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EFFECT OF FOOD AVAILABILITY AND HABITAT CHARACTERISTICS ON THE ABUNDANCE OF TORRENT DUCKS DURING THE EARLY BREEDING SEASON IN THE CENTRAL ANDES, ARGENTINA

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ABSTRACT.—Torrent Ducks (*Merganetta armata*) inhabit rivers and streams across the Andes. The species feeds mainly on aquatic invertebrates and occurs in rivers with high flow rate, large emergent rocks, and low anthropogenic disturbance. The objective of this work was to study the effect of food availability and environmental variables on the abundance of Torrent Ducks in two streams with different levels of anthropic disturbance and diverse environmental conditions. To describe each stream, we recorded density and richness of benthic macroinvertebrates and physical-chemical variables, and characterized the stream habitats. We also censused the number of Torrent Ducks present in each stream. We prepared a principal component analysis to portray features of each stream. Generalized linear models were used to estimate which environmental variables were associated with the ducks' abundance and to explore variations in biotic variables between streams and between sections within each stream. We recorded 40 individuals in the stream with the lowest disturbance (Arroyo Grande) and four individuals in the most highly disturbed stream (Río Blanco). Variation in abundance of Torrent Ducks was better explained by a higher density of *Notoperla,* Plecoptera (an aquatic insect associated with clean waters) and to a lesser extent by flow rate. *Received 5 September 2013. Accepted 18 April 2014.*

Key words: Andean streams, benthonic invertebrates, flow rate, habitat quality, *Merganetta armata*.

Variations in habitat resources and environmental factors affect animal fitness (Johnson 2007) and may have deep influence on the regulation and persistence of populations in a given area (Morris 2003, Morris et al. 2008). Habitat use is the way a species uses environmental factors for its survival and reproduction (Block and Brennan 1993, Jones 2001). The study of habitat use patterns describes the distribution of individuals in different habitats (Jones 2001) which may be analyzed at different geographical scales (Johnson 2007). In this context, habitat quality can be considered as the ability of the environment to provide appropriate resources and conditions for population persistence (Hall et al. 1997). Jones (2001) points out the importance of distinguishing habitat use from habitat selection. He proposes that habitat use patterns are the result of habitat selection processes. Therefore, the study of habitat selection includes the understanding of behavioral and environmental processes that affect survival and fitness of individuals (Jones 2001).

In studies of habitat use, it is important to quantify multiple habitat indicators because conditions favoring some parameters may not be the same favoring others (Franklin et al. 2000, Johnson 2007). Among these factors, food availability is one of the most studied (López-Sepulcre and Kokko 2005). Therefore, individuals may select foraging areas by taking into account the kind and the quality of resources available (Morris 2003, Morris et al. 2008).

Torrent Ducks (*Merganetta armata*) inhabit lotic habitats across the South American Andes range from Venezuela to southern Argentina (Johnsgard 1966, Fjeldså and Krabbe 1990). They are associated with rivers and streams characterized by rapids, cascades, and emergent rocks (Johnsgard 1966, Ringuelet 1977). These attributes may be related to stream oxygenation and abundance of invertebrate fauna (Johnsgard 1966, Ringuelet 1977). Torrent Ducks nest in rock holes, in the ground below the riparian vegetation near the water, in tree holes (Moffet 1970), or on small islands (Cardona and Kattan 2010). Riparian vegetation not only provides breeding sites but may also act as a refuge against predators (Colina 2010). Between feeding events, Torrent Ducks use

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emergent rocks as resting places (Johnsgard 2010). Previous work in northern Argentina reported that Torrent Ducks occurred only in rivers with high flow rate, large emergent rocks, and low anthropogenic disturbance (Sardina Aragón et al. 2011).

Torrent Ducks feed mainly on aquatic invertebrates and occasionally on small fishes (Johnsgard 1966). Larvae of several insects, including Trichoptera, Ephemeroptera, Coleoptera, Plecoptera and Lepidoptera, have been reported to be part of their diet (Moffet 1970, Riguelet 1977, Naranjo and Avila 2003, Cerón et al. 2010).

