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BLACK-AND-WHITE MONJITA (*XOLMIS DOMINICANUS*) FOLLOWED BY THE SAFFRON-COWLED BLACKBIRD (*XANTHOPSAR FLAVUS*): STATISTICAL EVIDENCE

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Noivinha (*Xolmis dominicanus*) seguida pelo Veste-amarela (*Xanthopsar flavus*): evidências estatísticas.

Key words: Black-and-white Monjita, *Xanthopar flavus*, Saffron-cowled Cowbird, *Xolmis dominicanus,* association, habitat, logistic regression, null model.

INTRODUCTION

The Saffron-cowled Blackbird (SCB) (*Xanthopsar flavus*) inhabits grasslands in Uruguay, Argentina, and southern Brazil. The species inhabits both grasslands, which are used as preferential habitat for foraging, as well as wetlands and marshes, where it breeds (Fonseca *et al.* 2004, Fraga 2005).

The SCB forms foraging flocks with other species (mainly other Icteridae and Tyrannidae) supposedly taking advantage of the fact that other species serve as sentinels for the flock. One of the species to which the SCB is associated is the Black-and-white Monjita (BWM) X*olmis dominicanus* (Fontana & Voss 1996).

There is descriptive evidence of an association preference of the SCB for BWM, rather than with other species (Días & Maurício 2002). The BWM exhibits the typical behavior of Tyrannidae, waiting on a perch usually less than 2 m above the ground and catching insects that pass by, preferably in areas where the soil is visible (Orians 1978) and, perhaps for this reason, it is a species that acts as an effective sentinel. The SCB forages by searching on the ground for invertebrates by walking around and picking them up (Ridgely and Tudor 1989). This behaviour makes the flock more vulnerable to attacks from predators and explains the need for constant vigilance (Dias & Maurício 2002).

The interaction between the SCB and BWM has long been recognized, but the exact nature of the interaction is unknown. The literature only provides descriptive evidence of this association and there is a lack of statistical evidence. Thus, the present study offers the first inferential assessment, using logistic

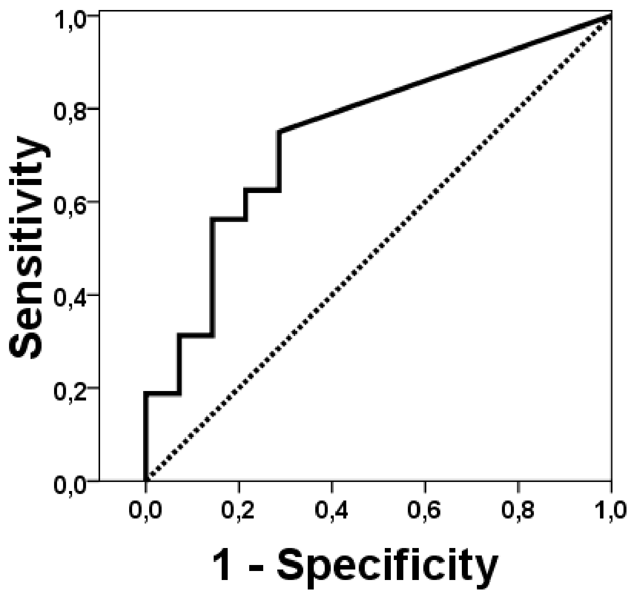

FIG. 1. Receiver Operating Characteristic (ROC) curve (solid line) and diagonal reference line (dotted line). The accuracy of predicting the presence of Saffron-cowled Blackbird by the presence of Black-and-white Monjita is fair (AUC = 0.746). Diagonal segments are produced by ties.

regression and null model to test whether such an association exists or is merely the product of chance.

STUDY SITE AND METHODS

The study was undertaken in the Araucaria Highlands, also known as Araucaria Plateau region (state of Rio Grande do Sul, southern Brazil) in the municipalities of São Francisco de Paula, Cambará do Sul, Jaquirana, Bom Jesus, and Vacaria between 29°26'46.9"S, 50°36'32.4"W and 28°31'10.2"S, 50°49'26.0"W. Thirty wetlands (marshes) were investigated on a monthly basis between November 2008 and March 2009. These marshes are small formations stemming from the accumulation of rainwater in depressions within the undulating terrain, which are dominated by aquatic macrophytes rooted in the soil (grasses and sedges) as well as bushes (*Ludwigia*, *Baccharis*), with no visible surface water. The mean area of marshes is 2.13 ± 2.32 ha, the greatest area has 10.5 ha while the smallest is 0.16 ha.

