Turdus philomelus philomelus. SONG THRUSH. Resident, more common about Montoir in the winter, when it fed on the marshy meadows bordering the bog. Its method of feeding and general actions at this time recall our Robin. Its song, however, is somewhat like the Thrasher's but contains some harsh notes.

Turdus viscivorous viscivorous. MISTLE THRUSH.—One at Montoir, January 1. Quite as large as our Brown Thrasher.

Turdus musicus. REDWING.—Only one identified, December 31, at Montoir.

Turdus merula merula. BLACKBIRD.—A common resident. Acts much like our Robin, feeding on the ground and flying up into hedges when alarmed, with the loud piercing cries which are so often heard from Robins at dusk. Their song, however, resembles that of the Thrasher, without the repetitions. Some phrases are almost as rich as those of the Wood Thrush.

Oenanthe oenanthe oenanthe. WHEATEAR.—One feeding in a wet meadow, at Montoir March 30.

Reading Public Museum, Reading, Pa.

THE BIRDS OF LAKE POOPÓ, BOLIVIA.

BY WILLIAM RAY ALLEN.

THE overflow of Lake Titicaca, especially voluminous during the rainy season, is poured out into the Bolivian Lake Poopó (Aullagas) and the salt marshes and lagoons of Coipasa. Despite a wide-spread popular belief concerning an underground outlet to the Pacific, the entire rainfall is probably taken up by evaporation. The river Desaguadero by which Titicaca drains into Poopó passes near Calacoto through a rock-channel in a narrow valley. This acts as a valve, regulating the flow of the water above. Lake Titicaca, therefore, varies in its level no less than five feet between its highest and its lowest known stages; and Lake Poopó below rises and falls with greater seasonal regularity. It cannot fluctuate more than two or three feet, while the excess overflows into the salt marshes.

As a result of the above situation we have the almost anomalous

occurrence of an extremely flat flood plain at an extremely high altitude; and it is of considerable magnitude also. Lake Poopó is at an elevation of 12,000 feet; it is fifty miles long and half as wide. The surrounding pampa and salt-plain has several times the area of the lake. The greatest known depth of the lake is thirteen feet; and the surrounding plain, except for a few ancient protrusive mountain peaks, exhibits but little greater relief than the lake bottom itself.

The immediate approaches of the lake present a very slight gradient. A zone, in width five to ten miles around it, is nowhere more than a few feet above the water level, except for a few low dunes. The lake may be seen from a distance only by climbing a mountain slope. Due to the confusing mirage, as one draws near he is never sure of sighting it until within less than a kilometer from the water's edge.

The relatively great variation in level under these circumstances brings about a seasonal increase and decrease in the size of the lake that is considerable. The writer visited it in January and February, 1919,[1] at the beginning of a belated rainy season. There was still exposed about the lake's margin a belt of hard, sun-cracked mud a mile wide, which at the height of the rainy season is under water. Moreover the writer waded out into the lake another mile before encountering water that was knee-deep.

In spite of the steady influx from the Desaguadero the deepening of the water at a given point does not proceed with regularity. There is a nearly diurnal rhythm in the overflow upon the mud zone, and a lesser withdrawal between advances. The whole acts very much as a *seiche.* But there is nightly a high south wind which is probably responsible for piling up the water upon the northerly shores. With the increment of water from the Desaguadero each night's flood advances a little further than the preceding.

As is to be expected, the north end of the lake has a much greater amount of mud. At the southern extreme, near Challapata, there is much more sand and the water is clear, except about the mouths of rivers. This end of the lake is fairly free of emergent

[1]As a member of the Irwin Expedition, and traveling fellow of the University of Illinois.

vegetation, such as bulrushes, while the northern portion of the lake, especially toward the east shore, produces enormous areas of the same. The southern portion, on the contrary, is rich in one or two species of Potamogeton.

The foregoing lengthy introduction may aid in explaining the few observed facts of local bird distribution which follow. Since Lake Poopó is so nearly inaccessible and so few observers have visited it, any meager, incidental data may have some value.

The reedy northern end of Lake Poopó was found inhabited by a considerable number of species. The bird fauna is not unlike that of the littoral of Lake Titicaca, but lacking some of its forms. There were among others: the Flamingo (*Phoenicopterus andinus*); Ducks; Coots (the Choca, *Fulica* sp.); Ibises; Gulls (*Larus serranus*); Heron (Pajaro bobo); Sentinal (Leke-leke, *Vanellus resplendens*); Hawks (Aquila); Negritos (close relative of our Red-winged Blackbird.) The above were all in abundance upon both lakes.