In mountain aquatic systems, macroinvertebrate diversity is affected by different variables such as: slope, flow rate, velocity, water oxygenation, temperature, pH, conductivity, substrate type and primary productivity (Hynes 1970, Burgherr and Ward 2001, Finn and Poff 2005, Füreder et al. 2005). Several studies on the relationships between environmental variables and benthic macroinvertebrate assemblages were conducted in west-central Argentina (Scheibler and Debandi 2008; Scheibler et al. 2014a, b). In the Mendoza river basin (central Andes of Argentina), the highest densities and richness of invertebrates were recorded during autumn and winter (Scheibler et al. 2014a). However in other freshwater studies, the highest macroinvertebrate diversity and abundance have been reported during spring, coinciding with the beginning of the ducks' reproductive period (Sánchez-Arguello et al. 2010, Kosnicki and Sites 2011).

The Torrent Duck has been categorized as a species of least concern (BirdLife International 2013), but some subspecies are considered vulnerable or endangered (Green 1996). In Argentina, this species is considered threatened because of its low abundance and sensitivity to changes (Lopez-Lanús et al. 2008). Previous studies have reported that the territory size of Torrent Ducks varies between 700 m and 2 km (Moffet 1970, Eldridge 1986, Naranjo and Avila 2003, Colina 2010). However, this species remains little studied and this is the first work conducted in the central Andes of Argentina.

Our objective was to assess what food availability and habitat characteristics are associated with abundance of Torrent Ducks. In particular, we studied food parameters (richness and abundance of macroinvertebrates), nest site availability, and riparian vegetation. We expected to find Torrent Ducks in areas with more food available, higher flow rates, more islands, large emergent rocks, and less distance from river edge to riparian vegetation. We conducted field work during the early breeding season (beginning of summer), because previous observations in the study area showed the highest presence of Torrent Ducks during January. Few studies on birds have directly measured habitat attributes to attempt to determine habitat quality; instead, most studies have used population density or habitat occupancy as an indirect measure of habitat quality (Johnson 2007). In this work, we directly measured Torrent Ducks' abundance and a set of different habitat characteristics that may influence habitat selection.

METHODS

Study Area.—The central Andes in Argentina comprise two parallel topographic units: the Cordillera Principal at the west and the Cordillera Frontal at the east (Abraham and Rodriguez Martinez 2000). The weather is cold and dry, with strong winds and low temperatures (Abraham and Rodriguez Martinez 2000, Mendez 2007). This area belongs to the High Andes region (Burkart et al. 1999).

Field work was conducted in and around two streams, Arroyo Grande and Río Blanco, located at similar altitudes on the central Cordillera Frontal in Mendoza, Argentina (69° 26′ W, 33° 36′ S). Arroyo Grande is ~75 km south of Río Blanco. Both streams have a glacial source but also receive water contributions from high Andes wetlands (Soria 2004, Mendez 2007). Vegetation is representative of the High Andes region, dominated by shrub communities of moldenke (*Junellia juniperina*), yellow firewood (*Adesmia pinnifolia*) and molle (*Schinus fasciculata*). In Arroyo Grande, the invasive plant rosa mosqueta (*Rosa* spp.) is also common (Soria 2004). The area of Arroyo Grande is moderately disturbed by humans through tourism and fly fishing, and two mountain shelters discharge wastewater effluents into the stream (Soria 2004). Río Blanco shows a higher degree of disturbance by tourism, mainly focused on skiing and mountaineering and because several mountain shelters discharge wastewater effluents into the stream (Soria 2004, Mendez 2007). The vegetation also differs, with a greater abundance of chacay (*Discaria trinervis*; Soria 2004, Mendez 2007).

Data Collection.—We carried out the field work in Arroyo Grande and Río Blanco during

December 2009. In order to estimate food availability, we collected samples from three sections in each stream: upper (2,600–2,800-m elevation), middle (2,300–2,600-m elevation) and lower (2,100–2,300-m elevation). Distance from the lower to the upper section was 6 and 5.5 km respectively. From each section we took three macroinvertebrate samples located at 100 m from one another using Surber nets (300 μm mesh size, 0.09 m^2 area) that remove the substratum of the river bed. We kept the samples in alcohol (95%) and identified the organisms to the lowest possible taxonomic level.

