DISTRIBUTION AND POPULATION STATUS OF THE ASH-BREASTED TIT-TYRANT (*ANAIRETES ALPINUS*, TYRANNIDAE) (BOLIVIA)

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DISTRIBUTION AND POPULATION STATUS OF THE ASH-BREASTED TIT-TYRANT (*ANAIRETES ALPINUS*, TYRANNIDAE) AROUND CHOQUETANGA VALLEY (DEPT. LA PAZ, BOLIVIA)

Abstract

Polylepis woodlands are distributed in the high Andes between 3,600 and 4,500 m above sea level. These woodlands constitute a unique habitat for many bird species, including the endangered Ash-breasted Tit-Tyrant, whose populations are confined to semi-humid *Polylepis* woodlands in Peru and Bolivia. Despite the urgent need for the conservation of this habitat and its endemic avifauna, little is known about the distribution and status of *Polylepis* woodlands in Cordillera Real, where two only populations of Ash-breasted Tit-Tyrants in Bolivia have recently been rediscovered. We used Geographic Information System (GIS) and aerial photographs to map potential distribution of *Polylepis* woodlands in Cordillera Real and visited 20 patches of these *Polylepis* woodlands. Through intensive searches using playback, we found 56 individuals of 14 populations of Ash-breasted Tit-Tyrants.

Although our research revealed eight-times increase in population size of Ash-breasted Tit-Tyrants in Bolivia, their known population size is still small, and the populations are heavily fragmented. Besides, most *Polylepis* woodlands suffer from continuous threats by local people through cattle grazing, cutting for firewood, and burning for farmlands. Considering the current distributions and population sizes of the Ash-breasted Tit-Tyrant, Cordillera Real is one of the most important areas for the conservation of this endangered bird species; thus, continuous monitoring of their populations and further studies on their natural history are urgently required.

INTRODUCTION

The paramo and puna zones at 3,500 - 4,500 m in the Andes are dominated by monotonous bunch-grass steppes and semi-desert. Locally, these habitats are broken by tiny woodland patches, which grow above the upper fringe of the montane cloud forests. These woodlands mainly comprise trees and bushes of the genus *Polylepis*, which are well adapted to places with regular night frost, certainly in highlands up to 5,000 m. *Polylepis* forms mixed stands with *Gynoxys*, *Buddleja*, *Escalonia* and *Weinmannia* (Fjeldsa 1993). The evidence on the distribution of high-altitude Andean woodlands indicates that man-made fires had a strong impact immediately after the Pleistocene and accelerated when the management of pastures started for domesticated camelids (Wing 1986).

The Ash-breasted Tit-Tyrant (*Anairetes alpinus*) is a small-bodied tyrant flycatcher with a very restricted distribution. It is categorized as an ENDANGERED SPECIES by BirdLife International according to IUCN Red List criteria, for the following reasons: (1) It is found only in a very small, declining and fluctuating range, of less than 5,000 km^2, which is severely fragmented (B1), (2) Continuous decline has been observed in its area of occurrence, area of occupancy and quality of its habitat (2a, b, c, e), and (3) The population size is less than 2,500 adult individuals and is declining continuously. Population structure potentially suffers from severe fragmentation because all subpopulations have fewer than 250 adult individuals (C2a) (BirdLife International 2000). This species is also included in “Red Book of the threatened vertebrates of Bolivia” (Rocha and Quiroga 1994).

The Ash-breasted Tit-Tyrant is confined to semi-humid *Polylepis* woods, mainly on steep slopes at an elevation of 3,600 - 4,600 m in Peru and Bolivia. They inhabit isolated patches of

Polylepis woodlands with an understory of *Gynoxys* shrubs and are found alone or in pairs, traveling at or above treeline (Ridgely and Tudor 1989). Usually only 1 - 2 pairs occupy a single patch of woodlands.

The two subspecies (*Anairetes alpinus alpinus* and *Anairetes alpinus bolivianus*) are recognized based on a belly color and disjunct distributions (Ridgely and Tudor 1989, Fjeldsa and Krabbe 1990). The subspecies *A. a. alpinus* occurs in the Central and Western Andean mountains (La Libertad, Ancash and Lima) in Peru. The subspecies *A. a. bolivianus* occurs in the Eastern Andes (Apurimac and Cuzco) in Peru, and the Cordillera Real (La Paz) in Bolivia (BirdLife International 2000). All these populations are heavily fragmented, and their population status is poorly known. Although there is no quantitative information on distribution of this species, considering the rapid deforestation rate of *Polylepis* woods for firewood, this species probably faces extinction in the very near future, if conservation measures are not undertaken immediately (Fjeldsa and Krabbe 1990).

In Bolivia the subspecies *A. a. bolivianus* was first collected in 1935, at Tilo Tilo, Dept. La Paz (This locality does not exist in current maps). This record had been considered the only one for this species in Bolivia (Parker and O'Neill 1980, Rocha and Quiroga 1994). In 1993, however, the species was rediscovered when a group of three individuals was observed in Choquetanga valley (Hennessey 2000). Recently *A. a. bolivianus* was found in *Polylepis* woodlands inside the Cotapata National Park and Natural Area of Integrated Management (Vogel and Hennessey 2002). Before our study , was known in Bolivia only in Choquetanga valley and Cotapata, where the relicts of *Polylepis pepei* are found.

