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DISTRIBUTION, RELATIVE ABUNDANCE, AND PREHISTORY OF BIRDS ON THE TARACO PENINSULA, BOLIVIAN ALTIPLANO

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Resumen. Usando datos de conteos por punto, otras observaciones, y especímenes capturados, describimos las comunidades de aves durante la temporada seca (Junio–Julio 1996) en dos sitios, Chiripa e Iwawi, en la Península de Taraco del Lago Titicaca, Bolivia. Nuestros datos incluyen los primeros censos cuantificados de aves terrestres de esta parte del altiplano Boliviano. Incluyendo las comunidades de aves de aguas abiertas, de las orillas del lago y de los terrenos elevados, registramos 52 especies en Chiripa y 49 especies en Iwawi, con 41 especies compartidas entre los dos sitios. Comparamos nuestros datos con los datos provenientes de huesos identificados de un sitio prehistórico (hace 1000 a 35000 años) arqueológico en Chiripa. Los huesos representan por lo menos 31 especies de aves e incluyen siete especies (*Podiceps* sp., *Phalacrocorax brasilianus*, *Chloephaga* sp., *Fulica* sp. (pequeño), *Metriopelia aymara*, *Ciccaba* cf. *C. albitarsus* y *Trogon* sp.) que no registramos en la Península de Taraco en Junio–Julio 1996.

Abstract. Using data from point-counts, other observations, and specimens taken during June–July 1996 (dry season), we describe the bird communities at two sites, Chiripa and Iwawi, on the Taraco Peninsula of Lake Titicaca, Bolivia. Our data include the first extensive censuses of landbirds from this part of the Bolivian altiplano. From the combined aquatic, lakeside, and upland bird communities we recorded 52 species at Chiripa and 49 species at Iwawi, with 41 species shared between the two sites. We compare our data with those derived from bones identified from a prehistoric (1000 to 3500 years old) archaeological site at Chiripa. The bones represent at least 31 species of birds, including seven (*Podiceps* sp., Phalacrocorax brasilianus, *Chloephaga* sp., *Fulica* sp. [small], *Metriopelia aymara*, *Ciccaba* cf. *C. albitarsus*, and *Trogon* sp.) that we did not record on the Taraco Peninsula in June–July 1996. *Accepted 5 February 1999.*

Key words: Altiplano, bird communities, Bolivia, Chiripa archaeological site, human exploitation of birds, Lake Titicaca, totoras.

INTRODUCTION

Detailed descriptions of bird communities are lacking for most of the Neotropics. Lists of birds are available for many places, but these lists typically lack information on relative abundance, habitat, microhabitat, elevational range, seasonality, and species associations.

The most detailed avifaunal descriptions of the altiplano, such as those of Dorst (1956a, 1956b, 1962), Vuilleumier & Simberloff (1980), Serrano & Cabot (1982), Fjeldså (1985), Vuillueumier (1986), Remsen & Traylor (1989), Fjeldså & Krabbe (1990), Ribera (1991), Rocha & Peñaranda (1995), and Rocha & Quiroga (1996) are highly informative but include few data derived from censuses.

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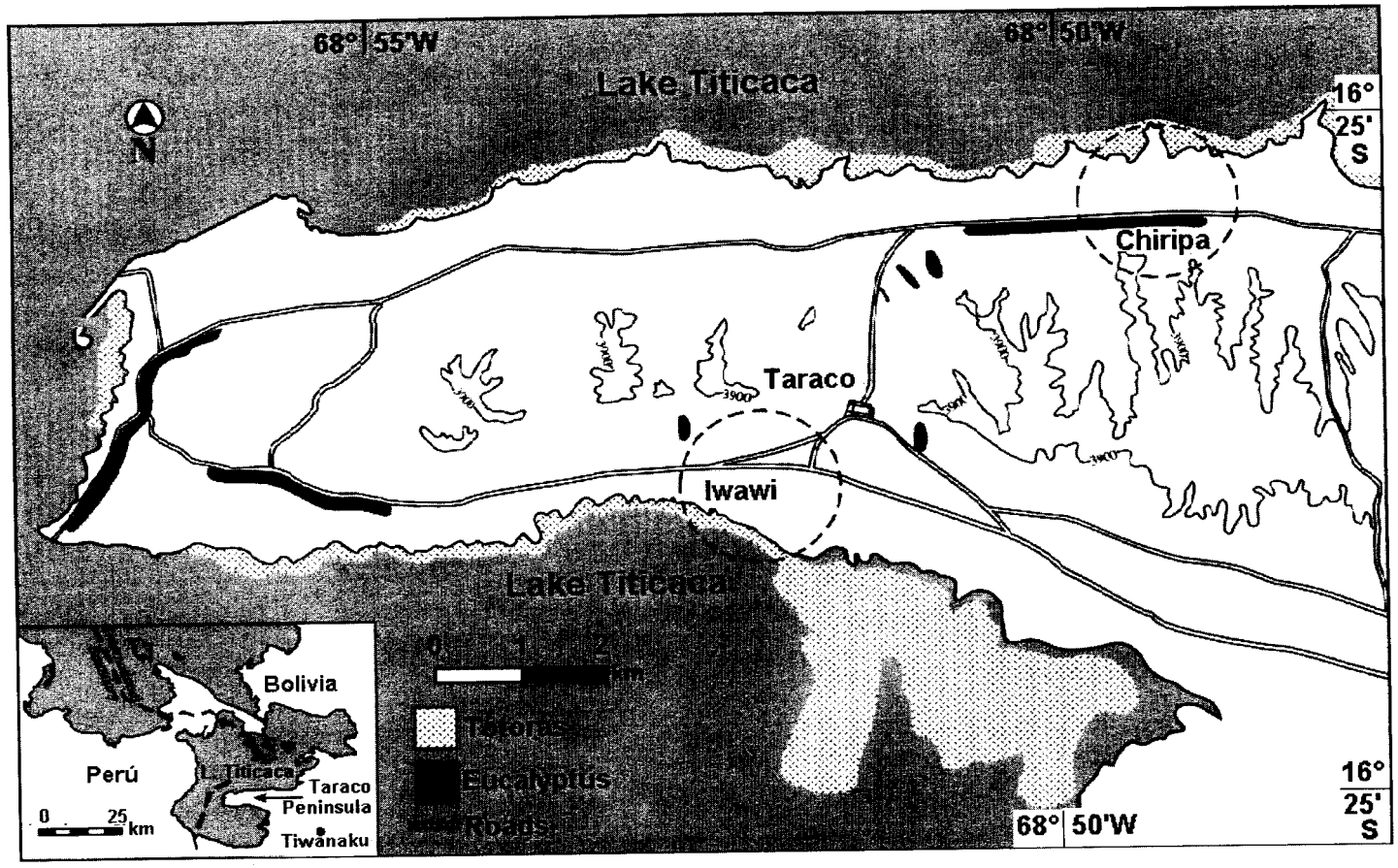

68° 55'W
68° 50'W
Lake Titicaca
N
16° 25' S
Chiripa
Taraco
Iwawi
Lake Titicaca
0 1 2 km
Totoras
Eucalyptus
Roads
68° 50'W
16° 25' S
Bolivia
Perú
L. Titicaca
Taraco Peninsula
Tiwanaku
0 25 km

In this paper we report results of bird censuses from two sites on the Bolivian altiplano. The vegetation of the altiplano is a nearly treeless grass-and-shrub steppe, locally called the puna, which occurs at elevations from *c.* 3400 m to 4400 m (Remsen & Traylor 1989, Morales 1990). This general habitat type corresponds to the Semi-Humid Sub-Alpine and Oreal Zone defined by Ellenberg (1979).

People have inhabited the Lake Titicaca basin since at least 10,000 years before present (B.P.), and have practiced agriculture there, often intensively, since about 3500 B.P. (Wing 1986, Balslev & Luteyn 1992, Binford & Kolata 1996, Hastorf *et al.* 1996). A major incentive for our survey of modern birdlife on the Taraco Peninsula was to evaluate long-term changes in the avifauna based on studies of prehistoric bird bones. Thus we provide historic perspective by reporting the identifications of bird bones from an archaeological site at Chiripa that represents about 2500 years of human occupation. The abundant bones from this site are important for learning the types of vertebrates consumed by prehistoric peoples as well as determining how prehistoric human activities may have influenced the distribution and abundance of vertebrates in the Lake Titicaca basin.

