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ORIGINAL ARTICLE

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Nest height, nest concealment, and predator type predict nest predation in superb fairy-wrens (*Malurus cyaneus*)

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Abstract Three factors and their interaction effects are increasingly recognized as important determinants of nest predation: nest concealment, nest height, and predator type. The risk of nest predation is predicted to vary across these variables because of nest detectability and accessibility. In general, however, few studies examine how these three variables interact in relation to nest predation, focusing instead on either nest concealment or nest height (whereby predator identity is usually not known). In this study, we examine the role of nest concealment and nest height for nest survival using both artificial and natural nests in the superb fairy-wren (*Malurus cyaneus*). We indirectly identified potential predators through marks left on artificial eggs and footprints left on tracking tunnels. Predation level at artificial nests was lower than at natural nests, and this could be due to a failure of some nest predators to locate cryptic nests in the absence of cues provided by parental activity. Our results supported the prediction that exposed and concealed nests have different levels of nest predation, which can be explained by variation in predator type. Visual predators were only detected at exposed nests, and survival from visual predators was lower for high nests that were also exposed. However, olfactory predators were detected irrespective of nest height or nest concealment. Because rodents use olfaction to locate nests, this could explain the lack of association between nest concealment and predation outcome at low nests. In addition, rodent footmarks near nests were significantly associated with rodent tooth marks on eggs.

Keywords Artificial eggs · Nest height · Predator type · Tracking tunnels

Introduction

Nest predation is the main cause of reproductive failure in birds (Ricklefs 1969), accounting for about 70% of nest lost. Many aspects of the nesting behavior of birds (such as nest site selection, nest concealment, and nest defense) have been shown to reduce nest predation (Montgomerie and Weatherhead 1988; Martin 1993; Meilvang et al. 1997; Boulton et al. 2003). According to the nest-concealment hypothesis, nests that are more concealed should be less vulnerable to predation (Ricklefs 1969; Filliater et al. 1994). However, the importance of nest concealment may differ between the nesting phases (incubation vs. nestlings), given that eggs and nestlings emit a different suite of cues that can be used by predators for detection (Remeš 2005b). Some studies report negative relationships between nest concealment and predation (Flaspohler et al. 2000; Martin et al. 2000; Weidinger 2002, 2004), while others have found no relationship (Nias 1986; Holway 1991; Götmark et al. 1995; Meilvang et al. 1997; Boulton and Clarke 2003). In addition, nest predation may differ with the height of the nest. For example, in long-tailed tits (*Aegithalos caudatus*), the probability of predation was higher for nests above 2.25 m than for lower nests (Hatchwell et al. 1999).

One plausible explanation for the conflicting results on the role of nest concealment found across species is that studies are typically unable to identify the nest predators (Remeš 2005a). Indeed, the importance of nest concealment to predation is related to predator type and nest conspicuousness (Burhans and Thompson III 1998). Different nest predators will use different cues (visual or olfactory) to find the nest. Nest predation is also determined by accessibility to predators, and nest height is a good proxy for accessibility across a range of taxa. Predation by different predators should therefore exert

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selection for different nest-site characteristics in terms of nest concealment and height (Martin 1987; Remeš 2005a). Cover above the nest is predicted to be important in relation to avian predation (Remeš 2005a), while cover below can be important for snake predation (Kleindorfer et al. 2003). But with the case of reptilian, nocturnal or mammalian predators (that use olfactory cues), nest concealment may not protect the nest from predation (Rangen et al. 1999; Remeš 2005a). So, the effect of nest concealment as an anti-predator strategy will depend on the primary sensory mode of the predator. Moreover, specific predators are often associated with different nest heights (Martin 1988b) and nest predation commonly differs between nest positions (Martin 1988a). Thus, a nest site could be highly susceptible to predation from one type of predator (e.g., snake), but experience low predation from a different predator (e.g., harrier) (Skutch 1985; Filliater et al. 1994; Kleindorfer et al. 2003). Therefore, nest concealment, nest height, and predator type and their interaction effects are increasingly recognized as important determinants of nest predation (Kleindorfer et al. 2003, 2005). The risk of nest predation is predicted to vary across these variables because of nest conspicuousness (how far the nest can be seen) and accessibility.