Polylepis woodlands typically fringe streams or form small patches in gorges, on rocky slopes and cliff-edges (Fjeldsa and Krabbe 1990). In Bolivia there are nine species of *Polylepis*,

many of which are threatened by human activities. Because the Ash-breasted Tit-Tyrant is a habitat specialist and limited to the woodlands of *Polylepis*, the greatest threat to the survival of the Ash-breasted Tit-Tyrant is probably the destruction of the *Polylepis* woodlands.

Polylepis pepei is a recently described shrub or small tree of up to 4m (Simpson 1979). This species is distinguished by its fewer, smaller leaflets and unique fruits with twisted ridges with knobs (but without spines) (Kessler 1995). It is a rare species, known only from 3,450 to 4,100 m on the upper limit of the Yungas forests in the transition zone from the forests to the puna on the outer eastern Andean ridges, and often grows together with other small trees such as *Escallonia* or *Gynoxys* sp. It prefers areas with some mist (Kessler 1995, Fjeldsa and Kessler 1996).

METHODS

Study Site.

The eastern slope of the Cordillera Real has a ecosystem of Andean paramo (Fjeldsa 1992, Ribera et al. 1994), between 3,000 and 3,500 m above sea level. The climate is mild and humid, and the temperature fluctuates between 6 and 12 ºC. The predominant vegetation is low trees and shrubs of genera *Buddleia incana, Escallonia, Gynoxys* and *Polylepis* and occasionally the patches of vegetation are covered with muss (Fjeldsa and Krabbe 1990, I.G.M. 1994).

We studied distribution and population status of Ash-breasted Tit-Tyrants in 7,850 km^2 area: 100 km diameter circle around Choquetanga valley. Choquetanga valley is located in "Mountain Puna" life zone between 3,800 and 4,200 m above sea level, at *ca.* 80 km northeast of La Paz, Dept. La Paz, Bolivia (16º19.4' S, 67º57.4' W). The area receives *ca.* 2,000 mm

precipitation per year, and the average monthly temperature fluctuates between 7.5 and 20.0 °C (Beck and García 1991, Ibisch et al. 2002). Choquetanga valley is roughly 4 km^2 and has rocky slopes and streams. The dominant vegetation of the area is *Polylepis pepei* and *Gynoxys asterotricha* (Hennessey 2000).

Choquetanga valley is identified as one of the key areas for the conservation (BO15) and designated as Endemic Bird Area (B35) because it is one of the five localities in the world where the Ash-breasted Tit-Tyrant has been observed (Wege 1995). The area is also considered as an Important Bird Area (IBA) that needs urgent study, according to the directory of IBAs in Bolivia (1999), mainly for the conservation of the Ash-breasted Tit-Tyrant (Hennessey 2000). We used three major approaches to study the distribution and population status of this highly endangered species.

Geographic Information System and aerial photographs

We used Geographic Information System (GIS) to estimate a potential distribution of *Polylepis* woodlands in 7,850 km^2 study areas. For basal information we used nine cartographic maps (5946-II Challana, 5945-I Zongo, 5945-II Milluni, 6045-III Unduavi, 6044-IV Chojlla, 6044-I Chulumani, 6044-III Palca, 6044-II Lambate, 6043 IV Cohoni; 1:50,000) obtained from Instituto Geografico Militar (IGM), 20 aerial photographs and one satellite image.

First, we located the known *Polylepis* forest with populations of Ash-breasted Tit-Tyrants (on aerial photographs), and we evaluated the following parameters: altitude, slope, aspect and proximity to bodies of water, such as rivers or streams. Second, we generated Digital Model of Elevations (DEM) with intervals of 20 m. Finally we added the information on slopes,

expositions and proximity to water into the DEM. We used grids of 30 m x 30 m as an analysis unit and generated potential distribution of *Polylepis* woodlands based on this model.

Intensive searching for Ash breasted Tit-Tyrants

We chose the 20 largest patches of potential *Polylepis* woods generated by the DEM. We spent two – three days in each patch. Each observer conducted line transects through *Polylepis* woods with 10 x 40 binoculars and a small recording equipment for playback. A recording of the contact call of the Ash-breasted Tit-Tyrant was obtained from Colección Boliviana de Fauna. The playback was conducted every 100 m to determine the presence or absence of the Tit-Tyrants at each census point (Legare et al. 1999). We repeated the same procedure for each *Polylepis* patch and estimated the population density of Ash-breasted Tit-Tyrants.

Vegetation

We collected following habitat data from each *Polylepis* woods: vegetation density, vegetation height, percent of *Polylepis*, and forest patch size. We collected and deposited plant samples at the Herbario Nacional de Bolivia for identification. To calculate a path size of each *Polylepis* woodlands, we recorded numerous geographic coordinates of peripheral of *Polylepis* woods.

RESULTS

Based on the DEM and aerial photographs we located 57 potential patches of *Polylepis* woodlands in our study area (Figure 1).

Between December 2002 and July 2003 we visited the 20 largest patches to confirm *Polylepis* woodlands found by DEM and the aerial photographs. In each *Polylepis* woods, we censused Ash-breasted Tit-tyrants and estimated population size in each patch (Figure 2). We found total of 56 individuals of Ash-breasted Tit-tyrants in 14 out of the 20 patches (Table 1).

