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Circular-shaped decals prevent bird-window collisions

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Abstract

Millions of birds die every year from collisions with glass panes worldwide. These estimates are still scarce in the tropics, and more studies are needed to evaluate the effectiveness of preventive measures. We compared the efficacy of two methods to prevent bird-window collisions: birds of prey vs. circular decals (BPD and CD, respectively), contrasted to glass panes without any intervention. We estimated bird-window collisions in four buildings, two twin buildings with CD treatment proportionally interspersed with no decals glass panes, and two BPD-treated buildings with proportionally control area without any device. We recorded 14 collisions from nine species, mostly *Columbina talpacoti* (4) and *Tangara sayaca* (3). The highest number of collisions was against glass windows with no intervention (9; 64%), followed by those with BPD (5; 36%). No accidents were recorded against glass panes with CD. Our data may support that circular decals are more efficient than BPD to prevent bird-window collisions.

Keywords Anthropogenic impacts · Bird strikes · Bird-friendly buildings · Reflective glass · Urban birds

Anthropogenic intervention in the environment is responsible for direct (e.g., collisions with human vehicles and structures, predation by domestic animals) and indirect (e.g., habitat loss, climate change) causes of bird deaths worldwide (Loss et al. 2015). Billions of birds are estimated to die every year from glass window collisions globally (Klem-Jr. 2015), the second-largest direct cause of bird deaths (Klem-Jr. 2009). In North America alone, these numbers exceed one billion a year (Machtans et al. 2013; Loss et al. 2014), and these estimates are scarce in the Neotropics (Basilio et al. 2020). This is worrying because tropical countries are home to the largest bird diversity in the world (Myers et al. 2000), probably leading to underestimated bird population declines (Basilio et al. 2020).

The reflective property of glass produces a mirror effect of the surrounding environment, simulating a continuum and representing an invisible barrier to birds (Klem-Jr. 2009; Aymí et al. 2017). Studies on bird-window collisions have increased (e.g., Borden et al. 2010; Kummer et al. 2016; Hager et al. 2017; Santos et al. 2017), and preventive measures have been proposed, usually aiming to visually sign the existence of an obstacle (Klem-Jr. 1990; Klem-Jr. 2009, Rössler et al. 2015, Klem-Jr and Saenger 2013, Ocampo-Peñula et al. 2016, Brisque et al. 2017).

Some methods have already been tested and proven effective in preventing those accidents in North America (e.g., circular adhesive patterns and vertical stripes (Rössler et al. 2015) and UV-reflective adhesives (Oviedo and Menacho-Odio 2015), while others did not result in significant reductions (e.g., birds of prey decals) (Klem-Jr. 1990; Brisque et al. 2017). In Latin America, efforts in houses and public and/or commercial buildings are scarce, prevailing birds of prey decals (Oviedo and Menacho-Odio 2015; Brisque et al. 2017).

Here we aim to verify whether circular-shaped decals widely used in North America (Rössler et al. 2015) are also effective in a Neotropical context. We predict that circular, small-diameter adhesives completely covering glass panes can more efficiently alert the presence of an obstacle to birds, thus reducing the number of bird collisions with glass windows.

The study was conducted in the Campus of the Federal University of São Carlos, Sorocaba, in the state of São Paulo (47° 31′ 28″ W; 23° 34′ 53″ S), Brazil. We collected building data from documents provided by the Campus administration

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(unpublished data): building area (square meters (sq m)), building height (m), and percentage of total glass area (TGA). We selected four 7-m-high buildings, hereafter ATLab (~ 8000 sq m; 3.1% TGA), GAD (~ 1000 sq m; 33.2% TGA), CCTS and CCGT (~ 3000 sq m; 13% TGA each). All buildings were surrounded by lawn and scattered trees.

The intervention with circular-shaped decals (CD) was performed in two buildings, CCTS and CCGT. Decals were made of self-adhesive white paper, in small circular sections of 1.8 cm in diameter (Rössler et al. 2015) and separated by 10 cm (Klem-Jr. 2009, Ocampo-Peñula et al. 2016) (Fig. 1), covering the entire glass surface. Glass windows having prior intervention with 20 × 40-cm birds of prey decals (BPD) and without any decals (ND) were also monitored (Fig. 1b) (see Brisque et al. 2017) in ATLab and GAD. Although there were more glass panes without any intervention in the campus, we restrict our collection to the four buildings above described. Thus, in the same buildings, we apply BPD vs. ND and CD vs. ND, alternating glass windows sets with and without decals.

Estimates of bird collisions were carried out in all buildings from March 2018 to March 2019 by daily surveys around each building up to 5 m far from glass panes. We searched and collected bird carcasses from possible collisions with glass windows, discarding those in poor condition (e.g., preyed parts). We also recorded data on sex (sexual dimorphism) to check whether this variable may affect collisions (Bevanger 1998; Pouliot 2008; Kahle et al. 2016). The number of collisions was compared among the three treatments (circular vs. birds of prey vs. non-intervention) by Friedman's statistical test for nonparametric data, using the Past software (Hammer et al. 2001).

