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IDENTIFYING NEST-PREDATOR SPECIES IN A SOUTHERN VICTORIAN WOODLAND USING REMOTELY TRIGGERED CAMERAS AT ARTIFICIAL NESTS

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I used remotely trigered cameras placed at artificial nests to identify nest-predator species in Langwarrin Flora and Fauna Reserve, a woodland remnant in southern Victoria. A quail egg placed on top of a microswitch inside a disused bird nest acted as the bait and trigger mechanism for a camera placed nearby. After 220 camera days at 22 different nest sites, 15 nest sites had been depredated by the Grey Shrike-thrush *Colluricincla harmonica*, and five had been depredated by the Little Raven *Corvus mellori*. Nest sites were more likely to be revisited, and were revisited more quickly, by Little Ravens than by Grey Shrike-thrushes.

INTRODUCTION

Predation of eggs or nestlings is the leading cause of nest failure for many bird species (Ricklefs 1969; Martin 1992). In Australian forest and woodland habitats, predation can account for up to 50 per cent of nests (Clarke and Clarke 2000; Ford and Trémont 2000; Berry 2001c). The nest-predator communities in Australian forest and woodland areas may comprise avian, mammalian and reptilian species (Beruldsen 1980; Major and Gowing 1994; Major *et al.* 1999). However, identification of the species responsible for nest predation in a particular habitat presents a major problem. Nest predation is a brief event, and direct observation of the predator species is rarely achieved.

Cameras that are triggered to take a photograph when a predation event occurs at a nest have become popular for identifying nest predators. Techniques have evolved from simple mechanical triggers (Picman 1987; Major 1991a; Picman and Schriml 1994) to sophisticated infra-red electronic sensors that detect movement of light and/or heat (Savidge and Seibert 1988; Laurance and Grant 1994; Fenske-Crawford and Niemi 1997), magnetic reed switches (Major and Gowing 1994; Major *et al.* 1999) and microswitches (Whelan *et al.* 1994; Sloan *et al.* 1998). In this study, I used a remotely triggered camera that is triggered by a microswitch to photograph predation events at artificial nests. The purpose of this study was to qualitatively identify predators of open-cup nests within a woodland remnant in southern Victoria, Australia.

METHODS

This study was conducted at Langwarrin Flora and Fauna Reserve, a 214 hectares woodland and heathland remnant 44 kilometres south south-east of Melbourne, Victoria (38°10'S, 145°11'E). Remotely triggered cameras comprised a Ricoh XF 30-E camera in a clear plastic box, with a hole cut out in front of the lens, fixed in a tree or bush using a bosshead and burette clamp. Tree branches were arranged over the box to shield the camera from view. A disused open-cup nest of a New Holland Honeyeater *Phylidonyris novaehollandiae* or Eastern Yellow Robin *Eopsaltria australis* was placed 60 centimetres from the camera in a tree fork (= camera nest). A Japanese Quail *Coturnix coturnix* egg pressed down on the button of a miniature microswitch that was placed inside the nest. The dimensions of the microswitch in the nest were 20 mm × 14 mm × 6 mm. A single loop of copper wire attached to the microswitch held the egg lightly in place. The microswitch was plugged into the remote trigger socket on the camera using electrical wiring that passed through a hole in the base of the nest. When the egg was lifted by a predator, the microswitch was released, sending a signal to the camera to take a photograph. The flash on the camera was left charged so as to fire immediately when the camera was triggered. The camera did not take a photograph if the batteries were too low to activate the flash.

Six cameras were deployed in the field at a total of 22 different nest sites during October 1999–February 2000. Nest sites were spaced at least 250 metres apart. Nests were placed in thick scrub at a height of 1–2 metres, the typical nest site of the New Holland Honeyeater and Eastern Yellow Robin in the study area (Berry 2001b). The camera batteries were changed daily, and the egg was checked for signs of a predation attempt at the same time. If a predation event had occurred, the egg was replaced and the camera reset. Cameras were moved to a new nest site after a maximum of 22 days. The mean numbers of revisits to a single nest site by each nest-predator species were compared using a Wilcoxon signed-rank test. The mean number of days between visits by a single species to a nest was compared between nest-predator species using a two-tailed *t*-test for independent samples. The significance level for these tests was set at $P < 0.05$.

RESULTS

After a total of 291 camera days at the 22 artificial nest sites, two different species were photographed during predation events (Table 1). The Grey Shrike-thrush *Colluricincla harmonica* was recorded at least once at 15 nest sites, and the Little Raven *Corvus mellori* was recorded at least once at five nest sites. The mean number of revisits (including the first visit) by each species to a nest site at which each species was recorded was significantly greater for the Little Raven ($Z = 2.0$, $P = 0.04$, Table 1). There were a total of 130 predation events, 83 of which resulted in photographs in which the nest-predator species could be identified: 42 of the Grey Shrike-thrush, and 41 of the Little Raven. The remaining 47 predation events resulted in a range of outcomes, the most common being that no photograph was taken as the batteries in the camera were flat when the event occurred (15% of predation events). Other reasons why predation events did not result in a photograph of a predator were: the egg was

TABLE 1

Number of nest sites at which photographs of each predator species were obtained and mean number of visits per site* by each species.

