Notornis, 2019, Vol. 66: 103-107
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SHORT NOTE

Long-tailed cuckoo (*Eudynamys taitensis*) predation on rifleman (*Acanthisitta chloris*) nestlings

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The rifleman (tītipounamu, *Acanthisitta chloris*) is a small (5–7 g) New Zealand endemic bird that lives in forested areas throughout the country. It is socially monogamous, with occasional cooperative breeding behaviour. It builds dome-shaped nests with a single entrance (~2.5 cm) in a variety of locations, including tree cavities, the dead fronds of tree fern trunks, and on the ground underneath leaf residues or roots (Sherley 1990). It breeds from September to February and can successfully rear several broods a year (Gray 1969; Sherley 1985). Predators include native New Zealand species like the morepork (ruru, *Ninox novaeseelandiae*) (Denny 2009), as well as introduced mammalian predators such as rats (*Rattus* spp.) and stoats (*Mustela erminea*) (Robertson 1985; Gill 2019). However, predation by long-tailed cuckoos (koekoeā, *Eudynamys taitensis*) on rifleman has not previously been reported. Here we describe observations of long-tailed cuckoo predation on rifleman nestlings and the vocal response of rifleman towards long-tailed cuckoos. To our knowledge, these are the first documented cases of long-tailed cuckoo predation on rifleman.

The long-tailed cuckoo is a medium-sized (125 g) summer migrant to New Zealand. It is a brood parasite, targeting mainly whiteheads (pōpokotea, *Mohoua albicilla*), yellowheads (mohua, *Mohoua ochrocephala*), and brown creepers (pipipi, *Mohoua novaeseelandiae*) as its hosts (Gill 2013). It has a generalist diet that includes insects (Gill 1980; Reed 1980), lizards, and the eggs and nestlings of small birds such as tomtits (*Petroica macrocephala*) and silvereyes (*Zosterops lateralis*) (Stidolph 1949; Robertson 1985; Beaven 1997; Gill *et al.* 2018). It forages solitarily in habitats that include the forest canopy, second-growth bush, and cultivated lands. It breeds throughout New Zealand from October to March while it winters in the Pacific Islands from April to September (Robertson 1985).

As part of a larger project, we monitored rifleman nests in the Boundary Stream Mainland Island, New Zealand (39°06'15.8"S, 176°48'06.1"E), from September 2018 to February 2019. This area has been managed by the Department of Conservation since 1979, and due to intensive management and translocation efforts, it is host to many New Zealand native birds including long-tailed cuckoos. For each rifleman nest found on our study site, we set up a Bioacoustic Automated Recorder (BAR) by Frontier Labs (Nathan, QLD, Australia) and a trail camera by Bushnell (TrophyCam Model 119776; Kansas City, MO, USA) to record the vocalizations and the interactions between parents and nestlings. All BARs and trail cameras were placed within 1.5–2 m from the entrance to a nest. All observations are based on trail camera footage (the camera time and date were set to local time and date) and recordings from the BARs.

The first predation event occurred on the 22 November 2018 (Fig. 1a–c). The nest cavity was 4.1 m high in a mahoe tree (*Melicytus ramiflorus*), with a tree cavity entrance of about 15 cm x 15 cm.

Received 11 March 2019; accepted 13 May 2019
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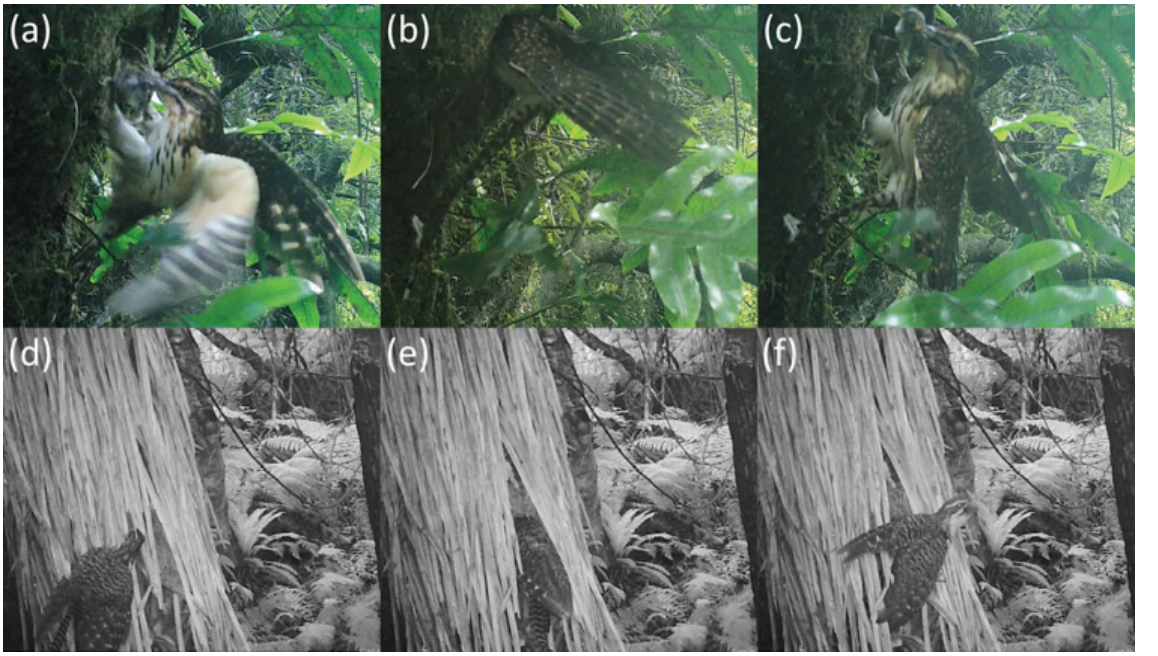

