognathus spinatus*. *Formosus* and *spinatus* both live west of the river, and both occupy the same general associations (see figs. C, F). But locally the two are often found on separate ground, *spinatus* adhering most closely to the vicinity of boulder-strewn hillsides and fractured outcrops, while *formosus* prefers smoother ground, as noted above.

At Riverside Mountain *formosus* was caught on the mesa, but not next to the abruptly rising base of the mountain where *spinatus* was found. But opposite Cibola, where pocket mice were phenomenally abundant, examples of *Perognathus spinatus*, *P. formosus* and *P. penicillatus* were all caught within a radius of fifty feet. The first two species were found in a single trap on successive mornings.

As further considerations with regard to the occurrence of *formosus* and *spinatus* on common ground, it is to be remembered that the two species belong to separate subgenera (*Perognathus* and *Chaetodipus*, respectively), and thus have structures so different that important differences in food or other requirements are suggested; so that the forms are probably complementary instead of violently competitive.

The breeding time of *Perognathus formosus* is indicated by the capture of blue-pelaged young at Potholes and Pilot Knob on April 28 and 29, and May 10 to 14. Preceding the first-named date no signs of breeding were in evidence, so that relative lateness in this annual function is indicated.

***Perognathus penicillatus penicillatus* Woodhouse**

Colorado Desert Pocket Mouse

A series of 196 specimens preserved, 184 as skins-with-skulls (nos. 9692-9875), two as skeletons (nos. 10720, 10721), and ten as alcoholics (nos. 10798-10807). The following localities are represented: California side: five miles below Needles, 8; opposite The Needles, 10; Chemehuevis Valley, 17; near Riverside Mountain, 16; near Blythe, 2; above Ehrenberg, 1; opposite Cibola, 35; twenty miles above Picacho, 10; eight miles below Picacho, 8; Potholes, 1; four miles below Potholes, 1; five miles northeast of Yuma, 5; near Pilot Knob, 8. Arizona side: Mellen, 12; above Bill Williams River, 2; Ehrenberg, 16; twenty-five miles below Ehrenberg, 3; ten miles below Cibola, 27; five miles northeast of Laguna, 8; near Yuma, 6.

In addition, the Museum contains four skins (nos. 5636, 5637, 5825, 5826) taken in 1861 by Dr. J. G. Cooper at Fort Mohave, on the Arizona side twelve miles above Needles.

It is at once patent that of the five distinct species of *Perognathus* found along the lower Colorado, *P. penicillatus* is both most abundant and most widespread. Very many more individuals were trapped day by day than were preserved.

It may be asked why explicit record is not here presented, not only of specimens saved, but of *all* the individuals trapped. The reason is that so similar in external appearance are the various species of *Perognathus*, that especially with our previous unfamiliarity with them, we were liable to many mistakes in identification in the field. After museum study was made of the suites of specimens brought home, with skulls cleaned and measurements tabulated, it was found that errors had actually occurred in a number of cases thus checked up. *Perognathus penicillatus* and *P. intermedius* had been confused on the Arizona side, and *P. penicillatus* and *P. formosus* on the California side, especially in the cases of immatures. Field determinations were therefore totally disregarded.

It may scarcely be necessary to remark that *penicillatus* (plus *angustirostris*, if the form designated by the latter name be considered tenable), *intermedius*, *spinatus*, and of course *formosus*, are all distinguishable with absolute certainty (for characters see Osgood, 1900). No difficulty was experienced in allocating all specimens as soon as cleaned skulls were available.

Although obtained at all collecting stations and from all associations, reference to the graph for frequency of occurrence (see fig. D) clearly shows that *Perognathus penicillatus* has marked preferences for one particular environment. This preferred habitat is characterized by ground of fine-grained sand. The second bottom along the river and the broad washes of the flatter parts of the desert furnish the ideal conditions; and in the most typical of these *penicillatus* is either the exclusive or the prevailing member of the genus present.

Penicillatus is the only species invading alkali depressions at the edges of the broad valleys back from the river (where *Suaeda* grows), and is the only species occurring regularly on parts of the overflow area of the river bottom. Referring again to the frequency record (fig. D), it is shown that *penicillatus* was found in every member of the riparian group of associations, even into the willows. Individuals were always, however, as far as record and memory serves to estab-

lish the point, trapped on dry surfaces, indicating a preference for dryness. On thoroughly dried-out, rather high sand banks along the river where the bottom strip was narrow, sign was noted to within a few feet of the edge of the swift current. Individuals were trapped on sand bars, at the time high and dry, but so slightly elevated that rising water would at first form islands of them and then engulf them completely.

No doubt, as with *Peromyscus*, aggressive individuals of *Perognathus penicillatus* are often thus caught and set adrift, thus giving a chance for transfer from one side of the stream to the other. As discussed in a general way elsewhere, there seems to be significant correlation between the fact of this free invasion of the river bottom and existence and similarity of the representatives of the species on both sides of the river.

The breeding season of *penicillatus* is of greater duration than that of the other pocket mice of the region, as shown by the following data. A female taken April 19 contained five embryos; another taken May 4 contained four embryos. Gray-coated young-of-the-year were taken as early as March 5 and at intervals from then on through April and into May.

After study of the Colorado River series in connection with the 120 additional specimens in the Museum from various localities in the Salton Sink region of the Colorado desert, I have come to the conclusion that the recognition of the name *angustirostris* as applying to any of the Colorado River specimens is impracticable. Osgood (1900, pp. 45-47) described a race *angustirostris* from the Colorado desert, type locality Carriso Creek, west side of the desert. The Museum has a good topotype series, and also a series from Mecca, in the bed of the Salton Sink at the northwest end of Salton Sea.

The characters assigned to "*angustirostris*" were, as compared with *penicillatus*, small size, less massive skull, and longer and more slender rostrum. Osgood referred his few specimens from the Colorado River, from Ehrenberg and above, to *penicillatus*, while those from Fort Yuma and all localities to the west he listed under *angustirostris*.

Close scrutiny of the extensive material now at hand shows great instability in all the alleged characters. There is as notable fluctuation in size from place to place up and down the river, as across the Colorado desert. The topotypes of *angustirostris* include some skulls as massive as many from Mellen, Arizona.

One thing is apparent, that the Mecca series includes more small specimens, with narrow-snouted skulls, than series of like extent from elsewhere. There is thus a *tendency* towards the existence of a race, of the characters assigned by Osgood to his *angustirostris*, in Salton Sink. But if the upper Colorado Valley specimens are *penicillatus*, so also are those from all the way down to Yuma and Pilot Knob and thence across to the east flank of the Coast Range in eastern San Diego and Riverside counties.

In view of the locally fluctuating variations through the region under consideration, the inclusion of all under the one name *penicillatus* seems now the wisest course. Should the *penicillatus* of Woodhouse prove to represent a truly distinct race, occupying the elevated north central deserts of Arizona, as hinted by Osgood, then *angustirostris* would be the name to be used for the subspecies of *penicillatus* occurring all along the Colorado Valley below the Grand Cañon, and through the Colorado desert.

Perognathus intermedius Merriam

Intermediate Pocket Mouse

A series of 82 specimens taken, nos. 9876-9955, saved as skins-with-skulls, and nos. 10785, 10786, as alcoholics. The localities of capture were all on the Arizona side of the river, as follows: Mellen, 19; foot of The Needles, 10; above Bill Williams River, 2; Ehrenberg, 13; twenty-five miles below Ehrenberg, 1; ten miles below Cibola, 27; five miles northeast of Laguna, 10.

