MOBBING ON THE STRIPED OWL (*ASIO CLAMATOR*) AND BARN OWL (*TYTO ALBA*) BY BIRDS IN SOUTHEAST BRAZIL: DO OWL DIETS INFLUENCE MOBBING?

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Resumo. – Comportamento de tumulto contra a coruja-orelhuda e a suindara por aves no sudeste do Brasil: a dieta das corujas influencia o tumulto? – O comportamento de tumulto ou mobilização é considerado uma adaptação anti-predação com a função de alertar outras aves para a presença de um predador, ao qual confunde e causa seu afastamento posterior. Testamos a hipótese de que a ornitófaga coruja-orelhuda *Asio* (= *Pseudoscops*) *clamator* deveria gerar um maior nível de tumulto do que a suindara *Tyto alba*, um predador ocasional de aves. O trabalho de campo foi desenvolvido de julho a agosto de 2006 in numa savana da Estação Ecológica de Itirapina (22°13'S, 47°53'W), sudeste do Brasil. Em 64 pontos experimentais exibimos um de dois modelos (um espécime montado de *T. alba* ou *A. clamator*) e reproduzimos respectivamente seus chamados típicos. Dois dias depois este processo foi repetido no mesmo ponto com o outro modelo (32 pontos para cada seqüência de modelos). Quarenta e cinco espécies de aves exibiram tumulto para ambas corujas, 38 para *A. clamator* e 33 para *T. alba*. A composição de aves tumultuadores foi similar para ambos modelos de corujas, que atraíram aves desproporcionalmente mais próximo (< 10 m) do que seria esperado ao acaso. Como previsto, números significativamente maiores de espécies e indivíduos produziram tumulto contra *A. clamator* do que contra *T. alba*. Adicionalmente, a intensidade de tumulto foi maior contra *A. clamator* do que *T. alba*, o que sugere identificação diferenciada do predador por parte das aves.

Abstract. – Mobbing behaviour is considered an anti-predator adaptation that functions to alert other birds to the presence of a true predator, confusing and causing the latter to retreat. We tested the prediction that the ornithophagous Striped Owl *Asio* (= *Pseudoscops*) *clamator* should generate heavier mobbing than the Barn Owl *Tyto alba*, an occasional predator of birds. Fieldwork was conducted between July and August 2006 in a savannah of the Estação Ecológica de Itirapina (22°13'S, 47°53'W), southeast Brazil. At 64 trial points we displayed one of two dummies (a mounted *T. alba* or *A. clamator* specimen) and broadcasted their respective typical calls. Two days latter this was repeated at the trial point with the other model (32 trials for each model sequence). Forty-five bird species mobbed both owls, specifically 38 for *A. clamator* and 33 for *T. alba*. Mobbing bird composition was similar for both models, which attracted birds disproportionally closer (< 10 m) than would be expected by chance. As predicted, a significantly larger number of bird species and individuals mobbed *A. clamator* than *T. alba*. Additionally, mobbing intensity was higher against *A. clamator* than *T. alba*, suggesting differential predator recognition by mobbing birds. *Accepted 16 April 2012.*

Key words: *Asio clamator*, *Tyto alba,* Cerrado Region, mobbing behaviour, predator recognition.

INTRODUCTION

Mobbing behaviour against owls is well-known among many bird species, particularly passerines. Most authors consider mobbing as an anti-predator adaptation functioning to alert other birds to the presence of a predator, confusing the predator and causing it to

retreat (Altmann 1956, Curio 1978, Curio *et al.* 1978, Frankenberg 1981, Flasskamp 1994, Caro 2005). Mobbers of Powerful Owl (*Ninox strenua*) were 8.75 times less preyed upon than non-mobbers (Pavey & Smyth 1998). On the other hand, mobbing by nesting birds can reveal nests to predators (McLean *et al.* 1986) and predators may injure or kill mobbing birds (Sordahl 1990, Motta-Junior 2007).

