

THE INFLUENCES OF THE SOUTHWESTERN DESERTS
UPON THE AVIFAUNA OF CALIFORNIA.

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THE following paper is an outline of a rather intricate problem which really merits the most intensive investigation. This I at one time hoped to undertake, but its consummation seems to be indefinitely postponed at present. In addition, the very nature of the problem and the character of the area involved inhibit for many years a painstaking and comprehensive treatment of the subject presented, because of lack of information relative to the precise movements of so many Californian birds during the migrations. For this reason—that the data on which some of my conclusions are based are admittedly sketchy—these conclusions are advanced somewhat tentatively and subject to later revision in some cases, but the majority seem to be fundamentally sound.

The southwestern deserts as here considered consist of those intensely arid areas of the Lower Sonoran Zone that, in Arizona, are situated west of the Babiquivari Mountains and south of the extensive Upper Sonoran stretches of Yavapai County; and in California, are situated east of the southern extensions of the Sierra Nevada and south of the jumble of mountain systems in the neighborhood of Death Valley. As a whole, this area is the most forbidding region in the United States—the most perfect desert barrier, theoretically, that we have. For vast stretches it supports only the scantiest desert bushes, chiefly creosote.

Roughly, the Californian portion of this area may be divided into two sections. The northernmost, here termed the central desert, is located to the north of the San Bernardino and Chocolate ranges, and includes the Mojave Desert. The parts of this that are located away from the Colorado River, or in other words, the somewhat more elevated portions, are particularly unattractive in appearance, with vegetation seldom vigorous even in the lower washes. On the whole, summer temperatures are high but not excessive, save in certain localities, and winter ones are often decidedly frosty. The climate is chiefly influenced by the high cordillera on the west, and probably in some degree, by the mountain ranges on the north. The southern or Colorado Desert

section resembles the other in its main characters, but the flora averages more luxuriant and diverse. Great numbers of cacti often abound, the washes support a more vigorous growth, and the low spots may boast thickets of thorny trees and several species of large bushes. The summers are burning hot, and in winter, although light frosts may occur at night, the days are usually decidedly warm. The climate here, too, is influenced by the mountain masses to the west, which deprive the region of most of the winter rains of the coast, and by the proximity of the Gulf of California, which often causes considerable humidity in summer with occasional severe storms. The deserts of southwestern Arizona considerably resemble the Colorado Desert, with summer showers even more prevalent.

The main topographic feature of these deserts is the number of small, detached mountain ranges, with evenly sloping valleys of beautiful regularity between. These may be from a few to a score or more miles wide. For the most part, these ranges are as near barren and desolate as one could well imagine, their scarred flanks reminding one of sun-mummied carcasses. Only a few of them are high enough to support meager and precarious Upper Sonoran caps upon their parched summits. In general, the trend of these is from northwest to southeast, but there are many exceptions.

Across this arid region there are two highroads of dispersal or migration which, to human eyes, would seem most logical for such species as are dependent upon a continuous water supply. One is the Gila River, which flows westward from the higher country of east-central Arizona, to join the Colorado at Yuma, and the other is the Colorado River itself, which enters the southwestern desert region from the northeast and empties into the Gulf of California. The Gila does not support an uninterrupted riparian flora (such as willows) but the drier stretches would not seem to be of sufficient size to deter the spread of most of the verdure-loving birds of the region. The bottomlands of the Colorado River, on the other hand, support an almost continuous ribbon of characteristic moisture-seeking growth, which is often in turn bordered with an especially vigorous desert flora. It is thus seen that there is a theoretical highroad between south-

central Arizona and the southeastern border of California, and that there is another north and south highroad almost bisecting the region, whose upstream extension, however, turns eastward through northern Arizona, and thus, unfortunately, it is eliminated as a continuous route from the mainland of western Mexico into the coastal sections of southern and central California. I am assuming that these theoretical highroads would be especially favorable for migratory birds other than those which prefer an arid habitat.