The preferences of this pocket mouse are to all appearances identical with those of the Harris ground squirrel. Both rodents are restricted to rocky hills and the hard-surfaced, coarse-graveled mesa. In both situations scattering creosote bushes form the prevailing vegetation, though on the hills *Encelia farinosa* is an additional conspicuous plant. *Perognathus intermedius* was in no case found so near the river as the second bottom (see diagram, fig. E). In fact, only three out of the 82 individuals caught were found in sandy desert washes, and these could have readily reached the points of capture in foraging down from home centers on adjacent hills or mesa.

Our series of record stations, as above named, carry the known range (see Osgood, 1900, pp. 52, 53) of *P. intermedius* to the west, and mark its limits in that direction as being at the east side of the

Colorado River bottom. The presence of the species was ascertained at every station where appropriate ground was trapped, from Mellen nearly to the Laguna dam.

Among all the specimens taken, only two were juvenals. These were taken above Laguna on April 24 and 25. None of the numerous females taken earlier in the season contained embryos, so that the breeding season would appear to be deferred in the case of this species until the advent of hot weather.

***Perognathus spinatus spinatus* Merriam**

Spiny Pocket Mouse

This pocket mouse was found only on the California side of the river. A series of 125 specimens was taken, nos. 9536-9651 (skins-with-skulls), 10713, 10714 (skeletons), 10787-10793 (alcoholics). Localities are represented as follows: opposite The Needles (practically topotypes of the species), 14; Chemehuevis Valley, 1; Riverside Mountain, 26; opposite Cibola, 36; twenty miles above Picacho, 32; eight miles east of Picacho, 6; Potholes, 4; Pilot Knob, 6.

The spiny pocket mouse proved to have much the same associational preferences as the antelope ground squirrel, namely, the hills and rough-surfaced mesas of the desert. It was found close to the river only where the riparian bottomland associations were pinched in to merest traces of their elements by the abutment of the hills. Places of this nature, where *spinatus* was caught within as near as a hundred yards of the water's edge, and yet on ground perfectly appropriate to the species, were opposite The Needles and twenty miles above Picacho.

At the latter locality the only exception to the above statements came to notice. An adult female was caught among the willows on first bottom and within seventy-five feet of the water, hence where proper conditions of topography and rising water *might* have resulted in transporting the animal to the opposite side of the river. But the excessive rarity of such a combination of circumstances probably accounts for the fact that *Perognathus spinatus* has never been found to the east of the Colorado River. The strip of bottomland at the point where this wanderer was captured was only about three hundred yards wide, and the species was found to occur commonly on the hillsides down to the outer edge. The individual probably occurred merely as a forager.

Opposite Cibola, as already noted under *P. formosus*, the spiny pocket mouse occurred on a broad desert wash, strewn with boulders. Specimens were trapped there, not only among boulders but around scraggly stumps of ironwood.

The breeding season apparently does not begin till April. On the 13th and 19th of that month females taken contained four embryos each. On April 28 and May 9 half-grown young were trapped.

***Lepus californicus deserticola* Mearns**

Colorado Desert Jack Rabbit

The eight specimens secured (nos. 10682-10689) came from the following localities: California side: five miles below Needles, twenty miles above Picacho, and near Pilot Knob; Arizona side: Ehrenberg, and five miles north of Laguna. Specimens from the two sides of the river are identical as far as I can see; and this is to be expected. For although the jack rabbit belongs primarily to the desert mesas, it forages also all over the flood-bottoms. I was told that this species of rabbit swims strongly when forced to take to the water.

Jack rabbits occurred through the region in 1910 in very small numbers. At some stations none at all were seen, though old sign was usually plentiful. The greatest numbers were observed on the mesa back of Ehrenberg, but not more than half a dozen could be seen during a three hours' circuit.

Two females shot near Ehrenberg, March 28 and 29, contained two and three embryos respectively.

The weight of an adult male (no. 10682) was four pounds, fourteen ounces; of an old female (no. 10683) six pounds.

***Sylvilagus auduboni arizonae* (J. A. Allen)**

Arizona Cottontail

The year of our exploration of the Colorado Valley was stated by the residents of the region to be an off-year for both jack rabbits and cottontails. Whatever the usual conditions, both kinds of rabbits were unexpectedly scarce.

The cottontails were chiefly riparian in their local distribution. In fact, the only individuals seen desertwards beyond the mesquite belt were in the salt-bush association closely adjacent, and (opposite The Needles) up a catclaw wash not to exceed one-half mile from the river.

The quail-brush association was the most preferred local habitat, the rabbits finding ideal refuges there beneath the thickets of *Atriplex lentiformis*. They ranged all over the bottomlands, and since individuals were seen on islands already cut off by rising water from main-land connection, it is probable that many rabbits are washed adrift each year and are carried from side to side of the river. We were assured that cottontails had been seen swimming in the river during flood time.

We procured twenty-one specimens of the cottontail (nos. 10661-10681), representing the following localities: Arizona side: Mellen, foot of The Needles, five miles northeast of Laguna; California side: opposite The Needles, Riverside Mountain, Blythe, opposite Cibola, eight miles east of Picacho, five miles northeast of Yuma, near Pilot Knob. A close examination of the comparable specimens from the two sides of the river shows no differences. This is explainable on the ground that to the distribution of this rodent the river forms no permanent hindrance.

The weight of an adult male (no. 10678) was 24 ounces, of an adult female (no. 10679), 26 ounces; both shot near Mellen.

Partly grown young were caught March 20 and April 3. A female taken May 6 contained two large embryos.

***Felis oregonensis browni* Merriam**

Yuma Cougar

We were told of the occurrence of cougars at several points along the river from Riverside Mountain south. They appear to range chiefly through the densely wooded bottomlands. One, however, was reported as having been seen in the rough hills constituting Riverside Mountain. In the vicinity of Ehrenberg, Cibola, and Potholes I was given more or less definite accounts of them. At a point on the California side four miles below Potholes, we saw fresh footprints of one within fifty yards of the main river channel.

From a rancher, J. C. Draper, who lives on the California side, eighteen miles north of Picacho, I purchased two skins with skulls, with the following history. Mountain lions had not been previously seen in his neighborhood for at least ten years. In the autumn of 1909 his hogs began to disappear, until eight were gone. Finally the tracks of a lion were found, and then the fresh trail where a 125-pound hog had been dragged a quarter of a mile through the brush. The beast was discovered nearby, treed by a dog, and shot. This was on

the California side of the river one and one-half miles below Draper's house, about November 15, 1909.

Meanwhile the hogs had become thoroughly frightened and had taken to swimming the river twice daily, to forage for mesquite beans on the Arizona side, where they appeared to feel safer. But in December traces of a lion were discovered on that side. After a pig and a coyote had been killed by the lion, the latter was trailed and treed by a dog, and shot by Draper. This was directly opposite the Draper house, on December 29, 1909. Draper stated his belief that the lions swam back and forth across the river at will.

Both lions were males, the first (no. 10586) measuring before skinning, 6 feet 6 inches in length, the second (no. 10587) 6 feet 4 inches. The skull of the first is imperfect, the whole base having been shot away; but that of the second is entire. The skins are flat, in fairly good condition, and measure, as now tanned, no. 10586: total length 2120 mm., tail 680; no. 10587: total length 2085, tail 710.

They show the following characters. Pelage: short, fine-haired and smooth; longest hairs on middle of back 17 mm. in no. 10586, and 24 mm. in no. 10587 (in *oregonensis* from western California the pelage is much heavier and coarser, 28 mm. long); tail slender due to shorter clothing of hair (much more bushy in Pacific slope *Felis*). Coloration pale: clay color on upper parts deepening towards hazel down middle of back, and becoming whitish on mid-lower surface and on insides of legs and thighs. Close examination discloses an admixture mid-dorsally of black-tipped tawny hairs and fewer pure white hairs; but uniform pale hazel hairs predominate. Outer sides of legs and tops of feet, pale clay color; hair of soles of feet between pads, prout brown. Tip of tail dorsally (in both specimens), dark burnt umber for about 50 mm. from tip; tail otherwise dusky tawny dorsally and pale clay color ventrally. Back of ears blackish, dulled because of admixture of white hairs, especially towards tip and inner margin. Ears relatively lightly clothed. Face pale, of color of back but duller; black patches at bases of whiskers not conspicuous, much mixed with whitish. Whiskers wholly white, except three or four dorsalmost ones which are blackish, light tipped.