This study uses a descriptive approach to quantify nest predation at natural and artificial nests in the superb fairy-wren (*Malurus cyaneus*). We identified potential nest predators from marks left on artificial eggs and footprints on tracking tunnels near artificial nests. We examined: (1) Nest predation and nest survival (daily survival probability) at natural and artificial nests. (2) The role of nest concealment (vegetation cover) and nest height for nest survival at natural and artificial nests. We predicted that high and exposed nests would have increased predation risk from visually hunting predators (Santisteban et al. 2002). We also predicted that nest predation at low nests would not be related to nest concealment because terrestrial predators mostly use olfaction (rodents) or temperature (snakes) to find nests (Clark and Wobeser 1997). (3) A statistical association between rodent occurrence (measured using tracking tunnels) and the percentage of artificial eggs with rodent marks at artificial nests. We predicted higher nest predation (marks on eggs) under conditions of higher rodent density.

Materials and methods

Study area

The study was conducted across 4 years (2004–2007) at four conservation parks in South Australia: (1) Sandy Creek Conservation Park (Mount Lofty Ranges; MLR) (34°36′ S, 138°51′ E) mainly consisted of open *Eucalyptus* woodland with invasive Bridal Creeper (*Asparagus asparagoides*) and Native Pine (*Callitris preissii*) (Rix 1976); (2) Scott Creek Conservation Park (MLR) (35°05′ S, 138°41′ E) was also dominated by low open *Eucalyptus* woodlands with open grassland areas and dense clumps of Blackberry (*Rubus fruticosus*); (3) Scott Conservation Park (MLR) (35°24′ S, 138°44′ E) consisted predominantly of open *Eucalyptus* woodlands with an understorey of Kangaroo Thorn (*Acacia paradoxa*) and Golden Wattle (*Acacia pycnantha*) (Paton and Paton 1980); and (4) a coastal area on the Fleurieu Peninsula, Newland Head Conservation Park (35°37′ S, 138°29′ E) was dominated by open *Eucalyptus* woodlands with open grassland areas and dense clumps of *Eucalyptus* and *Acacia paradoxa* (see also Kleindorfer et al. 2006; Lambert and Kleindorfer 2006; Schlotfeldt and Kleindorfer 2006; Colombelli-Négrel and Kleindorfer 2008).

Study species

The superb fairy-wren is a small insectivorous passerine that occurs in south-eastern Australia (Ford et al. 1986; Nias 1987; Tidemann et al. 1989; Tidemann and Schodde 1989; Rowley and Russell 1997). They are sedentary, territorial, and cooperative breeders that breed between August and January, with a peak during October–November (Mulder et al. 1994; Dunn and Cockburn 1998). Although superb fairy-wrens mostly forage on the ground in open grassy areas (discussed in Schlotfeldt and Kleindorfer 2006), they typically build domed nests in dense vegetation, such as shrubs or thick grasses (Rowley 1965; Nias 1986), which are subject to high levels of nest predation (24.3–55.1%) (discussed in Rowley and Russell 1997). In our study site, superb fairy-wrens built their nests between 5 and 120 cm off the ground, clutch size was 2–3 eggs, incubation 12–15 days, and nestlings phase 10–12 days (Colombelli-Négrel, unpublished data). The mating system is variable across populations: some birds breed in pairs and others show cooperative breeding with helpers from a previous brood (Langmore and Mulder 1992; Mulder et al. 1994; Mulder 1997). Extra-pair copulations are common, and about 90% of all nests contain at least one offspring sired by another male (Mulder et al. 1994; Dunn and Cockburn 1998). Females are uniparental incubators, and are usually the dominant feeder (Bradley and Bradley 1958; Tidemann 1986), while males have a bigger role in territory defense (Nias 1987). However, all males provide care to the nestlings (Rowley 1957, 1965; Mulder et al. 1994; Green et al. 1995).