Assuming mobbing has evolved as an anti-predator strategy, and that its benefits outweigh costs, we hypothesized this behaviour would be more intense against more dangerous or actual predators (Gehlbach & Leverett 1995, Reudink *et al.* 2007). For example, the Burrowing Owl (*Athene cunicularia*) infrequently eats birds (Jaksic & Marti 1981, Motta-Junior & Bueno 2004) and we rarely observed it being mobbed (only two observations in 25 years of field experience, see Motta-Junior *et al.* 2010). In North America, Altmann (1956) reported only one passerine species mobbing a mounted Burrowing Owl specimen. Conversely, Ragusa-Netto (2000) observed that mixed flocks of Brazilian savannah birds uttered disproportionally more alarm calls in response to bird-eating raptors (Aplomado Falcon *Falco femoralis* and Striped Owl *Asio clamator*).

Birds accounted for 21.2 to 44.6% by frequency (number of individuals) of prey taken by Striped Owls (Isaach *et al.* 2000, Motta-Junior *et al.* 2004). Conversely, < 4% of prey taken by Barn owls (*Tyto alba*) are birds (Jaksic *et al.* 1982, Marti 1988, Taylor 1994, Motta-Junior 2006). Hence, we predicted that the ornithophagous *A. clamator* should generate more mobbing (number of species and individuals, mobbing intensity) than *T. alba*. If mobbers recognize predator species, as shown by Curio *et al.* (1983), Gehlbach (1994), Gehlbach & Leverett (1995), and Reudink *et al.* (2007), then more birds and bird species should respond to *A. clamator* more often and intensely than to *T. alba*.

METHODS

Study area. Fieldwork was conducted at the Estação Ecológica de Itirapina (EEI, 22°13'S, 47°53'W), a 2300 ha area of mostly natural grassland savannah with sparse trees and shrubs. The area is in the south portion of the Cerrado Region and harbours some of the last remnants of natural grassland savannahs in State of São Paulo, southeast Brazil. The climate has marked dry (April–September) and wet (October–March) seasons. More detailed descriptions of vegetation physiognomies within Cerrado Region can be found in Oliveira-Filho & Ratter (2002).

Experimental procedures. For our experiment, we choose two syntopic and similarly-sized owl species that differ in diet and morphology: Barn Owl and Striped Owl. Specifically in the EEI, Barn owls were found to prey on few birds (0.7% of 3735 prey identified from pellets; JCMJ unpubl. data). Conversely, almost half of the diet of *A. clamator* at EEI consisted of birds (44.6% of 188 prey identified in pellets; Motta-Junior *et al.* 2004).

The owl models or dummies we used were one mount of each species in natural perched postures (Fig. 1). Each model was placed atop a 2.5 m pole. A total of 64 trial points for owl model displays were systematically set in a regular grid in grassland savannah habitat to assess bird mobbing behaviour. Although the minimum distance between trial points was 330 m, trials were effectively conducted at a minimum distance of 660 m in any single day to ensure independence among trial points (Deppe *et al.* 2003). We employed both visual and auditory stimuli to enhance mobbing events (Chandler & Rose 1988, Deppe *et al.* 2003). A cassette recorder connected to a Fender mini-amplifier was concealed at the base of the pole on which the dummies were mounted. We broadcasted the model species' respective common calls in

FIG. 1. Stuffed specimens of *T. alba* (left) and *A. clamator* (right) mounted in a natural perching position. Dark brown iris colours of both owls are as in living individuals.

five, 1-min sequences during each trial's 10 min observation period. Taped calls were recorded from local wild owls. In all trials, the pole and model were placed in a conspicuous location but within 2 m of a tree, providing perch sites for approaching birds (Gehlbach & Leverett 1995). At 32 (randomly chosen) of the 64 points the *A. clamator* dummy was firstly presented, then two days latter (a period to minimize or to avoid data dependency) at the same time and with similar weather the *T. alba* dummy was presented. Alternatively, the remaining 32 of 64 points had firstly *T. alba* presented and two days latter *A. clamator* presented. Thus, there were 32 independent (first displays) and 32 second display points for each owl species with a grand total of 64 trials for each owl species (first plus second displays). In case of no significant difference in results of first and second displays within each species, data were pooled.