While the skulls are small (see accompanying table of measurements) as compared with *oregonensis* of western California, they are larger than the type of "*Felis aztecus browni*" (Merriam, 1903, p. 73) as shown by the describer's measurements in the two particulars given by him. They agree much more closely with the measurements

given of the type of *Felis hippelestes aztecus* (Merriam, 1901, p. 593). Since the sagittal crest of our no. 10587 is very highly developed, it may be an older animal. Merriam's transverse diameter of bulla in the type of *browni* is 16 mm., while in our smallest specimen it is 19; his upper carnassial length in *browni* is 20.5; in our least it is 21.5, which, however, belongs to the otherwise largest skull. The type of *browni* came from the Colorado bottom, Arizona, twelve miles below Yuma.

There thus appears to be considerable variation, and it is probable that there is really less to distinguish *browni* from *aztecus* than the original description of the former indicates. However, our material proves that there is a well-marked desert form of the cougar, characterized, as compared with *oregonensis*, by smaller size, paler coloration, and shorter pelage.

CRANIAL MEASUREMENTS IN MILLIMETERS OF *FELIS OREGONENSIS BROWNII*
FROM THE COLORADO VALLEY

Mus. no.	Sex	Greatest length	Basilar length of Hensel	Zygomatic width	Interorbital constriction	Nasals	Width between tips of post-orbital processes	Occipito-nasal length	Height of skull, frontals above palatines ¹	Occipito-sphenoidal length	Transverse diameter of bulla from meatus to front of foramen lacerum posterius	Under jaw, anterior symphysis to posterior condyle	Greatest length of left upper carnassial	Greatest diameter of left upper canine
10586	♂	43.5	48	72	.....	77	...	...	144	21.7	13.6
10587	♂	198	161	127.5	36.0	41	61	180	73	62	19	134	22.5	12.7

¹ Measured from plane of inferior surface of palatines vertically to highest point on dorsal surface of frontals.

***Lynx eremicus eremicus* Mearns**

Desert Wildcat

Two bobcats were trapped by our party: a female (no. 10604) in a patch of screwbean trees in the river bottom on the California side five miles below Needles, February 21; and a male (no. 10605) in a wash lined with palo verde and catclaw on the Arizona side north of Mellen, February 27. In addition to these specimens, both saved as skins and complete skeletons, there is in the Museum a skin with the skull inside (no. 5620) taken by W. W. Holder at Mineral City (=Ehrenberg), Arizona, in 1864.

The three skins agree in relative pale tone of coloration as compared with appropriately selected material from the Pacific slope of southern California (= *Lynx eremicus californicus*). The paleness consists in more extended white-tipping to the hairs. The Mellen specimen is slightly the darkest; but there is as much or more variation in skins from a single locality elsewhere.

The measurements, in-the-flesh, of the two taken in 1910 are:

Mus. no.	Sex	Total length	Tail vertebrae	Hind foot	Height of ear	Tuft of hair on ear
10604	♀	815	150	175	63 ¹	25 ¹
10605	♂	780	150	170	75	26

¹ Measured on dry skin.

There are in the Museum three skins of wildcats from Victorville on the Mohave Desert, which are also somewhat pale in comparison with Pacific Slope skins. Aside from this character of paleness, I am unable to find any other diagnostic features in wildcats of the desert region, even after carefully following Mearns's description (1897, p. 457). *Eremicus* and *californicus* are certainly very close, though present material appears to me to warrant separate recognition (see Stephens, 1896, pp. 210, 211).

The weight of the male wildcat caught near Mellen was 18 pounds. The stomach of this animal contained the fragments of at least two wood-rats. These had not been chewed finely, but had been chopped up into chunks about an inch long; the feet were still entire.

***Canis ochropus estor* Merriam**

Desert Coyote

Coyotes were only fairly common along the Colorado Valley. They were occasionally seen on the desert mesas by daylight, but were rarely heard. It was evident from tracks on the mud bars that they foraged down to the river's edge at night.

The six specimens secured (nos. 10611-10616) represent the following localities, all on the California side: five miles south of Needles, opposite The Needles, twenty miles north of Picacho, and Pilot Knob.

The weights of three adult males were 16, 18, and 21 pounds; of two females, 18 and 20 pounds.

***Vulpes macrotis arsipus* Elliot**

Desert Kit Fox

This fox appeared to be a characteristic element in the purely desert fauna. The five specimens taken were all trapped on the desert mesas back from the river. In fact, no evidence at all was forthcoming to show that kit foxes ever visit the river or even the bottomlands. Their presence was generally detected in sandy tracts, especially around colonies of *Dipodomys deserti*. It is to be inferred that this rodent constitutes the main food-supply of the kit fox in localities where both occur.

The accompanying table shows the data appertaining to the specimens caught. Although a xerophilous species, examples from opposite sides of the river do not differ appreciably, in either cranial or external characters.

The two females taken at Pilot Knob showed evidence of having recently suckled young, though this stage was well passed.

LIST AND MEASUREMENTS IN MILLIMETERS OF *VULPES MACROTIS ARSIPUS*
FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Weight lbs.	Length	Tail vertebrae	Hind foot	Ear
10581	♀	Mellen, Ariz. side	Feb. 26	21 $\frac{1}{16}$	670	260	110	80
10582	♀	Ehrenberg, Ariz. side	Mar. 27	3	725	290	120	85
10583	♂	Opposite Cibola, Calif. side	Apr. 5	..	740	290	115	92
10584	♀	Near Pilot Knob, Calif. side	May 10	3 $\frac{1}{8}$	720	280	115	....
10585	♀	Near Pilot Knob, Calif. side	May 15	3	724	297	108	86

***Urocyon cinereoargenteus scotti* Mearns**

Arizona Gray Fox

The Colorado River bottom and nearby desert proved to be well populated with a form of gray fox. Specimens were taken, as shown in the accompanying table, on both sides of the river. Besides the localities represented by specimens, gray foxes were also seen on the California side near Pilot Knob; so that the species doubtless occurs continuously the whole length of the portion of the river explored by us.

Our Colorado River material added a subspecies to the known mammal fauna of the state. *Urocyon c. scotti* is well distinguished from *U. c. californicus*, of the San Diego district, on the basis of

LIST AND MEASUREMENTS IN MILLIMETERS OF ADULT SPECIMENS OF *TROGON CINEREOARGENTUS*
SCOTTI FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Length	Tail	hind foot	Ear	Weight (lbs.)	Basilar length of Hensel	Zygomatic width	Width of rostrum at narrowest part posterior to base of canine	Greatest width of braincase	Length of tooth-row last molar to incisors, inclusive	Diameter of bulla ¹
10594	♀	Needles, Calif.	Feb. 17	939	405	130			105.5	64.8	17.6	44.8	57.4	12.1
10595	♀	Melton, Ariz.	Feb. 27	938	416	132	82		101.4	61.5	16.1	42.5	59.2	13.5
10596	♂	Foot of The Needles, Ariz.	Mar. 6	975	435	132	87	6 ³ / ₄	106.5	63.7	16.5	42.1	60.0	12.2
10597	♀	Opposite The Needles, Calif.	Mar. 3	950	420	130	75	6	109.5	63.3	17.4	44.8	60.3	12.6
10598	♂	Opposite The Needles, Calif.	Mar. 3	940	415	125	80	7	107.6	63.7	17.2	44.9	59.3	12.8
10599	♂	Opposite The Needles, Calif.	Mar. 5	1000	425	137	80	7	108.7	64.4	17.1	44.2	59.3	12.2
10600	♂	Chemehuevis Valley, Calif.	Mar. 9	935	405	130	80	8	102.3	64.0	17.4	45.2	62.0	12.1
10601	♂	Chemehuevis Valley, Calif.	Mar. 10	940	390	130	80	7	109.5	64.7	17.2	45.9	60.9	13.0
10602	♂	20 mi. N. Picocho, Calif.	Apr. 15	948	390	124	86	6 ¹ / ₂	108.2	63.5	17.0	44.8	60.4	12.6
		Average		951	411	130	81	7	106.5	63.7	17.0	44.3	59.8	12.6