Prior to the inception, some twenty years ago, of extensive development of irrigation over much of the southern section, water holes were few and far between, either upon the desert floor, or in the arid mountains, and in the latter situation they were well hidden, with no verdant beacons to entice the avian traveller from afar. Hence, those species which habitually frequent rather succulent or arboreal surroundings could not have been tempted to cross this region under pristine conditions merely by wandering on and on through congenial surroundings, ever northward, and inversely at the approach of winter.

The central desert area is as yet but little altered by the hand of man except on its extreme western border, and elsewhere there is practically no agricultural development. Where irrigation is possible in this western portion conditions have been made attractive for many species of birds, and in such localities may be found a host of migrants, and probably an optimum avian population during the winter months. Although most of this is strictly within the Lower Sonoran Zone, introduced trees and developed moisture have made restricted, local environments that may contain more elements essentially Upper Sonoran in character than do the high, dry hillsides to the west that belong strictly to the latter zone. Hence, many species of birds which one would certainly not expect to find in Lower Sonoran surroundings even during the colder part of the year, wander to such oases from the neighboring highlands and are found on neighborly terms with species which normally occur about moist spots in the pure desert. In this respect our zonal problems are still further complicated.

Indications point strongly to the hypothesis that towards the close of the glacial period or shortly thereafter, the climate of

certain parts of eastern California was somewhat more humid than at present. This should mean that there was a correspondingly greater luxuriance of desert growth, with more extensive Upper Sonoran caps upon the desert ranges. Water holes would be more plentiful as well, and if these conditions obtained during the precise period (probably of great duration) when migration routes were first being established, such routes across the desert could have been fixed with less danger to the avian travellers than would now be the case. As aridity increased, these routes would not be changed in general (although they might be shortened and made more direct), but in all probability the flights between stops would merely be lengthened, and the entire distance from the Sierras to the Colorado River, say, might be made by some species without alighting.

The Salton Sea section has been flooded to sea level several times within its recent geological history, and it is quite possible, and indeed probable, that conditions at flood stage had an influence upon exact migration routes. As is well known, migrating birds are prone to follow a shore line, and this inland sea, being plainly visible from the San Bernardino and San Jacinto Mountains, must have enticed many birds, during the genesis of migration, to follow its shore line, and thence by the Alamo River (or its earlier counterpart) to the lower Colorado. The writer here follows the theory, more or less accepted, that a migration route may be somewhat altered in time, providing the new one is shorter than, and equally as attractive as, the old. This new route, once established, would probably be continued in spite of any increased aridity of climate. That it is an important highway during migration, at present, is attested by the hosts of birds that pass through the Coachella Valley. The probabilities are that it is decidedly the most important, concentrated route across the Californian deserts. More birds may pass over the central desert section, but in that area there is apparently no inducement for concentration. Birds may "hop off" from the main mountains at any point and cross to any part of the Colorado Valley, stopping wherever there seems to be promise of food.

A study of the published lists of birds for a number of stations upon the deserts, and for the Colorado River, brings to light only

ten small, migratory birds breeding exclusively in the Pacific Coast region, which may be considered, in the present state of our knowledge, as regularly migrating through, or wintering in, the lower Colorado River valley. These ten birds are:

- Vaux's Swift (*Chaetura vauxi*)
- Lawrence's Goldfinch (*Astragalinus lawrencei*)
- Sierra Junco (*Junco hyemalis thurberi*)
- California Yellow Warbler (*Dendroica aestiva brewsteri*)
- Hermit Warbler (*Dendroica occidentalis*)
- Tulé Yellow-throat (*Geothlypis trichas scirpicola*)
- Golden Pileolated Warbler (*Wilsonia pusilla chryseola*)
- Russet-backed Thrush (*Hylocichla ustulata ustulata*)
- Alaska Hermit Thrush (*Hylocichla guttata guttata*)
- Dwarf Hermit Thrush (*Hylocichla guttata nana*)