At each sampling point, we also recorded the following physical-chemical variables: pH, oxygen saturation (%), water temperature (°C), current speed (m/s, Gordon et al. 1994), stream width (m), depth (m) and slope and flow rate (m^3/s). We recorded and measured substrate compositions according to Cummins (1992) as large rocks (1–2 m^2), medium rocks (0.5–1 m^2), small rocks (0.25–0.5 m^2), cobbles (6.4–25 cm), pebbles (3.2–6.4 cm), gravel (0.2–3.2 cm) and sand (0.06–0.2 cm). We measured average shrub height in a 2 m^2 plot next to the shore on each sampling site and measured the distance between the stream shore and the nearest shrub taller than 50 cm. We also recorded the number and size of emergent large rocks and islands from 25 m upstream to 25 m downstream of each sampling site (Cummins 1992).

To determine population abundance of Torrent Ducks, two observers walked at a constant speed along Arroyo Grande and Río Blanco from the lower to the upper section. For each stream, we recorded all Torrent Ducks observed, and for each record we noted place, number of individuals, sex, and reproductive stage of each individual.

Statistical Analyses.—We collected 23 variables, including microhabitat (emergent rocks, islands, and characteristics of marginal vegetation), physical-chemical, and biotic variables (richness, diversity and density of macroinvertebrates), from the sampling sites. To examine which combinations of biotic and abiotic variables were more predictive in describing each sampling site, a Principal Component Analysis (PCA) was applied using INFOSTAT software (Di Rienzo et al. 2011). All data were standardized.

To explore variations in biotic variables (i.e., density, diversity and richness of macroinvertebrates) between streams (Arroyo Grande vs. Río Blanco) and stream sections (upper, middle and lower), a spatial analysis was performed. For this analysis we used Generalized Linear Models (GLMs, GENSTAT software, Version 4.2, 2005). Discrete data (density and richness) were analyzed using Poisson distribution with logarithm as link function, and tested with χ^2. Because residual errors in the model of density showed overdispersion (i.e., residual deviance was higher than the degree of freedom of the residual), the model was rescaled to correct for biases in the statistical test of hypotheses using F tests instead of χ^2 as a measure of fit. Continuous data (diversity) were analyzed using Normal distribution and identity link and tested with F.

To eliminate redundant information among the environmental variables measured, we carried out data reduction using Spearman's correlation analysis. Significantly correlated variables ($P < 0.05$) were eliminated, keeping those with high biological significance and/or those easily measurable in the field. Selected variables plus biotic variables were related to Torrent Ducks' abundance by means of GLMs. Since abundance of Torrent Ducks is a discrete variable, models assuming Poisson distribution and a log link function were used.

Several authors have demonstrated that stoneflies (Plecoptera) are useful as bioindicators of unpolluted waters in freshwaters systems (Stewart and Stark 2008, Miserendino et al. 2011, Arimoro et al. 2012). As we observed that *Notoperla* was the biggest and most exposed Plecoptera, we created a new variable using the density of this group as one indicator of water quality on each stream. Also, since there is only one datum for abundance of Torrent Ducks and three replicates for all the rest of the variables per stream section, GLM analyses were carried out relating duck abundance to the average of the replicates of all explaining variables.

Variable selection to build the best model explaining Torrent Ducks' abundance was as follows: one model was built for each variable (i.e., those selected from Spearman's correlation analysis and biotic variables such as richness, diversity, density, and density of Plecoptera), from the resultant models, the one with lowest residual deviance and AIC was selected; then, a new round of models was built with all the possible combinations of the previously selected variable plus the rest of variables (two-variable models), selecting again that model with lowest residual deviance and AIC. This criterion was

TABLE 1. Eigenvalues for the first (PCA1) and the second (PCA2) principal components.

Variables/Variance	PCA 1 51.41 (%)	PCA 2 17.2 (%)
pH	−0.15	−0.25
% O2 saturation	0.10	0.39
Water temperature	−3.8E-03	−0.29
Velocity	0.08	−0.03
Wet width	−0.25	−0.14
Depth	−0.28	−0.01
Flow rate	−0.26	−0.12
Transparency	−0.26	−0.18
Emergent rocks	0.25	0.25
Island	0.26	−0.06
Distance to vegetation	0.28	0.05
Vegetation height	0.01	−0.24
Slope	−0.06	0.09
Large rocks	−0.27	0.13
Median rocks	−0.09	0.41
Boulder	0.11	−0.33
Cobbles	0.27	0.03
Pebbles	0.28	0.09
Gravel	0.16	−0.10
Sand	0.16	−0.36
Macroinvertebrates density	−0.22	0.13
Macroinvertebrates richness	−0.26	0.13
Macroinvertebrates diversity	−0.25	0.14

followed until the variable entered into the model was not significant, using a normal approximation (*z*-statistic) for testing the hypothesis.