¹ Minimum distance between foramen lacerum posterius and anterior notch of meatus.

both external and cranial characters. *Scotti*, as exemplified by the Colorado River series, has a longer tail, higher ear and paler coloration; the rufous tinges are less bright; the white endings of the hairs on sides of body and tail and on top of head are more extensive, giving a grizzled effect in the desert race. The skull of *scotti* is of relatively lighter build; the teeth are smaller, being more slender and hence sharper; the auditory bullae are more inflated, that is, relatively higher and steeper-sided; the rostrum is conspicuously narrower. For measurements of *californicus* see Dixon (1910, p. 304) and for discussion of relationships see Grinnell and Swarth (1913, p. 373).

***Mephitis estor* Merriam**

Arizona Striped Skunk

A common species in the riparian strips along both sides of the river. Data pertaining to the eight specimens obtained is given in the accompanying table. This animal evidently does not stray out on to the open desert, being probably kept to the bottomlands by daily need for water; nor has it the physical ability to cover much distance in a night's travel. Those caught were in mesquite, screwbean, willow or arrowweed tracts. Tracks were often seen on the mud at the water's edge.

A male, no. 10576, weighed three pounds, two ounces. The female taken near Pilot Knob May 12 contained four foetuses.

This species of *Mephitis* is distinctly smaller than *M. occidentalis*. Although in all of the six skins of *estor* from the Colorado Valley there is much more white than in *occidentalis*, the amount varies individually to a large extent. In five out of the six there is a white pectoral patch, and in four of these there are additional flecks of white mid-ventrally. The longer hairs of the tail are in each case fully white; but a thick growth of relatively short hairs clothing the tail is black terminally, white at base. As the season advances it looks as though the long white hairs of the tail tend to be shed, leaving the tail of a darker tone, until the black even predominates.

The mid-frontal white streak varies in amount, but averages greater than in *occidentalis*. The dorsal white area (creamy white) is unbroken in no. 10575; in no. 10574 there are tufts of black in the mid-dorsal line over the rump; in the other four skins there is a well-defined black stripe separating the white into two lateral stripes

which join on the shoulders, and continue forward to cover the whole back part of the head behind an abrupt line of demarcation joining the ears. (See pl. 13, fig. 21.)

The question suggests itself whether or not geographic variation in proportion of white and black (as in *Mephitis estor* of the desert as compared with *M. occidentalis* of the Pacific slope of California) is correlated with the maximum condition of efficiency from the standpoint of utility. Granted that the sole purpose of the skunk's contrasted markings is to offer a signal of warning, then the maximum of efficiency will be reached when the proportion of black and white is such as to bring the greatest degree of conspicuity amid the average of the natural surroundings.

The surroundings on the desert, even in the riparian thickets, are far lighter-toned both night and day, than they are in the humid coast region. It would seem, therefore, that to secure the greatest conspicuity the increased proportion of white must be provided for the darker surroundings, and conversely the increased amount of black must be presented in the lighter surroundings. This is the reverse of the case in fact. Hence it looks as though the warning theory does not gain substantial support from this direction.

The problem of the significance of animal coloration promises important results when attacked upon a basis of the facts to be observed in geographic variation.

LIST AND MEASUREMENTS IN MILLIMETERS OF *MEPHITIS ESTOR* FROM THE
COLORADO VALLEY

Mus. no.	Sex	Nature of material	Locality	Date	Total length	Tail vertebrae	Hind foot	Ear
10574	♀	Skin and skeleton	Calif. side, 5 mi. south of Needles	Feb. 23	665	300	65	15
10575	♀	Skin and skeleton	Calif. side, Chemehuevis Valley	Mar. 9	625	300	70	25
10576	♂	Skin and skull	Arizona side, foot of The Needles	Mar. 5	642	330	70	23
10577	♂	Skull only	Arizona side, Ehrenberg	Mar. 26	625	300	68	18
12648	♂	Skeleton only	Arizona side, Ehrenberg	Mar. 24	610	288	71	17
10578	♂	Skin and skull	Calif. side, opposite Cibola	Apr. 6	525	300	70	25
10579	♀	Skin and skull	Calif. side, 20 mi. N. of Picacho	Apr. 12	615	322	69	20
10580	♀	Skin and skull	Calif. side, near Pilot Knob	May 12	595	280	64	22

Spilogale arizonae arizonae Mearns

Arizona Spotted Skunk

We were told of the presence of "hydrophobia" skunks among The Needles, Arizona. Mr. Stephens saw tracks of one in the river bottom on the California side five miles below Needles. The species is certainly not common, or our traps would have given more indication of its presence. The only specimen procured by our party was trapped in the arrowweed belt within one hundred yards of the river, on the California side at our last station, close to Pilot Knob. It is an adult male (no. 10573) with following external measurements by collector (Stephens): length 440, tail vertebrae 170, hind foot 46, ear 22, weight 18 oz. The cranium measures: basilar length 49.8, zygomatic breadth 36.1, mastoid breadth 30.9, interorbital width 14.4, height of brain-case (as measured by Howell, 1906, p. 37) 17.8.

I sent this skin-with-skull to the Bureau of Biological Survey, Washington, where Mr. A. H. Howell determined it to be "*arizonae* but not typical." He further considered it "as grading toward *martirensis*," which, from its geographical location, is quite to be expected (see Howell, 1906, pp. 29, 30, pl. 1). The present record is the basis of the first assignment of *arizonae* to Californian territory.

Taxidea taxus berlandieri Baird

Mexican Badger

While no badgers were secured by our party directly, I purchased a flat skin, with skull, of a young one at the Barber Ranch twenty miles above Picacho. This had been killed on the California side in the autumn of 1909. Badgers were reported as frequently seen in the vicinity of the Draper ranch, eighteen miles north of Picacho, and also on the Arizona side in the neighborhood of Cibola.

The skin secured (no. 10603) as compared with one of about the same age from Ventura County, California (no. 7078), is very much paler. The individual hairs have longer white tips, and a mid-dorsal white stripe extends from top of nose to rump. In the Ventura County specimen there is a white stripe from tip of nose to between shoulders, only. The skull of no. 10603 is smaller, doubtless due to younger age, but it appears to be also of relatively lighter build.

Procyon pallidus Merriam

Pallid Coon

An abundant representative of the riparian association everywhere. The accompanying list shows localities of capture from Needles to Pilot Knob, and also from one of the Colorado's distributaries, New River, in the delta region near Imperial, California.

At practically every place where we had occasion to examine the muddy margin of the river or its lateral sloughs, the conspicuous foot-prints of coons were to be seen. One coon was caught in an unbaited trap set for beaver beneath the surface of the water, at the river's edge.

The chief food of the coons was evidently fish. At a drying-up overflow pond, the shallow water of which was crowded with catfish, a profusion of the tracks of herons and coons showed a marked community of interests on the part of these two fishers.

No young-of-the-year came to notice. The female caught May 11 near Pilot Knob contained four embryos. The one caught near Imperial May 10 contained five embryos. The weight of the female no. 10610, was 16 pounds. Two fat males, nos. 10606, 10607, weighed 18½ and 18 pounds respectively. A lean male, no. 10609, weighed but 13 pounds. The very large old male (no. 7153), from near Imperial, weighed 20 pounds.