Each marsh was observed once per month, using two methodologies for the sampling of the birds: 15-min census from an elevated point using binoculars 10X50 and, subsequently, a visual census by walking in a constant speed around the marsh edge. The association was tested through Logistic Regression, by which we tested with SPSS 17.0 whether the presence of BWM influences the presence of SCB,. To test whether the association probability is different than that expected by chance, we compared a real linear regression model to a random linear regression model (10,000 iterations) between BWM and SCB abundance, using the EcoSim software program (Gotelli & Entsminger

TABLE 1. Linear Regression Models between abundances of Black-and-white Monjita and Saffron-cowled Blackbird, and comparison of observed and simulated models (iteration = 10,000).

	Intercept	Slope	R
Observed	2.294	2.291	0.513
Mean of simulated	6.807	-0.003	-0.001
Variance of simulated	2.697	0.697	0.035
Number of times observed < simulated	9916.0	84.0	84.0
Number of times observed = simulated	0.0	0.0	0.0
Number of times observed > simulated	84.0	9916.0	9916.0
Standardized Effect Size	1.399	2.748	2.748
P (observed <= expected)	0.008	0.992	0.992
P (observed >= expected)	0.992	0.008	0.008

2009). We applied the analysis over the cumulative number of individuals in the marshlands.

RESULTS AND DISCUSSION

The logistic model showed that the presence of BWM in a marsh influences positively the presence of SCB (Nagelkerke $R^2 = 0.28$; Wald = 5.94; $P = 0.014$; Y = -0.916+2.015X). The area under the ROC curve (AUC) is 0.75 (Null Hypothesis area = 0.5; SE = 0.092 Asymptotic P = 0.02). The ROC (Receiver Operating Characteristic) curve allows measuring the predictive power of independent variable over a binary dependent one. The AUC is a probabilistic measure of the test accuracy. AUC values vary between 0.5 and 1.0, where one is the perfect adjust of the model, and 0.5 is the fail of the model. The more AUC reaches 0.5, the more random is the association between variables. So the accuracy to predict the presence of SCB by the presence of BWM is fair (Fig. 1).

The regression analysis resulted in an observed model, in which BWM abundance had a positive influence over SCB abundance (Y = 2.294+2.291X; R = 0.51). The simulated model did not reveal a relationship between the species (Y = 6.807-0.003X; R = -0.001). The comparison of the observed model with the model generated from the average of simulations indicated that the association between SCB and BWM is different from what would be expected by chance, with the Observed Intercept lower than expected and Observed Slope and R greater than expected. Thus, the influence of BWM abundance over SCB abundance is greater than that expected by chance; if the association was random, the observed model would be equal to the simulated model. As we find models are different, we assume that this association exists indeed (Table 1, Fig. 2).

The results indicate that there is an association between the SCB and BWM, but it is not an obligatory association. This is indicated by the R values and cases in which the SCB occupied marshes without the presence of the BWM. On the other hand, the number of BWMs in a marsh had a certain influence over the size of the SCB flock.

Our field observations evidence that SCBs follow BWMs movements, as we often observed that when one or more BWMs left the marshland towards the neighboring grasslands, they were usually followed by the SCB flock. The same behaviour was observed by Dias & Maurício (2002). Our field observations neither argue for or against the hypothesis that there are benefits for neither. We believe that SCB follows BWM for the likely

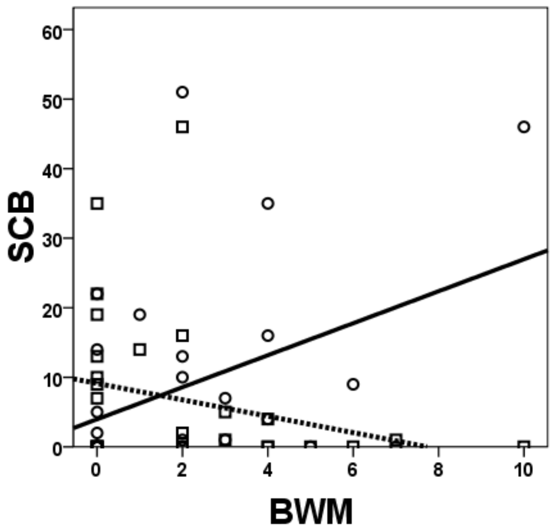

FIG. 2. Linear Regression between Black-and-White Monjita (BWM) and Saffron-Cowled Blackbird (SCB) abundances. Circles indicate the observed data and solid line represents the linear model of observed data. The squares indicate simulated data and the dashed line is the linear model for simulated data.

advantages provided by the sentinel behavior of the latter species, as is discussed in literature (Días & Maurício 2002, Fraga 2005). It is still necessary to quantify these benefits, such as measuring and comparing the foraging performance and response time of anti-predatory behaviour of SCB in the presence and absence of BWM.

As both species are classified as Vulnerable (Birdlife International 2008a, b), all new information is relevant. It is also important to quantify the co-occurrence of these two species to understand to what extent this association influences habitat selection and usage, as well as the role of environmental characteristics in these processes so that conservation and favorable management practices can be implemented.

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