Natural nests

We monitored natural nests ($N = 67$) between September and November for 4 years (2004–2007). The location of each nest was recorded using a GPS, but nests were not marked in any way. All adults at the nests were color-banded. Nests were monitored every 3 days for nesting content (eggs, nestlings) and outcome (active, predated). Predation was scored if nests, eggs, or nestlings were damaged or removed between visits and the nestlings were less than 10 days old. Nest-site characteristics were measured within 1 week after predation or the nestlings fledged. We measured two parameters surrounding the nest: (1) nest concealment (average vegetation cover above, below, and on the sides of the nest), and (2) nest height (measured from the ground to base of the nest). Vegetation cover was defined as the visual estimation of the percentage of vegetation concealing the nest when standing 1 m away. We also examined the role of seven nest-site vegetation parameters within a 10 m radius of the nest (nesting substrate height, nesting substrate diameter, number of trees, number of shrubs, undergrowth, percentage of ground cover, and percentage of canopy) (see also Lambert and Kleindorfer 2006), and none of these parameters was significantly related to predation outcome. Because we focus on nest height and nest concealment in this paper, we do not present other nest-site vegetation results, but they can be obtained upon request from the authors. Patterns of nest destruction after predation (undamaged, hole on top, turned inside-out, entrance enlarged) were noted for each nest to estimate the percentage of nests taken by different predators. This estimation is based on video recordings of real predator visits ($N = 7$) at superb fairy-wren nests for the same study population (Colombelli-Négrel et al. 2009). The video images showed that rats (bush rat, *Rattus fuscipes*) generally turned the nest inside out; mice (house mouse, *Mus musculus*) made holes on the top of the nest; and birds (e.g., currawongs) left the nest undamaged (Colombelli-Négrel et al. 2009).

Artificial nests

Artificial nests ($N = 150$) were placed during October and November (peak of breeding season) along five transects every 100 m to minimize a possible bias in nest predation due to nest density (Bergin et al. 1997). About 25 nests were placed at each of Scott Creek and Newland Head in 2006, and at Sandy Creek, Scott, Scott Creek, and Newland Head in 2007. We covered the artificial bamboo nests (12 × 15 cm) with coconut matting and grasses to produce nests that were similar in size and shape to natural superb fairy-wren nests (10 × 12 cm) (Colombelli-Négrel, unpubl. data). The nests were then "aired" outdoors for several weeks to reduce odor (Rangen et al. 2000; Berry and Lill 2003). Nests were placed at typical natural sites at different nest heights (range 5–120 cm; natural nests = 40 ± 3 cm–artificial nests = 44 ± 3 cm) and different levels of vegetation concealment (range 0–100%; natural nests = 43.6 ± 3.9%–artificial nests = 40.9 ± 2.2%) to test predictions of the nest-concealment hypothesis. The artificial nests were left for 14 days, which is the average length of the incubation phase in superb fairy-wrens.

Three artificial plasticine eggs were placed in each artificial nest. All the eggs were shaped and painted to match the superb fairy-wren natural eggs (Gardner 1998). Marks left on artificial eggs (scratches, tooth and triangular beak impressions) were used to indirectly identify the nest predators (see below). To avoid egg removal from nests, we attached the model eggs to the bottom of the nest using natural string fibers. To decrease bias in predation due to their artificial smell, the model eggs were soaked in a solution of water and bird fecal matter for 24 h before their use and then "aired" outdoors for several days (Fulton and Ford 2003; McGuire and Kleindorfer 2007; Galligan and Kleindorfer 2008). Subsequently, the nests and the eggs were handled using latex gloves. Like the natural nests, artificial nests were checked every 3 days to monitor nesting outcome. Predation was scored if the nest was torn apart, or if the eggs had marks, were removed, or were missing. Predated nest were removed from the field to avoid the possibility of further predation, and multiple predation was never scored. The marks on the artificial eggs were identified by comparing them to the literature and marks made by known predators on similar eggs. Eggs with large parallel teeth marks were scored as rat predation, and small triangular teeth marks were scored as mouse predation; eggs with scratches were scored as other mammals; eggs with triangular marks as avian predation; and eggs with fang marks as snake predation.