In the original description of *Procyon pallidus* (Merriam, 1900, p. 151), both external and cranial characters of this form are given. The cranial peculiarities mentioned, as compared with *Procyon psora*, do not appear to hold in our material. There is much variation in the respects mentioned, as will be understood from the table of measurements. In coloration alone, however, there is abundant basis for the recognition of *pallidus*.

The seven skins from the Colorado Valley, including Imperial Valley, although somewhat variable in coloration, are in mass effect conspicuously different from the coons of the Pacific Coast region. A large series of skins of the latter are available for comparison; and even selecting extremes from the *pallidus* and *psora-pacifica* series, no overlapping of characters can be found in the material at hand.

The general pallor of *pallidus* as compared with *psora* is due to: (1) The far less amount of black on the individual hairs everywhere except on the nose and cheeks. This is the converse of saying that much more of each hair is white. Along the sides, on the ears and on the light intervals between the tail-rings the hairs are pure white with no black tipplings. (2) The black areas are less in extent. The

seven or eight black tail bars are narrower, thus making the light intervals broader; the whole tail is thus very much lighter colored.

(3) The "black" color of the hairs is in many places not so intense, being, particularly on the tail and head, of a deep vandyke brown. Fading evidently brings a browning of the dark hairs to some extent.

(4) The under fur is very much paler in color. Dorsally it is vandyke brown instead of bistre; on the sides and belly it grades through cinnamon to pale clay color. In the facial region the typical coon pattern is present, but the white markings are not so conspicuously contrasted. This is due to the less intense black, and to the fact that the pileum is scarcely darker than the rest of the back. The post-mental area and the median nasal stripe are rather pale vandyke brown. Only the transocular black patch is retained in nearly its usual distinctness. The whiteness of the backs of the ears is a notable feature; and there is altogether lacking the black patch behind the ears usually so well marked in *psora*.

In a general way *pallidus* thus differs from *psora* in very much paler coloration. The two specimens from the vicinity of Imperial are topotypes of *pallidus*, and accord closely with the brief description of the form as given by Merriam. These two topotypes are the palest of our *pallidus*, but it will be observed from the list that they were secured in May. As might be expected from this circumstance, they had evidently been subjected to much more wear than especially our Needles and Mellen specimens, which are somewhat darker. It is easy to see that the cutting off of the black tips of the long hairs in the latter, particularly on the mid-dorsal region, would result in a decided paling in the general color.

Eliminating this factor of wear, and the slight amount of fading which very probably occurs (even though these nocturnal animals may not be exposed to intense sunshine to any large extent as they probably spend the day in drift piles or thickets rather than in trees), I cannot see that those specimens from farthest up the river are any paler than those from farther down the river, or than the topotypes.

It would not be reasonable, therefore, to hold that the apparently darker animals farthest up the river from the assumed center of differentiation (Colorado delta) indicate intergradation with darker coons to the northward, even though this might be expected. It is even possible that the cliff-confined river above forms an effectual barrier to the north, so that there has been little chance of mingling of coon strains from elsewhere. *Pallidus* may be hemmed in by ordinarily unrossable barriers, and hence has attained a clear-cut specific identity.

LEFT AND MEASUREMENTS IN MILLIMETERS OF *PROTON FALLIDUS* FROM THE COLORADO VALLEY AND DELTA

Mus. no.	Sex	Locality	Date	W.	T.	W.	T.	W.	T.	W.	T.	W.	T.	W.	T.	W.	T.	W.	T.
7153	♀ old ad.	6 mi. W. of Imperial, Calif.	May 10 ¹	860	365	133	56	111.1	81.5	96.1	21.2	40.0	66.2	16.1	9.7				
7153	♂ old ad.	6 mi. W. of Imperial, Calif.	May 8 ¹	910	288	138	59	117.2	89.3	91.7	27.6	43.5	71.5	16.9	13.0				
10006	♂ old ad.	5 mi. S. of Needles, Calif.	Feb. 23	865	300	131	54	111.2	81.8	98.5	25.8	41.7	68.8	16.8	11.3				
10007	♂ yg. ad.	Moien, Ariz.	Mar. 1	885	310	131	71	111.5	82.1	99.4	26.8	40.0	61.7	16.7	11.7				
10008	♀	20 mi. N. of Piencho, Calif.																	
10009	♂ yg. ad.	Poliholes, Calif.	Apr. 28	870	330	135	60	106.0	78.4	95.7	23.3	38.1	61.3	15.7	9.8				
10010	♀ old ad.	Ariz. side opp. Pilot Knob	May 11	870	300	120	46	104.6	82.7	96.5	21.9	38.1	65.0	16.2	9.8				

¹ Collected in 1909 by F. Stephens; the rest obtained on the 1910 Expedition.

Corynorhinus macrotis pallescens Miller

Pale Lump-nosed Bat

At Riverside Mountain, California, March 18, three bats were found at the end of a sloping drift in the Steece copper mine. They were clinging to the rock wall, and at once took flight, attempting to pass us towards the opening of the tunnel. Two were secured, nos. 10694, 10695. The fur of these has a slight reddish cast, which is doubtless wholly adventitious, due to the fine, sticky red dust with which the walls of the mine were covered. Both were females, one of them containing a single embryo.

Antrozous pallidus pallidus (LeConte)

Desert Pallid Bat

On several nights in April, large light-colored bats were momentarily observed flitting about in the moonlight close over our beds. At times the flutter of their wings was clearly audible. But they seldom appeared until it was too dark to shoot. On April 20, on the California side, eight miles east of Picacho, a specimen was shot at late dusk as it flew among willows across a patch of open sky. This, the only example of the species obtained (no. 10696), was a female containing two embryos.

Myotis occultus Hollister

Hollister Bat

This very distinct species was only recently described (Hollister, 1909, p. 43) from two specimens taken May 14 and 15, 1905, on the California side of the river in the bottomlands ten miles above Needles. The fact that our own expedition failed to detect the presence of this bat until the first week in May would point towards its late spring arrival in the region generally. We obtained six specimens, as listed in the accompanying table of measurements. The first was shot at late dusk close to the river bank between files of cottonwoods, in just the same association as those taken by Hollister. At our second locality of capture, the remaining five specimens were shot over the water in a back eddy of the river. Here these bats arrived in considerable numbers at early dusk to drink, flitting down to the water's surface and dipping several times before flying off among the willows and cottonwoods. We used a boat in shooting and retrieving the specimens obtained.

MEASUREMENTS IN MILLIMETERS OF *MYOTIS OCCULTUS* FROM THE COLORADO VALLEY

Mus. no.	Sex	Locality	Date	Total length	Tail vertebrae	Hind foot	Thumb	Forearm	Length of cranium over all	Zygomatic breadth	Breadth of brain-case	Interorbital constriction	Maxillary tooth-row
10702	♀	4 mi. S. of Poetholes, Calif.	May 1	85	35	9	5.9	35.4	15.2	9.8	7.7	3.9	5.8
10703	♀	5 mi. N.E. of Yuma, Calif.	May 3	89	34	8.9	5.3	35.5	.....	9.7	....	4.1	5.9
10704	♀	5 mi. N.E. of Yuma, Calif.	May 3	90	36	9	6.0	36.4	15.4	10.1	7.9	4.0	5.8
10705	♀	5 mi. N.E. of Yuma, Calif.	May 4	86	34	8.5	6.1	35.2	14.8	9.6	7.3	4.1	5.8
10706	♂	5 mi. N.E. of Yuma, Calif.	May 3	87	37	8	5.2	36.3	15.3	9.6	7.6	4.0	5.7
10707	♀	5 mi. N.E. of Yuma, Calif.	May 4	87	38	9	5.4	35.1	15.0	9.8	7.7	4.0	5.8
				87.3	35.7	8.7	5.6	35.6	15.1	9.8	7.6	4.0	5.8

Average of the six adults

I sent one example to the Bureau of Biological Survey, where Mr. A. H. Howell made the specific determination here employed. Our series bears out closely the characters assigned in the original description (Hollister, 1909, p. 43), and they are in all these respects surprisingly uniform. The very broad and flat-topped rostrum and braincase constitutes a character for discrimination from all other species of *Myotis* in California except *orinomus*. The proportions generally are peculiar (see table of measurements).