Most authors consider mobbing to occur only when a bird is < 10 m or < 5 m from the predator (e.g., Gehlbach 1994; Shedd 1982, 1983), however, there is no justification for these distances. We included records of birds in the 10–50 m concentric band because visibility in grassland savannahs generally is was good.

All birds that responded to the owl dummies were identified to species and their numbers were recorded (the birds were observed through Zeiss 8x30 binoculars). Additionally, we recorded the intensity of mobbing for each bird on a rank scale of 1 to 7 (modified from Chandler & Rose 1988 and Shedd 1982, 1983). The ranks were defined as: 1 - silent or vocal approach to the model showing nervous movements/calls within <50–10 m; 2 - silent or vocal approach within <10–5 m; 3 - silent within < 5–2 m; 4 - vocal within < 5–2 m; 5 - silent < 2 m; 6 - vocal < 2 m; 7 - physical con-

TABLE 1. Comparison of mobbing by birds for each owl species's dummy according to order of model presentation. Values for first and second model displays are mean ± SE. Mann-Whitney test (z) and associated probabilities are shown.

Tyto alba first vs second displays (n^1 = n^2 = 32)	*Tyto* 1st	*Tyto* 2nd	z	P
Number of bird species	1.875 ± 0.370	2.156 ± 0.319	1.128	0.259
Number of bird individuals	2.312 ± 0.503	3.250 ± 0.502	1.813	0.070
Mobbing intensity sum rank	4.531 ± 1.386	4.688 ± 0.945	1.229	0.219
Asio clamator first vs second displays (n^1 = n^2 = 32)	*Asio* 1st	*Asio* 2nd	z	P
Number of bird species	2.344 ± 0.290	2.656 ± 0.289	0.853	0.394
Number of bird individuals	3.000 ± 0.469	3.844 ± 0.450	1.840	0.066
Mobbing intensity sum rank	4.625 ± 0.820	6.656 ± 1.332	1.423	0.155

tact. During a trial, a bird first recorded for example at < 50–10 m to the model and subsequently approached to < 2 m vocalizing was recorded as rank 6 and only one individual was counted. The mobbing intensity at each trial was the rank sum for all birds detected mobbing the model during the trial.

The observer (JCMJ) was concealed 15 m away from the model and wore camouflage clothes. Abrupt movements and noise were avoided. At each trial, data were recorded during a 10 min period. Only birds observed mobbing or that appeared alarmed with the model were counted and ranked; birds that looked relaxed were not considered for the analysis. Trials were performed early morning (06:30–09:30 h) and late afternoon (15:30–18:30 h) in July–August 2006. This was prior to the breeding season for birds in southeast Brazil and was done to avoid seasonal variation in mobbing intensity (Altmann 1956; Shedd 1982, 1983).

Statistical analysis. As data were not normally distributed (Kolmogorov-Smirnov test, all P < 0.05) and the variances were not homogeneous (Levene test, all P < 0.05), we employed nonparametric statistics in all analyses, including Mann-Whitney (z) and Spearmann Rank correlation (r_s) (Siegel & Castellan 1988, Zar 1999). Statistical tests comparing the owl species were one-tailed because there was an *a priori* expectation that the ornithophagous owl species should be more strongly mobbed. All other tests were two-tailed. Statistical tests were considered significant at P < 0.05 and all calculations were performed using SPSS v. 10 (SPSS, 1999).

RESULTS & DISCUSSION

The presentation of owl species dummies, combined with broadcasting of their respective common local calls, was an effective technique to elicit mobbing in cerrado birds, as showed by Shedd (1982, 1983) and Chandler & Rose (1988) for other owls in North America. There were no significant differences in mobbing (number of species or individuals, mobbing intensity) between the two model presentation sequences (Table 1). Hence, all trial data were pooled by owl species (n = 64 trials).