Tracking tunnels

Tracking tunnels are rectangular polyethylene tunnels designed to allow the target animal to walk through unhindered and leave their tracks on tracking cards. The tunnels were acquired from Connovation Ltd, NZ. Animals are lured to the track with bait (peanut butter mixed with bacon and oats) that is placed inside the tunnel on an inkpad. Animals enter the tunnel to eat the bait, stand on the inkpad, and leave tracks when they leave the tunnel. The tracks are recorded on a tracking card (absorbent white cardboard), and the ink is non-drying. The tunnels are 500 mm long with a square profile (100 × 100 mm).

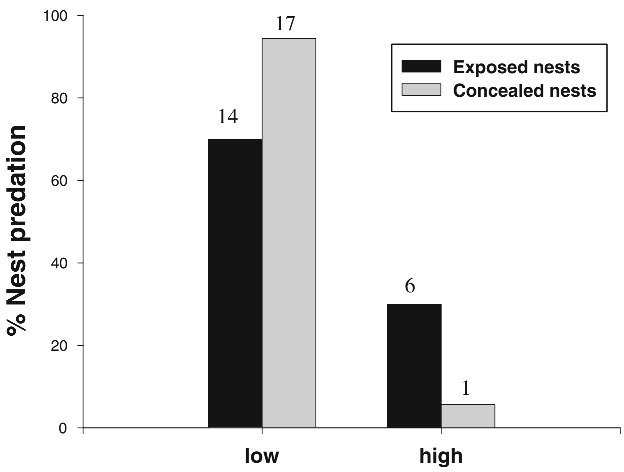
Rodent activity was assessed by recording rodent tracks in tracking tunnels ($N = 150$). We used 25 tracking tunnels per park located at 100-m intervals along each transect, near the location of the artificial nest experiment (within 20 m). Parks and transects were the same as those used for the artificial nest trials in 2006 and 2007. The tracking tunnels experiment started 1 week after the artificial nest experiment to avoid attracting the animals to the artificial nests, and lasted for 5 days. The tunnels only (without the cards or bait) were first placed along the different transects to allow animals to habituate to their presence. Two days later, we added the ink-cards and left the baited tracking tunnels in the parks for three nights. After the third night, the tunnels and the cards were removed from the site and brought back to the laboratory for examination. Footprints were immediately identified (see Hasler et al. 2004) and we made a digital picture of each footprint and card.

Statistical analysis

Out of the 67 active nests, data analyses were performed on 49 nests: five nests had missing data and 13 nests were abandoned due to weather disturbance, and thus they were not included in the analysis. All means are presented ± SE. To satisfy conditions of normality required for multivariate analysis, all percentage data were square root and $\ln(x + 1)$ transformed. The nest height categories were low (0–60 cm) and high (61–120 cm), and nest concealment categories were exposed (0–40% cover) and concealed (41–100% cover) (Fig. 1). The justification to divide the nest concealment categories into 0–40 and 41–100% was based on the observation that no nest had 40–60% vegetation cover above the nest, and only one nest had 40–60% vegetation cover below the nest. Based on patterns of nest destruction for natural nests and marks left in the artificial eggs for artificial nests, we categorized the predator types as follows: 'none', 'visual predators' (birds), 'olfactory predators' (snakes, rodents, and others mammals), and 'unknown'.