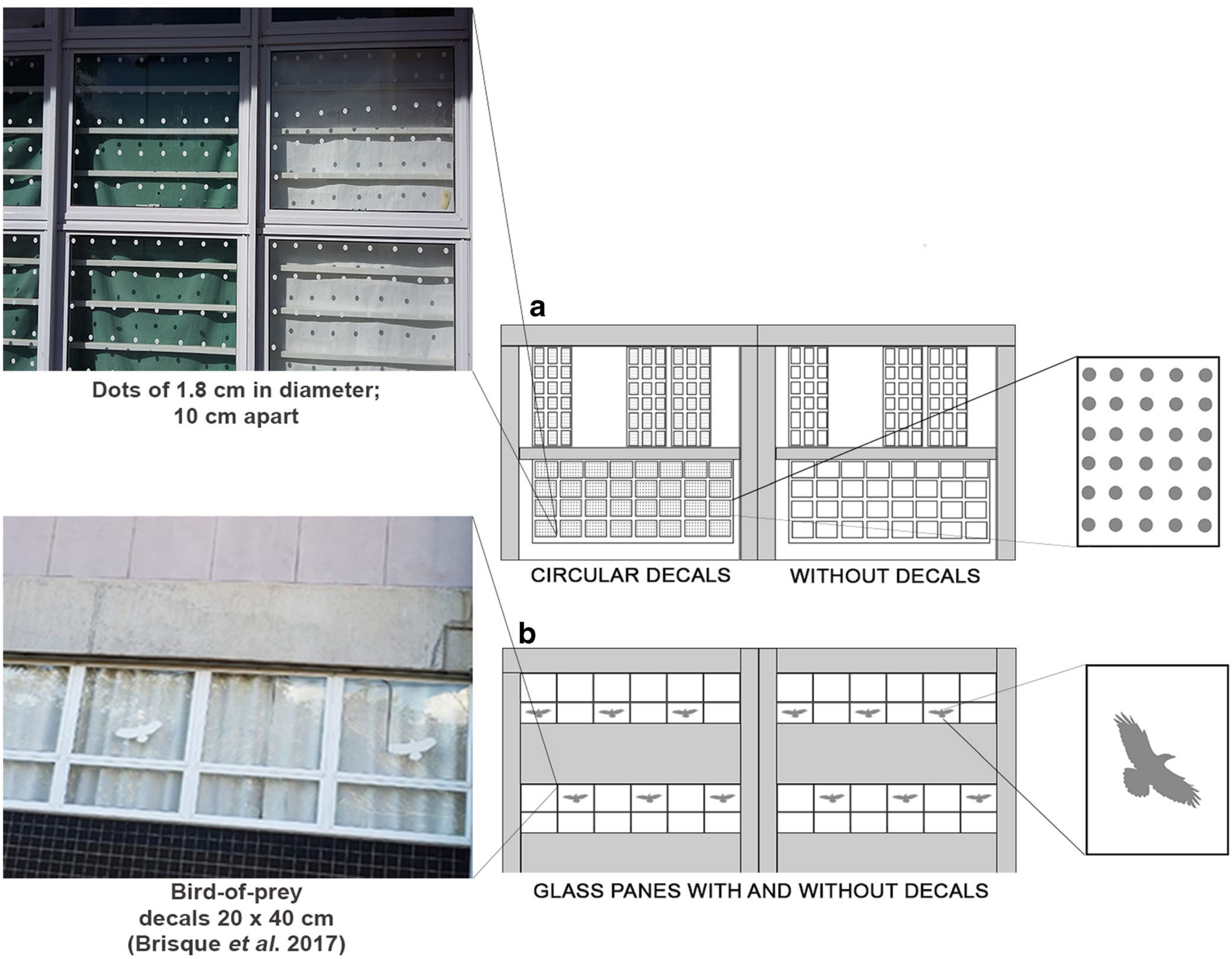

Fig. 1 **a** Schematic representation of two blocks of twin buildings (CCTS and CCGT) with glass windows having circular-shaped decals (1.8 cm diameter, separated by 10 cm) and no decals (control area). **b** Schematic representation of ATLab and GAD blocks with glass panes having 20 × 40-cm birds of prey decals (0.08 sq m) and windows without intervention

Table 1 Bird collision with glass windows in four buildings in the Campus of Federal University of São Carlos, Sorocaba, SP, Brazil. *ND*, no decals; *CD*, circular decals; *BPD*, bird of prey decals. Migratory status: *R*, resident; *M*, migratory