STUDY SITE

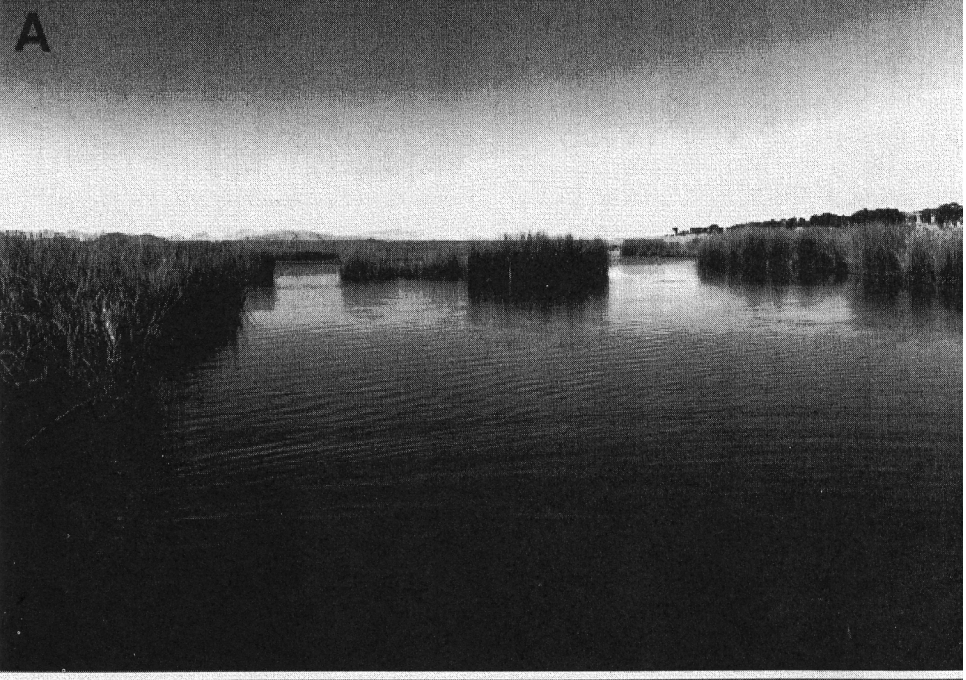
The Taraco Peninsula extends *c.* 15 km westward into the southeastern part of Lake Titicaca in Ingavi Province, Department of La Paz, Bolivia (Fig. 1). The 75 km^2 peninsula ranges in elevation from *c.* 3805 m at the lake shore to *c.* 3900 m at the summits of the central hills. Mean annual precipitation is *c.* 700 mm, 70% of which falls during December–March. The driest months are June and July, each with a mean precipitation of 4–5 mm (Binford & Kolata 1996). During our stay (15 June–25 July 1996) we experienced no rain heavier than a drizzle. Mean minimum temperatures range from *c.* –2°C in June and July to about 3°C from November through March. Mean maxima range from *c.* 13° to 16°C, distributed irregularly over the year. The temperature fluctuates by *c.* 10–15°C each day (Binford & Kolata 1996).

One of our two study sites lies in and around the community of Chiripa, on the northeast coast of the peninsula. The other site, in and around the community of Iwawi (also spelled Iguague), is 6 km southwest of Chiripa on the Taraco Peninsula's south coast (Fig. 1). Human habitations cluster mostly along the major roads, *c.* 500–1000 m from the shore of Lake Titicaca There is no reliable or official population estimate for the Taraco Peninsula (M. W. Binford, pers. comm.). We crudely estimate that several thousand people live there, yielding a population density of *c.* 40 persons per km^2.

Beds of totora reeds (*Scirpus tatora*; Cyperaceae) occupy the shallows around most of the shoreline and extend as far as 500 m offshore (Figs. 1, 2A). Small changes in lake level yield major changes in the extent of totoras (Vacher *et al.* 1992) and the amount of inundated terrestrial habitat. The reed beds off the southern shore of the peninsula are much more extensive now than they were in the late 1980's (J. Albarracín-Jordan, pers. comm.).

Salty mud flats (Fig. 2B) dominate the zone between the totora beds and cultivated fields. Where the lakeshore lacks totoras, the shoreline is a muddy beach.

On the lower slopes of the central hills and on the flats within one km of Lake Titicaca is a mosaic of pasture, fields in various stages of cultivation, and patches of dry grassland (Fig. 3A). Springs create wet meadows, called bofedales Morales 1990), on flats near the lake. On the northern side of the peninsula, single bofedales cover as much as 10 ha, while on the southern side they are smaller, fewer, and usually restricted to the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B

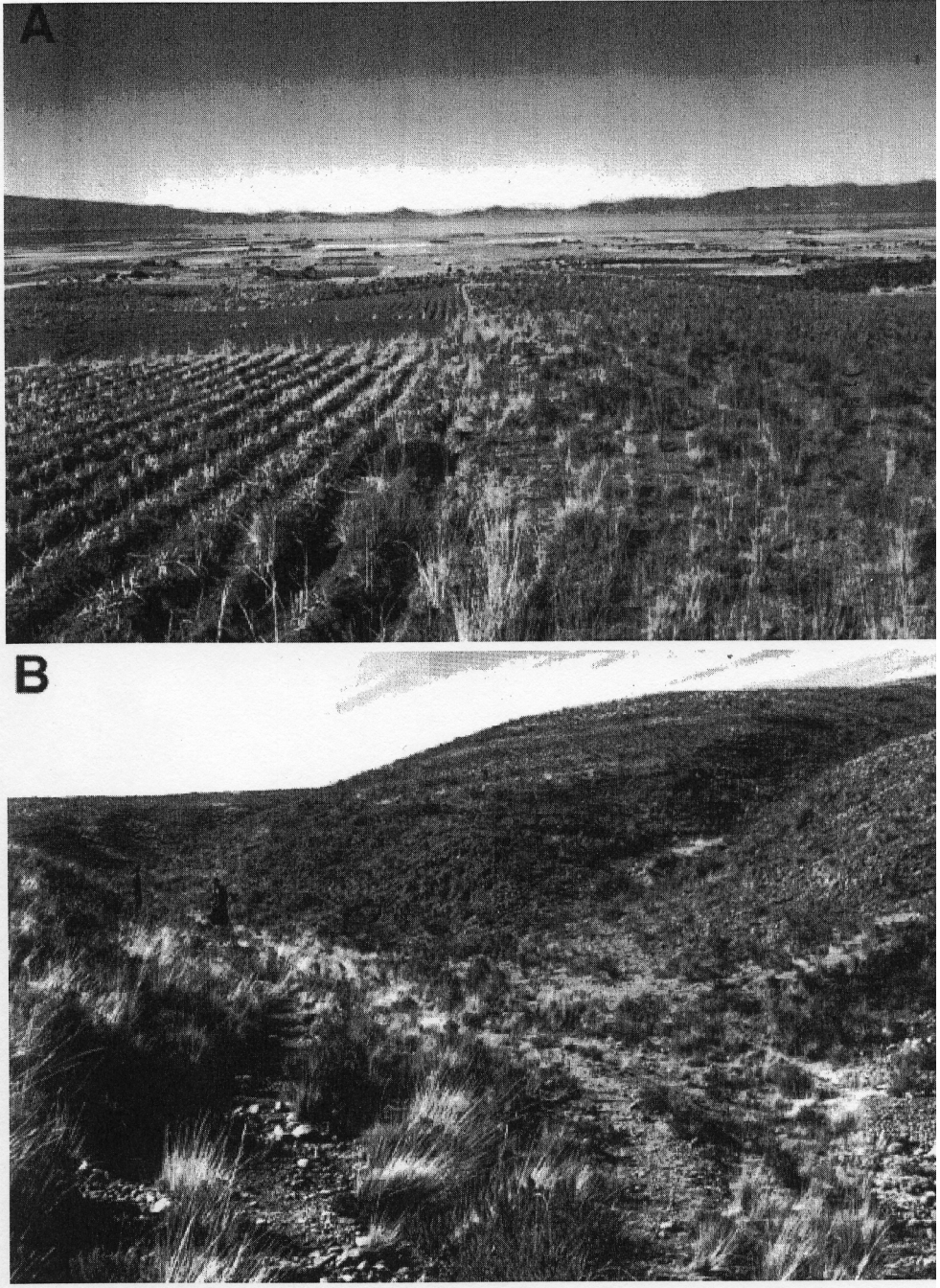

FIG. 3. Habitats of the Taraco Peninsula, Lake Titicaca, Bolivia, June–July 1996. A) Slope field mosai

floors of quebradas (ravines).

Most of the hills and quebradas in the center of the peninsula are covered with scattered *Baccharis* (Asteraceae) shrubs shorter than 65 cm, thorny scrub, and *Stipa* (Poaceae) grasses (Fig. 3B).

The peninsula has no forest of native trees such as *Polylepis* spp. (Rosaceae) or *Buddleja* spp. (Loganiaceae). The most common trees are introduced *Eucalyptus* (Myrtaceae), which grow mostly along roads. Other non-native trees such as *Pinus* cf. *radiata* (Pinaceae), as well as a few *Buddleja* spp., are planted as ornamentals and grow only in a few sparse clumps near houses.

Plow furrows of various ages are evident nearly throughout the fields and pastures of the peninsula. Only in the steepest quebradas is there land that does not show signs of recent cultivation.

METHODS

AMK and TW worked in the vicinity of Chiripa from 15 June through 4 July, and in or near Iwawi from 11 through 25 July 1996. Cristian Olivo Quiroga and Manuel Olivero joined them for one week each at Chiripa in the second half of June. On 7 and 8 July AMK and TW spent a total of 7 hr studying the birds in a grove of *Polylepis* sp. at Juli, Depto. Puno, Perú, *c.* 50 km NW of Chiripa (Fig. 1). This grove occupies about 5 ha at an elevation of *c.* 4100 m on the slopes of a craggy hill called Yacari.

Skins and skeletons that we collected or salvaged are deposited in the collections of the Florida Museum of Natural History (UF) and the Colección Boliviana de Fauna (CBF), Museo Nacional de Historia Natural, La Paz. The 1.5 hrs of audio recordings we made are at UF. Stomach contents and blood samples are at CBF.