All statistical analyses were performed using SPSS 14.0 for Windows (SPSS Inc., Chicago, USA). The Mayfield method was used to estimate nest survival and survival rates for natural and artificial nests (Mayfield 1975; Johnson 1979). Survival rates at artificial nests were compared with natural nests during the incubation period using one-way ANOVA. Although we would have liked to test the effects of park, year, nest type, nest concealment, nest height, and predator type (all independent variables), and all interaction terms on nest survival (dependent variable), this was not possible due to our small sample size. Therefore, park and year were tested as effects on nest survival, and were not significant at natural nests (ANOVA year: $F_{3.48} = 0.59$, $P = 0.63$; park: $F_{3.48} = 0.22$, $P = 0.88$), but there was an effect of year at artificial nests ($F_{1.149} = 21.04$, $P < 0.001$; $F_{3.149} = 0.97$, $P = 0.41$); the interaction terms were not significant. We used a three-way ANOVA to test for the effects of nest concealment, nest height, and predator type (all independent variables) on nest survival (dependent variable). Because there was a significant effect of year for artificial nests, we examined nest survival in relation to nest concealment, nest height, and predator type for each year separately. We tested the association between rodent marks on tracking tunnels and rodent marks on eggs using a linear regression.

a Natural nests



b Artificial nests

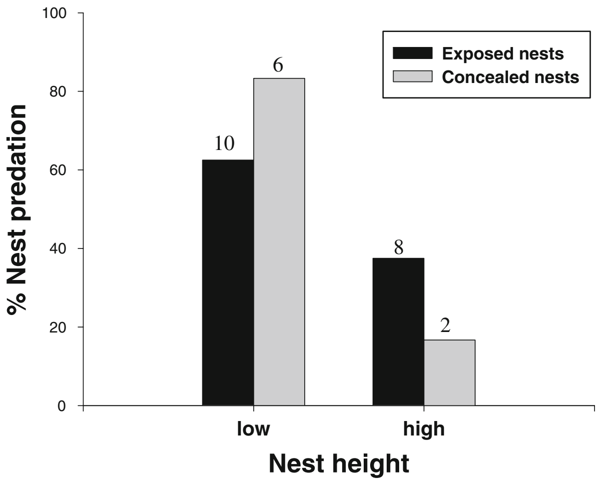


Fig. 1 The percentage of nests that were depredated is shown for different categories of nest concealment and nest height. Nest concealment was classified as "*exposed*" (0–40% vegetation cover of the nest) or "*concealed*" (41–100% vegetation cover of the nest). Nest height was classified as "*low*" (0–60 cm from the ground) or "*high*" (61–120 cm from the ground). The sample size was 54 natural nests and 150 artificial nests, and is presented above each category

Results

Natural nests

We monitored a total of 67 natural nests across 4 years (2004–2007). About 12 nests were found at Sandy Creek, ten at Scott Creek, 13 at Scott, and 32 at Newland Head. None of the nests contained a nestling brood parasite. Overall, 40 out of 54 nests (74.1%) were predated (Table 1). The overall survival rate of natural nests was 27% during the incubation phase and 55% during the nestling phase (Table 2). Patterns of nest destruction after predation events were as follows: 20 out of 40 nests showed signs of rodent predation based on previous video recordings (see "Methods"): 12 nests were turned inside-out, and eight nests had a hole on the top. Patterns of nest destruction for the other 20 nests were as follows: $N = 15$ not damaged; $N = 5$ entrance enlarged. Therefore, nest predation by rodents was estimated to account for approximately 50% of natural nests. We used a three-way ANOVA test to examine the effect of 'nest concealment × nest height × predator type' on nest survival, and the interaction term 'nest

Table 1 Superb fairy-wren natural nests monitored in South Australia across 4 years (2004–2007) ($N = 67$)

	2004	2005	2006	2007	Total
Fledged (%)	2 (12.5)	2 (18.2)	4 (17.4)	6 (35.3)	14 (20.9)
Predated during incubation	12 (75.1)	3 (27.2)	13 (56.5)	1 (5.9)	29 (43.3)
Predated during nestling	1 (6.2)	2 (18.2)	4 (17.4)	4 (23.5)	11 (16.4)
Abandoned	1 (6.2)	4 (36.4)	2 (8.7)	6 (35.3)	13 (19.4)
Total nests per year	16	11	23	17	67