Scientific name	Sex	Migratory status	Wet season			Dry season		
			ND	CD	BPD	ND	CD	BPD
Columbina talpacoti (Temmincki, 1810)	F	R	1	0	0	0	0	1
Columba livia Gmelin, 1789	I	R	0	0	0	2	0	0
Chloroceryle americana (Gmelin, 1788)	F	R	1	0	0	0	0	0
Elaenia mesoleuca (Deppe, 1830)	I	M	0	0	0	0	0	1
Troglodytes musculus Naumann, 1823	I	R	1	0	0	0	0	0
Turdus leucomelas Vieillot, 1818	I	R	1	0	0	0	0	0
Tangara sayaca (Linnaeus, 1766)	I	R	0	0	2	1	0	0
Volatinia jacarina (Linnaeus, 1766)	F	R	2	0	0	0	0	0

We found 14 individuals from eight species as fatal victims of collisions against glass panes (Table 1), mostly resident species ($n = 13$). *Columbina talpacoti* ($n = 4$) and *Tangara sayaca* ($n = 3$) were the most frequent (Fig. 2). Collisions were recorded both in the rainy ($n = 8$) and in the dry season ($n = 6$) and most individuals were adults ($n = 13$). Circular-shaped decals were more efficient to prevent collisions, compared with birds of prey and untreated glass panes ($\chi^2 = 6.17$; $p = 0.02$).

Our data are inconclusive in detecting the season-related variation. Collisions in autumn and spring migrations in North America and Mexico cause nearly 34 million fatalities each year (Klem-Jr. et al. 2009). In the Southern Hemisphere, bird collisions with glass windows are regular throughout the year (Ocampo-Peñuela et al. 2016). In Brazil, no relation was found between seasons and the number of these fatalities (Brisque et al. 2017; Santos et al. 2017). Yet, in Colombia, there were increases between August and September (Agudelo-Álvarez et al. 2010, Ocampo-Peñuela et al. 2016).

We could not detect the effect of sex on the likelihood of collisions. However, previous studies show a higher number of male collisions (~ 66%) (Pouliot 2008; Kahle et al. 2016), which may be linked to territoriality and aggression, mostly in the reproductive season (Hager and Craig 2014).

Some species are more prone to collisions due to behavior (Dunn 1993) and migratory status (Loss et al. 2014). Residents predominated among the species we recorded, as in previous studies in both urban and rural areas in Brazil (Brisque et al. 2017; Santos et al. 2017) and Colombia (Ocampo-Peñuela et al. 2016). This can be explained by the abundance of these species in urban-dwelling areas (e.g., *C. talpacoti* and *T. sayaca*) (Sabo et al. 2016). In the Northern Hemisphere, nearly 70% of collision victims were migratory species (Loss et al. 2014), which can also be assigned to the greater number of species that perform this behavior compared with those in the Southern Hemisphere. Earlier studies have found high numbers of Columbidae colliding with human structures, including windowpanes (Dolbeer 2006; Ocampo-Peñuela et al. 2016), which may also be due to the relatively small size of their wings, which provide less agility for reaction to unexpected obstacle avoidance (Bevanger 1998; Rayner 1988).

Despite the limited number of collisions, our results may agree that circular-shaped decals can be efficient measures in avoiding bird collisions with glass panes. Earlier tests in North America with decals of achromatic patterns in controlled environments have shown greater efficiency of both circular and vertical stripes compared with other types (Rössler et al. 2015). UV-reflecting adhesives have also been proved to be effective (Ocampo-Peñuela et al. 2016), mainly for Passeriformes, which have a high ultraviolet perception (Hastad and Ödeen 2014). Birds of prey decals have not reduced collisions either in North America (Klem-Jr. 1990) or in Brazil (Brisque et al. 2017). We suggest that differences in the number of collisions between birds of prey and circular decals are due to the methods themselves; birds of prey decals usually are not applied covering the whole glass panes. We agree this can greatly contribute to making the first technique less efficient. Small circular-shaped decals usually cover the entire surface and are more effective in alerting birds to the presence of an obstacle to avoid, which is the main target of these preventive interventions.

Research addressing bird-window collisions has increased in the Southern Hemisphere in the last years (Agudelo-Álvarez et al. 2010; Ocampo-Peñuela et al. 2016; Brisque et al. 2017; Santos et al. 2017). However, our study is pioneering in Brazil by evaluating the effectiveness of preventive methods (but see Basilio

Fig. 2 Fatal victims of bird collisions with glass windows. **a** *Volatinia jacarina* (female), **b** *Columbina talpacoti*, and **c** *Tangara sayaca* against glass windows without intervention. **d** *Tangara sayaca* against glass windows whit bird of prey decals. Photos: **a** and **d** A.J. Piratelli; **b** B.C. Ribeiro; **c** F.C. Piña-Rodrigues (with permission)

et al. 2020). Yet, due to the local scale of our results, new data are needed for testing efficient and appropriate interventions in both the country and tropical America.

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Authors' contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by BCR and AJP. The first draft of the manuscript was written by BCR and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Consent to participate The authors declare that they consent to participate in this manuscript.

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