

1 Title: The trade-off between color and size in lizards' conspicuous tails

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3 Running title: Color and size of lizards' tails

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18 Declarations of interest: none.

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21 Highlights

22 1) The roles of blue and red tails as decoys were not corroborated.

23 2) Tail color and size interact while influencing predation rates.

24 3) Larger red-tailed lizards are more prone to be attacked by birds.

25 4) The benefit of having conspicuous tails appears to decrease as body size increases.

26 Abstract

27 A tail of conspicuous coloration is hypothesized to be an advantageous trait for many
28 species of lizards. Predator attacks would be directed to a non-vital, and autotomizable,
29 body part, increasing the chance of survival. However, as body size increases it also
30 increases the signaling area that could attract predators from greater distances, increasing
31 the overall chance of predation. Here, we test the hypothesis that there is a trade-off
32 between tail color and size, affecting predation probabilities. We used plasticine replicas
33 of lizards to study the predation patterns of small and large lizards with red and blue tails.
34 In a natural environment, we exposed six hundred replicas subjected to the attack of free-
35 ranging predators. Large red-tailed models were attacked more quickly, and more
36 intensely, by birds. Mammals and unidentified predators showed no preference for any
37 size or colors. The attacks were not primarily directed to conspicuous tails when
38 compared to the body or the head of our replicas. Our study suggests that red color signals
39 in large lizards could enhance their detection by visually oriented predators (i.e., birds).
40 The efficacy of conspicuous tails as a decoy may rely on associated behavioral displays,
41 which are hard to test with static replicas.

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43 Keywords: Chromatic contrast, Color vision, Predator-prey interaction, Prey size, Tail
44 autotomy.

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51 1. Introduction

52 Over evolutionary history, prey has developed several defense strategies to
53 maximize survival rates in encounters with predators (Dawkins and Krebs, 1979).
54 Predators play a strong evolutionary pressure over preys modifying their phenotypes
55 (Castilla et al., 1999; Losos et al., 2004). In lizards, some of these strategies include
56 escaping (Cooper, 2003; Hawlena, 2009; Schall and Pianka, 1980), deimatic behavior
57 (Sherbrooke and Middendorf, 2001; Shine, 1990), morphological adaptations (Losos et
58 al., 2002), tail autotomization (Bateman and Fleming, 2009), and cryptic or conspicuous
59 color patterns (Fresnillo et al., 2015a; Stuart-Fox et al., 2004). Frequently, the same lizard
60 species can combine two or more of these strategies in its predator avoidance repertoire
61 (Pianka & Vitt, 2003; McElroy, 2019).

62 The use of color patterns as a defense strategy includes cryptic coloration, which
63 conveys camouflage against dull backgrounds, decreasing the probability of detection by
64 predators (Macedonia et al., 2004; Stuart-Fox et al., 2004). In contrast, conspicuous
65 coloration can be used to frighten (Badiane et al., 2018) and discourage (Hasson, 1991)
66 predators, or to redirect attacks to a non-vital region of the prey's body, usually the tail
67 (Bateman et al., 2014; Castilla et al., 1999; Fresnillo et al., 2015a; Murali and
68 Kodandamaraiah, 2016; Ortega et al., 2014; Watson et al., 2012; Wilkinson, 2003). Such
69 redirection can occur by distinct mechanisms, depending on whether the conspicuous
70 coloration is related to a longitudinal striped body (Murali and Kodandamaraiah, 2016,
71 2017) or a colorful tail (Bateman et al., 2014; Fresnillo et al., 2015a).

72 Many lizard species from several unrelated families have tails with conspicuous
73 coloration, which may be blue, green, or red, in contrast to the usually cryptic body-color
74 (Murali et al., 2018). Although there are alternative hypotheses to explain the evolution
75 of conspicuous tails (see Belliure et al., 2018; Clark and Hall, 1970;), several studies

76 proposed that they can act as an effective decoy, directing predators' attacks to the tail
77 (Bateman et al., 2014; Castilla et al., 1999; Fresnillo et al., 2015a; Nasri et al., 2018;
78 Ortega et al., 2014; Watson et al., 2012). Murali et al. also (2018) found that colorful tails
79 in lizards are associated with diurnal species, suggesting that this trait has been selected
80 against visually oriented predators. Nonetheless, it is still unknown to what extent
81 predator-based selection has driven the evolution of color variation in lizards (McElroy,
82 2019).