RESULTS

Principal Component Analysis showed that PC1 accounted for 51.4% of the variability, whereas PC2 explained 17.2% of it. PC1 was defined mostly from stream characteristics (river width, depth, flow rate, and transparency), microhabitat variables (island and distance of vegetation), substrate composed of large rocks, cobbles and pebbles, and biotic variables (density, richness and diversity of macroinvertebrates). PC2 axis was defined by physical-chemical variables (pH, oxygen and water temperature), vegetation height, and substrate composed of medium rocks, boulders, and sand (Table 1, Fig. 1). Between Arroyo Grande and Río Blanco we found striking differences in the environmental variables. Arroyo Grande was defined by the highest pH (7.5), transparency (maximum value: 0.6 m) and flow rate values, greater depths (mean: 0.85 m), and substrate composed of a high percentage of large rocks and represented by the highest macroinvertebrate diversity (Table 2). In the lower section we recorded a peak in flow rate (41.8 m^3/s) and river width (14.4 m). Río Blanco

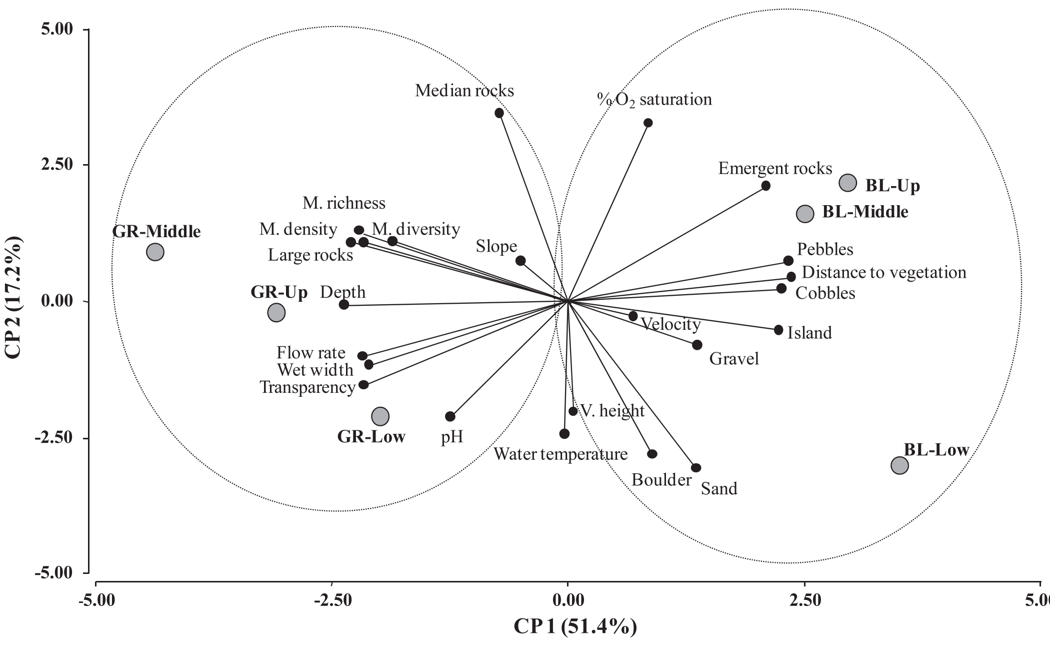

FIG. 1. Biplot of sampling sites and biotic and abiotic variables resulting from PCA.

TABLE 2. Mean and standard deviations of physical-chemical variables in Río Blanco and Arroyo Grande.