In addition to *ad libitum* observations we conducted a series of point counts (see below) at both Chiripa and Iwawi. We censused birds in the following habitats: 1, AQUATIC: totora—reed beds adjacent to open water but not including mud flats (Fig. 2A); 2, LAKESIDE: mud flat—lying between the lake shore and the more upland habitats, a discontinuous mixture of mud flats, totora stubble, and other short grasses (Fig. 2B); 3, LAKESIDE: flat field mosaic—within 0.5 km of the lake shore, a mixture of level pastures and fields in various degrees of cultivation, including fields (newly plowed, with mature crops, newly harvested, with crops in shocks, or fallow); 4, UPLAND: slope field mosaic—same composition as flat field mosaic, but on slopes at base of hills, *c.* 1 km or more from the lake shore (Fig. 3A); and 5, UPLAND: quebrada—dry ravines covered with low scrub (Fig. 3B). We observed or collected birds on beaches and the open water of the lake but did not conduct point counts in these habitats because of difficult access (water) or lack of enough sites (beach).

We established three sites in each of the five censused habitat types on each side of the peninsula, and censused each site three times (Table 1). We devised our own census method (cf. Bibby *et al.* 1992: 86) to take into account the relative openness of the habitat, the relatively high visibility of the birds, and the tendency of some species to leave at our approach. At each site we counted all birds seen or heard within a 100-m radius for five minutes. We began counting at 50 m from the edge of the circle as we approached it, so as to include birds that fled the count circle, a necessity in these open habitats. When we arrived at the center of the circle we remained still and counted until the end of the five-minute count period. We located the edges of count circles at least 30 m from houses out of regard for the residents' privacy.

Our account of the Taraco Peninsula's prehistoric avifauna is based on bones excavated at the Chiripa Site (see Prehistoric

exploitation of birds). These specimens are housed temporarily at the Florida Museum of Natural History and University of California (Berkeley) Department of Anthropology, but eventually will be returned to the Bolivian Instituto Nacional de Arqueología in La Paz. Identifications were made by DWS through direct comparisons between the prehistoric bones and modern skeletal specimens, especially those collected by AMK and TW in 1996.

BIRD COMMUNITIES

We found 60 species of birds, representing 28 families, on the Taraco Peninsula (Table 1). This total includes birds in both censused and uncensused locations.

Aquatic Habitats. Lake Titicaca has a major influence on species composition at our sites. Of the 31 species we recorded in aquatic habitats, 13 were restricted to them. Totoras along the lakeshore support relatively high numbers of individuals, especially at Chiripa (Tables 1 and 2). Thousands of waterbirds, mainly *Fulica ardesiaca*, congregate well offshore of the totora zone where the water is shallow enough to sustain submergent weeds such as Chara (Characeae) but are scarce in the deeper, more turbulent water beyond.

Lakeside Habitats. Of the 21 species we found on mudflats (lakeshores not bordered by totoras), 12 also occurred in the totoras. We found that few species used the bofedales, although these meadows (considered part of the flat field mosaic) are the preferred habitat of *Plegadis ridgwayi,* which is the most common species in them. *Anas flavirostris* also appears to favor this habitat over lakeside totoras. The mud/salt flats support intermediate to low numbers of species and individuals (Tables 1 and 2), whereas the flat field mosaic at Chiripa sustained more species (30) than any other habitat at a single site. Most of the very large inter-site difference in mean number of individuals in the flat field mosaic is due to the high numbers of *Agelaius thilius* recorded at Chiripa.

Upland Habitats. We found roughly as many species in the two categories of upland habitats combined as in the aquatic or lakeside habitats. Of the 32 species recorded in upland habitats, 23 were shared with lakeside and only 10 with aquatic habitats. The censuses in slope field mosaic tended to yield intermediate numbers of species and high to low numbers of individuals, without the great disparity between Chiripa and Iwawi as in the flat field mosaic. Quebradas were consistently low in numbers of species and individuals (Tables 1 and 2). In the central hills few birds are found other than *Muscisaxicola maculirostris*, *Phrygilus plebejus*, *P. alaudinus*, and a few *Nothoprocta ornata.*

Variability in count numbers. Dry-season flocking behavior contributed to great variability in the number of individuals from count to count. We found no individuals in at least one count in two of five habitat types on the Chiripa side, and in four of five habitat types on the Iwawi side. In these same habitat types we had high counts of 341, 18, 10, 7, 327, and 25 individuals (Table 1). The greatest contributors to these fluctuations were the passerines *Sicalis uropygialis*, *Agelaius thilius*, and *Carduelis atrata*, which roved in flocks of up to *c.* 300, 200, and 80 birds, respectively.

SPECIES ACCOUNTS

Unless indicated otherwise, the sequence and nomenclature follow Remsen & Traylor (1989). For females, ONE, OSE, and OE represent ovary not enlarged, slightly enlarged, and enlarged, respectively. For males, TNE, TSE, and TE represent testes

TABLE 1. Number of individuals per species in point counts on the Taraco Peninsula, Lake Titicaca, Bolivia, June–July 1996. Numbers not in parentheses are the mean number of individuals per species per count for all nine counts in the habitat indicated, including counts that yielded zero individuals. The first number in parentheses is the number of counts in which we found the species; the second is the range in number of individuals per count when recorded. These data do not include birds that flew over the count circle without alighting. See methods for count methods and definitions of habitat types. A plus (+) indicates that we found the species in the habitat indicated, but not during point counts. A = abundant, C = common, U = uncommon, and R = rare; see species accounts for definitions. Sequence and nomenclature follow Remsen & Traylor (1989).

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
TINAMIDAE											
Nothoprocta ornata	—	—	0.1 (1;1)	—	+	—	+	—	+	—	C
Nothura darwinii	—	—	—	—	+	—	+	0.1 (1;1)	+	0.3 (2;1–2)	C
PODICIPEDIDAE											
Rollandia rolland	1.1 (4;2–4)	0.4 (2;2)	—	—	—	—	—	—	—	—	A
Rollandia microptera	+	0.1 (1;1)	—	—	—	—	—	—	—	—	C
ARDEIDAE											
Nycticorax nycticorax	+	0.1 (1;1)	—	—	—	—	—	—	—	—	U
Bubulcus ibis	—	—	—	—	0.11 (1;1)	—	—	—	—	—	C
Egretta thula	—	0.1 (1;1)	—	—	—	—	—	—	—	—	U

TABLE 1. Continuation.

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
PHOENICOPTERIDAE											
Phoenicopterus chilensis	0.2	0.2	—	—	—	—	—	—	—	—	U
	(1;2)	(1;2)									
THRESKIORNITHIDAE											
Plegadis ridgwayi	—	—	—	—	+	+	+	+	—	—	A
CATHARTIDAE	+	—	+	—	+	—	+	—	+	—	U
Cathartes aura	+	—	+	—	+	—	+	—	+	—	U
ANATIDAE											
Anas flavirostris	3.0	0.1	—	—	+	+	—	—	—	—	U
	(3;5–12)	(1;1)									
Anas georgica	12.0	+	0.3	—	0.6	+	—	—	—	—	A
	(4;5–45)		(2;1–2)		(2;2–3)						
Anas puna	4.3	1.7	—	—	—	—	—	—	—	—	A
	(5;2–20)	(3;5)									
Anas cyanoptera	—	+	—	—	—	—	—	—	—	—	U
Oxyura jamaicensis	—	+	—	—	—	—	—	—	—	—	U
ACCIPITRIDAE											
Circus cinereus	0.2	+	+	+	+	0.1	+	+	+	+	C
	(2;1)					(1;1)					
Buteo polyosoma	—	—	—	—	—	+	+	+	+	+	C

TABLE 1. Continuation.

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
FALCONIDAE											
Phalcoboenus megalopterus	—	—	+	+	+	+	+	+	+	+	U
Falco sparverius	—	—	+	+	0.3 (2;1–2)	+	+	+	+	+	C
Falco femoralis	—	—	+	+	+	+	+	+	+	+	U
RALLIDAE											
Rallus sanguinolentus	+	0.6 (4;1–2)	—	—	—	—	—	—	—	—	U
Gallinula chloropus	1.9 (5;1–8)	1.2 (5;1–5)	—	—	0.1 (1;1)	—	—	—	—	—	A
Fulica ardesiaca	16.6 (6;2–45)	6.7 (7;1–30)	—	—	—	—	—	—	—	—	A
RECURVIROSTRIDAE											
Himantopus mexicanus	—	—	—	+	—	—	—	—	—	—	U
CHARADRIIDAE											
Vanellus resplendens	—	0.6 (3;1–3)	3.8 (9;1–9)	1.6 (4;1–5)	2.7 (7;1–5)	0.6 (4;1–2)	2..2 (8;1–4)	1.1 (4;1–4)	+	+	A
Charadrius alticola	—	0.1 (1;1)	—	0.1 (1;1)	—	—	—	—	—	—	C
SCOLOPACIDAE											

TABLE 1. Continuation.

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
Tringa melanoleuca	—	+	—	—	—	—	—	—	—	—	R
Gallinago andina	0.1 (1;1)	—	—	—	—	—	—	—	—	—	U
THINOCORIDAE											
Thinocorus rumicivorus	—	—	—	—	—	+	—	—	—	—	U
LARIDAE											
Larus serranus	+	+	+	+	0.6 (5;1–5)	+	+	+	—	—	A
COLUMBIDAE											
Columba maculosa	—	—	—	—	+	+	+	+	—	—	A
Zenaida auriculata	—	—	—	—	+	+	0.1 (1;1)	+	—	—	A
Metriopelia ceciliae	—	—	—	—	+	+	0.9 (4;1–4)	+	—	—	A
Metriopelia melanoptera	—	—	—	—	0.2 (1;2)	+	0.2 (1;2)	+	—	—	A
PSITTACIDAE											
Bolborhynchus aurifrons	—	—	—	—	—	—	—	—	+	—	R
TYTONIDAE											
Tyto alba	—	—	—	—	+	—	—	—	—	—	R

TABLE 1. Continuation.