Fig. H. Right upper dental series of *Myotis occultus*, no. 10702, ♀; middle upper premolar absent. $\times 4$.



Fig. I. Right upper dental series of *Myotis occultus*, no. 10706, ♂; middle upper premolar present. $\times 4$. Variation in general proportions from those of preceding figure possibly due to age.

An interesting fact pointed out by Hollister is the variability in a feature usually considered of much more fundamental importance than the external characters employed in distinguishing members of the genus, namely, the presence or absence of the middle upper premolar (pm^3). In one of Hollister's specimens this tooth was present, in the other absent; in three of ours it is present, in three it is wanting. Thus fifty per cent of the individuals so far collected lack the tooth in question, certainly a remarkable aberrancy from the norm in the genus *Myotis* (see Miller, 1907, p. 201), and denoting a tendency to specialization in this member of the genus, along a line regularly shown in other closely related genera (see figs. H, I).

***Myotis californicus pallidus* Stephens**

Stephens Little Pallid Bat

The accompanying table shows certain circumstances of capture of this species. Although obtained at but the two localities, Mellen, on the Arizona side, and opposite The Needles, on the California side,

I was fairly sure that I saw the same species at other localities along down the river. Those obtained were all shot at late dusk, considerably later in the evening than most of the appearances of *Pipistrellus hesperus*. Instead of flying high, against the sky, as in the case of the latter species, *M. c. pallidus* was almost always foraging low over the bushes of the second bottom, or along shallow washes between clumps of mesquite, seldom appearing above the sky-line. The movements of flight were peculiar also.

LIST AND MEASUREMENTS IN MILLIMETERS OF *MYOTIS CALIFORNICUS*
PALLIDUS TAKEN IN 1910 ON THE COLORADO RIVER

Mus. no.	Sex	Locality	Date	Length	Tail vertebrae	Hind foot
10698	♂	Mellen, Ariz.	Feb. 26	75	38	5
10699	♂	Mellen, Ariz.	Feb. 28	77	38	6
10700	♂	Opposite The Needles, Calif.	Mar. 1	81	40	6
10701	♀	Opposite The Needles, Calif.	Mar. 3	75	35	6

The four specimens obtained are uniform among themselves and with a topotype specimen of *Myotis californicus pallidus* (no. 7350) from Vallecito, on the western side of the Colorado desert in extreme eastern San Diego County. All agree closely with the description of *M. c. pallidus* (Stephens, 1900, p. 153). An additional feature, as compared with *Myotis californicus californicus* from Monterey, California, is the smaller skull of *pallidus*, with decidedly smaller braincase, less inflated in the parietal region.

Myotis velifer (J. A. Allen)

Cave Bat

Not obtained by our party; but there are in the Museum three skins-with-skulls (nos. 7762-7764) taken by Charles Camp at Needles July 16 and 18, 1909. Mr. Camp states that this species was roosting in numbers in an old storehouse from which they were routed out and shot. One of the specimens was forwarded to the Bureau of Biological Survey, Washington, where the above determination was confirmed by A. H. Howell. I do not find a previously recorded occurrence of this species for California.

Pipistrellus hesperus hesperus (H. Allen)

Cañon Bat

The most abundant representative of the order Chiroptera observed during the period of our work. Seen abroad at dusk as early in the season as February 23, when the nights were still so cold that ice formed in suitable places. Numerous at Mellen, February 23 to 28, and swarming in the vicinity of The Needles March 1 to 3. Thenceforth seen at nearly every station all the way down the river. One thing was conspicuously noticeable in regard to occurrence, namely, that this bat varied directly in degree of abundance with nearness to cliffs, or hillsides with outcroppings of fractured rock. In other words, this species probably dwelt exclusively in the rocks during the day, from which it emerged at early dusk to forage out over the river bottom in the near vicinity.

Individuals were often seen before the sunlight had yet left the eastern hilltops. On one occasion, as we were floating down the river near Picacho, a *Pipistrellus* appeared in flight in the glaring forenoon sunshine, dipped down to the surface of the water, where it touched, and thence flitted back to a crevice in the nearby cliff.

Seventy-four specimens of this species were shot (nos. 10382-10423, 10746-10777), 42 being preserved as skins and 32 as alcoholics. Eighteen out of this series are from the California side of the river near Pilot Knob, only about six miles due west of old Fort Yuma, and are thus practically topotypes of *Pipistrellus hesperus*.

In reviewing the Museum's entire collection of *Pipistrellus* from California, it becomes clearly apparent that while there is but one species represented, there are two appreciably different subspecies of this species, one a pale-colored form occupying the arid desert regions from Owens Valley and the vicinity of Walker Pass southeast to the Mexican line, the other a darker-colored form occurring on the Pacific slope of southern California (in the San Diegan district) and in certain parts of the San Joaquin and Sacramento valleys.

It appears to the writer that we have here two races well worthy of recognition in nomenclature. The name *hesperus* was based on the desert form. A name is apparently available for the Pacific race in the *Vesperugo merriami* of Dobson (1886, p. 124). This has always been synonymized under *Pipistrellus hesperus*. While the habitat is given by Dobson as "North America (Locust Grove, State of New York)", an error was committed, for the type really came from Red Bluff, Tehama County, California (*vide* Miller, 1897, p. 31). Dobson

received his specimen from C. H. Merriam, whose residence at that time was Locust Grove, New York.

The case seems to be clear, and I propose that the Pacific slope race be called *Pipistrellus hesperus merriami* (Dobson), the type locality of which is thus Red Bluff, California. The characters of this form, as compared with *P. h. hesperus*, lie in the darker, distinctly browner tone of coloration both above and below, and in somewhat larger size throughout. The Museum has specimens, unequivocally of this form, from the following localities, all within the state of California: Marysville Buttes, Sutter County; Raymond, Madera County; Cuyama Valley, Santa Barbara County; Fort Tejon, Kern County; San Francisquito Cañon, northern Los Angeles County; vicinity of Pasadena; Escondido, San Diego County.

***Eptesicus fuscus* (Beauvois)**

Large Brown Bat

One shot at dusk on the California side near Pilot Knob, May 6. Other bats supposed to be the same species were seen flying down the river high overhead the same evening. A strong west wind was blowing at the time. The species was not seen at any other place.

The specimen secured (no. 10697) is an adult female. It appears to differ in small size and extreme paleness from the average of the species from California. It about equals in the latter respect the palest out of a series of ninety brown bats from the Pacific slope of California. The color dorsally is uniform isabella color, ventrally pale wood brown. Measurements: length 107 mm., tail vertebrae 44, foot 9, forearm 42.5, longest finger 72, ear (dry) 12. The skull, too, is appreciably small.

A general inspection of the Museum's series of this species from California points towards the existence within the state of at least three geographic races based on size and depth of color. But so much of the total area is unrepresented by specimens that systematic analysis at this time seems inadvisable.

***Nyctinomus mexicanus* Saussure**

Mexican Free-tailed Bat

We were fairly certain of seeing this bat at almost every station, as a rule flying high and often squeaking loudly. Only three specimens were secured (nos. 10690-10692) the first two at Mellen, February 26, the third in Chemehuevis Valley, March 11.