83 Although conspicuous tails have received increasing attention in the last decades,
84 there are still important questions to address on this topic. One of the most intriguing
85 issues is the occurrence of this trait predominantly in small-bodied lizards (Pianka & Vitt,
86 2003). Even in some moderate-sized species, colorful tails occur mostly in juveniles,
87 fading as the lizard approaches the minimal size for sexual maturity, usually around 40
88 mm of snout-to-vent length (Bateman et al., 2014; Castilla et al., 1999; Hawlena et al.,
89 2006; Ortega et al., 2014). A possible explanation for this pattern links coloration to
90 foraging mode, suggesting that colorful tails are only advantageous in juveniles due to
91 their riskier behavior (Hawlena et al., 2006; Nasri et al., 2018). Such explanation does not
92 consider that conspicuous tails persist in adult small-bodied lizard species (e.g.,
93 *Micrablepharus* spp. and *Vanzosaura* spp.), however, despite ontogenetic changes in their
94 behavior.

95 In this study, we present the results of predation experiments using lizard replicas
96 placed in the field. Our main goals were to test 1) the effectiveness of different tail colors
97 as decoy and 2) the possible trade-off between tail color and body size in predation
98 avoidance. We hypothesize that there may be a trade-off between tail size and its use as
99 a colorful decoy for predator attack. While colorful tails would be beneficial for small
100 lizards, the increase in body (tail) size would enhance the range of the color signal,

101 potentially attracting more predators and becoming disadvantageous. We also
102 hypothesize that tails reflecting longer wavelength colors (e.g., red) attract more predators
103 than those exhibiting short wavelengths (e.g., blue), since shorter wavelengths suffer
104 more Rayleigh scattering than longer wavelengths, being transmitted for shorter distances
105 (Bradbury & Vehrencamp, 2011). On one hand, if the decoy hypothesis is correct, we
106 expect that red-tailed and blue-tailed lizards will be attacked more frequently in the tail
107 when compared to brown-tailed replicas. On the other hand, if the trade-off hypothesis is
108 correct, large lizards with colorful tails (blue and red) should be more attacked than their
109 smaller counterparts.

110

111 2. Material and methods

112 2.1 Lizard replicas

113 We hand-made a total of 600 lizard replicas from non-toxic white plasticine, in
114 two different sizes, 300 large replicas (130 mm, total length) and 300 small replicas (60
115 mm, total length). Replicas were coated with non-toxic paint to resemble some of the
116 color patterns exhibited by lizards of the study region (Figure 1S). Therefore, all replicas
117 had brown dorsum and black flanks, but varied in tail color, which could be conspicuous
118 (blue or red) or cryptic (brown), giving us six different experimental treatments that
119 varied in color and size: large blue-tailed replicas, small blue-tailed replicas, large red-
120 tailed replicas, small red-tailed replicas, large brown-tailed replicas, and small brown-
121 tailed replicas (Figure 1).

122 2.2 Predation experiments

123 Our research protocol was approved by the Ethics Committee on The Use of
124 Animals of our institution (protocol 075/2015) and is following Brazilian law. It complies
125 with ARRIVE guidelines and was carried out following the U.K. Animals (Scientific

126 Procedures) Act, 1986, and associated guidelines, EU Directive 2010/63/EU for animal
127 experiments.



128 Figure 1. Six types of treatments used in our experiments. From left to right: large red-tailed replica, large
129 blue-tailed replica, large brown-tailed replica, small red-tailed replica, small blue-tailed replica, and small
130 brown-tailed replica. Small panels indicate the reflectance spectra of each kind of paint used to coat our
131 replicas.

132

133 Field experiments were carried out in *Parque Estadual da Dunas* (5° 48' S; 35°
134 11' W), an Atlantic Forest reserve located in Natal, the capital city of Rio Grande do
135 Norte state, northeastern Brazil. Two small lizard species, with conspicuous tails, can be
136 found in the state (Figure S1): the blue-tailed *Micrablepharus maximiliani* (Reinhardt and
137 Lutken, 1861), which inhabits the very locality of the experiment, and the red-tailed
138 *Vanzosaura multiscutata* (Amaral, 1933), that occurs in surrounding semiarid areas
139 (Freire, 1996).