Other coast birds undoubtedly make this journey, but they are all of species which occur during the breeding season as far east as the 115th meridian, and hence, may enter the region by way of Nevada or Utah. In this connection, species which spend the summer on any part of the desert, even in the Upper Sonoran Zone, are not considered. The above ten species constitute a mixed lot, both as to zonal affinities and location of breeding ranges, and no conclusions can safely be drawn concerning them. It seems merely that at some time in the past, certain individuals of these species, or possibly all individuals from certain restricted areas, have, for obscure reasons, chosen to migrate across the desert.

Many Pacific Coast birds, perhaps the majority of migratory individuals, travel by way of the coast and mountains of southern California and thence into similar portions of Lower California. Numbers continue clear to Cape San Lucas, but it seems logical to suppose, as we have some grounds for doing, that others cross the gulf to the Mexican mainland at various intermediate points, which movements would have become established at some period when the Gulf of California was considerably less extensive than at present. Sundry forms (it is unsafe to hazard an opinion as to just which) as, for instance, a majority of the subspecies of Fox Sparrows (*Passerella*), evidently do not cross the desert at all, unless as stragglers, but those that leave the United States do so via Lower California. To such the desert has proven a

barrier—a wall, so to speak, reared to the east which has forced their migrations along the montanic or coastal highways. Thus, the avifauna of Lower California is appreciably enriched in comparison with what its condition would be were this desert barrier nonexistent.

It seems hardly necessary to call attention here to the fact that the deserts act as a very effective barrier against the eastward spread of many non-migratory species which now occupy the less arid country to the westward. Certain of these, as the Anthony's Towhee (*Pipilo crissalis senicula*) and Valley Quail, (*Lophortyx californica vallicola*) have pushed down into the borders of the desert and are found together with their desert counterparts—Abert's Towhee (*Pipilo aberti*) and Gambel's Quail (*Lophortyx gambeli*)—in the vicinity of Palm Springs. It seems unlikely that these San Diegan forms will ever become thoroughly established under desert conditions. Irrigated ranches now provide local environments which might prove congenial in many ways, but the combination of different conditions of climate and severe ecological competition by desert species of the same genera or like habits would probably prove too much for them. However, if such a dispersal ever does occur, it will undoubtedly be from just this point—through Palm Springs and into the Coachella Valley.

A few species of Californian birds may be able to do without a direct water supply—evidence is inconclusive on this point—but the number cannot be more than half a dozen. The remainder frequent the vicinity of ranches and oases, most of them showing a preference for such habitats as have been fostered by the hand of man, or else the tangle of natural growth along the infrequent water courses. During the last twenty years, irrigation has been enormously developed in the Imperial Valley, and to a lesser extent, in the Coachella Valley, so that there is now a line of verdure, narrow in spots, in which there is no break of more than about five miles (if we except the length of the Salton Sea) from the Gulf of California to the San Jacinto Mountains. It is logical to presume that this associational change will not alter migration routes for a great many years, if it ever does—at least to an appreciable extent. During the winter, the irrigated fields of the

Imperial swarm with Gambel's Sparrow (*Zonotrichia leucophrys gambeli*), Western Vesper Sparrow (*Pooecetes gramineus confinis*), Western Savannah Sparrow (*Passerculus sandwichensis alaudinus*) and such birds, but these have hardly been enticed from districts nearer the coast. Rather are they individuals that, were there no irrigation, would be forced to pass over Imperial Valley to find suitable range farther south. They are merely travellers of the air decoyed by green fields.