Figure 1. Screenshots of video footage of long-tailed cuckoo predation on rifleman nests at the Boundary Stream Mainland Island Reserve, New Zealand. Long-tailed cuckoos depredated rifleman nests on the 22 November 2018, at 1108 h (a–c), and another nest on the 30 November 2018 (d–f) at 1419 h. For both events, trail cameras detected the long-tailed cuckoos at the nest holes (a,d), reaching their heads inside the nests (b,e), grabbing a nestling in the beak (c), and swallowing a nestling (f). Low light levels at the second site (d–f) generated black and white footages. Video footages were taken from trail cameras Bushnell TrophyCam (Model: 119776; Kansas City, MO, USA).

Rifleman nestlings at this nest were 14 ± 2 days old (rifleman fledge at ~20 days). A long-tailed cuckoo arrived at this nest at 1103 h and stayed for five minutes. During this time, it removed nest material from the tree cavity, and made several attempts to grab nestlings. A rifleman adult – probably one of the parents – was audible in the background of the camera recording, and produced long and consistent series of agitated calls and a total of 9 trills with decrescendo notes (Fig. 2a, d). At 1108 h, the long-tailed cuckoo grabbed a single nestling in its beak and flew away. The nestling produced a high pitch, broad-band distress call when captured (Fig. 2b). Once the cuckoo left the area, the parent stopped producing agitated calls and trills. Thirty-four minutes after the cuckoo departed, the female rifleman entered the nest to feed the remaining nestlings. At 1640 h on the following day, a long-tailed cuckoo appeared again on the trail camera, and stayed 13 minutes at the nest. The long-tailed cuckoo removed more nesting material from the nest, including feathers and twigs, but it did not take any nestlings. During this time, a rifleman adult produced a series of agitated calls and a total of 13 trills (Fig. 2a, d). A day later, we found a live nestling outside its nest with its parents attending it at the base of the nest tree. We did not hear any begging sounds coming from the nest, suggesting that this nestling was the last of its brood. The nestling did not survive the night outside its natural nest. The trail camera did not pick up any subsequent predation events or visits by the long-tailed cuckoo. The long-tailed cuckoo was not banded, so we are unsure if the same individual visited the nest on those occasions.

The second long-tailed cuckoo predation event at a rifleman nest occurred on the 30 November 2018 and the 01 December 2018. This nest was built inside the dead fronds of a soft tree fern (kātote, *Cyathea smithii*), and was 2.9 m above the ground. The nestlings at this nest were 13 ± 2 days old. On the 30 November 2018, a long-tailed cuckoo visited this nest twice, roughly an hour apart, for two minutes in total, and consumed three nestlings (one nestling from 1308–1309 h and two nestlings from 1418–1419 h). At arrival, it pushed its head in the nest, retrieved a nestling, and immediately swallowed it before leaving. At 1309 h, a rifleman parent generated rapid high-frequency agitated calls and a rapid trill (i.e. similar to Fig. 2a, d). Seventy minutes later, the long-tailed cuckoo visited the nest a second time. It forced its head inside the nest again, and emerged