140

141 We conducted four repetitions of the same predation experiment, in 2017 (March,
142 June, November) and 2018 (March). Each experiment consisted of placing 150 lizard
142 replicas (25 of each experimental treatment) in the field for 20 days and recording
143 predation marks left in the plasticine. Replicas were placed along a non-linear trail, at

144 every five-meter interval, in such a way that their position could be alternated between
145 the trail's edge and forest interior (Figure S2). Replicas of different treatments were
146 randomly assigned to each available position. Substrate did not vary along the trail and
147 consisted of leaf litter over light brown sand. To prevent any predator from carrying the
148 replicas away, each of them was attached to the nearest vegetation by a transparent fishing
149 line, which was anchored to the bottom of the replica and remained hidden under the leaf
150 litter.

151 Inspections for predation marks were made every two days. We recorded the
152 following details if a replica had been attacked: to which treatment the attacked replica
153 belonged; the type of mark left by the predator (bird peck, mammal bite, or unidentified
154 predator); and in which body region the attack was launched (tail or body, which included
155 head, trunk, and limbs). Marks left by ants (bite marks) were distinct and not counted as
156 predator attacks (Shepard, 2007). Upon attack, replicas were removed from the field site
157 and were not replaced, to avoid biased attacks made by accustomed predators (Marshal
158 et al., 2015).

159 2.3 Spectrometry and visual modeling

160 To help us interpret the results of the experiment, we used visual modeling to
161 understand how the main predators (i.e., birds) perceived the colors of replicas against
162 the natural background. So, we measured the reflectance spectra (i.e., coloration) of each
163 painted plasticine used to craft our replicas (Figure 1), as well as the reflectance spectra
164 of the natural background (i.e., leaf litter), by using a USB4000-UV-VIS spectrometer
165 (Ocean Optics Inc., Dunedin, Florida) connected to a laptop computer running software
166 SpectraSuite (Ocean Optics Inc., Dunedin, Florida). Through a bifurcated QR450-7-XSR
167 optic fiber (Ocean Optics Inc., Dunedin, Florida), the spectrometer was connected to a
168 DH-2000-BAL light source (Ocean Optics Inc., Dunedin, Florida) and a probe.

169 Measurements were taken at a 45° angle and a constant distance of five millimeters from
170 the tip of the probe. For calibration of our spectrometric system, we used a spectralon
171 reflectance standard WS-1-SL (Ocean Optics Inc., Dunedin, Florida) as our white
172 standard, and turned the light source off, obstructing the probe orifice with a black cloth,
173 for determining our black standard. Spectra averaged to scan and boxcar were set at 10
174 and 5, respectively.

175 The color difference between our replicas and the natural background was
176 modeled using “pavo 2” (Maia et al., 2019), an R package. We ran receptor noise limited
177 (RNL) models (Vorobyev et al., 1998), which gave us chromatic contrast values, in just
178 noticeable difference (JND) units, between the reflectance spectra of our replicas and the
179 leaf litter. Because the leaf litter at the experiment site consisted of leaves of varying
180 colorations, we contrasted the coloration of our plasticine replicas (e.g., brown, black,
181 blue, and red patches) with thirty-four different leaf litter measurements, and considered
182 how the visual system of avian predators would discriminate replicas and background
183 based on color alone.

184 There is a consolidated view that small deviations in receptor sensitivities do not
185 affect model results significantly, it is, therefore, possible to use the spectral sensitivities
186 of closely related species in models, if those of the species in focus are not known (Olsson
187 et al. 2018). Since no information on the visual systems of native avian predators is
188 available, we have employed blue tits’ (*Cyanistes caeruleus*) parameters in our visual
189 model, which has been considered as a good proxy for passerine vision. The
190 tetrachromatic vision of *Cyanistes caeruleus* counts with four classes of cones with
191 different spectral sensitivities: ultraviolet sensitive cones (UV), blue-sensitive cones (S),
192 green-sensitive cones (M) and red-sensitive cones (L). For calculation of absolute
193 quantum catches for each of cone type we ran *vismodel*, from “pavo 2 package” (Maia et

194 al., 2019), with the following arguments: *visual* = “bluetit”; *achromatic* = “none”; *illum*
195 = “forestshade”, since our experiments took place in an Atlantic Forest area; *trans* =
196 “bluetit”; *qcatch* = “Q_i”; *bkg* = “ideal”; *vonkries* = “false”; *scale* = “1”; *relative* = “false”.
197 Chromatic contrasts between replicas and leaf litter were calculated by using *coldist*, from
198 “pavo 2 package” (Maia et al., 2019), with the following arguments: *noise* = “neural”,
199 since we were only interested in modeling color signals for strictly diurnal predators (e.g.,
200 birds); *achromatic* = “false”; *n* = c(1,1.9,2.7,2.7), representing blue tits’ retinal relative
201 proportion of photopigments (UV: 1.0; S: 1.9; M: 2.7; L: 2.7; Hart et al. 2000); *weber* =
202 “0.1”; *weber.ref* = “longest”; *weber.achro* = “false”.