	Río Blanco			Arroyo Grande		
Environmental variables	Upper section	Middle section	Lower section	Upper section	Middle section	Lower section
pH	7.37 (0.20)	7.10 (0.04)	7.40 (0.09)	7.50 (0.15)	7.39 (0.05)	7.48 (0.05)
O_2 saturation (%)	94.33 (1.53)	95.00 (0.00)	89.07 (3.10)	90.53 (2.37)	90.83 (2.75)	92.10 (0.79)
Water temperature (°C)	5.37 (1.75)	7.03 (0.57)	11.67 (1.10)	6.50 (1.70)	10.01 (0.46)	6.83 (0.49)
Velocity (m/s)	3.67 (0.24)	3.03 (0.98)	3.41 (0.40)	2.85 (0.21)	3.36 (0.28)	3.51 (0.13)
Width (m)	3.80 (0.92)	6.40 (0.69)	5.20 (1.83)	10.00 (1.83)	10.00 (1.83)	12.40 (2.50)
Depth(m)	0.43 (0.08)	0.55 (0.13)	0.42 (0.08)	0.82 (0.06)	0.80 (0.09)	0.77 (0.06)
Flow rate (m^3/s)	6.05 (1.81)	9.05 (3.89)	7.25 (2.26)	23.18 (3.91)	26.65 (4.33)	33.75 (9.21)
Slope(°)	36.33 (14.57)	24.67 (5.03)	25.00 (13.23)	27.33 (6.81)	30.67 (16.77)	36.67 (25.17)
Number of emergent rocks (km^2)	793.3 (223)	1026.6 (251.6)	1,060 (336.45)	500 (200)	533.3 (190)	593.3 (100.6)
Number of islands with vegetation (km^2)	40 (20)	40 (34.6)	40 (34.6)	33.3 (11.5)	6.6 (11.5)	20 (0.58)
Height of riparian vegetation (m)	0.47 (0.40)	0.97 (0.40)	1.00 (0.35)	1.20 (0.00)	0.53 (0.61)	0.80 (0.69)
Distance of vegetation to stream border (m)	0.47 (0.40)	0.93 (0.46)	1.00 (0.35)	0.63 (0.60)	0.50 (0.62)	0.53 (0.61)
Dominant substrate	Medium rocks	Large rocks	Small rocks and pebbles	Large and medium rocks	Large and medium rocks	Large and small rocks

was defined by a greater number of emergent rocks and islands, greater distances to shrubs, substrate was composed of pebbles, cobbles, boulders, sand, and gravel and by the highest water temperature (12.9 °C), velocity (4.1 m/s), and oxygen values (96%) (Table 2).

With regard to food availability, we found individuals from 3 phyla: Platyhelminthes (1 taxon: Family Dugesiidae, Order Tricladida, Class Turbellaria), Annelida (1 taxon: Order Oligochaetha, Class Clitellata), and Arthropoda (16 taxa: Class Arachnida and Class Insecta). Class Arachnida was represented only by the sub-Class Acari (1 taxon). Class Insecta was represented by 6 orders and 13 families (15 taxa). Among them, we were able to determine the genus in six cases (Table 3). All the taxa were present in Arroyo Grande, but five of them were absent in Río Blanco (Table 3). The most represented taxon (richness and abundance) was Class Insecta. Most of the insects present were from the Orders Diptera (relative abundance: 55.9%) and Ephemeroptera (relative abundance: 29.2%, Table 1). We estimated that the middle section presented higher macroinvertebrate density (maximal density: 2307 vs. 841 and 819 individuals/m^2), higher taxonomic richness (maximal richness: 15 vs 11 and 10 species) and higher diversity (maximal diversity: D_{mg} = 1.8 vs 1.49 and 1.34) than the upper and lower sections respectively. In Río Blanco, the most represented taxon (richness and abundance) was also Class Insecta, represented by the Orders Ephemeroptera (relative abundance: 50.6%), Diptera (20.4%) and Trichoptera (20.1%, Table 3). We estimated that the upper section presented higher density of macroinvertebrates in relation to the middle and lower sections (921 vs 254 and 431 individuals/m^2) but the highest diversity was recorded in the middle section (D_{mg} = 1.09 vs 0.98 and 1.02 corresponding to the lower and upper sections of the river). GLM results showed significant differences between streams in macroinvertebrate density ($F_{1,17} = 5.13$, $P = 0.04$), richness ($\chi^2_{1,17} = 8.59$, $P = 0.003$), and diversity ($F_{1,17} = 6.51$, $P = 0.023$). However, no significant differences were found between sections.