A total of 397 individuals of 45 bird species were observed mobbing both owls, 38 species for *A. clamator* and 33 for *T. alba* (Table 2). Only eight non-passerines were observed, and within this group, hummingbirds were responsible for more intense mobbing (Table 2). Among passerines, Streamer-tailed Tyrant (*Gubernetes yetapa*), Lesser Elaenia (*Elaenia chiriquensis*), House Wren (*Troglodytes*

TABLE 2. Bird species recorded mobbing dummies of the owls *Asio clamator* and *Tyto alba* models at Itirapina, southeastern Brazil. The figures are number of bird individuals according to distances from models. Scientific nomenclature after Remsen *et al.* (2011).

Bird species	*Asio clamator*			*Tyto alba*			Both owls
	< 10 m	> 50–10 m	Total	< 10 m	> 50–10 m	Total	All distances
Columbidae							
Patagioenas picazuro					1	1	1
Leptotila verreauxi		1	1				1
Trochilidae							
Eupetomena macroura	6		6	3		3	9
Chlorostilbon aureoventris				2		2	2
Colibri serrirostris	1		1				1
unident. sp. "short-tailed"		1	1				1
Picidae							
Colaptes campestris		2	2		1	1	3
Veniliornis mixtus					1	1	1
Furnariidae							
Synallaxis albescens	3	7	10	1	4	5	15
Synallaxis frontalis	1	1	2				2
Thamnophilidae							
Formicivora rufa					2	2	2
Tyrannidae							
Camptostoma obsoletum	1	3	4	1	3	4	8
Elaenia flavogaster	3	3	6	1		1	7
Elaenia obscura					1	1	1
Elaenia chiriquensis	3	2	5				5
Elaenia sp.	1		1		2	2	3
Phyllomyias fasciatus	1	2	3	2		2	5
Gubernetes yetapa	4	2	6				6
Serpophaga subcristata		2	2				2
Xolmis cinereus	2		2				2
Corvidae							
Cyanocorax cristatellus	1	4	5	1	5	6	11
Hirundinidae							
Alopochelidon fucata	1		1	2		2	3
Troglodytidae							
Troglodytes aedon	3	3	6	6	1	7	13
Turdidae							
Turdus leucomelas		2	2		2	2	4
Turdus amaurochalinus		1	1				1
Mimidae							
Mimus saturninus		3	3	1	2	3	6
Coerebidae							
Coereba flaveola	1		1	1		1	2
Thraupidae							
Schystochlamys ruficapillus	2		2	1	3	4	6
Neothraupis fasciata	6	16	22	2	13	15	37

TABLE 2. Continuation.

Bird species	Asio clamator			Tyto alba			Both owls
	< 10 m	> 50–10 m	Total	< 10 m	> 50–10 m	Total	All distances
Cypsnagra hirundinacea	2	11	13		10	10	23
Thraupis sayaca	2		2	3		3	5
Tangara cayana		1	1	2		2	3
Emberizidae							
Coryphospingus cucullatus	7		7	7	2	9	16
Sicalis luteola	3	2	5	7	4	11	16
Emberizoides herbicola		14	14	2	17	19	33
Volatinia jacarina	6	40	46	6	32	38	84
Sporophila caerulescens		2	2	1	1	2	4
Zonotrichia capensis	3	10	13	1	5	6	19
Ammodramus humeralis				1	2	3	3
Saltator atricollis	3	14	17		7	7	24
Cardinalidae							
Piranga flava				2		2	2
Parulidae							
Geothlyps aequinoctialis		1	1	1		1	2
Icteridae							
Pseudoleistes guirahuro		1	1				1
Sp. 1 unident. "krrr" alarm		1	1				1
Sp. 2 unident. "póc" alarm		1	1				1
Number of individuals	66	153	219	57	121	178	397
Number of species	24	29	38	24	23	33	45

aedon), and Red-crested Finch (*Coryphospingus cucullatus*) were the main species approaching closest to the models and disproportionally to the band areas (Table 2). However, no physical contacts were recorded and only 32 and 27 bird individuals for *A. clamator* and *T. alba*, respectively, approached the model < 5 m.

There was no significant differences in species composition between models, although some mobber species were exclusive to each owl species (Table 2) (correlations for *A. clamator* x *T. alba*, n = 45, < 10 m, r_s = 0.403, P = 0.0061; < 50–10 m, r_s = 0.516, P = 0.0003; all distances, r_s = 0.578; P = 0.0001).