Fieldwork

The detailed description of each field site appears in the following:

PONGO AREA

Choquetanga Valley (S 16°18´51.5" - W 67°57´28.2", 4,000 m)

Choquetanga Valley is where the Ash-breasted Tit-tyrant was rediscovered after 60 years without record in Bolivia (Vogel and Hennessey 2002). Although this population had been known since 1996, no quantitative study had been conducted.

On 7 September, M. Isabel Gómez, Kazuya Naoki and Yorema Gutierrez visited Choquetanga Valley, we observed four individuals of Ash-breasted Tit-Tyrants and quantified the vegetation structure. These woodlands were separated in two patches, and the vegetation covered 70% of them (*Polylepis pepei* occupied 80% of the total vegetation, and *Gynoxys asterotrichia* and other shrubs occupied 20%).

On 29 September and 19 October, the members of the team visited Choquetanga Valley to standardize the methodology; we failed to find an Ash-breasted Tit-Tyrant because of the rain and fog.

Mina Elba (S 16°18´56.0" - W 67°59´29.7", 3,934 m)

Between 24 and 25 May, M. Isabel Gomez and Mauricio Ocampo visited the *Polylepis* woodlands at Mina Elba. We quantified the population size of Ash-breasted Tit-Tyrants and vegetation structure. We found one *Polylepis pepei* woodlands, mapped these woods and used the playback to find an Ash-breasted Tit-Tyrant. The woodlands had a north exposition and a surface area of 3,000 m^2. The scattered vegetation covered 80% (90% *Polylepis pepei*, 5% *Gynoxys asterotricha*). *Polylepis* are 1- 1.5 m high. Ash-breasted Tit-Tyrants responded well to the playback, and we saw one pair. In addition, we recorded one individual of the endangered Royal Cinclodes (*Cinclodes aricomae*) near the woodlands.

Kkota Khuchu Valley (Mina Lourdes) (S 16°17´55.2" - W 67°58´6.7", 4,100 m)

Carlos Zambrana and Mauricio Ocampo visited the valley on 5 January 2002, and M. Isabel Gomez and Kazuya Naoki on 13 January 2002. Both parties walked along Rio Keota Kyushu between 4,400 and 3,800 m above sea level. We found several patches of *Baccharis*, but no *Polylepis* woods. Although the aerial photograph taken in 1978 showed some continuous vegetation, the most vegetation had been cleared possibly by local farmers.

MINA SAN LUIS AREA

On 7 - 9 March, M. Isabel Gomez, Mauricio Ocampo, Claudia Flores, Miguel Molina and Janira Urrelo visited the *Polylepis* woodlands at Mina San Luis Area. We quantified the population size of Ash-breasted Tit-Tyrants and vegetation structure. We found four *Polylepis* woodlands in this area and mapped two of these woods. We heard the response to playback in

one of these woods. Unfortunately we were unable to map the other two woods because of the heavy rain and fog.

Mina San Luis woodlands 1 and 2 (S 16°18´58.7" - W 67°55´37.4", 3,712 m and S 16°18´36.9", W 67°55´37.4", 3,776 m respectively).

On 9 March, we walked behind these woodlands; both of them have northwest exposition. We could not used playback to find Ash-breasted Tit-Tyrants because of the heavy rain and fog.

Mina San Luis woodlands 3 (S 16°17´34.0" - W 67°56´35.5", 3,910 m)

We visited this woodlands, employed playback, but failed to find Ash-breasted Tit-Tyrants. The woodlands had northwest exposition and covered *ca.* 20,000 m^2. Three patches composed these woodlands. *Polylepis pepei* covered 80% of these patches and grass covered 20%.

Mina San Luis woodlands 4 (S 16°18´29.7" - W 67°55´6.5", 3,800 m)

This woodlands was 4,000 m^2 and had a northwest exposition. The dominant species was *Polylepis pepei* (70%), and some grass species (25%). We used playback to find Tit-Tyrants. We heard the response to playback of one individual, but we could not locate it because of fog.

COSCAPA AREA

Coscapa (S 16°17´28.6" - W 67°55´23.5", 3,900 m)

Between 15 and 17 April, M. Isabel Gomez, Mauricio Ocampo, Rosenberg Hurtado and Jessica Purcell visited Coscapa Valley. We found one *Polylepis* woodlands. We mapped the woodlands with GPS and censused Ash-breasted Tit-Tyrants using playback. Ash-breasted Tit-Tyrants responded to the playback, and we counted five individuals of Tit-Tyrants, one pair and one familiar group in these woods. The woodlands was 8,000 m^2 with north exposition, and the vegetation covered 60% of woods (90% *Polylepis pepei* and 10% grassland). *Polylepis* in these woods was 2 - 2.5 m high.

SANJA PAMPA AREA

Between 3 and 13 January, M. Isabel Gomez, Mauricio Ocampo, Carlos Zambrana and Kazuya Naoki visited Sanja Pampa. We found four *Polylepis* woodlands. We mapped these *Polylepis* woods with GPS and censused Ash-breasted Tit-Tyrants using playback. We found Tit-Tyrants in three of the five woods.