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
STRIGIDAE											
Athene cunicularia	—	0.2	—	—	+	0.2	—	—	—	—	C
		(1;2)				(1;2)					
PICIDAE											
Colaptes rupicola	—	—	—	0.1	+	1.1	0.1	0.1	+	0.1	C
				(1;1)		(2;2–9)	(1;1)	(1;1)		(1;1)	
FURNARIIDAE											
Geositta cunicularia	—	—	0.4	0.7	+	0.4	+	+	+	+	C
			(2;1–3)	(4;1–2)		(2;2)					
Geositta tenuirostris	—	—	+	+	+	+	—	—	—	—	U
Upucerthia cf. *U. jelskii*	—	—	—	—	—	+	—	—	—	0.1	R
										(1;1)	
Cinclodes fuscus	+	—	—	—	—	—	—	—	+	—	U
Phleocryptes melanops	2.2	4.0	—	—	—	—	—	—	—	—	A
	(8;1–5)	(9;1–11)									
TYRANNIDAE											
Agriornis microptera	—	+	—	—	—	—	—	—	—	—	R
Agriornis montana	—	—	—	—	—	—	+	—	—	—	R
Muscisaxicola maculirostris	—	—	0.1	+	+	+	1.1	0.2	0.8	0.1	A
			(1;1)				(7;1–2)	(2;1)	(6;1–2)	(1;1)	

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overall
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abundance
Lessonia oreas	0.3	—	0.4	0.3	0.1	—	—	—	—	—	A
	(2;1–2)		(3;1–2)	(3;1)	(1;1)						
Tachirus rubrigastra	1.9	2.8	—	—	—	—	—	—	—	—	A
	(9;1–4)	(8;1–6)									
Anairetes cf. *A. flavirostris*	—	—	—	—	—	—	—	—	0.2	—	R
									(1;2)		
HIRUNDINIDAE											
Notiochelidon cyanoleuca	+	+	+	+	+	+	+	+	+	+	C
Hirundo rustica	—	—	—	—	—	—	+	—	—	—	R
MOTACILLIDAE											
Anthus furcatus	—	—	0.3	—	0.3	0.1	—	—	—	—	C
			(3;1)		(3;1)	(1;1)					
TURDIDAE											
Turdus chiguanco	—	—	—	—	—	—	0.1	+	—	—	C
							(1;1)				
EMBERIZIDAE											
Zonotrichia capensis	1.2	+	0.2	+	6.0	+	5.0	1.0	4.1	+	A
	(4;1–5)		(1;2)		(5;6–20)		(3;10–20)	(2;2–7)	(7;1–15)		
Phrygilus punensis	—	—	—	—	—	—	2.3	+	0.4	—	C
							(4;4–6)		(2;1–3)		

	Aquatic: Totora		Lakeside: mudflat		Lakeside: flat field mosaic		Upland: slope field mosaic		Upland: quebrada		Overa
	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	Chiripa	Iwawi	abunda
Phrygilus plebejus	—	—	—	—	—	—	—	6.9 (4;2–20)	+	+	A
Phrygilus alaudinus	—	—	—	—	—	—	0.3 (2;1–2)	+	0.2 (1;2)	3.1 (3;1–25)	C
Sicalis uropygialis	1.1 (1;10)	—	6.8 (2;1–60)	+	13.4 (3;6–100)	+	8.9 (2;5–75)	33.3 1;300)	0.1 (1;1)	—	A
ICTERIDAE											
Agelaius thilius	19.0 (8;1–50)	2.8 (7;2–6)	1.3 (3;1–10)	+	59.6 (6;1–200)	+	+	+	—	—	A
FRINGILLIDAE											
Carduelis atrata	18.3 (4;20–80)	+	1.1 (1;10)	+	2.9 (3;1–20)	+	10.1 (3;7–75)	—	+	—	A
TOTAL NUMBER OF SPECIES	23	26	19	18	31	27	28	24	22	15	

TABLE 2. Number of species and individuals recorded in point counts on the Taraco Peninsula, Lake Titicaca, Bolivia, June–July 1996. Each mean is for nine counts (three repetitions at each of three sites), including those that yielded zero birds. See methods for count methods and definitions of habitat types.

Habitat type	Site	Mean number of species per count (range)	Mean number of individuals per count (range)
AQUATIC			
Totora	Chiripa	7.6 (4–12)	83.1 (6–157)
Totora	Iwawi	6.0 (4–7)	21.8 (9–46)
LAKESIDE			
Mudflat	Chiripa	3.1 (2–6)	15.6 (3–86)
Mudflat	Iwawi	1.6 (0–3)	2.7 (0–7)
Flat mosaic	Chiripa	4.3 (0–8)	87.2 (0–341)
Flat mosaic	Iwawi	1.3 (0–3)	2.7 (0–10)
UPLAND			
Slope mosaic	Chiripa	4.3 (2–8)	32.0 (4–180)
Slope mosaic	Iwawi	1.7 (0–3)	42.8 (0–327)
Quebrada	Chiripa	1.9 (0–3)	5.9 (0–18)
Quebrada	Iwawi	0.9 (0–2)	3.8 (0–25)

not enlarged, slightly enlarged, and enlarged, respectively. SU means sex unknown. For passerines, the skull was fully ossified (pneumatic) unless otherwise stated. Abundance categories for the Species Accounts and Table 1 are as follows. Abundant = found daily, often > 5 individuals/h; common = recorded daily or almost daily, usually < 5 individuals/h; uncommon = recorded 3–20 times per month but not necessarily each week; rare = once or twice per month. These definitions assume that the observer is in suitable habitat.

Ornate Tinamou (*Nothoprocta ornata*). Found only on the Chiripa side of the peninsula. More common in uplands but also within 500 m of the shore of Lake Titicaca. Single birds seen much more often than pairs.

Darwin's Nothura [Tinamou] (*Nothura darwinii*). 1–2 birds frequently flushed from lakeside fields at both sites. Less frequent in uplands. Most common tinamou on the peninsula.

White-tufted Grebe (*Rollandia rolland*). Common to abundant, alone or in groups of 2–3, where open water and totoras mingle. Sometimes entangled in fishing nets (both of our specimens thus salvaged) and eaten by local people. Specimens: Chiripa—UF 39217, 21 June, male TNE, 260 g; Iwawi—UF 39209, 11 July, male TNE, 260 g, culmen 23 mm, wing 115 mm, tarsus 38 mm.

Short-winged [Titicaca Flightless] Grebe (*Rollandia microptera*). In same habitat as R. rolland. Specimen: Chiripa—UF 39628, 28 June, male TNE, 642 g, culmen 33 mm, wing 110 mm, tarsus 55 mm.

Cattle Egret (*Bubulcus ibis*). In groups of up to 8 in open habitats, mainly fields near the lake.

Snowy Egret (*Egretta thula*). Observed only on the Iwawi side, in or flying over totoras.

Black-crowned Night-Heron (*Nycticorax nycticorax*). Adults only, in totoras, usually hidden from shore. Apparently uncommon, but our estimate of abundance may be low because of limited visibility in totoras.

Chilean Flamingo (*Phoenicopterus chilensis*). Groups of up to 150 always found near Iwawi and eastward about 2 km along the lake shore in patches of open water near and among totoras. Uncommon near Chiripa, in groups of 2–10. Chilean Flamingos occur sporadi-

cally but sometimes in large numbers at Lake Titicaca (Campos 1987, Dejoux 1992). In the 1990's they were present in large numbers only since April 1996 (J. Albarracín-Jordan, pers. comm.). The ecology of Bolivia's three species of flamingos is discussed by Maier & Kelly (1994) and Rocha (1994). Specimen: Iwawi—UF 39627, 11 June (salvaged for us by others), male TNE.

Puna Ibis (*Plegadis ridgwayi*). In groups of 2–12, in spring-fed wet meadows on the Chiripa side. Less common on the Iwawi side, where habitat is less suitable. Specimens: Chiripa—UF 39344, 23 June, male TNE, 440 g, culmen 95 mm, wing 297 mm, tarsus 100 mm; UF 39343, 28 June, female ONE, 515 g, culmen 93 mm, wing 262 mm, tarsus 76 mm; UF 39351, 28 June, female ONE, 465 g, culmen 87 mm, wing 269 mm, tarsus 71 mm; UF 39756, 28 June, female ONE, 490 g, culmen 93 mm, wing 270 mm, tarsus 75 mm; UF 39757, 28 June, female ONE, 505 g, culmen 90 mm, wing 278 mm, tarsus 77 mm.

Turkey Vulture (*Cathartes aura*). Over all habitats on the Chiripa side. Not seen at Iwawi.

Speckled Teal (*Anas flavirostris*). In fields, wet meadows, and the shallows of Lake Titicaca; most frequently in groups of 3–5 in wet meadows. Specimens: Chiripa—UF 39335, 28 June, male TE, 465 g, culmen 33 mm, wing 221 mm, tarsus 38 mm; UF 39348, 23 June, male TE, 445 g; UF 39299, 23 June, female ONE, 370 g.

