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Nests and Nest Site Characteristics of Rufous-throated Dipper (*Cinclus schulzi*) in Mountain Rivers of Northwestern Argentina

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Abstract.—The Rufous-throated Dipper (*Cinclus schulzi*) is an endemic and threatened bird that inhabits the mountain rivers of southern Yungas of Argentina and Bolivia. This is the rarest and least known species of the genus, in part because of its restricted distribution. The aim of this study was to describe the nests and nest sites of the Rufous-throated Dipper in mountain rivers of northwestern Argentina. Five rivers were surveyed in transects of 3 to 6 km long from 2010 to 2013. The shape, size, substrate and building material of nests and nest and non-nest characteristics were assessed and compared in plots of 2 by 2 m. Plots with nests were compared to non-nesting plots for a number of habitat characteristics. Most nests found (78.57%; n = 28) had a globular shape, were attached to rocky substrates and were built using moss. The height of nests above the water level (P = 0.02), slope (P = 0.03) and watercourse width (P < 0.01) varied among rivers. Plots at nest sites had significantly higher values of some habitat characteristics than non-nesting plots, including emergent rocks (P < 0.01), slope (P < 0.02), greater number of rapids (P < 0.01), number of pools (P < 0.01), water velocity (P < 0.05), and river depth (P < 0.01), but had narrower watercourse width (P < 0.01). Previously, the understanding of the breeding ecology of the Rufous-throated Dipper was based only on anecdotal evidence. Understanding the breeding habitat requirements is a prerequisite for the development of a conservation action plan for this threatened species.
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Key words.—Argentina, breeding biology, breeding habitat, *Cinclus schulzi*, conservation, Rufous-throated Dipper, southern Yungas, watershed.

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The Rufous-throated Dipper (*Cinclus schulzi*) is an endemic passerine bird currently categorized as Vulnerable by the International Union for Conservation of Nature (BirdLife International 2012). It inhabits mountain rivers of the southern Yungas of Argentina and Bolivia (Chebez *et al.* 2008). This is the least known species of the genus, and it has the most restricted distributional range of species in the genus (Tyler and Ormerod 1994). The Rufous-throated Dipper has a very specialized diet and forages on waters with a rich environment for macroinvertebrates. Rufous-throated Dipper global population numbers are estimated to be < 4,000 individuals with populations highly fragmented and thought to be declining (BirdLife International 2012). The main threats to the species are related to anthropogenic disturbances (e.g., water course diversion, pipeline construction and mining) that change, degrade and pollute rivers (Chebez *et al.* 2008).

The Rufous-throated Dipper has a low reproductive potential, and during the breeding season (November to April) it can be seen in pairs with active breeding territories (Tyler and Ormerod 1994). The spacing distance between nesting pairs can influence the occupation of nest sites making potentially suitable sites unavailable due to territorial behavior and exclusion effects (Salinas Melgoza *et al.* 2009). The first nest descriptions of the Rufous-throated Dipper in rivers of northwestern Argentina were made by Dinelli (1918) and Olrog (1949, 1979) and later by Fraga and Narosky (1985), Salvador *et al.* (1986), Tyler and Tyler (1996) and de la Peña (2005). Detailed knowledge of breeding site characteristics is necessary to understand avian reproductive strategies and the mechanisms that regulate population dynamics (Auer *et al.* 2007). Information on habitat requirements allows predictions regarding the ability of species to adapt to disturbed habitats, and is needed for the development of effective conservation and management strategies for threatened species (Reading and Miller 2000). The objectives of this study were to describe nests and nest sites, determine habitat variables associated with nests and assess distances between nests of the Rufous-throated Dipper in mountain rivers of northwestern Argentina.

METHODS

Study Area

The southern Yungas extends through the eastern slopes of the Andes in Argentina and Bolivia and is the southernmost limit of neotropical montane forests (Hueck 1978). Fieldwork was conducted in the highest elevation zone of the southern Yungas (i.e., the cloud forest at an elevation from 1,700 to 2,500 m) (Cabrera 1994). The dominant tree species in the cloud forest are white pine (*Podocarpus parlatorei*) and alder (*Alnus acuminata*) (Cabrera 1994). The climate has a marked seasonality, characterized by a cold and dry period during the Austral winter. The average annual temperature is 13.9 °C, and rainfall is concentrated during the Austral summer and ranges between 1,000 and 3,000 mm per year (Minetti 2005).