203 We classified the crypticity of our replicas’ patches according to the chromatic
204 contrast they exhibited against the leaf litter. Following Siddiqi et al., (2004), we adopted
205 three levels of detectability: cryptic ($\Delta S < 1$ JND), poorly detectable ($1 \text{ JND} \leq \Delta S \leq 3$
206 JND) and detectable ($\Delta S > 3$ JND). The higher the chromatic contrast, the higher the color
207 difference between a replica and its surroundings, favoring their detectability.

208 2.4 Statistical analyses

209 First, we generated Kaplan-Meier survival curves for each treatment and
210 compared them using Log-rank (Mantel-Cox), Breslow (Generalized Wilcoxon), and
211 Tarone-Ware tests. To check the frequency distribution of attacks between all six
212 treatments, we used Pearson's chi-squared test. For survival analyses, replicas showing
213 marks on the body and/or tail were considered as attacked ($n = 223$, from a total of 600
214 replicas).

215 We also build generalized linear mixed-effects models with R package lme4 vs.
216 1.1 (Bates et. al 2015) for testing whether attacks directed to the tail or body (response
217 variable) were related to lizard size, tail color, or the interaction of size and color. Four
218 different generalized linear mixed-effects models considered the attacks from 1) all

219 predators combined, 2) mammals, 3) birds, and 4) mammals and birds. Replicas'
220 individual IDs were entered as a random factor.

221 We also compared the chromatic contrast between leaf litter and each replicas'
222 colored patches, by running a Friedman test, with Wilcoxon *post-hoc*.