Yellow-billed Pintail (*Anas georgica*). Abundant but unpredictable, with up to 300 in grain fields within 200 m of the lake shore. Also on the lake. One with four downy young in totoras 4 July. Specimens: Iwawi—UF 39339, male TE, 770 g, culmen 43 mm, wing 255 mm, tarsus 42 mm; UF 39353, female ONE, 619 g, culmen 41 mm, wing 240 mm, tarsus 35 mm. Both 24 July.

Puna Teal (*Anas puna*). Restricted to the lake shallows. Flocks of 3–30 common among totoras or in open water. Specimens: Chiripa—UF 39336, male TNE, 455 g; UF 39337, male TNE, 505 g, culmen 61 mm, wing 223 mm, tarsus 42 mm; UF 39354, male TE, culmen 59 mm, wing 231 mm, tarsus 47 mm; UF 39338, female ONE, 447 g, culmen 47 mm, wing 211 mm, tarsus 36 mm; UF 39349, female ONE, 440 g, culmen 52 mm, tarsus 46 mm. All 23 June.

Cinnamon Teal (*Anas cyanoptera*). Unpredictable, in deep and shallow water. Only on the Iwawi side of the peninsula.

Ruddy Duck [black-cheeked form] (*Oxyura jamaicensis andina*). Same as for *Anas cyanoptera*. Specimen: Chiripa—UF 39350, 21 June, female ONE.

Cinereous Harrier (*Circus cinereus*). Most commonly over totora beds, but also occasionally over all other habitat types.

Variable Hawk (*Buteo polyosoma*). Over uplands, and perched among *Eucalyptus*. *Buteo polyosoma* and *B. poecilochrous* have been shown to be indistinguishable in morphometry, plumage, and vocalizations (Farquhar 1998). If the two could be distinguished from one another, *B. poecilochrous* ("Puna Hawk") would be expected at this elevation and in this habitat (Fjeldså & Krabbe 1990).

Mountain Caracara (*Phalcoboenus megalopterus*). Common near Iwawi, less so near Chiripa. 1–3 birds in varied habitats from lakeshore to hills on the central part of the peninsula.

American Kestrel (*Falco sparverius*). In all terrestrial habitats.

Aplomado Falcon (*Falco femoralis*). 1 or 2 birds (a pair?), most often near lakeshore, but also in the hilly center of the peninsula.

Plumbeous Rail (*Rallus sanguinolentus*). Usually hidden in totoras, on both sides of the peninsula. More common on the Iwawi side because of greater extent of totoras.

Common Moorhen (*Gallinula chloropus*). On both sides of the peninsula, in totoras and on beaches.

Slate-colored [Andean] Coot (*Fulica ardesiaca*). Often in loose rafts of up to tens of thousands on sheltered water. Common as well in totoras and up to 50 m inland on mud/salt flats. Specimens: Chiripa—UF 39208, 23 June, male TNE, 1550 g; UF 39222, 23 June, male TSE, 1300 g, culmen 41 mm, wing 236 mm, tarsus 78 mm; UF 39760, 28 June, female OE, culmen 40 mm, wing 230 mm, tarsus 67 mm; UF 39761, 28 June, female ONE, culmen 36 mm, wing 220 mm, tarsus 63 mm.

Andean Lapwing (*Vanellus resplendens*). The most common bird on beaches and mud/salt flats, and the most common non-passerine in cultivated fields. Thrives in human-influenced habitats. Usually in loose groups of 3–5 individuals, but as many as 15–20. Specimens: Chiripa—UF 39340, 23 June, male TNE, 225 g, culmen 34 mm, wing 226 mm, tarsus 61 mm; Taraco—UF 39355, *c.* 16 June (found dead), male TNE; Iwawi—UF 39321, 18 July, male TNE, 210 g, culmen 35 mm, wing 221 mm, tarsus 55 mm; UF 39341, 18 July, male TNE, 210 g, culmen 33 mm, wing 228 mm, tarsus 50 mm; UF 39342, 19 July, female ONE, 192 g, culmen 35 mm, wing 225 mm, tarsus 50 mm; UF 39356, 18 July, female ONE, 170 g, wing 210 mm, tarsus 54 mm.

Puna Plover (*Charadrius alticola*). On the Iwawi side only. Nearly restricted to beaches. Rare on mud/salt flats.

Black-necked Stilt (*Himantopus mexicanus*). Two on the beaches at Iwawi 15 July.

Greater Yellowlegs (*Tringa melanoleuca*). One, in first week of July, calling while flying over Iwawi totoras.

Puna Snipe (*Gallinago andina*). Only on the northern side of the peninsula, alone or in pairs. Favors cut totora reeds at the edge of the lake and spring-fed meadows.

Least Seedsnipe (*Thinocorus rumicivorus*). In flocks of 15–20 in pastures and plowed fields near Lake Titicaca. Seen irregularly, and only on the Iwawi side. Specimens: Iwawi—UF 39232, 25 June, male TNE, 52 g; UF 39352, 16 July, female ONE, 60 g, culmen 9 mm, wing 131 mm, tarsus 9 mm; CBF 03201, 25 June.

Andean Gull (*Larus serranus*). Over all habitats but only rarely over the shrub and grassland hills in the center of the peninsula. Most common on the lake but also frequented fields in various stages of cultivation, even far from water. Specimens: Chiripa—UF 39357, male TNE, 440 g, culmen 35 mm, wing 370 mm, tarsus 54 mm; UF 39214, female ONE, 482 g, culmen 49 mm, wing 361 mm, tarsus 55 mm; UF 39762, female ONE, 500 g, culmen 42 mm, wing 360 mm, tarsus 58 mm; UF 39763, SU, 495 g, culmen 34 mm, wing 370 mm, tarsus 55 mm; all 28 June.

Rock Dove (*Columba livia*). Non-native. More closely confined to the vicinity of habitations than the other columbids. More common near buildings than *C. maculosa*, which replaced it in *Eucalyptus* groves farther from houses.

Spot-winged Pigeon (*Columba maculosa*). In flocks of up to 12 birds. Also around buildings, but more widespread than *C. livia*.

Eared Dove (*Zenaida auriculata*). Mainly around human habitations and in planted groves. One pair building nest 23 July. Specimen: Taraco—UF 39347, 23 July, female OSE, 120 g, culmen 15 mm, wing 148 mm, tarsus 23 mm.

Bare-faced Ground-Dove (*Metriopelia ceciliae*). Around human habitation and in planted groves. Stays closer to structures than *M. melanoptera* or *Zenaida auriculata*. Specimens: Chiripa—UF 39213, 27 June, male TSE, 55 g, culmen 11 mm, wing 92 mm, tarsus 19 mm; UF 39235, 27 June, male TNE; UF 39236, 26 June, male TSE, culmen 10 mm, wing 101 mm, tarsus 19 mm; UF 39216, 23 June, female OSE, 51 g, culmen 11 mm, wing 98 mm, tarsus 18 mm.

Black-winged Ground-Dove (*Metriopelia melanoptera*). Not as common as *M. ceciliae*, but more common farther from structures. One carrying nest material 23 July. Specimens: Chiripa—UF 39210, 28 June, female OE, 78 g, culmen 19 mm, wing 130 mm, tarsus 20 mm; UF 39212, 26 June, SU, 81 g, culmen 15 mm, wing 126 mm; UF 39345, 26 June, SU, 74 g, culmen 13 mm, wing 125 mm, tarsus 18 mm; Taraco—UF 39346, 23 July, male TSE, 74 g, culmen 14 mm, tarsus 21 mm.

Mountain Parakeet (*Bolborhynchus aurifrons*). One flock of 11 seen 26 June on the Chiripa side. Clusters of several dozen holes 9–10 cm in diameter observed in dirt walls of quebradas, about half of which seemed fresh enough to be usable. Local people told us that parakeets used the holes, but because flickers also used them, the number of holes does not reliably indicate the number of parakeets.

Barn Owl (*Tyto alba*). One, a dead nestling, near an abandoned church in Chiripa third week of July.

Burrowing Owl (*Athene [Speotyto] cunicularia*). Almost always in pairs, in fields near Lake Titicaca, often perched atop shocks of grain.

Andean Flicker (*Colaptes rupicola*). In all open habitats, usually in groups of 3–10. Roosts in holes in banks of quebradas and adobe buildings. Specimens: Chiripa—UF 39298, 28 June, male TNE, 174 g, culmen 49 mm, wing 175 mm, tarsus 29 mm; UF 39253, 9 June (salvaged for us by others), female ONE; Iwawi—UF 39254, 20 July, male TNE, 141 g, culmen 44 mm, wing 162 mm, tarsus 30 mm; UF 39255, 19 July, male TNE, 172 g, culmen 47 mm, wing 167 mm, tarsus 27 mm; UF 39220, 21 July, female ONE, 156 g, culmen 45 mm, wing 169 mm, tarsus 32 mm.

Common Miner (*Geositta cunicularia*). The most numerous furnariid in terrestrial habitats. Most often in groups of 2–3 in cultivated fields and mud/salt flats. Specimens: Iwawi—UF 39245, female OSE, 29.8 g, culmen 19 mm, wing 100 mm, tarsus 20 mm; CBF 03359, 18 July, SU, skull 80% ossified. Both 18 July.