Laguna Chiar Kkota (S 16°14´38.4" - W 68°01´01.1", 3,978 m)

The largest *Polylepis* woods in this area (15 ha). The woods was composed by *Polylepis pepei* (80%), grass (5%) and *Gynoxys* (10%). Because more than half of the woods was found at extremely steep slope and 25% was above bog, we censused only *ca*. 40% of the woods. We mapped five pairs of Ash-breasted Tit-Tyrants in the censused area. By multiplying the number of pairs found in the censused areas, we estimated between 10 and 15 pairs in this *Polylepis* woods. Unfortunately the margin of these woods was cut and many *Polylepis* trees were found on the ground for the later use as firewood.

Laguna Taypi Kkota (S 16°14´29.1" - W 68°01´57.3", 3,798 m)

The second largest *Polylepis* woods in this area (7 ha). We mapped five pairs of Ash-breasted Tit-Tyrants in the censused area. By multiplying the number of pairs found in the censused areas, we estimated between seven and 10 pairs in this *Polylepis* woods.

Laguna Chaco Kkota (S 16°14´45.4" - W 68°02´29.3", 4,046 m)

We mapped three pairs of Ash-breasted Tit-Tyrants in the censused area and estimated *ca.* five pairs in this *Polylepis* woods. We observed and recorded the vocalization of another critically endangered *Polylepis* specialist, Royal Cinclodes (*Cinclodes aricomae*), in this woods (also seeVogel and Davis 2002).

Cerro Pajonal (S 16°15´26.1" - W 68°02´17.0", 3,990m)

Sparse woods composed with *Polylepis pepei* and *Gynoxys asterotricha* extended on the southern slope of Cerro Pajonal. We spent one afternoon censusing Ash-breasted Tit-Tyrants. The rain and fog prohibited us to spend more time in this small patch. Although we did not observe an Ash-breasted Tit-Tyrant here, two dense patches of *Polylepis pepei* are probably large enough to support one or two pairs of Tit-Tyrants.

Quebrada Jiskha Tetatal (S 16°15´19.8" - W 68°02´54.5", 4,035 m)

This small patch (2 ha) contains *ca*. 40 trees of *Gynoxys* and *Baccharis* and no *Polylepis*. Although one pair of *Polylepis* specialist, Tawny Tit-Spinetail, was observed foraging, no Ash-breasted Tit-Tyrant was found.

TIQUIMANI AREA

Between 31 April and 4 May, M. Isabel Gomez, Mauricio Ocampo, Claudia Flores, Miguel Molina and Jesus Martinez visited Tiquimani Area. We found four *Polylepis* woodlands. We mapped these *Polylepis* woods with GPS and censused Ash-breasted Tit-Tyrants using playback. We found Ash-breasted Tit-Tyrants in all these woods.

Uma Palca woodlands 1 (S 16°12´36.7" - W 68°03´46.7", 3,722 m)

This small and narrow patch is 4,000 m^2 and with a southeast exposition. It is dispersedly covered by *Polylepis pepei* (60%). A pair of Ash-breasted Tit-Tyrants was observed foraging on the vegetation.

Uma Palca woodlands 2 (S 16°12´38.8" - W 68°03´36.2", 4,162 m)

The second largest *Polylepis* woods in this area (9,000 m^2) had southeast exposition. We mapped three pairs of Ash-breasted Tit-Tyrants in the censused area. *Polylepis pepei* was 2 m high and covered 80 - 90% the total vegetation.

Uma Palca-Tiquimani (S 16°12´39.7" - W 68°03´28.5", 4,141 m)

This woods had sparse trees of *Polylepis pepei* (20%) and *Baccharis* sp. (60%). We mapped the area and searched for Tit-Tyrants using playback, but we did not find any Tit Tyrant.

Behind this patch, 50 m following the trail, in a patch of *Gynoxys asterotrichia* and *Baccharis* sp. we observed a pair of Ash-breasted Tit-Tyrants foraging. The vegetation covered both sides of the Tiquimani River and was connected to the *Polylepis* woods by shrubs.

Laguna Viscachani (S 16°12´15.5”-W 68°06´47.9”, 4,048 m)

We mapped one pair of Ash-breasted Tit-Tyrants in the censused area. On a second visit, we observed other *Polylepis* specialist, the Royal Cinclodes and the Tawny Tit-Spinetail. The vegetation covered 90% (*Polylepis pepei* 80% and grassland 15%). *Polylepis* was 2 - 2.5 m high, and the woods had an east exposition.

TAQUESI AREA

Between 31 May and 3 June, Miguel Molina, Jesus Martinez and Jessica Purcell travelled the road thought San Francisco Mine and La Reconquistada Mine. We found several patches of *Polylepis pepei* in the area.

We located two patches of *Polylepis pepei* at 2 km from Totora Pata village. The valley was on the intersection between Pupusani and Totor Jahu rivers. These valleys (S 16° 15’ 03’’, W 67° 31’27’’) contained two *Polylepis* patches, in which shrubs of *Baccharis* and other native species dominated.