Pavey & Smyth's (1998) findings that non-mobbers were preyed on by owls 8.75 times more often than mobbers were apparently not confirmed by our data. Although only one mobbing species was detected as prey in the pellets of *A. clamator* in EEI (*Volatinia jacarina*, Motta-Junior *et al.* 2004), the ratio between non-mobber and mobber numbers in the *A. clamator* diet at EEI was only 1.5 (n = 57 pellets plus 10 pellet debris, Motta-Junior *et al.* 2004). However, although the diet was studied at the same location, it was not at the same time, which could mislead this ratio. This question remains controversial, since Gehlbach & Leverett (1995) suggested that mobbers are more preyed upon than non-mobbers.

Mobbing birds were disproportionately closer to models than expected by chance (Fig. 2); G = 169.43; d.f. = 1; P < 0.0001 for
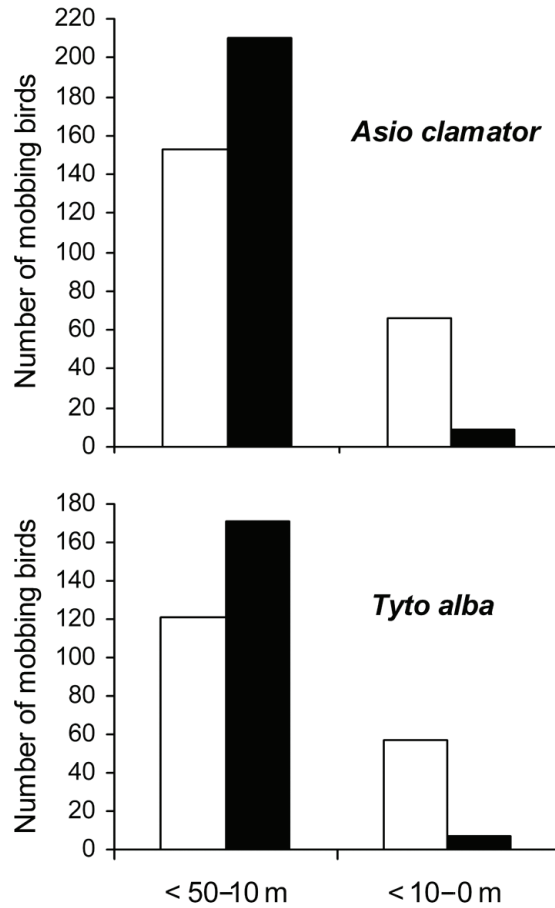
FIG. 2. Frequency distribution of number of mobbing birds to distance intervals to owl models. White bars and black bars are observed and expected frequencies respectively. Expected frequencies were derived for the distance from model interval areas, comprising the < 50–10 m and < 10–0 m radius; assuming a random distribution of birds within a 50 m radius circular area centred on the owl model. Data from 64 trials by owl species.

A. clamator, $G = 153.62$; d.f. $= 1$; $P < 0.0001$ for *T. alba*. These results indicate that a "general owl shape" and associated calls appear to elicit mobbing by savannah birds in a similar way for both owl species, implying a general innate recognition of owls as predators (Altmann 1956). However, more detailed quantitative comparisons of mobbing data between the two owl species' models revealed differences (see below).