We recorded 40 Torrent Ducks in Arroyo Grande: 10 females, 11 males, 17 chicks, and 2 fledglings. Eleven individuals were in the lower section, 22 in the middle section and seven in the upper section. We identified nine reproductive couples along the stream (density = 1.5 pair/ 0.5 km), one pair in the lower section (density = 0.5 pairs/ 0.5 km), six pairs in the middle section (density = 3 pairs/0.5 km), and two pairs in the upper section (density = 1 pair/0.5 km). Chicks and fledglings were always with adults in groups of 2–4 individuals. In Río Blanco we found four Torrent Ducks: three females and one isolated

TABLE 3. Mean density of benthic macroinvertebrates (individual/m^2) and standard deviation (in parentheses) collected at each sampling site.

Macroinvertebrates Order Family Genus	Río Blanco			Arroyo Grande		
	Upper section	Middle section	Lower section	Upper section	Middle section	Lower section
Ephemeroptera						
Leptophlebiidae						
Massartellopsis	214.67 (178.51)	85 (44.91)	159.3 (135.95)	221.67 (150.32)	407.33 (337.67)	7.33 (6.35)
Baetidae						
Andesiops	22.00 (0)	25.67 (27.68)	22.00 (11.00)	18.33 (6.35)	29.33 (31.75)	18.33 (31.75)
Trichoptera						
Limnephilidae	177.67 (218.76)	18.33 (6.35)	7.33 (6.35)	11.00 (11.00)	36.67 (25.40)	3.67 (6.35)
Hydrobiosidae						
Cailloma	0	0	7.33 (12.70)	7.33 (12.70)	14.67 (12.70)	14.67 (25.40)
Plecoptera						
Gripopterygidae						
Notoperla	11 (11)	7.33 (12.70)	0	25.67 (16.80)	29.33 (22.90)	11 (19.05)
Antarctoperla	0	0	0	7.33 (12.70)	44.00 (44.00)	3.67 (6.35)
Limnoperla	0	0	0	0	7.33 (6.35)	22 (19.05)
Coleoptera						
Elmidae	0	0	0	0	11.00 (11.00)	22.00 (22.00)
Staphylinidae	7.33 (12.70)	0	0	3.67 (6.35)	0	0
Hemiptera						
Belostomatidae	0	0	0	3.67 (6.35)	0	0
Diptera						
Chironomidae	81.33 (73.79)	36.67 (16.80)	51.33 (44.46)	218 (130.05)	481.67 (433.41)	307 (215.45)
Athericidae	0	7.33 (6.35)	0	25.67 (16.80)	125.33 (70.44)	14.67 (16.80)
Simuliidae	3.67 (6.35)	7.33 (12.70)	18.33 (31.75)	44.33 (58.77)	73.67 (28.15)	29.33 (33.61)
Blephariceridae	3.67 (6.35)	0	3.67 (6.35)	3.67 (6.35)	11.00 (0)	3.67 (6.35)
Tabanidae	0	0	0	0	3.67 (6.35)	0
Others macroinvertebrates						
Dugesiidae	22 (38.11)	7.33 (6.35)	3.67 (6.35)	0	22 (38.11)	3.67 (6.35)
Acari	3.67 (6.35)	0	0	7.33 (6.35)	7.33 (6.35)	0
Oligochaetha	3.67 (6.35)	3.67 (6.35)	22 (38.11)	0	29.33 (33.61)	3.67 (6.35)

fledgling. We recorded one female in the lower section, one female in the middle section, and one female and one fledgling in the upper section.

From 20 variables of microhabitat and physical and chemical characteristics of each stream section, we retained 10 after Spearman's correlation for the GLM analysis. The variables finally used in the GLM analysis were: pH, oxygen saturation, slope, flow rate, vegetation height, medium rock, small rock, gravel and sand.

Generalized Linear Models (GLMs) showed that density of Plecoptera was the variable that best explained variability in Torrent Ducks' abundance. After the first round of model selection, this variable showed the lowest residual deviance and AIC, explaining >87% of data variability ($Z = 3.91$, $P < 0.001$). In the second round of model selection, flow rate was the variable selected ($Z = 2.24$, $P = 0.025$), explaining an additional 11% of data variability. More complex models showed no significant variables.