The riparian fauna of the Colorado River is, to a large extent, the same as that of the river systems of southwestern Arizona—it is Arizonan rather than Californian—and contains certain faunal elements formerly found nowhere else in California. The development of irrigation has now opened up an avenue of dispersal into the Imperial Valley. Many forms—I may say the majority—have availed themselves of this opportunity in varying degree and are now well established within this area. Indeed, some of them have increased prodigiously, and others, slower to gain foothold, will probably do so in future. As ecological congestion results within this district it is only reasonable to presume that an overflow will occur, and at least a few of the species, such as the doves, should extend into the Coachella Valley. Whether others of weaker flight can surmount the barriers imposed by the barren shores of the Salton Sea remains to be seen. If so, more individuals of these species may occur upon the Pacific slope as "accidentals," but it seems unlikely that any will become well established in the western portions of the state.

What of the deserts as a barrier to the dispersal of the indigenous birds of south-central Arizona—the Cardinal (*Cardinalis cardinalis superbus*), Pyrrhuloxia (*Pyrrhuloxia sinuata sinuata*) and Palmer's Thrasher (*Toxostoma curvirostre palmeri*), say—and even the species so characteristic of the higher mountains of that section? The three forms mentioned are birds of the heavier brush or mesquite thickets. These associational conditions are met with rather sparingly in southwestern Arizona, and the westward spread of such birds has evidently been hindered for this reason, even though one would imagine that they could easily extend their ranges along the Gila River. Although it is practically certain that the climate of *parts* of the desert was once more humid, as

mentioned above, this distributional fact seems to argue against such humidity having extended in marked degree or uninterruptedly over the *southern* deserts, for more mesquite thickets would then have occurred, which should have been followed by the extension of the ranges of some of these birds. However, it is not impossible that they did so extend but that their distribution became contracted some time later. Similarly, it seems that a marked increase in the humidity of the southern deserts (probably resulting in a zonal elevation) would have allowed some slight infusion into southwestern California of several of the Mexican tableland forms that are now so characteristic of the southern Arizona mountains, but if such an infusion ever occurred it has left no trace.

The conclusions reached are that the deserts of southeastern California introduce an arid fauna into this portion of the state, of course; that they act only as a partial barrier to migrating birds, the result being that a greater number of migrants are deflected along the mountains to the west and into Lower California than would otherwise be the case were there no deserts present; that they operate as a barrier to most of the non-migratory birds that are indigenous to the bordering regions on the west and on the east, and that they have been operative as such a barrier for a very long time; that the southern desert is being much changed environmentally by man's agency, the result being that hosts of avian individuals which formerly were forced to winter beyond the southern border of California are now enabled to remain within the state during that season; and that irrigation has enabled the characteristic fauna of the lower Colorado River valley to spread within the confines of California, and to occupy an increasingly important position in its avifauna.

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YELLOW-LEGS SKELETONS.

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THE writer has been interested in comparing the skeletons of the two Yellow-legs, *Totanus melanoleucus* and *Totanus flavipes*, the skeleton of an adult male of each species taken at Mastic, Long Island, August 23, 1919, being used for that purpose.

The sternum of the former, the Greater Yellow-legs, enlarged three times, is almost exactly of the same length as that of the latter, the Lesser Yellow-legs, enlarged four times; so that by multiplying dimensions of the two by 3 and 4 respectively, it is possible to eliminate size difference and obtain proportional differences. The flaring sides of the sternum, and the shape of its vertical keel, are appreciably different in the two, the keel in the Lesser Yellow-legs shorter and deeper. The skull proper of the Greater Yellow-legs is smaller, but its bill longer, more particularly the solid tip of the bill, the upper mandible much more rigid. The leg of the Lesser Yellow-legs, on the other hand, is the longer, such greater length involving each of the three leg joints, very conspicuous in the middle one. To make a digression at this point, we may say that the skeleton of an adult male Stilt Sandpiper (*Micropalama himantopus*) was also at hand, and comparison with this unrelated bird was at times of interest. In its long legs it is the terminal or tarsal joint which is lengthened, the proportions of the joints being quite different from those of *Totanus*.