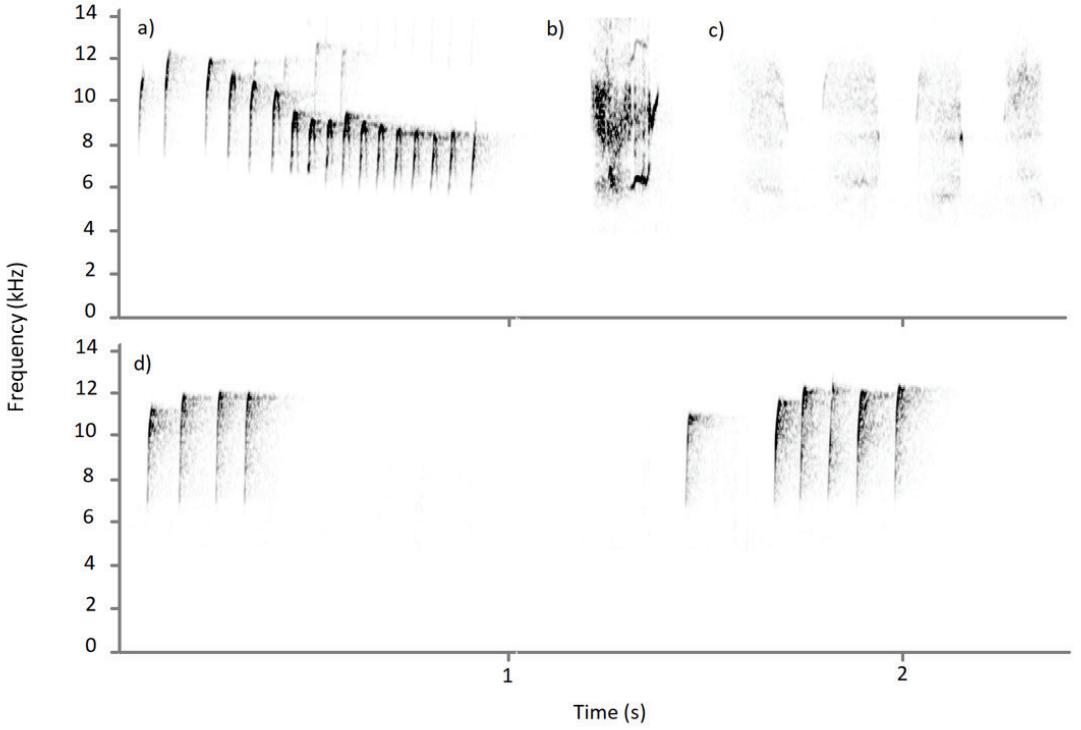

Figure 2. Selection of spectrograms of rifleman vocalizations during predation events by long-tailed cuckoos in Boundary Stream Mainland Island Reserve, New Zealand. Rifleman parents produced trills (a) and agitated calls (d) towards long-tailed cuckoos at their nests and rifleman nestlings produced distress calls (b–c) when picked up by long-tailed cuckoos. The adult trill (a) and the agitated calls (d) were recorded on the 22 November 2018. On the 22 November 2018, at 1108 h, a long-tailed cuckoo grabbed a nestling that produced a high pitch broad-band nestling call (b). On the 30 November 2018, at 1419 h, another nestling produced distress calls (c) before being swallowed by a long-tailed cuckoo. Spectrograms were created with Syrinx Version 2.6h (Transform size 512, FFT Window Type Blackman) (Burt 2006). All recordings can be found on xeno-canto (www.xeno-canto.org): catalogue numbers - Fig. 2a XC470957, Fig. 2b XC470956, Fig. 2c XC470958, Fig. 2d XC470955.

with a second nestling in its beak. It then reached inside the nest for a third nestling. Once in its beak, the third nestling produced a distress call (Fig. 2c, at 1419 h) before it was swallowed. The following day, at 0856 h, a long-tailed cuckoo visited the nest for the third time. However, it left the nest shortly after, without inserting its head in the nest and attempting to capture any nestlings. After this predation event, no rifleman adult was seen feeding at this nest, suggesting that the long-tailed cuckoo depredated the whole rifleman clutch. As with the first nest, the cuckoo was not banded, so we are unsure if the same individual visited the nest on each occasion.

We also recorded a third visit by a long-tailed cuckoo to a rifleman nest, but in this case, no predation occurred. This nest was also built in the dead fronds of a soft tree fern, along its trunk, and was 2.8 m high. On the 27 November 2018, a cuckoo visited a rifleman nest at three different times, a few minutes apart (0903 h, 0906 h, and 0908 h). The nest had fledged the same morning, and we were not aware of any predation on the nest in the days prior to fledging. This visit may suggest that this long-tailed cuckoo knew about the location of this nest but decided to delay its predation.