Pupusani River woodlands (S 16º14’57’’ – W 67º31’51’’, 3,850 m)

This woodlands covered 6,000 m^2 of extension, and the *Polylepis* trees were 1.5 – 2 m high. This area was on a rocky hillside and the trees were relatively far away to each other (10 - 20 m). Ninety percent of the area were covered by the vegetation, of which 10% was *Polylepis pepei* and 80% was grassland and *Gynoxys asterotricha*. In this patch we did not detect the presence of Ash-breasted Tit-Tyrants.

Rio Totor Jahu woodlands (S 16º14’43’’ – W 67º31’36’’, 3,900 m)

The second woodlands was on the valley near the Totor Jahu river, which originated from the Percata and Quilim Khota Lagoons. These are small patches with *ca*. 20 m of diameter, and they are connected with each other by some trees. *Polylepis* woods on the rocky and humid hillside was 1.5 - 2 m high and covered 20 - 30% of the area. The rest, 80%, was covered by grassland. In this woodlands one individual of Ash-breasted Tit-Tyrant was observed together with other *Polylepis* specialist such as Giant Conebill (*Oreomanes fraseri*).

Laguna Kelluani woodlands (S 16º14'56'' – W 67º30'23'', 4,000 m)

The woodlands on proximity of the Kelluani Lagoon were on the humid hillside with north exposition. In the area, were found two small patches, which were separated by 100 m. The first patch covered two ha. and the second did a half ha. *Polylepis* was 1.5 - 2 m high and were accounted for 30% of the total vegetation. We recorded a pair of Ash-breasted Tit-Tyrants, which responded to the playback on the border of the patches.

Cerro Percapata (S 16º 14'34'' - W 67º30'07'', 4,081 m)

After the tunnel of the mine, 400 m from the trail, we found patches of *Polylepis pepei* in the hill of Cerro Percapata, near Santa Elena river. Ninety percent of the woodlands was covered by vegetation, 20% of which was *Polylepis*. The trees were 2 m high and were extent in the canyon. In this woodlands we employed playback, but we didnot find an Ash-breasted Tit-Tyrant.

Mina La Reconquistada woodlands (S 16º14'31'' – W 67º30'04'', 4,046 m)

We visited a patch located at 600 - 700 m from the mine La Reconquistada. Approximately a half of the patch was covered with herbaceous plants, and the rest was covered with *Polylepis* of 2 m high. The woodlands was approximately one ha. We censused from the border and observed a pair of Ash-breasted Tit-Tyrants. We also found a few patches of the *Polylepis* woods near the summit (S 16º14'30''-W 67º29'58''**,** 4,053 m), with scattered trees. We did not find an Ash-breasted Tit-Tyrant, in these patches near the summit.

LAMBATE AREA

On June, Miguel Molina, Juan Carlos Bermejo and Jessica Purcell visited woodlands near Taca and Lambate.

Taca (S 16º24'54''- W 67º22'18'', 3,500 m)

The forest was approximately 2 km from Taca village followig the road to Kilinbaya. This was relatively large (*ca*. 50 ha), and the *Polylepis racemosa* trees were 3 m high. Seventy percent of the vegetation was covered by *Polylepis*, which were separated at 1 - 2 m. At the beginning of the forest, *P. racemosa* was dominant; however, the vegetation became more typical montane forest as we descent. We did not find any Ash-breasted Tit-Tyrant in these *Polylepis racemosa* woods.

We also searched the forest near Lambate village, but we did not find an Ash-breasted Tit-Tyrant. We visited the area, behind Illimani Mountain, where a *Polylepis* woodlands were

supposed to be (Fjeldsa and Kessler 1996), but we did not find any remnant of *Polylepis* woodlands.

COHONI AREA

Between 26 and 28 December, M. Isabel Gomez and Kazuya Naoki visited several *Polylepis* woodlands east of Cohoni (S 16°43´31.8", W 67°48´6.5", 3,668 m).

Pucaya (S 16°43´12.4" - W 67°48´21.7", 3,751 m)

On 26 and 27 December, we visited several patches of *Polylepis racemosa* woodlands, including one large patch (S 16°43´40.7", W 67°47´46.2", 3,602 m), around the village of Pucaya. In the large woods and three small patches, we searched for Ash-breasted Tit-Tyrants using playback at every 50 m.

A nearly half of the largest *Polylepis* woods at Pucaya was recently burned by the local people for the expansion of agricultural land. We observed several *Polylepis* specialists, such as the Giant Conebill (*Oreomanes fraseri*) and the Tawny Tit-Spinetail (*Leptasthenura yanacensis*); however, we did not find a Ash-breasted Tit-Tyrant in these *Polylepis racemosa* woods.

Mina Urania (S 16°41´40.3" - W 67°47´8.7", 3,698 m – 1st patch and S 16°41´39.4", W 67°46´57.3", 3,658 m)

We visited *Polylepis racemosa* woodlands near Mina Urania on 28 December. Three *Polylepis* patches were found along the road between Mina Urania and Atahuallani. These patches were 60 x 30, 100 x 130, and 250 x 50 m respectively with several small relicts around. In this area we used playback at every 50 m but did not find an Ash-breasted Tit-Tyrant. The

woods seemed slightly wetter and were located higher than Pucaya. Several bird species common in these woods were not observed at Pucaya. For example, the Bolivian endemic and *Polylepis* specialist, the Black-hooded Sunbeam (*Aglaeactis pamela*), was common at Mina Urania, but was not observed at Pucaya.