Slender-billed Miner (*Geositta tenuirostris*). Only on the Chiripa side, in the same habitats as *G. cunicularia*. Specimen: Chiripa—UF 39218, 14 July, female ONE, 32.2 g, culmen 27 mm, wing 112 mm, tarsus 27 mm.

Plain-breasted Earthcreeper (*Upucerthia* cf. *U. jelskii*). One observed briefly in a brushy quebrada on the Iwawi side 24 July.

Bar-winged Cinclodes (*Cinclodes fuscus*). In habitats similar to those of *G. cunicularia*, but also uncommon among totoras and along streams in quebradas. Only on the Chiripa

side of the peninsula.

Wren-like Rushbird (*Phleocryptes melanops*). The most common furnariid on the peninsula. Specimens: Chiripa—UF 39231, 30 June, male TNE, 13.8 g, culmen 11 mm, wing 64 mm, tarsus 21.5 mm, skull unossified; Iwawi—UF 39223, 16 July, male TNE, 15 g, culmen 17 mm, wing 68 mm, tarsus 22 mm, skull unossified; UF 39244, 16 July, female ONE, 13 g, culmen 14.5 mm, wing 62 mm, tarsus 24 mm, skull unossified; UF 39251, 15 July, female ONE, 12 g, culmen 15 mm, wing 61 mm, tarsus 21 mm, skull unossified; UF 39300, 16 July, female ONE, 12.5 g, culmen 15 mm, wing 61 mm, tarsus 26 mm, skull unossified; CBF 03204, 13 July, male, 16 g, skull unossified; CBF 03355, 16 July, male, 13 g, wing 65 mm.

Many-colored Rush-Tyrant (*Tachuris rubrigastra*). Restricted to totoras and the small, wet, muddy areas between them. Up to 9 birds caught in one mist net in one hour. Specimens: Iwawi—UF 39243, 16 July, male TNE, 7.0 g, tarsus 25 mm, skull unossified; CBF 03196, 13 July, male, 7.0 g, skull unossified; CBF 03205, 16 July, male TNE, 6.5 g, skull unossified; CBF 03369, 16 July, SU, 7.5 g, skull unossified; CBF 03198, 16 July, male TNE, 8.0 g.

Yellow-billed Tit-Tyrant. (*Anairetes* cf. *A. flavirostris*). Three seen 13 July in hillside scrub near Chiripa. While *A. parulus* seems likelier to occur on the peninsula than *A. flavirostris* (range maps in Fjeldså & Krabbe 1990: 472–473), we clearly saw the yellow at the base of the mandible characteristic of *A. flavirostris*; the bill of *A. parulus* is all black (Fjeldså & Krabbe 1990, Ridgely & Tudor 1994). No specimen could be obtained.

Black-billed Shrike-Tyrant (*Agriornis montana*). One collected 23 July in a mosaic of fields and abandoned buildings 1 km north of Taraco. Specimen: Taraco—CBF 03202, 23 July, female, 50 g, culmen 23 mm, wing 130 mm, tarsus 34 mm.

Gray-bellied Shrike-Tyrant (*Agriornis microptera*). One, netted in totoras at Iwawi 16 July. Specimen: Iwawi—CBF 03203, 16 July, SU, 54.5 g.

Spot-billed Ground-Tyrant (*Muscisaxicola maculirostris*). The only species of *Muscisaxicola* we found on the peninsula. Abundant, seen as one or two birds in all open habitats, especially cultivated fields and mud/salt flats. Specimens: Chiripa—UF 39252, 14 July, male TNE, 15 g, culmen 12 mm, wing 85 mm, tarsus 26.5 mm; UF 39242, 26 June, female ONE, 11.5 g, culmen 11 mm, wing 82 mm, tarsus 26 mm.

Andean Rufous-backed (White-winged) Negrito (*Lessonia oreas*). In loose groups of 1–5 birds on mud/salt flats, and sometimes as far as 100 m from shore on floating mats of totoras. Specimens: Chiripa—UF 39241, 30 June, male TNE, 13 g, culmen 8 mm, wing 77 mm, tarsus 23 mm; Iwawi—UF 39230, 19 July, male TNE, 14 g, culmen 10 mm, wing 79 mm, tarsus 24 mm.

Blue-and-white Swallow (*Notiochelidon cyanoleuca*). The only common species of swallow on the peninsula. Flocks of 30+ birds over all habitats and roosting in *Eucalyptus* groves.

Barn Swallow (*Hirundo rustica*). One collected in a stubblefield 1 km west of Chiripa 29 June. Specimen to CBF.

Chiguanco Thrush (*Turdus chiguanco*). Restricted to human-influenced habitats such as the grounds around buildings and roadside *Eucalyptus* groves. Specimens: Chiripa—UF 39215, 23 June, female OSE, culmen 24 mm,

wing 143 mm, tail 117 mm; Taraco—CBF 03199, 23 July, female OSE, 82 g, culmen 20 mm, wing 133 mm, tarsus 37 mm.

Short-billed Pipit (*Anthus furcatus*). In pastures and plowed fields. Specimen: Chiripa—UF 39249, 30 June, male TNE, 19.5 g, culmen 9.5 mm, wing 85 mm, tarsus 21 mm, skull unossified; Iwawi—CBF 03368, 18 July, male TNE.

Rufous-collared Sparrow (*Zonotrichia capensis*). Most common near human habitation but present in all habitats from totoras 20 m offshore to dry quebradas. The most widely distributed bird on the peninsula. Specimens: Chiripa—UF 39250, 16 July, female ONE, 23.5 g, culmen 11 mm, wing 81 mm, tarsus 24 mm, skull unossified; CBF 03370 and CBF 03371, both 26 June, male TNE.

Olive-backed Sierra-Finch (*Phrygilus punensis*). Near buildings and in farmlands, singly or in groups of up to 10. The most widely distributed species of *Phrygilus* on the peninsula. Specimen: Chiripa—UF 39219, 27 June, SU, skull unossified.

Ash-breasted Sierra-Finch (*Phrygilus plebejus*). Occurrence unpredictable. Flocks of 100+ observed in upland fields and quebradas. Found farther from buildings than *P. punensis*. Some singing in late June. Specimens: Chiripa—UF 39247, 12 July, male TNE, 12 g, culmen 8 mm, wing 71 mm, tarsus 21 mm, skull unossified; Iwawi—UF 39224, male TNE, 17 g, culmen 8.5 mm, wing 73 mm, tarsus 20 mm; UF 39246, SU, 15 g, culmen 8 mm, wing 72 mm, tarsus 20 mm, skull unossified; CBF 03207, SU, 13 g, skull unossified; CBF 03354, male TSE, 15 g. All 19 July.

Band-tailed Sierra-Finch (*Phrygilus alaudinus*). In habitats similar to those of *P. plebejus*. In flocks of up to 40 birds. Specimen: Chiripa—UF 39225, 29 June, male TNE, 22.5 g, culmen 12 mm, tarsus 24 mm.

Bright-rumped Yellow-Finch (*Sicalis uropygialis*). In all terrestrial habitats but most abundant in cultivated fields. Specimens: Chiripa—UF 39226, 30 June, female ONE, 25 g, culmen 9 mm, wing 95 mm, skull unossified; Iwawi—UF 39221, 19 July, male TNE, culmen 9 mm, wing 81 mm, tarsus 18.5 mm, skull unossified; UF 39240, 19 July, male TNE, culmen 9 mm, wing 88 mm, tarsus 19 mm; UF 39227, 18 July, SU, 18 g, culmen 9 mm, wing 79 mm, tarsus 20 mm; CBF 03353, 19 July, male TNE, 23 g.

Yellow-winged Blackbird (*Agelaius thilius*). Flocks of 5–75 occur unpredictably in totoras and in terrestrial habitats up to 1 km from Lake Titicaca. Specimens: Chiripa—UF 39228, 26 June, male TNE, 31.5 g, culmen 15 mm, wing 88 mm, tarsus 20 mm, skull unossified; Iwawi—UF 39211, 24 July, male TNE, 42 g, culmen 22 mm, wing 99 mm, tarsus 23 mm.

Black Siskin (*Carduelis atrata*). In flocks of up to 200; most abundant near buildings and the lake shore, but also common in upland fields and quebradas. Specimens: Chiripa—UF 39229, male TNE, 16 g, culmen 9, wing 74, tarsus 16, skull unossified; UF 39238, male TNE, 14 g, culmen 8, wing 79, tarsus 15.5, skull unossified; UF 39239, female ONE, 15 g, culmen 8, wing 78, tarsus 13, skull unossified. All 26 June.

PREHISTORIC EXPLOITATION OF BIRDS AT CHIRIPA

The Chiripa archaeological site was excavated in 1992 by a field team led by Christine Hastorf. This well known prehistoric site, overlooking the shore of Lake Titicaca, represents five distinct cultural phases that range in age from *c.* 3500 to 1000 B.P. (Hastorf *et al.* 1992,

TABLE 3. Birds from excavations at the Chiripa site, Taraco Peninsula, La Paz Province, Bolivia. Identifications by D. W. Steadman. * = taxon not recorded within a 5-km radius of Chiripa in June–July 1996 by A Kent and T. Webber; ** = most or all bones in this family or order not yet identified to species; *** = taxon not necessarily different from those identified more precisely. Numbers represent the number of identified specimens (NISP), with family-level totals in parentheses. Because the values for NISP closely track the values for minimum number of individuals (MNI) in zooarchaeological assemblages (Grayson 1984, and many others studies), data for MNI are not presented.