Throughout the breeding season, we documented the visit and predation events at three rifleman nests (Fig. 1). The long-tailed cuckoos visited two types of rifleman nests: a nest constructed in a tree-cavity (Fig. 1a–c) and two nests built in the dead fronds of tree fern trunks (Fig. 1d–f). This demonstrates the aptitude of long-tailed cuckoos to locate and access diverse types of nests. Rifleman also nest near or on the ground, but we have not yet observed predation by long-tailed cuckoos on these nests. This may be because cuckoos probably do not spend much time on the ground (I Moran *pers. obs.*). This may further explain why some rifleman nest near the ground:

to avoid cuckoo predation, a strategy that may have been adaptive before the introduction of terrestrial mammalian predators. It is also important to note that the long-tailed cuckoos visited nests built in large tree cavities with relatively large entrances which could have facilitated access to the nestlings. Furthermore, we found that all attempted predation events occurred late in the nestling period, within a week of the expected fledging date. This may indicate that long-tailed cuckoos prefer to prey on older nestlings. Alternatively, it may be that the loud begging noises of the nestlings, or the high rate of nest visitation by parents later in the nestling period, facilitate the ability of long-tailed cuckoos to locate nests. Finally, long-tailed cuckoos may delay their predation on known nests to prey on older nestlings, as suggested by the third visit to a nest. This last possibility would warrant future investigation as it would require planning on the part of the predator.

The vocal responses of riflemen towards long-tailed cuckoos were conspicuous and distinctive from the other vocalisations used by this species during nest feeding contexts (Fig. 2). The adult rifleman produced alarm responses including agitated calls (Fig. 2a), and trills (Fig. 2d) referred to by Higgins *et al.* (2001) as alarm calls with rapid high frequency decrescendo notes. Agitated calls consisted of a repetition of similar structured, short, sharp, elongated notes with a frequency range between around 6.5 kHz and 12 kHz, while the trills consisted of similarly structured notes that decreased in frequency from higher frequencies (~8–12 kHz notes) to lower frequencies (~6–8 kHz). We also documented the distress calls of rifleman nestlings in response to long-tailed cuckoo predation (Fig. 2b, c). The distress calls of the nestlings were broad-banded notes between around 6–11 kHz and were about ~0.2–0.3 s in duration.

Long-tailed cuckoo predation on rifleman opens up the possibility for cuckoo brood parasitism on rifleman nests. A study investigating cuckoo artificial egg rejection and desertion by New Zealand birds found that rifleman may recognize cuckoo eggs; two out of eleven rifleman pairs abandoned their nests with artificial shining cuckoos' eggs (Briskie 2003). Further studies on egg rejection and recognition in rifleman should be investigated. Alternatively, similarly to shining-cuckoos that seem to be general predators of avian eggs (Briskie 2007), long-tailed cuckoos appear to be general predators of nestlings, even for species they do not parasitize. In addition, unlike previous reports of cuckoo predation events, in which long-tailed cuckoos left no signs of nest destruction around the open cup nests of tomtits after predation (Beaven 1997), we show that long-tailed cuckoos substantially destroy the structure of rifleman nests. Future studies on rifleman nest destruction by long-tailed cuckoos may give additional insight on nest suitability for brood parasitism.

The three instances of long-tailed cuckoo predation and visit on rifleman nests reported here support the predatory status of long-tailed cuckoos on rifleman in New Zealand and suggest that long-tailed cuckoos may have important ecological impacts on the populations of rifleman in New Zealand. Further studies on how long-tailed cuckoos impact rifleman populations via predation and potential brood parasitism are needed and will improve our current understanding of the ecology and distribution of rifleman and long-tailed cuckoos in New Zealand.

ACKNOWLEDGEMENTS

We would like to thank J. Leung for his help collecting data during our 2018–2019 field season. We would also like to thank the Department of Conservation ranger, M. Melville, for his help during our stay at the Boundary Stream Mainland Research Station. We are also grateful to the Iwi community from the Maungaharuru region and the Department of Conservation, New Zealand, for facilitating and supporting our research at Boundary Stream Mainland Island. We also thank our reviewer and Dr Craig Symes, editor of *Notornis*, for providing reviews to our manuscript. This research is funded by the Marsden Fund (17-UOA-086) and the University of Auckland, and was approved by the University of Auckland Animal Ethics Committee (protocol 001866) and by the NewZealand Department of Conservation (FAU 55391).

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Keywords: long-tailed cuckoo, *Eudynamys taitensis*, rifleman nestlings, *Acanthisitta chloris*, predation, vocal response to predation, Boundary Stream Mainland Island