DISCUSSION

Population status and distribution of Ash-breasted Tit-Tyrant

We visited the total of 22 patches of *Polylepis* woodlands, including humid and dry woodlands and recorded 56 individuals of Ash-breasted Tit-Tyrants divided in 14 subpopulations. Our study increased the population size of Ash-breasted Tit-Tyrant in Bolivia in 700 percent. However, the population size of this endangered species is still small, and the population is severely fragmented. In Peru, the Ash-breasted Tit-Tyrant is known in four areas, and it is said to be relatively common only in Abra Malaga woodlands (Cuzco/Apurimac departament). The number of subpopulations of Ash-breasted Tit-Tyrants is difficult to assess, but it is probably *ca.* 20 – 30 (Engblom et al. 2002). The Sanja Pampa area contained at least three subpopulations of Ash-breasted Tit-Tyrants with 13 pairs/family groups, and the total population estimate was 21 pairs/family groups. Combined these are the largest populations of the Ash-breasted Tit-Tyrant known in Bolivia and possibly in both Peru and Bolivia.

We confirmed that the distribution of the subspecies *Anairetes alpinus alpinus* was limited to humid *Polylepis* woodlands in the eastern of the Cordillera Real in Bolivia (BirdLife International 2000). Parker and O'Neill (1980) suggested that the patchy distribution of Ash-breasted Tit-Tyrants closely paralleled those of Tawny Tit-Spinetails in Peru. The woodlands

located on the southern slope of Cordillera Real (Pucaya and Mina Urania) are drier than the northern slope. These *Polylepis* woods on the southern slope are mainly composed with *Polylepis racemosa* and taller (2 - 2.5 m) than *Polylepis pepei* woods on the northern slope. These dry *Polylepis racemosa* woods located at lower elevation on the southern slope do not seem to support a population of Ash-breasted Tit-Tyrants.

Distribution of *Polylepis pepei*

The genus *Polylepis* include nine species and eight subspecies in Bolivia, and different species of *Poylepis* are adapted to different ecological zones (Kessler 1995, Fjeldsa and Kessler 1996). Most *Polylepis* stands are rather small and form isolated pockets of forest in the otherwise barren Andean landscape, where forests usually do not cover more than a few square kilometres (Fjeldsa and Kessler 1996). Mapping the distribution of *Polylepis* was conducted previously (Fjeldsa and Kessler 1996, Braun 1997). These studies however used only elevation and precipitation and did not verify predicted forests in the field. The more detailed study of a spatial distribution of *Polylepis* was carried out in the west of Bolivia, and the distribution of the *Polylepis* woods on the flanks of Sajama Volcano was determined using remote-sensing and GIS methods, based on a digital elevation model, computer simulated solar irradiance, and LANDSAT-MSS data. The spatial distributional pattern of the forests was coincident with the daily variation in soil temperatures in the root zone (Braun 1997).

In this study we mapped the potential distribution of *Polylepis pepei* and visited various predicted woodlands for verification. The modelling of the potential distribution was accomplished using the remote-sensing and GIS, based on a digital elevation model, a LANDSAT satellite image, and aerial photographs. We also considered the exposition and the

proximity to water bodies. A seventy percent of the predict vegetation was verified in the fieldwork, and *Polylepis pepei* corresponded to most of the woodlands. Our study showed that the distribution of *Polylepis pepei* is strongly related with elevation and the proximity to water bodies such as streams, rivers and lagoons. We faced two difficulties to find *Polylepis* woodlands by GIS: the model did not discriminate between *Polylepis* and other shrub vegetation such as *Baccharis* or *Gynoxys*, and some of the woodlands predicted were burned or cut recently because the area received a strong impact of wolfram mines.

We found the woodlands on rocky slopes, on boulder-scree, and along small streams and lagoons. Those preferences of *Polylepis* woods have been observed by numerous researchers, and some of them argued that these sites provide special microclimatic conditions necessary for *Polylepis* (Simpson 1979, Fjeldsa and Kessler 1996).

Using GIS, the potential area for *Polylepis pepei* in Bolivia was calculated *ca*. 1496.2 km^2. Much of the area is located inside Madidi National Park and Cotapata National Park (Ibisch et al. 2002). Most of our study was conducted in Cotapata National Park and Natural Area for integrated Management, in which 49.5 km^2 of the potential area of *Polylepis pepei* is found. This represents 8.2% of the vegetation in the protected area. However, only 16.4 km^2 (2.7%) are found in a good condition.

Threats to the habitat

The Ash-breasted Tit-Tyrant is a habitat specialist, and its distribution is limited to *Polylepis* woodlands (Fjeldsa and Krabbe 1990). Thus, the greatest threat to the survival of this species is the destruction of these woodlands. The current threats to *Polylepis pepei* woodlands in Bolivia are: (1) Cattle grazing, which probably has limited the *Polylepis* woodlands into rocky

and steep places, inaccessible to cattle and caused major fragmentation of the forest, (2) Burning for agriculture, which has caused a considerable reduction in the amount of vegetative cover, leaving the remaining soil less protected against solar radiation and erosion (Hennessey 2000), (3) Landslides, which can cause further damage after the cattle grazing has left the majority of the *Polylepis* woodlands vulnerable (Hennessey 2000), and (4) Cutting for firewood, which has been one of the factors causing the destruction of the *Polylepis* forest in the past and present.