223

224 3. Results

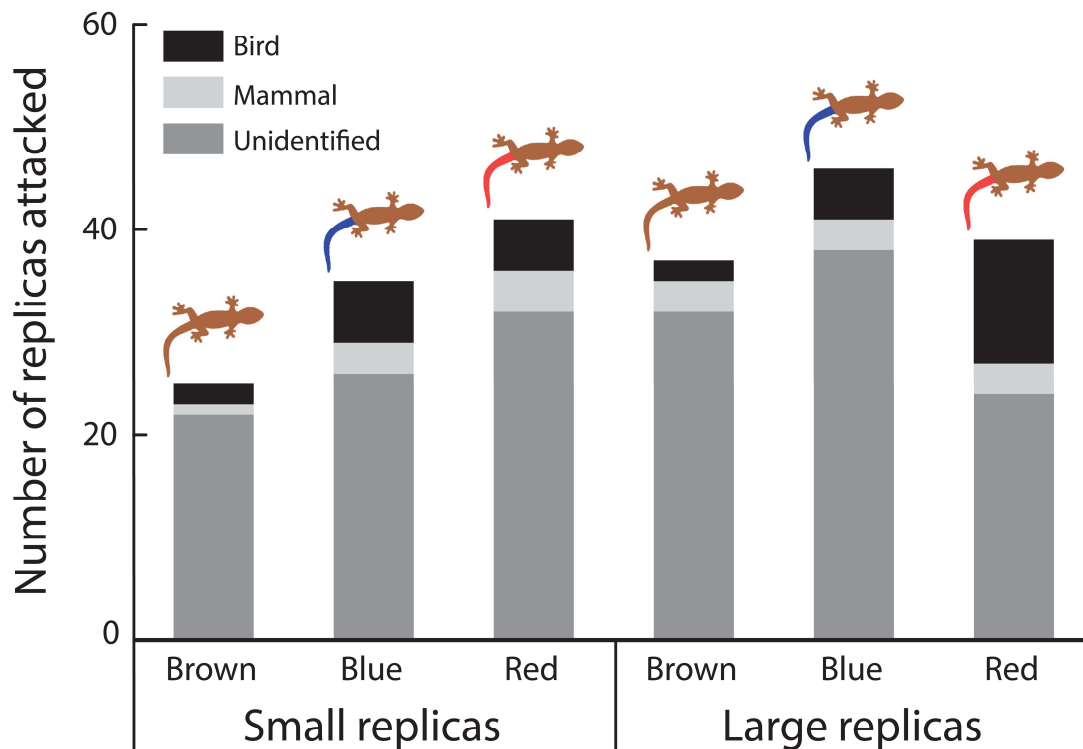
225 3.1 Behavioral data

226 Among all the 600 replicas placed in the field, 223 (37%) suffered some kind of
227 predator attack. All six treatments were attacked at least once, and most of the replicas
228 attacked were large blue-tailed ($n = 46$, 21%), small red-tailed ($n = 41$, 18%) and large
229 red-tailed ($n = 39$, 17%) (Figure 2). Unidentified predators were responsible for 78% (n
230 $= 174$) of the attacks, followed by birds ($n = 32$, 14%) and mammals ($n = 17$, 8%).

231 Considering survival curves for the total number of replicas attacked (i.e., pooling
232 data from all kinds of predators), we found no difference between treatments (Log-rank:
233 $df = 5$, $P = 0.08$ / Breslow: $df = 5$, $P = 0.12$ / Tarone-ware: $df = 5$, $P = 0.098$). The same
234 was true for the number of replicas attacked by mammals alone (Log-rank: $df = 5$, $P =$
235 0.807 / Breslow: $df = 5$, $P = 0.807$ / Tarone-ware: $df = 5$, $P = 0.808$) and by unidentified
236 predators alone (Log-rank: $df = 5$, $P = 0.141$ / Breslow: $df = 5$, $P = 0.272$ / Tarone-ware:
237 $df = 5$, $P = 0.198$). However, large red-tailed replicas were significantly more attacked by
238 birds, when compared to replicas of other treatments (Log-rank: $df = 5$, $P = 0.017$ /
239 Breslow: $df = 5$, $P = 0.07$ / Tarone-ware: $df = 5$, $P = 0.01$) (Figure 3).

240 The frequency of attacks between the six treatments was marginally significant
241 ($\chi^2 = 24.57$, $df = 15$, $P = 0.056$). Values of adjusted residuals in the crosstab suggest that
242 some frequencies are higher than expected by chance. More specifically, small brown-
243 tailed replicas were less attacked than randomly expected (observed counts: 75; expected

244 counts: 62.8; adjusted values: 2.8), large blue-tailed replicas suffered more unidentified
245 attacks than expected (observed counts: 38; expected counts: 29; adjusted values: 2.2),
246 while large red-tailed ones suffered more bird attacks than expected (observed counts:
247 12; expected counts: 5.3; adjusted values: 3.3) (Table S1).