**Tinamidae – tinamous (34): species A (large); species B (small)
**Podicipedidae – grebes (110): **Podiceps* sp.; *Rollandia rolland*; *Rollandia microptera*
Phalacrocoracidae – cormorants (5): **Phalacrocorax brasilianus* – 5
Ardeidae – herons (2): *Nycticorax nycticorax* – 2
**Phoenicopteridae – flamingos (19): species A
Anatidae – swans, geese, ducks (40): **Chloephaga* cf. *C. melanoptera* – 1; *Anas flavirostris* – 3; *Anas puna* – 1; *Anas georgica* – 7; ***Anas sp. – 10; *Oxyura jamaicensis* – 18
**Accipitridae – hawks (13): cf. *Buteo* sp. – 13
**Rallidae – rails, coots (340): *Rallus* sp. – 5; *Fulica* sp. A (large); **Fulica* sp. B (small)
Recurvirostridae (1): *Himantopus mexicanus* – 1
Charadriidae – plovers, lapwings (6): *Vanellus resplendens* – 6
Laridae – gulls, terns (2): *Larus serranus* – 2
Columbidae – pigeons, doves (19): *Metriopelia ceciliae* – 5; **Metriopelia aymara* – 9; ***Metriopelia* sp. – 5
Psittacidae – parrots (1): cf. *Bolborhynchus aurifrons* – 1
Tytonidae – barn owls (4): *Tyto alba* – 4
Strigidae – owls (5): **Ciccaba* cf. *C. albitarsus* – 5
**Trogonidae – trogons (2): **Trogon* sp. – 2
Picidae – woodpeckers, flickers (5): *Colaptes rupicola* – 5
**Passeriformes – songbirds (21): Suboscine spp. (at least 2 species); Oscine spp. (at least 2 species)

1996, Kolata 1996). The 1992 excavations at Chiripa yielded tens of thousands of bones and scales of vertebrates, dominated by the remains of fish and camelids. Hastorf and her team conducted additional extensive excavations at Chiripa in May–July 1996. The analysis of prehistoric birds that follows is based on 629 bird bones, recovered in 1992, that DWS has identified to the level of family, genus, or species. A more detailed analysis is planned for the future, which will incorporate the many bird bones from the 1996 excavations and will attempt species-level identifications of passerines and certain difficult groups of non-passerines.

Whereas most studies of prehistoric vertebrates from the altiplano region have focused on camelids and cervids (i.e., Wing 1986, Miller & Gill 1990, Miller & Burger 1995), the bone assemblage from Chiripa is taxonomically diverse (a large variety of fish, amphibians, reptiles, birds, and mammals) and therefore requires detailed analyses for many groups of vertebrates. In a sample of 3687 bones identified by DWS that includes all five of Chiripa's cultural phases, the relative abundance of fish bone per cultural phase ranges from 15 to 71% of all bone, compared to 0.3–10% for toad bones, 0–1% for reptile bones, 4.6–16% for small mammal (mostly rodent) bones, 12–79% for large mammal (camelid) bones, and 0–9% for bird bones.

The approximately 31 taxa of birds identi-

TABLE 4. Summary of prehistoric birds from the Chiripa site.

	Number of bones	Number of species
All upland species	110 (18%)	15 (48%)
All aquatic species	519 (82%)	16 (52%)
All species likely to be netted	490 (78%)	10 (32%)
Total	629	31

fied (Table 3) show that prehistoric peoples of the Taraco Peninsula exploited a broad range of aquatic and terrestrial species. Bones of coots, grebes, ducks, and other aquatic species make up 82% of the bird bones (Table 4). The aquatic species are dominated by those that dive (or tip) and therefore are susceptible to capture with fishing nets (78% of all bird bones).

Tinamous, doves, and passerines are the most common upland taxa of birds. Tinamous and doves are popular traditional gamebirds through much of the Neotropics. The large and small species of tinamou probably represent *Nothoprocta ornata* and *Nothura darwinii*, but this has not been confirmed through direct comparisons.

The bone assemblage from the Chiripa Site suggests some long-term changes in the avifauna of the Taraco Peninsula. Among the bones are those of seven species that AK and TW did not find on the peninsula in June–July 1996. These include four aquatic or semiaquatic species (a large grebe *Podiceps* sp., the cormorant *Phalacrocorax brasilianus*, goose *Chloephaga* sp., and a small coot *Fulica* sp.) and three landbirds (the dove *Metriopelia aymara*, owl *Ciccaba* cf. *C. albitarsus*, and trogon *Trogon* sp.). The absence of these species during our surveys in June–July 1996 is unlikely to be due to seasonality.

No large species of *Podiceps* inhabits the Lake Titicaca region today. The Great Grebe, *P. major*, occurs on the nearby Peruvian coast and in wetlands up to 1200 m elevation in much of Chile and Argentina (Fjeldså & Krabbe 1990: 68). The Neotropic Cormorant *Phalacrocorax brasilianus* and Andean *Goose Chloephaga melanoptera* occur in the Lake Titicaca region today but we could not find them living at Chiripa or Iwawi. A species of *Fulica* smaller than *F. ardesiaca* occurs among the bones from Chiripa. Possible species represented by these bones include the Red-fronted Coot *F. rufifrons*, White-winged Coot *F. leucoptera*, or American Coot *F. americana*, none of which occurs in the region.

The Golden-spotted Ground-Dove *Metriopelia aymara* occurs locally in the general Lake Titicaca region and has nested at Checayani, Azángaro Province, Perú, near the northern end of Lake Titicaca (Roe & Rees 1979). The habitat preference of *M. aymara* (Fjeldså & Krabbe 1990: 197) suggests that it might be less tolerant of human-modified habitats than other species of *Metriopelia*.

The owl bones referred to *Ciccaba* are strigid rather than tytonid because of these characters. Mandible: stout and short in lateral aspect, with a more decurved ramus; processus mandibulae elongate. Femur: sulcus patellaris and sulcus intercondylaris shallow; crista tibiofibularis more protrudent from trochlea fibularis. Tarsometatarsus: proximomedial tendinal bridge present. Pedal phalanx: distal sulcus shallow; acrotarsal and plantar tips of proximal articulation more symmetrical. Among medium-sized genera of neotropical owls (*Pulsatrix, Ciccaba, Strix, Rhinoptynx, Asio*), the Chiripa bones are referred to *Ciccaba* rather than to the others because of these characters. Mandible: Proportionately stout overall, with reduced fenestra mandibulae; processus coronoideus prominent. Femur: impressio ansae muscularis iliofibularis large and elongate; in distal aspect, wide gap between condylus medialis and condylus lat-

eralis. Tarsometatarsus: medium stoutness; foramen vasculare distale small. The pedal phalanx is not diagnostic beyond being from a strigid owl of the same size as the three more diagnostic elements.

The species of *Ciccaba* used in these comparisons was *C. virgata*, whereas the only high Andean species of *Ciccaba* is the Rufous-banded Owl, C. *albitarsus*, which occurs discontinuously from Venezuela to Bolivia in dense humid forests at elevations from 1700 to 3000 m. The approximate relative size of *C. virgata* (total length 33 cm) versus *C. albitarsus* (total length 36 cm; see Hilty & Brown 1986: 231) agrees with the skeletal comparisons, as the bones from Chiripa consistently are slightly larger than those of *C. virgata*. The nearest record of *C. albitarsus* is *c.* 75–100 km north of Lake Titicaca (Fjeldså & Krabbe 1990: 228). That *Ciccaba* cf. *C. albitarsus* may have lived nearer to Chiripa in the past, rather than having been traded into Chiripa prehistorically, is evidenced by the fact that two of the referred bones (a femur and pedal phalanx) are from a juvenile.

Two very distinctive bones are referred to the genus *Trogon* because of these characters. Mandible: unique shape and position of fenestra mandibulae; hemispherical articular fossa. Humerus: diagonal placement and distinct borders of fossa musculo brachialis. Both bones are much smaller than in *Pharomachrus*, the only other South American genus of Trogonidae. The only species of *Trogon* above 2000 m elevation in the Andes today is the Masked Trogon, *T. personatus*. The highest record we can find for *T. personatus* is from humid forest at 3050 m elevation, 1 km south of Chuspipata, Depto. La Paz, Bolivia (Remsen 1985). In the central Andean part of its range *T. personatus* occurs in wet forests at mid-elevations, probably no closer to Lake Titicaca than *c.* 50–80 km (Fjeldså and Krabbe 1990: 301). We are unaware of any records of *T. personatus* from *Polylepis* forest, the forest-type that occurs nearest to Chiripa. The two trogon bones from Chiripa, regardless of species, might be from a bird traded to the site from elsewhere, perhaps for its brightly colored plumage.

TABLE 5. Comparison of avifaunas at Chiripa and Iwawi, based on data in Tables 1 and 2.

	Number of species recorded	Mean number of species per count[1]	Mean number of individuals per count[1]
Chiripa	52	21.2	223.8
Iwawi	49	11.5	73.8

[1]Sum of all habitats.

DISCUSSION

The list of 60 native bird species that we found on the Taraco Peninsula during the dry season is certainly not complete. We were still finding new species during our last week of field work (*Agriornis montana* on 23 July, *Upucerthia* cf. *U. jelskii* on 24 July). A few others probably also occur there because of their habitat preference and range, such as *Muscisaxicola rufivertex*, *M. alpina*, and *M. capistrata* (Fjeldså & Krabbe 1990, Dejoux 1992). Nevertheless, we believe that we recorded most species that inhabit our study sites in June and July. Remsen & Traylor (1989) report 126 species from the entire puna zone of Bolivia, 72 (57%) of which are restricted to this zone. Of the 60 species we recorded, 24 (40%) are confined to puna and 18 others (30%) reach their greatest abundance there.