Sectors of five rivers in the cloud forests of the southern Yungas in northwestern Argentina were selected for this study: 1) *Huayco Grande*, Santa Victoria Department, Salta Province: 22° 16′ 39″ S, 64° 44′ 48″ W (elevation 1,666 m); 2) *Caspalá*, Valle Grande Department, Jujuy Province: 23° 30′ 13″ S, 64° 58′ 19″ W (elevation 1,532 m); 3) *Yala*, Dr. Manuel Belgrano Department, Jujuy Province: 24° 07′ 14″ S, 65° 27′ 25″ W (elevation 1,677 m); 4) *Los Morados*, San Antonio Department, Jujuy Province: 24° 19′ 41″ S, 65° 26′ 15″ W (elevation 1,679 m); and 5) *Los Sosa*, Monteros Department, Tucumán Province: 26° 59′ 47″ S, 65° 39′ 42″ W (elevation 1,543 m).

Nest Characteristics and Distance between Nests

At each river, 3- to 6-km long transects were surveyed by walking along the river banks and searching intensively for nests from August to December 2010-2013. Nests found were categorized as used (when eggs or chicks were recorded), in development (in different building stages), old (no record of eggs or chicks were found in that breeding season), and decayed (destroyed partially). At each nest, the shape (globular or not globular), materials used for building (mud, moss, lichens, algae, dry leaves and feathers) and nest substrate (rock, ground, tree and bridge walls) were recorded. The following nest characteristics were measured with a metric tape or calipers: 1) height above the water level to the nest; 2) nest height; 3) width; 4) depth; 5) nest opening horizontal and vertical width; 6) internal depth; and 7) nest wall thickness. Additionally, the distance between active nests (including used nests and nests in development) within each breeding season, as well as the distance between active nests of each breeding season with those from the previous breeding season at each river, were measured.

Nest and Non-nest Plot Characteristics

Habitat variables at each nest found were measured in plots of 2 by 2 m (Loegering and Anthony 2006). Within each plot, the following habitat variables were recorded: 1) elevation (meters above sea level) and geographic coordinates (recorded with a GPS unit); 2) emergent rocks (%) (visually estimated as the percentage of the plot covered with rocks); 3) river slope (%) (measured with a clinometer); 4) number of rapids (i.e., section with higher water velocity and less depth; characterized by the formation of white water) and pools (i.e., section with lower water velocity and depth of more than 40 cm; characterized by the formation of backwater); 5) watercourse width (m) (determined by visually estimating the distance between cliffs or river banks); 6) river width (m) (determined by measuring the distance between shores with a metric tape); 7) water depth (m) (measured at five points using a graduated stick with a height of 1.80 m); and 8) water velocity (m sec^{-1}) (determined by the number of seconds it took a Styrofoam sphere to travel 10 m in the river). The same habitat variables measured for nest plots were recorded for non-nest plots. Non-nest plots were taken systematically every 150 m in 3-km long transects and every 225 m in 4.5-km long transects. Therefore, all transects consisted of 20 non-nest plots and were reassessed during each breeding season in the same period when nests were found (i.e., 40 non-nest plots for Huayco Grande and Caspalá, 60 for Los Sosa, 80 for Yala and Los Morados).

Data Analysis

River depth was calculated as the mean value from five measurements taken at each plot. Nest distance and nest and nest plot characteristics among rivers were tested for differences using ANOVA (F) or Kruskall-Wallis (H) tests according to the normal or not normal distribution of the data (Quinn and Keough 2002). Nest and non-nest plot characteristics were compared using Kolmogorov-Smirnov (KS) tests (Quinn and Keough 2002) for each river and grouping all rivers together. A non-parametric test was selected since data did not fulfill normality assumptions. Statistical analyses were performed with INFOSTAT in statistical program R (Di Rienzo *et al.* 2011).

RESULTS

Nests Characteristics

We found a total of 28 nests (13 active, 11 in development, 2 old and 2 decayed) on the five rivers during the survey period (Table 1). Only one nest was used twice in the same breeding season, in 2012 at Los Morados. Most nests (78.57%; n = 22) had a globular shape, two had a shape adapted to the substrate, and the shape of four could not be determined since they were not completed. Nests were adhered to a rocky substrate, and only two of them were adhered to an old bridge wall in Los Sosa. All of the nests were built with moss as the main building material woven with leaves of alder (*Alnus acuminate*), pampas grass (*Cortaderia* sp.) and different grass species, lichens, algae, feathers and pieces of plastic or Styrofoam. All of the nests found had a dome and cup. Inspected cups (n = 18) were arranged with a circular mattress of pampas grass covered by moss and feathers. Nest characteristics did not differed among rivers (Table 1). Height of the nest above the water level was significantly lower at Los Sosa than at the other rivers (H = 11.74, P = 0.02; Fig. 1). Slope and watercourse width were the only nest plot characteristics that differed significantly among rivers (Table 2). Distance of active nests did not differ significantly among rivers (F = 0.88, P = 0.47; Fig. 1), but distance of active nests to nests from the previous season was significantly greater at Los Morados than at Caspalá (H = 9.20, $P < 0.03$; Fig. 1).