Table 2 Nest survival rates (± SE) for the different parks: the results are shown for natural nests ($N = 54$) and artificial nests ($N = 150$)

	Newland head	Scott	Scott creek	Sandy creek	Total
Natural nests					
Incubation	0.23 ± 0.02	0.43 ± 0.04	0.57 ± 0.03	0.11 ± 0.03	0.27 ± 0.00
Nestlings	0.37 ± 0.02	0.92 ± 0.04	0.80 ± 0.02	0.33 ± 0.07	0.55 ± 0.00
Overall	0.28 ± 0.01	0.59 ± 0.02	0.69 ± 0.02	0.15 ± 0.03	0.37 ± 0.00
Artificial nests	0.83 ± 0.00	0.97 ± 0.01	0.93 ± 0.00	0.92 ± 0.00	0.65 ± 0.00

concealment × nest height × predator type' was significant ($F_{10.48} = 3.86$, $P = 0.001$) (Table 3; Fig. 1).

Artificial nests

At artificial nests, the incubation survival rate (65%) was higher than at natural nests (27%) ($F_{1.177} = 119.34$, $P < 0.001$) (Table 2). Most artificial eggs had rodent teeth marks (53.6%, $N = 14$: mouse 32.2%—rat 21.4%). The other marks on eggs were classified as follows: other mammals (entrance enlarged and eggs completely eaten, or scratches on the eggs; $N = 9$; 35.7%), birds (triangular marks; $N = 2$; 7.1%), and snake (two bites on the top and one underneath; $N = 1$; 3.6%). The three-way interaction effect (nest height × nest concealment × predator type) for artificial nests was significant for each study year (ANOVA 2006: $F_{7.49} = 17.92$, $P < 0.001$; 2007: $F_{6.99} = 86.00$, $P < 0.001$) (Table 3; Fig. 1, 2). The data across years were pooled for presentation but can be obtained upon request from the authors.

Tracking tunnels

We identified two types of footprints on the cards and both were from rodents: the bush rat (*Rattus fuscipus*) and a mouse. Identification of the mouse species was not possible because most mouse footprints are, in general, similar. We suspect most prints were from the house mouse (*Mus musculus*) because it is common in the parks and nest predation at natural nests was observed on video camera (Colombelli-Négrel et al. 2009). There was a significant association between rodent marks on tracking tunnels next to nests with rodent marks on eggs ($\beta = 0.21$, $t = 3.99$, $P < 0.01$) (Fig. 3). Newland Head had the most rodent marks in all cases. However, a comparison between 2006 and 2007 for Newland Head showed a decrease in rodent marks, and presumably the rodent population (2006 rodent marks = 19/25, 2007 rodent marks = 10/25).

Table 3 Results of the three-way ANOVA to test for the effects of nest concealment, nest height and predator type on nest survival for natural nests ($N = 54$) and artificial nests ($N = 150$)

	df	*F*	Significance
Natural nests			
Nest concealment	1	0.399	0.532
Nest height	1	0.267	0.609
Predator type	3	6.072	0.002
Concealment × height	1	0.143	0.708
Concealment × predator	2	0.449	0.642
Height × predator	2	0.613	0.547
Concealment × height × predator	10	3.865	0.001
Artificial nests			
Nest concealment	1	17.396	0.001
Nest height	1	32.603	0.001
Predator type	2	192.599	0.001
Concealment × height	1	0.060	0.807
Concealment × predator	1	17.854	0.001
Height × predator	2	16.209	0.001
Concealment × height × predator	8	58.872	0.001

Discussion

The results of this study show that patterns of nest predation differed in relation to nest height, nest concealment, and predator type. Predation level at artificial nests was lower than at natural nests, and this could be due to a failure of some nest predators to locate cryptic nests in the absence of cues provided by parental activity. Visual predators were only detected at exposed nests, and nest survival from visual predators was lower for high nests that were also exposed. However, olfactory predators were detected irrespective of nest height or nest concealment. Finally, we found a positive correlation between the occurrence of rodents (estimated using tracking tunnels) and rodent marks on artificial eggs. Rodent predation at artificial nests inferred from tooth marks on eggs (54%) was comparable to rodent predation at natural nests inferred from nest condition (50%).