Overall, the modern dry season avifaunas of Chiripa and Iwawi are fairly similar. We recorded 52 species at Chiripa and 49 species at Iwawi (Table 5); the two sites shared 41 species. Within habitat types, the mean numbers of species per count were consistently higher at Chiripa than at Iwawi (Tables 1, 2

and 5). The same was true for the mean number of individuals per count except in the slope field mosaic. One obvious difference between the two sites was that Chiripa appeared to be wetter overall, with more wet meadows, more *Eucalyptus*, and, to judge by water levels in wells, a higher water table. On the other hand, large flocks of *Phrygilus plebejus* and smaller flocks of *P. alaudinus*, which were nearly restricted to dry quebradas in the vicinity of Chiripa, were much more common and widely distributed at Iwawi.

We saw no hummingbirds (or flowers) on the peninsula. Local residents told us that hummingbirds are common outside of the dry season, when plants are flowering. From published distributions (Vuilleumier 1969, Remsen & Traylor 1989, Fjeldså & Krabbe 1990, Rocha and Peñaranda 1995), we presume that at least three species of hummingbirds would occur seasonally on the Taraco Peninsula (*Colibri coruscans*, *Oreotrochilus estella*, and *Patagona gigas*).

Nightbirds to be expected, but that we did not find, are *Bubo virginianus* and *Caprimulgus longirostris*, which do not call in June–July. We spent little time out at night and did not use playbacks of recordings to search for them.

With the exception of *Tringa melanoleuca*, we missed the appearance of expected northern hemisphere migrants such as *Pluvialis dominica*, *Tringa flavipes*, *Phalaropus tricolor*, and *Calidris bairdii*, which can be common in migration or as austral summer residents in the puna of the central Andes (Fjeldså & Krabbe 1990). Dejoux (1992) also lists *Pluvialis squatarola* and *Tringa solitaria* as occurring at Lake Titicaca.

Some other Bolivian puna sites have a richer mix of steppe species, including tinamous, seedsnipes, miners, and ground-tyrants. For example, at the Reserva Eduardo Avaroa in far southwestern Bolivia, Rocha & Quiroga (1996) found *Attagis gayi*, two species of *Thinocorus*, two species of *Upucerthia*, and seven of *Muscisaxicola*. At 715,000 ha, the reserve is much larger than the Taraco Peninsula, has a much sparser human population, and is less cultivated.

One of the two most obvious faunal differences between the Taraco Peninsula and some other puna sites is the lack of certain conspicuous aquatic or semi-aquatic species, such as *Podiceps occipitalis*, *Phalacrocorax brasilianus*, *Theristicus melanopis*, *Chloephaga melanoptera*, and *Fulica gigantea*. All of these species occur, for instance, at the Reserva Nacional de Ulla-Ulla, *c.* 150 km NNW of the Taraco Peninsula (Ribera & Hanagarth 1982, Serrano & Cabot 1982). Ulla-Ulla covers 240,000 ha and has a small human population. We did see two *T. melanopis* in wet cultivated fields on the Peruvian shore of Lake Titicaca directly west of the peninsula, and E. Flores (pers. comm.) has seen *C. melanoptera* on the northeast shore of the lake. Dejoux (1992) lists *Phalacrocorax brasilianus*, *C. melanoptera*, and *F. gigantea* as occurring at unspecified places on the lake. He also cites Aparicio (1957) as listing *Podiceps occipitalis* and 16 other aquatic and semi-aquatic species for the lake that had not been found again as of 1992. Of those 20 species we found *Egretta thula*, *Anas cyanoptera*, and *A. flavirostris*. We do not know whether such differences reflect changes in the avifauna over the past several decades, regional differences between parts of the lake, or seasonal variation.

Because of the absence of *Polylepis* woodland on the peninsula, a major part of Bolivia's highland avifauna is lacking on the Taraco Peninsula. Fjeldså (1992) noted that even isolated patches of *Polylepis* forest as small as 2–5 ha typically support 25–40 species of birds. In seven hours at a small (5 ha) *Polylepis* grove near Juli, Perú (Figure 1), we found 10 species that we never recorded near Chiripa or Iwawi (*Oreotrochilus estella*, *Patagona gigas*, *Leptasthenura aegithaloides*, *L.* cf. *L. yanacensis*, *Ochthoeca oenanthoides*, *Myiotheretes rufipennis*,

Troglodytes aedon, *Diglossa sittoides*, *Phrygilus fruticeti*, and *Catamenia* sp.). The *Polylepis* grove and the Taraco Peninsula did have some species in common: *Buteo polyosoma*, *Phalcoboenus megalopterus*, *Falco femoralis* (these three species flying over or roosting in nearby cliffs), *Zenaida auriculata*, *Metriopelia ceciliae*, *M. melanoptera* (nesting in *Polylepis*), *Notiochelidon cyanoleuca* (flying over the grove), and *Zonotrichia capensis* (on edge of and inside the grove).

Ellenberg (1979) and Kessler & Driesch (1993) argue on present-day ecological grounds that *Polylepis* formerly grew throughout a zone that includes the Taraco Peninsula. On the other hand, pollen from sediment cores from southern Lake Titicaca suggest that over the last 3500 years *Polylepis* has not been more common regionally than at present (Leyden 1989, Binford *et al.* 1996, B. Leyden in litt.). While there may once have been some *Polylepis* groves on the peninsula, most likely in quebradas, there is no evidence that *Polylepis* woodland once blanketed the peninsula. The species inhabiting the region near southern Lake Titicaca is *P. tomentella* (Simpson 1986). The principal reasons for local declines of *Polylepis* have been cutting for lumber and firewood, and especially burning to improve grazing for livestock (Fjeldså 1993, Kessler & Driesch 1993).

The prehistoric bones from Chiripa suggest some other long-term changes in the avifauna, including the likely former presence of seven species that we did not find in the area in June–July 1996 (*Podiceps* sp., *Phalacrocorax brasilianus*, *Chloephaga* sp., *Fulica* small sp., *Metriopelia aymara*, *Ciccaba* cf. *C. albitarsus*, and *Trogon* sp.). Overhunting might be involved in the local loss of the first four species (especially *Chloephaga*), whereas removal of native woodlands might account for the loss of the last two. The site of Chiripa is situated only *c.* 10 m above the current water level (elev. 3805 m) of Lake Titicaca. This water level is known to have fluctuated greatly during the past several millennia, with levels as much as 30 m lower than modern during the early occupation of Chiripa, and modern levels being attained only within the last millennium (Mourguiart *et al.* 1998, Thompson *et al.* 1998). Thus regional hydrographic changes may also have fueled long-term changes in the Chiripa avifauna.

Ours is the first attempt to use prehistoric bones for long-term perspective on changes in Andean avifaunas. Future research, including species-level identifications of both nonpasserine and passerine bones, promises to be fruitful but, like this study, may be limited by the availability of modern skeletons, a concern throughout the Neotropics.

Totoras were not widespread and may not even have been present at Lake Titicaca at 3000 B.P. (Binford & Kolata 1996). This would influence the distribution of totora-obligate birds such as *Phleocryptes melanops* and *Tachuris rubrigastra*, as well as various grebes, ducks, and coots. People living along the lakeshore cut large numbers of totoras, mainly for livestock feed. Fjeldså (1985) concluded that such cutting in the 20th century has reduced the overall extent of the totoras on the lake, and by creating a mix of open water and reedbeds has increased the bird species richness of the shore zone. Local community regulation may help to prevent over-exploitation of totoras (Lavieil & Orlove 1992).

Species of birds that may have become more common because of human activities are *Colaptes rupicola* (which uses adobe walls and rockpiles), and *Agelaius thilius*, *Sicalis uropygialis*, and *Carduelis atrata* (which feed heavily on cereal crops).

We saw no hunting with guns and heard little gunfire. Flocks of *Anas georgica* and *Agelaius thilius* raid crops, but we saw no attempts to drive them off. One resident did ask us to shoot the *A. thilius* in his oats. Highly edible birds such as tinamous, ducks, and doves are common. Grebes die regularly in fish nets;

fishermen gave us two *Rollandia rolland* and two *R. microptera* that had been killed in this way. Collecting eggs (of *Fulica ardesiaca* in the instances we saw) seems to be common.

The native fish fauna of Lake Titicaca is dominated by 23 endemic species of killifish in the genus *Orestias*, some of which are shallow-water specialists (Parenti 1984, Villwock 1986). In recent decades large numbers of non-native fish (especially rainbow trout, *Salmo gairdnerii*, and pejerrey, *Basilichthys bonariensis*) have been introduced into the lake (Laba 1979, George 1985); their effect on populations of fish-eating birds is unknown.

Habitats unmodified by human activities are virtually absent on the Taraco Peninsula. In recent years, however, there has been a strong net movement of people from rural areas to cities (Binford & Kolata 1996). If that trend continues, agriculture may be abandoned to an extent that allows rejuvenation of quasi-natural habitats on some parts of the peninsula. We hope that our data will help to establish a sound basis for comparison as the birdlife here continues to change.

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