Nest and Non-nest Plots

When grouping all rivers, plots at nest sites had significantly higher values than non-nesting plots for some habitat characteristics, including emergent rocks, slope, number of rapids and pools, water velocity, and water depth. However, plots at nest sites had narrower watercourse widths than non-nesting plots (Table 2).

DISCUSSION

The shapes, dimensions, substrates adhered to and building materials used for

Table 1. Number of nests and nest characteristics of the Rufous-throated Dipper (*Cinclus schulzi*) found from 2010 to 2013 in mountain rivers of northwestern Argentina. Values are expressed as means ± SD. Comparisons were conducted with ANOVA test (F); significant differences ($P < 0.05$).

	Huayco Grande	Caspalá	Yala	Los Morados	Los Sosa	Test value and significance level	Total
Number of nests	1	4	12	8	3		28
Nest width (cm)	—	23.5 ± 2.1	21.4 ± 3.2	20.3 ± 2.4	22.8 ± 3.9	F = 0.7, P = 0.6	21.5 ± 2.9
Nest height (cm)	—	21.5 ± 0.7	21.8 ± 5.4	19.9 ± 1.4	22.3 ± 3.9	F = 0.3, P = 0.8	21.2 ± 3.9
Nest depth (cm)	—	25.0 ± 4.2	18.3 ± 2.8	18.2 ± 3.8	18.8 ± 6.0	F = 2.2, P = 0.1	19.0 ± 3.9
Opening vertical height (cm)	—	7.5 ± 0.7	6.9 ± 1.5	6.3 ± 0.4	7.5 ± 0.0	F = 1.0, P = 0.4	6.8 ± 1.2
Opening horizontal width (cm)	—	7.0 ± 1.4	5.9 ± 1.2	5.5 ± 0.6	6.3 ± 0.4	F = 1.2, P = 0.4	5.9 ± 1.0
Internal depth (cm)	—	17.5 ± 0.7	16.8 ± 1.4	15.4 ± 1.5	15.5 ± 1.4	F = 1.6, P = 0.2	16.2 ± 1.5
Wall thickness (cm)	—	9.0 ± 0.0	9.3 ± 2.1	6.0 ± 0.0	7.8 ± 1.1	F = 0.9, P = 0.5	8.6 ± 1.9

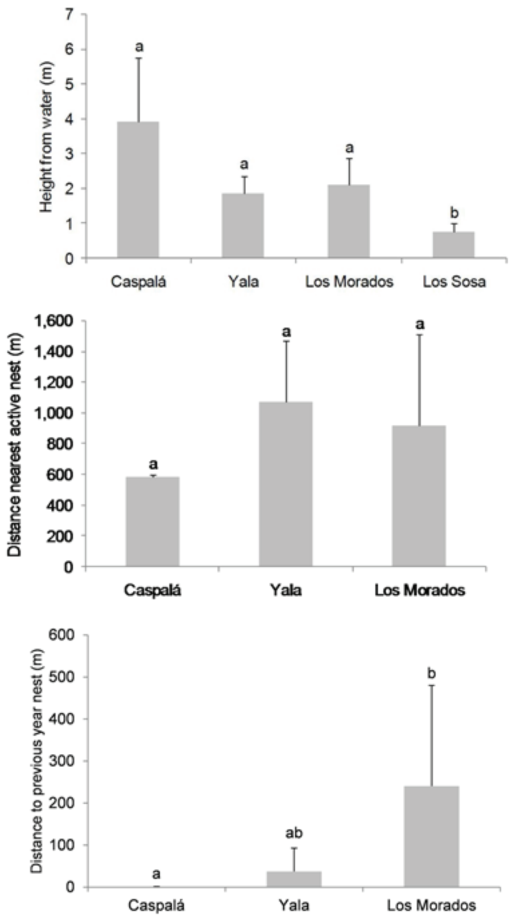

Figure 1. Height from the water level to nests of Rufous-throated Dipper (*Cinclus schulzi*), distance between active nests of the same breeding season and distance between active nests and nests of the previous breeding season at mountain rivers surveyed in northwestern Argentina from 2010 to 2013. Values are given as mean ± SD; different letters are significantly different: rivers with "a" are not signifcantly different ($P < 0.05$) from each other; rivers with the "b" differ significantly ($P < 0.01$) from other rivers.

nests of the Rufous-throated Dipper were similar to those previously recorded (Fraga and Narosky 1985; Salvador *et al.* 1986; Tyler and Tyler 1996; de la Peña 2005). Furthermore, these characteristics coincide with the shape, substrate and material for nests described for other species of dippers (*Cinclus sp.*) (Smiddy *et al.* 1995; Loegering and Anthony 2006). Nests found in this study had two defined structural zones: a dome and a cup. Height of the nest above the water level

Table 2. Nest plots of Rufous-throated Dipper (*Cinclus schulzi*), total nest plot characteristics grouped and non-nest plot characteristics measured from 2010 to 2013 in mountain rivers of northwestern Argentina. Different letters are significantly different among rivers for that characteristic, and asterisks are significantly different between nest plots and non-nest plots ($P < 0.05$).