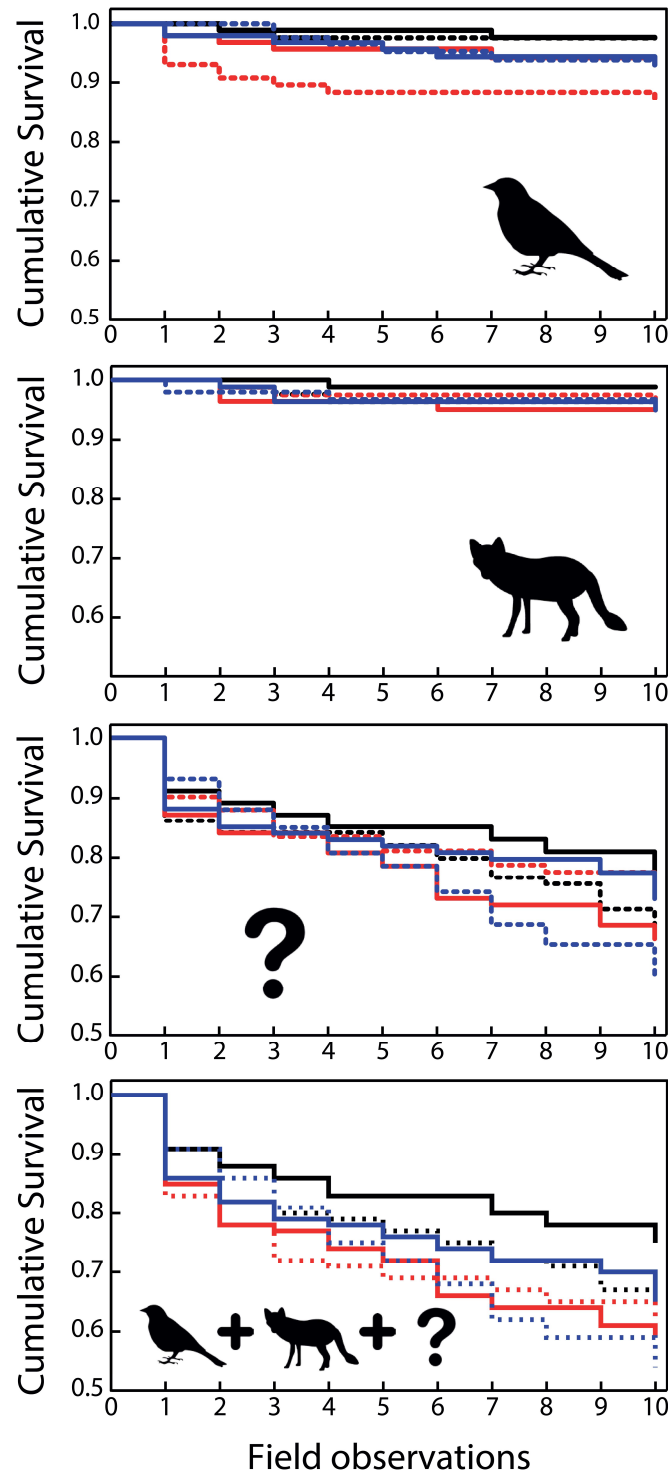


248 Figure 2. Number of attacks suffered by replicas of each treatment. Data from four repetitions are pooled.

249 Total number of replicas used = 600.

250

251 Regarding our generalized linear mixed-effects models, that accessed the
252 frequency of attacks directed to the tail or the body, we found no significant effect (Table
253 S2) of color ($p > 0.05$), size ($p > 0.05$), or any interaction between these variables ($p >$
254 0.05). These results were consistent when we analyzed attacks performed by all kinds of
255 predators, only by mammals, only by birds, and the attacks performed by mammals and
256 birds (i.e., disregarding unidentified predators).



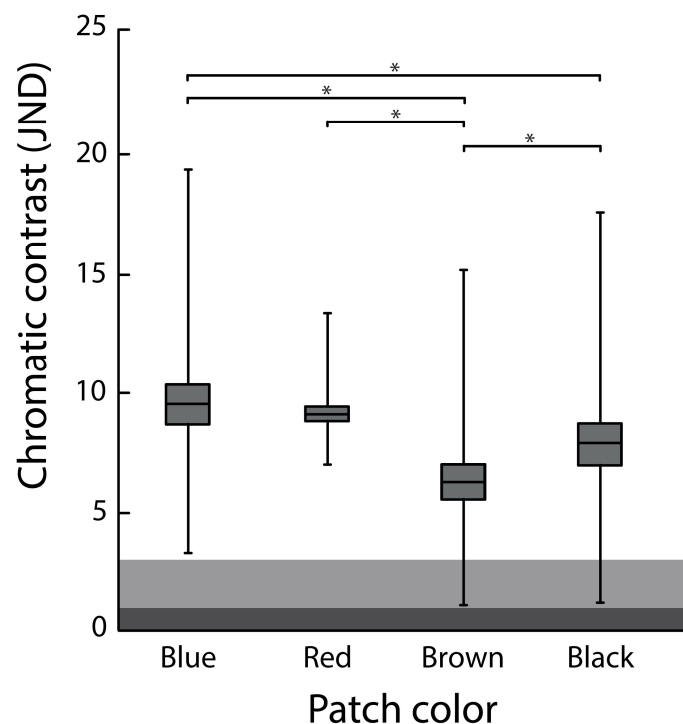
257 Figure 3. Kaplan-Meier survival plots for attacks performed by birds, mammals, unidentified predators
258 (indicated by a “?” sign), and all kinds of predators pooled. Different treatments are indicated by different
259 lines: small brown-tailed replicas = black solid line; large brown-tailed replicas = black dashed line; small
260 red-tailed replicas = red solid line; large red-tailed replicas = red dashed line; small blue-tailed replicas =
261 blue solid line; large blue-tailed replicas = blue dashed line. Data from four repetitions are pooled. Each

262 repetition consisted of ten field observations, conducted throughout twenty experimental days. Total
263 number of replicas used = 600.