DISCUSSION

The Torrent Duck is one of four anatid river specialists that inhabit mountain streams around the world. Other river specialists are the Blue Duck (*Hymenolaimus malacorhynchos*) from New Zealand, the African Black Duck (*Anas sparsa*) from Africa, and the Salvadori's Teal (*Salvadorina waigiuensis*) from New Guinea (Eldridge

1986). Although they are not closely related (Livezey 1986), they occupy fast and clean mountain streams that share some physical characteristics and invertebrate fauna throughout the world (Kear 1975, Johnsgard 2010).

Distribution and abundance of animals is generally related to the distribution and abundance of their food supply (Percival and Evans 1997). Our study supports this assertion since differences between Arroyo Grande and Río Blanco may be caused mainly by differences in food abundance. We observed that Río Blanco was more affected by human impact than Arroyo Grande, and in concordance, we found lower macroinvertebrate diversity. It has been widely reported that land use negatively affects water quality and in consequence, biodiversity of benthic macroinvertebrates (Miserendino et al. 2011).

Pair density of Torrent Ducks was higher in Arroyo Grande than in Río Blanco. The pair density recorded in Arroyo Grande is one of the highest reported in comparison to other locations (Naranjo and Avila 2003, Vila and Aprile 2005, Cardona and Kattan 2010, Sardina Aragón et al. 2011) and is the highest record for the Andes (McCracken, pers. com.).

Like the Blue Ducks and the Salvadori's Teals, Torrent Ducks feed mainly on benthic macroinvertebrates (Johnson 1963, Moffet 1970, Cerón et al. 2010, Johnsgard 2010). GLM results showed that abundance of Torrent Ducks was explained by density of Plecoptera and flow rate. In our study, the highest density of Torrent Ducks was found in Arroyo Grande. This stream, with respect to Río Blanco, showed the highest density of macroinvertebrates, especially Simuliidae larvae that are preferred in this species diet (Cerón et al. 2010); highest densities of Plecoptera and Ephemeroptera, which could indicate better water quality (Miserendino et a. 2011); and the highest flow rate. We found the highest densities of Torrent Ducks and macroinvertebrates in the middle section of the Arroyo Grande. Previous studies in the region showed that highest macroinvertebrate density and richness in the middle section of aquatic systems are explained by coexisting species from upper and lower sections of the river (Scheibler and Debandi 2008, Scheibler et al. 2014). Those results suggest that Arroyo Grande provides better conditions for Torrent Ducks.

PCA results showed that Arroyo Grande had higher flow rate than Río Blanco. Our results suggest that stream flow rate could be playing a primary role in the prevalence of Torrent Ducks. Similarly, previous research pointed out the importance of stream flow in the abundance of the four river specialist ducks (Eldridge 1986, Johnsgard 2010, Sardina Aragón et al. 2011). Stream flow affects macroinvertebrate community structure (Kosnicky and Sites 2011), water transparency, and food searching associated with transparency (Johnsgard 2010). Furthermore, clean running waters are essential to the presence of stoneflies (Stewart and Stark 2008). Lower values in diversity, taxonomic richness, and macroinvertebrate density in Río Blanco could be explained by higher human disturbance on this stream. In the present study, we did not take direct measures that indicate pollution, and therefore future work should study phosphorus and nitrogen content in both rivers in order to estimate real pollution levels.

Sardina Aragón et al. (2011) found a positive correlation between the number of emergent rocks and density of Torrent Ducks in northern Argentina. Our PCA results show an inverse correlation, because emergent rocks were positively associated with Río Blanco, where Torrent Ducks' density was lower. Nonetheless, although emergent rocks in Arroyo Grande were scarce, they were significantly larger than in Río Blanco. Males may stand on larger rocks to watch stream banks while females and chicks feed. Further studies should address the importance of the presence of emergent rocks on this species' abundance.

There is increasing evidence that the abundance of many waterbird species is declining worldwide (Wen et al. 2011, BirdLife International 2013). Although the Torrent Duck is not an endangered species (BirdLife International 2013), it is a threatened species in Argentina (Lopez-Lanús et al. 2008). The Torrent Duck is a monotypic genus and one of the very few river specialist ducks in the world (Eldridge 1986). Therefore, it is important to understand the regional environmental characteristics affecting its distribution and abundance. Stream flow and food availability in this region seem to be positively related to Torrent Ducks' abundance. Future works should extend temporal (during the breeding season) and spatial scales, and pay special attention to perturbed and unpolluted freshwater systems in order to improve our knowledge of this species.

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