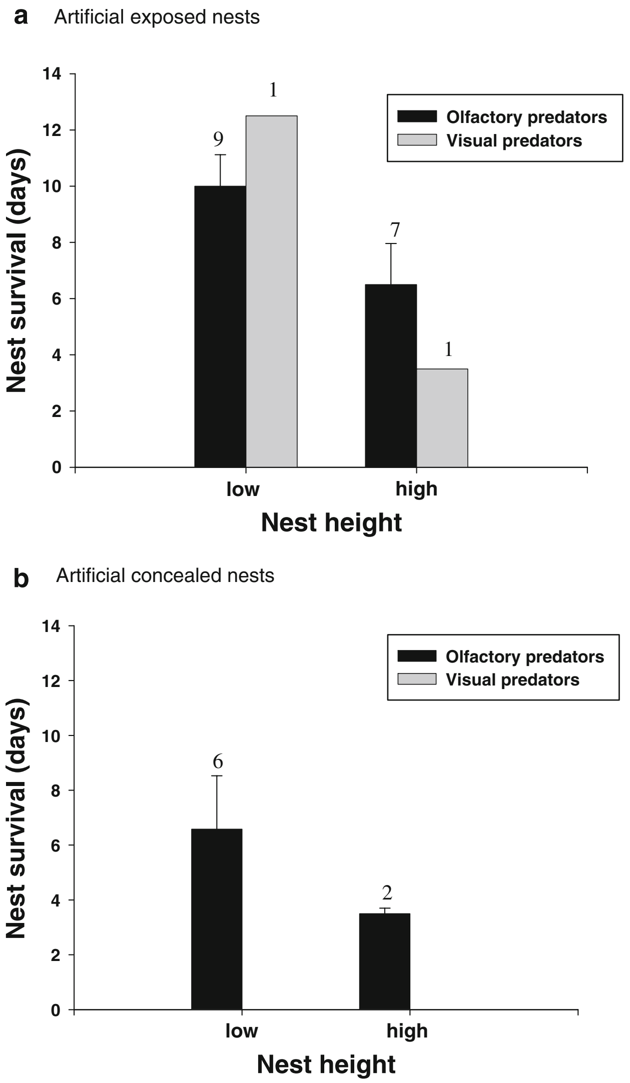


Fig. 2 Nest survival (± SE) at artificial nests that had evidence of nest predation by olfactory or visual predators (using marks on artificial eggs; see "Methods", $N = 26$). Data on nest survival are shown for nest height and nest concealment, but not for fledged nests. The three-way ANOVA interaction effect (nest height × nest concealment × predator type) was significant for nest survival. Visual predators were only detected at exposed nests, and survival from visual predators was lower for high and exposed nests. Olfactory predators were detected irrespective of nest height or nest concealment. The sample size was 150 artificial nests, and is presented above each category

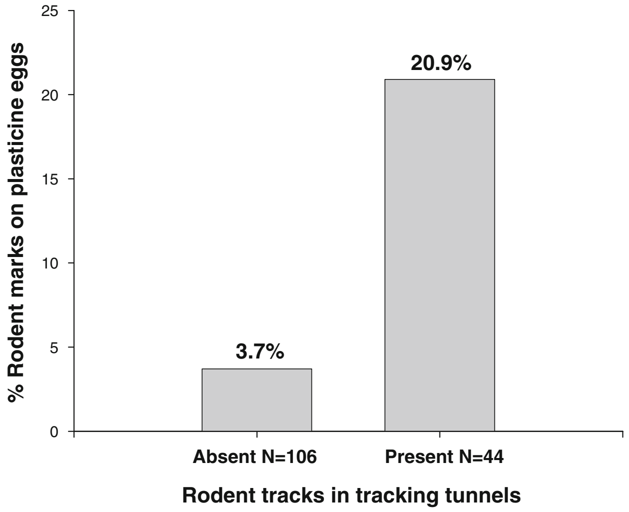


Fig. 3 Percentage of plasticine eggs with rodent marks that were adjacent to tracking tunnels that also had rodent marks (2006–2007). We only considered plasticine eggs and tracking tunnels that were immediately adjacent to each other; all artificial nests with plasticine eggs also had tracking tunnels in their immediate vicinity 1 week after measuring predation outcome at the artificial nests. We used this temporal pattern to avoid luring predators to the nest with the baited tracking tunnels