264

265 3.2 Visual modeling

266 Our visual model showed that, for visually-driven predators, such as passerines,
267 every replicas' body patches were expected to be detectable against the leaf litter (i.e., ΔS
268 > 3 JND) (Figure 4). Blue and red tails were predicted to show equivalent levels of
269 conspicuity ($Z = -0.299$, $P = 0.765$), although blue tails were predicted to be the most
270 conspicuous of all body parts, contrasting significantly more from the leaf litter when
271 compared to more cryptic body regions, such as black flanks ($Z = -5.086$, $P < 0.0001$) and
272 brown dorsum/tails ($Z = -5.086$, $P < 0.001$). Red tails' conspicuity was predicted to match
273 that of black flanks ($Z = -1.479$, $P = 0.139$), and to differ from brown dorsum/tails'
274 chromatic contrast values ($Z = -5.086$, $P < 0.0001$). Brown dorsum/tails were also
275 predicted to be more cryptic than black flanks ($Z = -4.283$, $P < 0.0001$).



276 Figure 4. Chromatic contrast (ΔS) between replicas' body patches (i.e., blue tail, red tail, brown tail/dorsum,
277 and black flank) and leaf litter, according to the visual system of avian predators. Mean values are indicated

278 by central horizontal black lines, SEM is limited by the boxes, while maximum and minimum values are
279 indicated by whiskers. Detection thresholds are indicated by areas of different colors: the dark grey area
280 refers to situations in which $\Delta S < 1$ JND, the light grey area illustrates situations in which $1 \text{ JND} \leq \Delta S \leq 3$
281 JND, while the white area indicates situations in which $\Delta S > 3$ JND.

282

283 4. Discussion

284 Some of our results corroborate the hypothesis that there is a survival trade-off
285 between body size and tail color in lizards. Although the results of our generalized linear
286 mixed-effects were unable to indicate any effect of color or size on the frequency of
287 attacks directed to replicas' tails or body region, the hypothesis was supported by data
288 from our survival analysis curves. Large red-tailed replicas were more frequently and
289 rapidly attacked by birds than all other treatments, suggesting greater conspicuity of this
290 kind of prey to visually oriented predators. Most birds are not just visually oriented but
291 also rely primarily on color vision while foraging (Sherry, 2016). According to our visual
292 model, birds should segregate blue and red tails from the background with the same
293 aptitude. However, it is important to state that our visual model only took into
294 consideration how a theoretical passerine visual system, under ideal conditions, would
295 discriminate two objects based on color alone. Under field conditions many additional
296 variables (e.g., outline, texture, brightness, glossiness, movement) gain importance in
297 explaining the detection of colored targets, so modeling predictions only takes us to a
298 certain point.

299 Although our visual model predicts blue and red tails to be equally conspicuous
300 to birds, our behavioral data failed to confirm this prediction and showed, for example,
301 large blue tails to be more cryptic than large red ones. This disparity between our
302 theoretical predictions and our behavioral data might be, at least, partially explained
303 through the effect of Rayleigh scattering, which disperses shorter electromagnetic waves

304 through the air (e.g., blue color) more intensely than longer electromagnetic waves (e.g.,
305 red color), in such a way that blue signals tend to attenuate more vigorously and cannot
306 be easily perceived at greater distances (Bradbury & Vehrencamp, 2011). Conversely,
307 red signals travel longer distances and, consequently, might attract more predators, as
308 shown by our predation experiment. When compared to smaller replicas, larger replicas
309 produce stronger color signals, capable of enduring more attenuation, and propagating to
310 longer distances. As birds take advantage of flight and perching on branches to scan the
311 landscape for prey (Sherry, 2016), they are the predators that benefit most from long-
312 distance signals. Birds are the most important predators of small to moderate-sized lizards
313 and exert strong selective pressure on them (Pianka & Vitt, 2003), reinforcing the
314 importance of such trade-offs in the evolutionary history of this group.