Species	No. nest sites	Mean No. visits per site*
Grey Shrike-thrush *Colluricincla harmonica*	15	2.8 (*s.e.* ± 0.5)
Little Raven *Corvus mellori*	5	8.2 (*s.e.* ± 0.6)

*only includes nest sites visited at least once.

damaged without the egg being lifted from the trigger (10.8% of predation events); the camera malfunctioned (3.8%); the trigger failed due to clogging by egg contents (2.3%); the predator could not be identified from the photograph (1.5%); the egg fell from the nest unassisted (1.5%); and human error (0.7%). The mean number of days between visits by a single species to a nest was 2.3 for the Grey Shrike-thrush (*s.d.* = 1.5, n = 24) compared with only 1.6 (*s.d.* = 1.1, n = 34) for the Little Raven, a significant difference (t_{56} = 2.2, P = 0.031).

DISCUSSION

This study identified the Grey Shrike-thrush and Little Raven as predators of camera nests at Langwarrin Flora and Fauna Reserve. Corvids are well-known nest predators worldwide (Picozzi 1975; Angelstam 1986; Andrén 1992; Hannon and Cotterill 1998). Several lines of evidence indicate that corvids are important predators of eggs and nestlings in Australia, including direct observation of predation events on natural and artificial nests (Bourke 1948; Dorfman and Read 1996; Major *et al.* 1996), photographs from remotely triggered cameras (Gardner 1998; Major *et al.* 1999), footprints at depredated shorebird nests (Berry 2001b), and eggshell remains recovered from corvid stomachs (Rowley and Vestjens 1973). The Grey Shrike-thrush is primarily insectivorous and is not as well known as a nest predator. Still, evidence does exist, again in the form of photographs using remotely triggered cameras (Major 1991b; Gardner 1998; Major *et al.* 1999) and direct observation (Bridges 1994).

The Grey Shrike-thrush is considered to be a forest-dependent or forest-edge species (Howe 1984; Loyn 1985; Major *et al.* 1999; Berry 2001a), while the Little Raven is usually associated with open country and small remnants (Loyn 1985; Luck *et al.* 1999). Given that the majority of species nesting in Langwarrin Flora and Fauna Reserve are forest or woodland-dependent species (Berry, in press), the level of nest predation on camera nests by the Little Raven in this small, isolated remnant is a concern. Such species were probably not exposed to high levels of nest predation by Little Ravens in contiguous habitats, but the rates of nest predation by such open-country species on forest species may be increasing due to habitat fragmentation and degradation (Wilcove 1985; Angelstam 1986; Andrén 1992).

Some predators, such as corvids, are particularly good at learning, and can adapt their behaviour in order to exploit food resources such as artificial nests (Picozzi 1975). This was indicated by the fact that the Little Raven was significantly more likely than the Grey Shrike-thrush to be recorded more than once at a nest site and revisited nest sites more quickly. Because cameras were reset at the same nest site after a predation event occurred, it was likely that the same individual bird returned to a nest site and was photographed more than once. For independence of observations, cameras should be moved to a new nest site after each predation event (Major and Kendal 1996; Major *et al.* 1999). Predators may also learn to recognize the (even disguised) camera box at the nest, or even the researcher when setting up camera nests. It is important that researchers minimize such problems in quantitative studies of nest-predator identity.

No mammals were photographed preying on nests in this study. This was unexpected, considering that small mammals were identified as predators of 24 per cent of marked plasticine eggs from artificial nests placed in the same study area (Berry 2001b). Mammals species present at Langwarrin Flora and Fauna Reserve include the Agile Antechinus *Antechinus agilis*, Black Rat *Rattus rattus*, Swamp Rat *R. lutreolus*, House Mouse *Mus musculus*, Common Ringtail Possum *Pseudocheirus peregrinus* and Common Brushtail Possum *Trichosurus vulpecula* (Opie 1983; Berry, pers. obs.). These species are known or suspected to prey on bird nests (Beruldsen 1980; Major and Gowing 1994). The lack of nest predation by small mammals in this study may have been due to the size of the Japanese Quail eggs used. The egg used in the camera nest had to be large and robust, as small, fragile eggs were not suitable for use with the microswitch trigger mechanism. Smaller-sized mammals, however, may not have been able to trigger the camera, as the Japanese Quail eggs may have been too large for them to manipulate (Roper 1992; Haskell 1995; DeGraaf and Maier 1996). The Eastern Yellow Robin and New Holland Honeyeater produce eggs much smaller (21–22 × 15–16 mm, Beruldsen 1980) than Japanese Quail eggs (32–38 × 24–27 mm), and consequently these species may be vulnerable to a wider range of predators than was revealed in this study. Additionally, no snakes were photographed taking eggs from artificial nests, despite frequent sightings of Tiger Snakes *Notechis scutatus* and Red-bellied Black Snakes *Pseudechis porphyriacus* in the study area. Predation on artificial nests by reptiles may be precluded by a lack of parental activity at these nests, as reptiles may rely primarily on parental activity as a cue when locating nests (Major *et al.* 1999; Davison and Bollinger 2000). In addition, the incidence of nest predation by Grey Shrike-thrushes and Little Ravens may be over-represented by artificial nests due to the absence of parental defence (Major *et al.* 1999).

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