Overall, nest predation was highest during the incubation phase, as in New Holland honeyeaters (*Phylidonyris novaehollandiae*) in the same region (Lambert and Kleindorfer 2006). Nests that were well concealed generally had lower nest predation, and—at artificial nests—visual predators were only detected at exposed nests. The importance of nest concealment can be explained by avian nest predation in the superb fairy-wren, as avian predators mainly use visual cues to find the nest (Santisteban et al. 2002). Pied currawong (*Strepera graculina*) (Nias 1987; Bayly and Blumstein 2001) and grey shrike-thrush (*Colluricincla harmonica*) (Nias 1987) are suspected nest predators at other study sites, and grey currawong (*Strepera versicolor*) are known nest predators of nestlings in our study site (Colombelli-Négrel et al. 2009).

Predation level at artificial nests was lower than at natural nests, which contradicts the results of other studies comparing predation outcome between natural and artificial nests (Wilson and Brittingham 1998; King et al. 1999) (but see Martin 1987; Roper 1992; Davidson and Bollinger 2000). There are many potential explanations for differences between natural and artificial nest studies. Some authors point to the use of unrealistic artificial nests and eggs that therefore do not attract typical predators (King et al. 1999). Artificial nests may also exclude some predators, such as snakes that have rarely or never been documented consuming eggs at artificial nests (Davidson and Bollinger 2000). However, this was not the case in our study: the artificial eggs we used very closely resembled natural eggs, and we have evidence for one predation attempt by a snake. Another explanation for the difference between natural and artificial nest results could be due to a failure of some nest predators to locate cryptic nests in the absence of cues provided by parental activity (Gardner 1998), odor, and/or nestling calls (Wilson and Brittingham 1998; Martin et al. 2000; Muchai and Du Plessis 2005). There may also be interaction effects between nestling conspicuousness and parental nest defense behavior: nestlings have been shown to respond to parental alarm calls near the nest and thereby change their conspicuousness to different predator types (discussed in Kleindorfer et al. 1996).

Rodents were implicated as frequent and important nest predators of superb fairy-wrens (at both artificial and natural nests), a finding that differs from previous research on superb fairy-wrens (Gardner 1998). The importance of rodents as nest predators also differs for other bird species that were studied in the same study sites using similar artificial nest techniques (McGuire and Kleindorfer 2007; Galligan and Kleindorfer 2008). Thompson III and Burhans (2004) found that snakes were the major nest predator for real nests whereas mice and raccoons were the major nest predators for artificial nests. In addition to evidence of rodent predation at artificial nests, we identified rodents as important predators of natural nests using video surveillance (Colombelli-Négrel et al. 2009). Rodents are considered important nest predators of passerine nests (Pietz and Granfors 2000; Maier and Degraaf 2001) and generally find well-concealed nests in the vegetation (Weidinger 2002). Because rodents are identified as an important nest predator in general, tracking tunnels might provide first estimations about rodent densities with reduced effort over a short period of time.

Superb fairy-wren nests seem to suffer high predation from different predator types, lowering the fitness payoff of a single pure strategy for nest concealment and height. Building nests with one particular set of attributes (e.g., low and concealed nests) might decrease predation from one type of predator but increase its vulnerability to another. Superb fairy-wrens breed several times per year and have long life-spans. Future research could examine how nest placement (height, concealment) varies in birds that renest across years, also in relation to previous breeding attempts (see also Kleindorfer 2007).

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