Correlated with the shallowness of the water of Poopó is the absence of diving-birds. The abundant flightless grebes of Lake Titicaca are wanting. The cormorant, which prefers diving from an elevation, finds unfavorable this lake of only two dimensions. No Gallinules were observed, nor the great goose-like Huayata (*Bernicla melanoptera.*)

Still fewer species were found at the southern end of Poopó. A few plover species, the Gull, and the Flamingo were the only birds to be seen.

The black-headed Gulls occur everywhere on the pampas, even following up the courses of small streams. On Poopó they were few in number, being here reduced to feeding upon the small dead fishes which were to be found.

The Flamingo is rather uniformly distributed about the lake, usually occurring in companies of a score or more, and working in extended order in water of the depth of from one to two feet. In such waters where cover for the approaching hunter is wanting it is manifestly impossible to get within easy gunshot. They may be followed long distances, and will always keep walking ahead of the pursuer, foraging as they go, and seldom resorting to flight. The bird presents a conspicuous, but altogether decep-

tive target. Furthermore at some distance one's image of a Flamingo company becomes grotesquely confused with the elongated reflections in the water and with the mirage. It is thus difficult to gauge the distance, even at long gun-range. This bird occurs in surprising numbers, for it has not only the protection of its own wariness, and of its remoteness, but it is about the only bird of the high Andes which receives much legal or sentimental favor. The sight of the Parihuana usually elicits exclamations of pleasure in any group of men. No evidence of their nesting was seen in either Titicaca or Poopó. The only nesting sites accurately reported by the inhabitants were both in northern Chile—Laguna Roja near Collahuasi, and another lake near Chiu-chiu.

The southerly shores of Lake Poopó are *par excellence* the abode of shore-birds. Several species of plover were taking full advantage of the situation. The writer estimated that for each mile of shore line there were well in excess of ten thousand birds. By all evidence they were chiefly winter residents. No indications of nesting on the part of any species were noted here, nor were the sex glands in the enlarged condition of the breeding season. However, just across the Chilean border at Lake Ascotan, ducklings were found that were nearly old enough to leave the nest. On that morning the temperature at Cebollar across the lake was 14° F., the usual temperature of the season. The nest was adjacent to a warm spring-fed pool at the foot of an extinct volcano. Some heat may have been derived from that source, making the spot more habitable.

Several factors probably contribute to the determination of bird distribution in the altiplane. Lake Titicaca's production of the greater number of species cannot be ascribed to any one or two of these factors. It is much the larger and deeper body. Not only as a matter of size, but through its striking effect in tempering the climate, is this important. In variability of contour—shore and bottom—Titicaca stands at one extreme, Poopó at the other. Aside from its rushes and cattails, the latter affords no shelter whatever.

Lake Titicaca does have remarkably few plant and animal species for the Torrid zone. But, since it is tributary to Poopó and at a higher elevation, it might reasonably be expected to produce the fewer, except for the above environmental factors.

The considerable salt content of Lake Poopó does not likely affect the bird population directly. Yet the latter may be influenced through the effect of the salt upon other organisms. Laguna Salinas is only slightly higher than Titicaca, and within its basin, though cut off from it. In contour, bottom, etc. it is comparable to Poopó. But through its salinity, which is much higher than that of Poopó, it has eliminated virtually all plant life. Very few animal species exist in it—no essentially aquatic species except Phyllopoda, not even fish. Hence, on account of food, there are few birds, if for no other reason. There are numerous Plover, and a few Flamingoes, Ducks and Gulls. Other conditions being essentially the same, then, as in Poopó, this lake pretty well demonstrates wherein salinity does affect the avifauna.

Lake Poopó's fluctuations in level upon its flat flood plain result in a striking separation of food materials, not unlike the sorting of littoral forms upon tidal flats, through their relative size and specific gravity. Here the materials sorted are few in kind. The shore-birds always feed in water of not more than an inch or two in depth, and rarely a hundred feet from its margin. Hence they were sometimes feeding on an advancing, sometimes a retreating lake margin. In each situation some were killed and the alimentary tracts examined for parasites. Especially at the north end of the lake, the stomachs were at one stage of the water filled almost entirely with weevils which were being driven from the shelter of the dry sun-cracks. Upon the withdrawal of the water the Tiutico fed nearly exclusively upon the seeds of Potamogeton or Malacochaete which were being left by the ebb. The change in diet corresponded always with the stage of the water.

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