The conservation of *Polylepis pepei* is important not only as habitats for Ash-breasted Tit-Tyrant but also for the survival of *P. pepei* itself: *P. pepei* is categorized as VULNERABLE by the UICN (2003).

Avifauna of the *Polylepis* woodlands

The more humid and mossy *Polylepis* woodlands have deep and fertile soils, a varied vegetation of herbs, shrubs and vines, and a rich insect life. The complex structure of the *Polylepis* trees provides diverse feeding niches for birds; and well over 100 birds species occur regularly in *Polylepis* woodland, but there is a continuous range of specializations from opportunistic visitors to highly specialized species (Fjeldsa 1992). We recorded 55 species of birds in the *Polylepis* woodlands (see Table 2). Some of these species are threatened or have a limited range. These include Olivaceous Thornbill, Hooded Sunbeam, Line-fronted Canastero and Royal Cinclodes.

The Olivaceous Thornbill has disjunct and restricted range. Observations suggest that it uses *Polylepis* patches when breeding (Fjeldsa and Kessler 1996). The Hooded Sunbeam is an endemic hummingbird to Cordillera Real (Fjeldsa and Krabbe 1990, Fjeldsa and Kessler 1996). The Line-fronted Canastero has a restricted range, disjunct in northern Peru and in Cordillera

Real Bolivia (Fjeldsa and Kessler 1996). The Royal Cinclodes (*Cinclodes aricomae*) is rare and local in *Polylepis* woodlands in paramo of South eastern Peru and western Bolivia, usually in pairs or family groups (Fjeldsa and Krabbe 1990, Clements and Shany 2001). It is categorized as a critically endangered species by Birdlife International (2000) according to IUCN Red List criteria because the species has a declining and small population, which is severely fragmented. Mean territory size is probably 3 - 4 ha. Engblom (2002) suggested that the world population was probably at most 250 pairs considering the studied areas in Peru and Bolivia.

In Bolivia no information of this species was available several years ago. In 2000 T. Valqui (pers. com.) recorded this species in Madidi National Park. The species was also recorded in *Polylepis* woodlands inside the Cotapata National Park and Natural Area for Integrated Management (Vogel and Davis 2002). In this study, we recorded three subpopulations of Royal Cinclodes. Two of these records are new for the specie. The species probably requires large territories as it flakes up large areas of moss cover with its strong bill to acquire invertebrates (Fjeldsa and Kessler 1996, Engblom et al. 2002). The Royal Cinclodes is a sensitive species to the human activities because the moss cover on rocks, trunks and branches rapidly disappears when the canopy is opened through logging or burning and the sun dries out the moss (Engblom et al. 2002).

Conservation of the Ash-breasted Tit-Tyrant

Many areas for conservation need to be established in the Andes due to the complex patterns of endemism in this region (Fjeldsa and Rahbek 1998). With our study we proposed three Important Bird Areas (IBA's) for conservation of the Ash-breasted Tit-Tyrant and Royal Cinclodes in the Cordillera Real (see Figure 3).

The southeastern slope of the Cordillera Real is the most important area for the conservation of the Ash-breasted Tit-Tyrant in Bolivia. The valleys of Choquetanga, Tiquimani, Coscapa, Mina Elba, Taquesi and its vicinity provide a fragile habitat for the Ash-breasted Tit-Tyrant, now being the only place where this species is found in Bolivia.

Despite the importance of Taquesi Area for the conservation of the birds, this area is not protected and no study exists to establish a management plan for the area. The woodlands near the Laguna Viscachani, where we observed a pair of Ash-Tit breasted-Tyrant, a Tawny Tit-Spinetail and Royal Cinclodes, is also important for the conservation and suffers human impact by cutting and grazing activities.

Sanja Pampa area contained the largest populations of Ash-breasted Tit-Tyrants in Bolivia. Thus, we consider this area extremely important for the conservation of the Ash-breasted Tit-Tyrant. The area is inside of Cotapata National Park and Natural Area for Integrated Management, but its management plan has not been completed. We propose this area as a priority for the conservation of *Polylepis pepei* woodlands.

Ash-breasted Tit-Tyrants have heavily fragmented populations. Their population status is not well known, and both species are very local and rare. Although there is no quantitative information on distributions of this species, considering the rapid deforestation rate of *Polylepis* woods for firewood, these species probably face extinction in the very near future, if conservation measures are not undertaken. Without further information on basic biology such as territory size, breeding season, clutch size, mortality rate, migration, it is difficult to establish conservation plan to assure the survival of the species.

RECOMMENDATION

Information on the population status and distribution of the Ash-breasted Tit-Tyrant is critical for recognizing the key areas and outlining a strategy for the conservation of this species. Besides little is known about basic biology of the Ash-breasted Tit-Tyrant, which is indispensable to establish adequate management plan. We recommended to extent our approach to other mountain ranges in Bolivia, especially the northeast of the Cordillera Real and the Cordillera de Apolobamba to discover other key areas. In the Cordillera Real, we consider the Sanja Pampa area extremely important for the conservation of the Ash-breasted Tit-Tyrant strongly recommended continuous monitoring the populations.