A significantly greater number of bird species mobbed *A. clamator* per trial (mean $\pm$ SE $= 2.50 \pm 0.20$) than *T. alba* (2.02 ± 0.24) (Mann-Whitney $z = 2.291$; $P = 0.011$; $n_1 = n_2 = 64$; Fig. 3A) and the number of individual birds which mobbed *A. clamator* per trial was greater (3.42 ± 0.33) than *T. alba* (2.78 ± 0.36) (Mann-Whitney $z = 1.980$; $P = 0.024$; $n_1 = n_2 = 64$ (Fig. 3B). Further, the mean mobbing intensity rating per trial was greater for *A.*
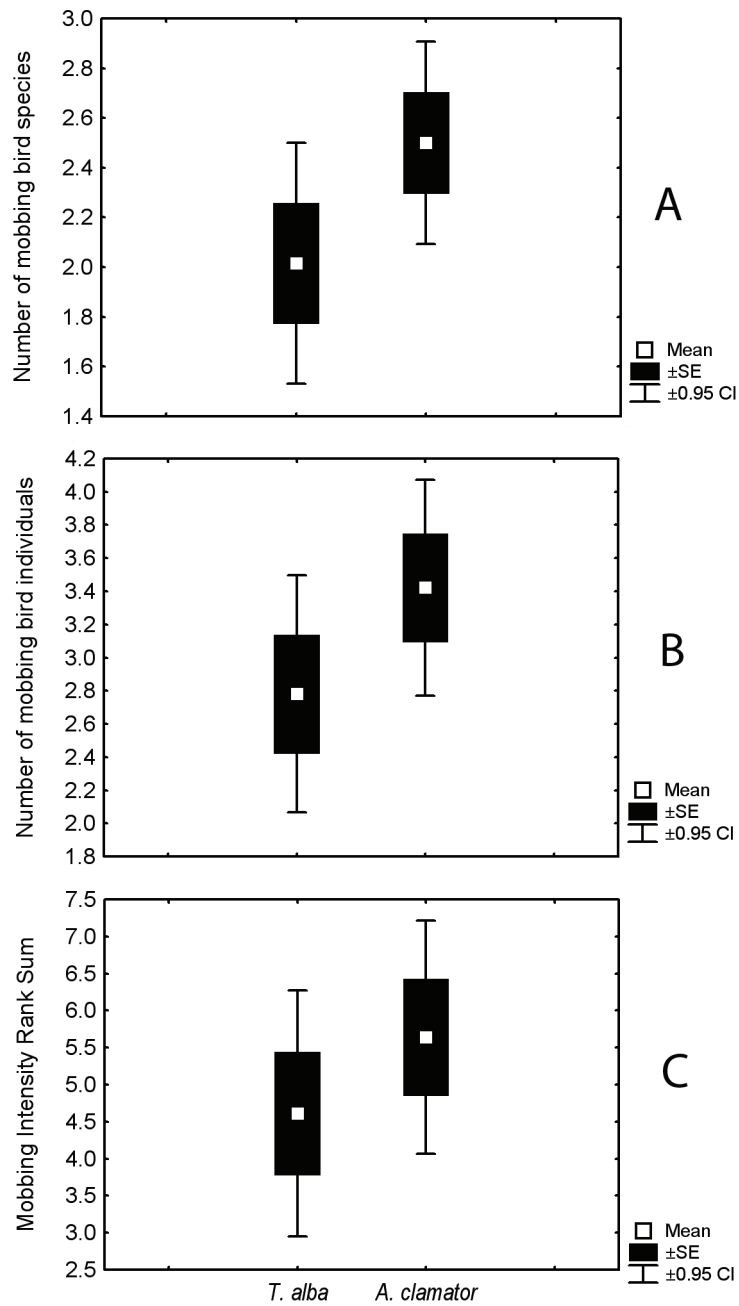
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FIG. 3. Comparative measures of bird mobbing against two owl species models at EEI, southeast Brazil. A- mean number of mobbing bird species per point for each owl species. B - mean number of mobbing individuals per point for each owl species. C - mean mobbing intensity rank sum per point for each owl species. N = 64 trials by owl species.

clamator (5.64 ± 0.79) than *T. alba* (4.61 ± 0.83) (Mann-Whitney $z = 2.187$; $P = 0.014$; $n_1 = n_2 = 64$; Fig. 3C).

We conclude that a regular bird-eating owl (*A. clamator*) is more strongly mobbed than an occasional bird predator (*T. alba*), suggesting predator recognition by mobbing bird species, as found for the Eastern Screech-Owl *Megascops asio* (Gehlbach & Leverett 1995) and for the Ferruginous Pigmy-Owl *Glaucidium brasilianum* (Reudink *et al.* 2007). Further studies on mobbing behaviour including this pair of owl species but in other localities, or other pair of species differing in diet may be conducted to evaluate the generality of our conclusions.

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