Variables	Huayco Grande	Caspalá	Yala	Los Morados	Los Sosa	Total Nest Plot	Total Non-nest Plot
Emergent rocks (%)	50.0 ± 0.0	50.0 ± 29.4	37.1 ± 14.5	46.9 ± 17.5	50.0 ± 0.0	43.6 ± 17.2	29.0 ± 18.4 *
Slope (%)	11.0 ± 0.0	4.3 ± 1.7 ab	4.3 ± 2.6 a	6.9 ± 2.6 bc	8.7 ± 1.5 c	5.8 ± 2.9	4.2 ± 2.4 *
Number of rapids	3.0 ± 0.0	1.5 ± 1.3	1.2 ± 0.6	1.7 ± 0.8	2.3 ± 1.2	1.6 ± 0.9	1.0 ± 0.8 *
Number of pools	2.0 ± 0.0	1.5 ± 1.3	1.0 ± 0.5	1.4 ± 0.5	1.0 ± 0.0	1.2 ± 0.7	0.8 ± 0.6 *
Watercourse width (m)	12.8 ± 0.0	8.3 ± 1.0 a	17.4 ± 14.1 a	51.4 ± 19.0 b	8.9 ± 5.3 a	24.8 ± 22.0	49.6 ± 31.0 *
River width (m)	7.9 ± 0.0	6.2 ± 2.0	4.7 ± 0.9	4.0 ± 1.0	4.9 ± 0.9	4.8 ± 1.4	5.5 ± 1.9
Water depth (cm)	43.8 ± 0.0	42.9 ± 5.1	36.5 ± 11.0	40.7 ± 11.8	37.7 ± 4.6	39.0 ± 9.8	32.8 ± 8.6 *
Water velocity (m sec^{-1})	1.1 ± 0.0	1.2 ± 0.2	1.2 ± 0.3	1.2 ± 0.2	0.9 ± 0.1	1.1 ± 0.2	1.0 ± 0.3 *

was the only nest characteristic that differed among rivers surveyed in this study. Nests located at higher heights might suggest the need for greater protection from natural (e.g., river floods, predators) or anthropogenic (e.g., tourism) disturbances. However, we did not test this hypothesis, and other explanations also might be plausible and need to be tested (e.g., availability of nesting sites at greater heights above water) (Del Guasta 2003; Loegering and Anthony 2006).

Nests in Caspala occur at a distance of 600 m (Fig. 1), which suggest that this might also be the spacing required between active breeding pairs and territories. Distances between active nests did not differ among rivers, which might suggest that river quality was similar (Feck and Hall 2004). Distance of active nests from those of the previous breeding season was smaller than the distance of active nests from the same breeding season (i.e., new nests were always close to nests from the previous breeding season). This result might suggest site fidelity of breeding pairs among years.

Watercourse width and slope were the only two nest plot characteristics that differed among rivers. Nests were found in plots with a narrower watercourse width than those in non-nest plots. Narrow watercourses can correspond with river sectors that also have vertical rock formations, providing substrate for building nests that are protected from predators (Loegering and Anthony 2006). Nests were found in nesting plots with a higher percentage of emergent rocks, slope and number of rapids and pools than non-nest plots. Emergent rocks, rapids and pools increase habitat heterogeneity, which in turn results in a greater diversity of benthic invertebrate groups on which dippers feed (Ormerod and Tyler 1986; Santamarina 1990). Chen and Wang (2010) found a close relationship between food abundance and the number of rapids, and rapids were the sites most frequented used by Brown Dipper (*C. pallasii)* for feeding. Nests were found in plots with higher water velocity and water depth than non-nest plots. Feck and Hall (2004) found that American Dipper (*C. mexicanus)* builds nests in river sections with greater water velocity.

Previously, the understanding of the breeding habitat requirements of the Rufous-throated Dipper was based only on anecdotal evidence of nests and nesting sites. Understanding a species breeding habitat requirements is a prerequisite for making informed management and conservation decisions, particularly for threatened species. Further studies are necessary to elucidate the biology of this little known species and to develop a strategic conservation action plan for the Rufous-throated Dipper.

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