Macrotus californicus Baird

California Leaf-nosed Bat

One of the rooms of an adobe ruin on the Arizona side, ten miles below Cibola, showed considerable bat excrement on the floor. No bats could be found in the thatch above, so the place was visited in the evening. No bats appeared in the vicinity until all daylight had faded. Then two were seen flying about the ruins; and by means of a lantern and butterfly net, one was caught in the room referred to. This was probably used by the bats merely to repair to while eating the moths caught outside; wings of the latter were strewn upon the floor.

The specimen obtained (no. 10693) is an adult male; the date April 8.

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PLATE 3

Map of Needles-to-Yuma portion of lower Colorado River, showing stations from which collecting was carried on by the 1910 expedition from the California Museum of Vertebrate Zoology. (See itinerary, pp. 53-57.)

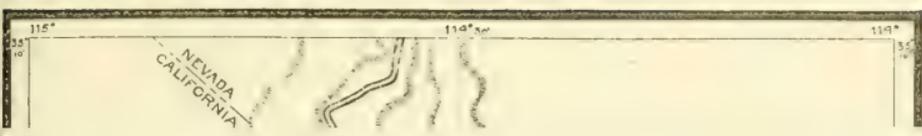


PLATE 3

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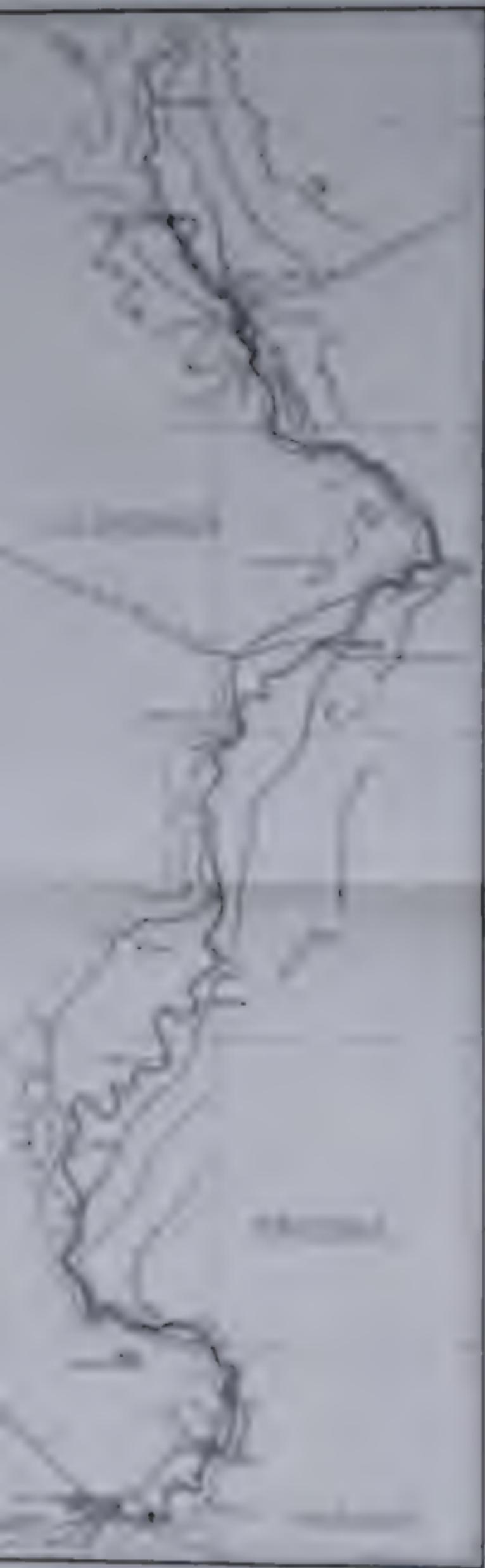


PLATE 4

Fig. 2. Looking up the Colorado River from Mellen, Arizona. At this date, February 27, 1910, the river was at a low stage, leaving many mud bars uncovered. These bars were resorted to as forage grounds by herons and ravens.

Fig. 3. California shore near Pilot Knob, showing dense mass of cane (*Phragmites communis*), partly submerged, and in part hanging over the bank into the water. The log held fast by the tangle of cane was the favorite resort of muskrats (*Ondatra zibethica pallida*), two of these animals being caught at this particular place. This cane is a conspicuous riparian element on permanent banks from the vicinity of Picacho to the Mexican line. Resident birds showing marked preference for these cane thickets were *Melospiza melodia saltonis* and *Geothlypis trichas scirpicola*. Photograph taken May 15, 1910.



Fig. 2



Fig. 3

PLATE 5

Fig. 4. Looking north over the flood plain of the Chemehuevis Valley, California side. At this date (March 10, 1910) only the cottonwoods had come into leaf. This is the typical willow-cottonwood association of the riparian belt as found in all the broad valleys. The component plants are willows, of two species, cottonwood, guatemote, and screw bean. Some of the latter show in the foreground because of the mistletoe clumps in their as yet leafless branches. At the time of taking this picture birds of the winter visitant category were plentiful (see text, p. 71).

Fig. 5. The arrow-weed association, the typical element in which is the arrow-weed (*Pluchea sericea*). This plant forms an almost continuous growth over the river flood plain outwardly adjacent to the willow-cottonwood association. Animal life was poorly represented in this association as compared with any other of the region. Those birds and mammals found therein appeared nearly all to traverse it only incidentally, in passing between the mesquite and willow associations. Photograph taken near Pilot Knob, May 11, 1910.



Fig. 4



Fig. 5

PLATE 6

Fig. 6. Portions of quail-brush (in foreground) and mesquite associations, paralleling each other and situated next outwardly from the arrow-weed association. Photograph taken on the Arizona side about one mile above Mellen, February 27, 1910. On this date the deciduous mesquites were still leafless, the dark patches being masses of the mistletoe (*Phoradendron californicum*). The latter parasitic plant produces an almost perennial and abundant crop of berries which form a staple food supply for many species of birds, notably the phainopepla, western bluebird, western robin, and mockingbird. The quail-brush (*Atriplex lentiformis*), because of its stoutly interlacing and spiny branches, forms an ideal refuge for such animals as the cottontail rabbit and desert quail. Abert towhees are permanent inhabitants of this belt as well as of the adjacent one on each side, while the winter-visiting *Zonotrichias* make it their headquarters.

Fig. 7. Mesquite (*Prosopis juliflora*) in full leaf and fruit, the latter the bean-like pods. The mesquite marks a distinct association, the outermost one of the riparian set of associations. Both the foliage and the fruit constitute important food sources for many of the animals of the region, either directly or indirectly. Among birds, characteristic permanent residents are the crissal thrasher and Abert towhee. The Colorado river wood rat (*Neotoma albigula venusta*) is a characteristic mammal. Photograph taken near Pilot Knob, May 11, 1910.



Fig. 6



Fig. 7

PLATE 7

Fig. 8. The salt-bush association, on second-bottom above the reach of the highest overflow. The large plant in the center of the picture is the creosote bush (*Larrea divaricata*) which in places invades the second bottom nearly or quite to the edge of the mesquite and grows to larger size in such places than on the desert mesa. The prevailing low, light-colored shrub, is the salt-bush (*Atriplex polycarpa*). Winter visiting birds of this association were: Nevada sage sparrow, Brewer sparrow and desert Bewick wren; mammals caught at this point were *Dipodomys merriami* and *Perognathus penicillatus*. Photograph taken one mile above Mellen, Arizona, February 27, 1910.

Fig. 9. Typical wash association, the catclaw (*Acacia greggii*) being the plant most constantly present. Thickets of catclaw are to be seen in the right foreground, while large ironwood and palo verde trees are to be seen in the middle distance. The distant hill slopes are dotted with creosote bushes, while *Atriplex polycarpa* margins the wash in the immediate foreground. Resident birds of this wash association were: verdin, plumbeous gnatcatcher, and cactus wren. Photograph taken March 10, 1910, on California side, near lower end of Chemehuevis Valley.