Information about other species associated to *Polylepis* woodlands, such as the Royal Cinclodes, Giant Conebill, Line-fronted Canastero and Tawny Tit-Spinetail, is necessary to understand the relationship between *Polylepis* woodlands and its avifauna. Thus, we recommended to conduct studies on natural history and the distribution of those species. For an effective conservation of the *Polylepis* woodlands we emphasize the importance of the integration of the local people in conservation action, reforestation, of *Polylepis* woodlands, use of alternative source for firewoods, and programs and campaigns of environmental education.

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Table 1. Number of individuals of Ash-breasted Tit-Tyrants recorded in the Cordillera Real

Locality	***Polylepis* woodlands**	**Nº of individuals**
Pongo	Valle de Choquetanga	4
	Mina Elba	2
	Mina San Luis	1
Coscapa	Coscapa	5
Sanja Pampa	Laguna Taypi Kkota	10
	Laguna Chiar Kkota	10
	Laguna Chaco Kkota	7
Tiquimani	Uma Palca 1	2
	Uma Palca 2	6
	Uma Palca-Tiquimani	2
	Laguna Viscachani	2
Taquesi	Totor Jahu	1
	Laguna Kelluani	2
	Mina La Reconquistada	2
Total		56

Table 2. List of the species recorded in the *Polylepis* woodlands on the Cordillera Real

Family	**Scientific Name**	**English Name**
Cathartidae	*Vultur gryphus*	Andean Condor
Accipitridae	*Buteo poecilochrous*	Puna Hawk
	Buteo polyosoma	Red-backed Hawk
Falconidae	*Phalcoboenus megalopterus*	Mountain Caracara
Scolopacidae	*Gallinago jamesoni*	Andean Snipe
Columbidae	*Columba maculosa*	Spot-winged Pigeon
Trochilidae	*Oreotrochilus estella*	Andean Hillstar
	Pterophanes cyanopterus	Great Sapphirewing
	Aglaeactis pamela	Black-hooded Sunbeam
	Chalcostigma olivaceum	Olivaceous Thornbill
	Chalcostigma stanleyi	Blue-mantled Thornbill
	Colibri coruscans	Sparkling Violet-ear
Furnariidae	*Cinclodes fuscus*	Bar-winged Cinclodes
	Cinclodes aricomae	Royal Cinclodes
	Leptasthenura yanacensis	Tawny Tit-Spinetail
	Leptasthenura fuliginiceps	Brown-capped Tit-spinetail
	Asthenes dorbignyi	Rusty-vented Canastero
	Asthenes humilis	Streak-throated Canastero
	Asthenes maculicauda	Scribble-tailed Canastero

	Asthenes urubambensis	Line-fronted Canastero
	Upucerthia andaecola	Rock Earthcreeper
Formicariidae	*Grallaria andicola*	Stripe-headed Antpitta
Rhinocryptidae	*Scytalopus magellanicus*	Andean Tapaculo
Tyrannidae	*Anairetes alpinus*	Ash-breasted Tit-Tyrant
	Anairetes parulus	Tufted Tit-Tyrant
	Ochthoeca fumicolor	Brown-backed Chat-Tyrant
	Ochthoeca oenanthoides	D'orbigny's Chat-Tyrant
	Ochthoeca leucophrys	White-browed Chat-Tyrant
	Mecocerculus leucophrys	White-throated Tyrannulet
	Muscisaxicola alpina	Plain-capped Ground-Tyrant
	Muscisaxicola cinerea	Cinereus Ground-Tyrant
	Muscisaxicola albifrons	White-fronted Ground-Tyrant
Hirundinidae	*Hirundo rustica*	Barn Swallow
	Notiochelidon murina	Brown-bellied Swallow
	Pygochelidon cyanoleuca	Blue-and-white Swallow
Turdinae	*Turdus chiguanco*	Chiguanco Thrush
	Turdus fuscater	Great Thrush
Motacillidae	*Anthus bogotensis*	Paramo Pipit
Thraupidae	*Oreomanes fraseri*	Giant Conebill
	Diglossa brunneiventris	Black-throated Flowerpiercer
	Diglossa carbonaria	Gray-bellied Flowerpiercer
	Thraupis bonariensis	Blue-and-yellow Tanager
	Conirostrum ferrugineiventre	White-browed Conebill
	Conirostrum cinereum	Cinereous Conebill
Emberizidae	*Phrygilus punensis*	Peruvian Sierra-Finch
	Phrygilus unicolor	Plumbeus Sierra-Finch
	Phrygilus plebejus	Ash-breasted Sierra-Finch
	Phrygilus alaudinus	Band-tailed Sierra-Finch
	Diuca speculifera	White-winged Diuca-Finch
	Catamenia inornata	Plain-colored Seedeater
	Zonotrichia capensis	Rufous-collared Sparrow
	Idiopsar brachyurus	Short-tailed Finch
Cardinalidae	*Saltator aurantiirostris*	Golden-billed Saltator
Fringillidae	*Carduelis atrata*	Black Siskin
	Carduelis xanthogastra	Yellow-bellied Siskin