315 On one hand, our survival trade-off hypothesis seems to be adequate to explain
316 the predominance of red tails in small lizards, since our results presume a size threshold
317 from which having a red tail becomes more disadvantageous. On the other hand, our
318 predation experiment showed that blue-tailed replicas were equally attacked by birds,
319 regardless of body size, which does not explain the prevalence of blue-tailed lizards in
320 small-bodied species. So, a still unanswered question is why blue tails do not persist in
321 adult lizards of moderate sizes (e.g., several species of the family Scincidae). Pianka and
322 Vitt (2003) hypothesized that these larger species lose their flashy tails to avoid the need
323 for autotomy during adulthood when all energy must be saved to be used during the sparse
324 reproduction episodes. In contrast, because tiny species, generally, produce more clutches
325 per year, spending energy on regenerating a lost tail would not compromise much of their
326 reproductive success (Pianka & Vitt, 2003). Yet, the same explanation might be applied
327 to tails of other colors, including red tails. These hypotheses, as well as others mentioned
328 before [e.g., increased movement hypothesis (Hawlena, 2009); aggression avoidance

329 hypothesis (Fresnillo et al., 2015b)], are not mutually exclusive. None of these hypotheses
330 alone seem to explain the occurrence of colorful tails in all their natural variation of size
331 and colors. Only a more comprehensive work, which compiles the results of experimental
332 studies and data on life-history traits of most lizard species with brightly colored tails,
333 can elucidate the relative contribution of the mechanisms proposed in each hypothesis
334 and the cases where they may have acted in synergy.

335 We did not find support for the hypothesis that conspicuous tails serve as decoys
336 for predators. Our result contradicts similar studies with lizard replicas that endorse the
337 efficacy of blue (Bateman et al., 2014; Watson et al., 2012), red (Fresnillo et al., 2015;
338 Nasri et al., 2018), and green (Castilla et al., 1999) colors in redirecting predator attacks
339 towards the tail. A possible explanation for that could be related to the type of predators
340 recorded in each study. Most of these previous experiments based their conclusions on
341 avian attacks solely and were conducted in temperate regions. In our study, conducted in
342 a tropical forest site, even when we restricted our analyses to bird attacks, we found no
343 preference for body or tail. We are aware that color itself may be not enough to redirect
344 predators' attacks to the tail. Indeed, several studies have suggested the importance of tail
345 displays (e.g., lashing, wagging, waving) combined with conspicuous colors to
346 effectively attract predator's attention (Cooper & Vitt, 1985; Hawlena, 2009; Nasri et al.,
347 2018). Despite the success of previous studies that used static replicas to corroborate the
348 decoy hypothesis, we believe that movement stimuli can be decisive to direct the attack
349 of some predators (Paluh et al., 2014). Perhaps our study did not corroborate this
350 hypothesis because in our study area, unlike previous studies, there is a predominance of
351 predators that depend on tail displays to unleash their attacks.

352 Regardless of inherent limitations, clay model experiments have proven to be an
353 important tool for investigating predator-prey interactions (Bateman et al., 2017). While

354 replicas seem to be convincing for birds (Paluh et al., 2015), there are still many doubts
355 about their efficiency for other types of predators, such as mammals, snakes, and
356 invertebrates, that might end-up prioritizing the use of non-visual sensory modalities
357 when searching for prey. Indeed, in our experiment, unidentified predators accounted for
358 most of the attacks (78%). These indistinct marks were likely left by arthropods, which
359 are foragers mostly oriented by chemotactile cues (Greenfield, 2002). In this case, the
360 damages in the replicas were randomly caused and their predominance in the body would
361 be merely due to the greater volume of that part compared to the tail. To avoid
362 misinterpretations, Bateman et al., (2017) recommend caution when attributing
363 unidentified marks in clay replicas to predator attacks. Nevertheless, further
364 investigations should be encouraged, to evaluate how replicas that mimic prey's color and
365 shape are effective in attracting predators and eliciting their response. Particularly,
366 because it may be possible that non-avian predators have been underestimated by
367 literature.

368

369 5. Conclusion

370 Here, we have experimentally shown, for the first time, the interaction of two
371 important lizard morphological variables (color pattern and body size) as a predator
372 avoidance strategy. Despite failing to confirm the effectiveness of conspicuous tails as
373 decoys our experiment succeeded to show how a color signal that is beneficial for small-
374 bodied and/or juvenile lizards may become disadvantageous for a larger-bodied and/or
375 adult animal. Conspicuous tails have evolved independently, multiple times, among
376 different groups of lizards (Murali et al., 2018). Understanding the evolutionary forces
377 behind this amazing morphological trait, and its nuances, can be enlightening, not just for
378 the study of lizards, but also for the understanding of predation ecology in general.

379

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394 7. References

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