Fig. 8

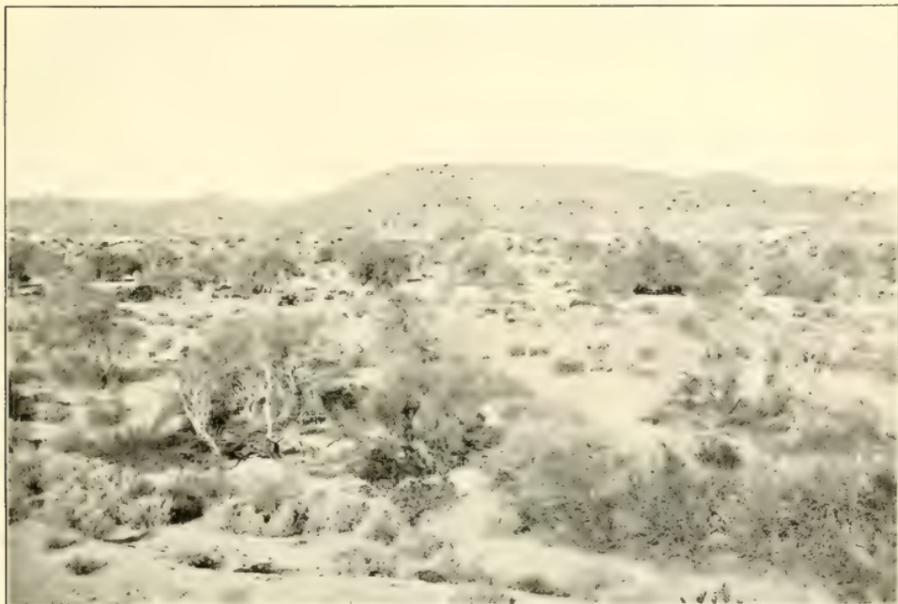


Fig. 9

PLATE 8

Fig. 10. Ironwood tree (*Olneya tesota*) photographed March 10, 1910, in the wash pictured in the previous plate. This individual, an unusually large one, was 90 inches in circumference of trunk two feet above the ground, 31 feet in extreme height, and with a foliage expanse of 50 feet. The thorny branches afforded protection to several nests, old and new, of the verdin. The blossoms of this plant, which appear in May, attract numerous hummingbirds.

Fig. 11. Palo verde tree (*Parkinsonia torreyana*) of unusual size. At the time of blossoming, in April, this tree is resorted to by many migrating birds, both for the flower nectar and the insects. Like other elements in the wash association the palo verde is frequented by verdins, plumbeous gnatcatchers and cactus wrens. Photograph taken February 27, 1910, on the Arizona side above Mellen, near the mouth of the Sacramento wash.



Fig. 10



Fig. 11

PLATE 9

Fig. 12. Giant cactus (*Cereus giganteus*) on California side four miles north of Potholes. A palo verde stands immediately beyond, its trunk being nearly hidden by that of the cactus. The extreme height of the latter was 28 feet. Openings may be seen in the upper branches. Two of these were inhabited by a pair each, respectively, of the Gila woodpecker and ash-throated flycatcher. Photograph taken April 23, 1910.

Fig. 13. Giant cactus on California side four miles above Potholes, photographed April 23, 1910. In a hole in this cactus was found a brood of gilded flickers (just beneath short left-hand branch), and three feet higher up in a cavity opening on the opposite side of the trunk was a saguaro screech owl.



Fig. 12

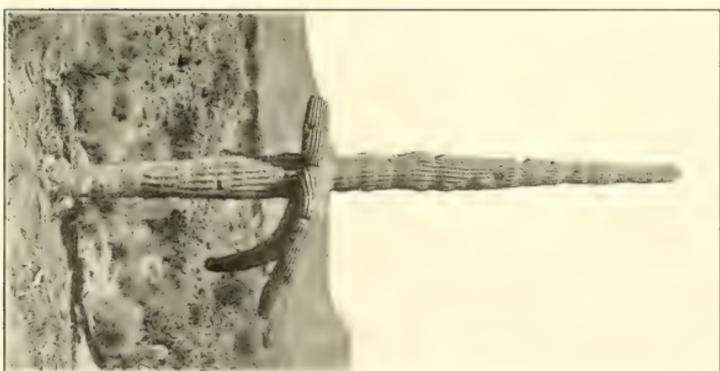


Fig. 13

PLATE 10

Fig. 14. Looking due south from Mellen, Arizona, and toward the group of spire-pointed hills known as "The Needles." The Colorado River in the right distance. Typical rocky mesa in the immediate foreground, the scattering plants being creosote bushes. The desert mesa is here seen to abut closely upon the river, leaving only very narrow riparian strips. Mammals trapped on the mesa at this point were *Perognathus intermedius* and *Ammospermophilus harrisi*. Photograph taken February 28, 1910.

Fig. 15. Photograph taken March 7, 1910, on the Arizona side, from upper slope of The Needles. Channel of the Colorado River at extreme left. The chief vegetation on the steep rocky slopes is the creosote bush and *Encelia farinosa*. The latter reappears so persistently upon such ground that its name has been selected to apply to the association marked by its presence. Mammals trapped on this slope were *Neotoma intermedia desertorum*, *Perognathus intermedius* and *Ammospermophilus harrisi*.



Fig. 14



Fig. 15

PLATE 11

Fig. 16. Group of burrows of the large kangaroo rat (*Dipodomys deserti*). Tracks of the animals may be seen in the soft aeolian sand, here accumulated to considerable depth. The dessicated remains of a brief-lived annual vegetation may be seen on the sand between the creosote and the salt-bushes. Other species of mammals trapped in this, a variation of the salt-bush association, were: *Citellus tereticaudus*, *Peromyscus eremicus*, and *Perognathus penicillatus*. Photograph taken about one mile north of Mellen, Arizona, February 27, 1910.

Fig. 17. Mouth of burrow of the large kangaroo rat (*Dipodomys deserti*), showing parallel imprints of the hind feet and the tail in the soft sand. Photograph taken above Mellen, Arizona, February 27, 1910.



Fig. 16



Fig. 17

PLATE 12

Fig. 18. Burrow of the Harris ground squirrel (*Ammospermophilus harrisi*) beneath creosote bush on desert mesa near Mellen, Arizona. The wind-worn pebbles of the mesa surface are here well shown, the loose sand being continually removed by the prevailing winds. Photograph taken February 28, 1910.

Fig. 19. Ironwood tree almost completely killed by the rising of the water level in the soil at the outer edge of second bottom. A nest of the Lucy warbler (*Vermivora luciae*) was situated 35 inches from the ground in a cavity in the side of the trunk. Photograph taken April 12, 1910, near the Draper ranch, on the California side eighteen miles north of Picacho.



Fig. 18



Fig. 19

PLATE 13

Fig. 20. Nest of the Lucy warbler (*Vermivora luciae*) in crevice on side of trunk of partly dead ironwood shown in plate 12, figure 19. This nest contained three eggs. Photographed April 12, 1910, on the California side, eighteen miles above Picacho.

Fig. 21. Selected specimens of *Mephitis estor* from the Colorado Valley: at left, no. 10575, Chemehuevis Valley, California side; middle, no. 10574, five miles south of Needles, California side; at right, no. 10579, twenty miles above Picacho, California side. The variation shown is individual. If the contrasted black and white markings are of warning significance, hence of adaptive advantage to the species, why should the desert skunks have proportionally much more white than skunks from the humid northwest coast belt of the United States? (See text, p. 256.)

FIG. 20. *Phoca vitulina*.



FIG. 20

FIG. 21. *Phoca vitulina*.



FIG. 21

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