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SHORT NOTE

Grey warbler (*Gerygone igata*) aggressive behaviour towards rifleman (*Acanthisitta chloris*) fledglings

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Organisms interact with one another to form complex ecological networks that involve intricate relationships between species. Agonistic behaviour between heterospecifics, in which individuals of one species are aggressive towards another, can elucidate direct and indirect inter-species competition and threats. New Zealand forests, with their unique avian communities, offer an ideal system to study these aggressive interactions.

Several native New Zealand birds, such as the bellbird (korimako, *Anthornis melanura*; Withers 2009) and brown creeper (pīpipi, *Mohoua novaeseelandiae*; Gray 1969), are known to show aggression towards rifleman (tītitipounamu, *Acanthisitta chloris*), the smallest New Zealand bird. Here, we describe the vocal and physical behaviours of rifleman in response to aggression from other New Zealand bird species, in particular the grey warbler (riroriro, *Gerygone igata*; Stidolph 1939), tūī (*Prosthemadera novaeseelandiae*), and North Island robin (toutouwai, *Petroica longipes*). Because aggression from grey warblers was the most commonly observed, we then focus on grey warbler aggression and contrast it with the levels of aggression observed from other species (bellbird, tūī, and North Island robin) towards rifleman. In addition, grey warblers are a similar size to rifleman (rifleman 5–7 g, grey warblers 6 g). Finally, we suggest possible explanations for the aggressive behaviour of grey warbler towards rifleman fledglings.

From September 2018 to February 2019, we monitored a rifleman population throughout their breeding season in Boundary Stream Mainland Island Reserve, New Zealand (39°06′15.8″S, 176°48′06.1″E). In particular, upon fledgling, we recorded the vocalisations of rifleman fledgling groups using Zoom H6 digital recorders (Hauppauge, NY) with Sennheiser K6 microphones (Sennheiser electronic GmbH & Co. KG, USA). Rifleman fledglings stay in natal groups, usually consisting of three to four fledglings, for four to five weeks post-fledging, and are dependent on their parents to supplement their feeding (Sherley 1985). During this time they produce broadband frequency calls that are conspicuous acoustically; this makes them easily detectable and distinguishable from rifleman adult vocalisations. Their dull grey plumage and streaks on the throat and chest can also be used to distinguish rifleman fledglings from adults (Higgins *et al*. 2001; Withers 2013). While monitoring the rifleman population in Boundary Stream Mainland Island, we observed a number of aggressive behaviours towards rifleman from native New Zealand birds.

We observed grey warblers chasing rifleman fledglings on four occasions, from 30 November to 27 December 2018. In all cases, the rifleman fledglings were between two days and 15 days

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post-fledging. In each chasing event, an adult grey warbler silently chased a single fledgling, during which the rifleman fledgling produced distress calls in flight (Fig. 1a). In two cases, this triggered alarm responses from the rifleman parents (Fig. 1b). The length of the chases varied from a few seconds, where the grey warbler briefly pursued a fledgling, to a few minutes, where the chase was persistent and involved longer aerial loops in the tree foliage. On another occasion, two chases in the same fledgling group were recorded eight minutes apart during which the rifleman parents produced agitated calls and alarm trills in response to the grey warbler's presence and chasing of the fledglings. Interestingly, we observed that chases exclusively occurred between the adult grey warblers and rifleman fledglings, and not between adults of both species.

We also observed aggression from adult bellbirds towards rifleman juveniles, a behaviour that has been reported before (Withers 2009). During our observation, a female bellbird seized a rifleman fledgling with its beak while flying. Both of them then dropped to the ground and the fledgling escaped. The rifleman parent of the fledgling group produced alarm calls directed at the attacker until it flew away from the area. Additionally, we observed robins and tūī chasing adult rifleman at our field site. The robin initiated the chase while the individual rifleman was foraging in the tree branches. In the case of the tūī, an adult rifleman pair mobbed a tūī approximately 20 meters from their fledgling group which resulted in the tūī showing aggression towards the adult pair. The tūī chased the adult pair for approximately 10 seconds before leaving the area.

Overall, we found that grey warblers, bellbirds, robins, and tūī showed varying levels of aggression towards rifleman: the bellbird chased and physically attacked rifleman fledglings, the grey warbler only chased the fledglings and not the adults, and the robin and tūī chased only the adult rifleman.

Interspecific aggression between bird species can result in competitive exclusion, niche differentiation, and even local extinction, and may explain species speciation and species distribution (Robinson & Terborgh 1995; Jankowski *et al.* 2010; Freeman *et al.* 2016; Bauer & McDonald 2018). We suggest three non-mutually exclusive explanations why grey warbler chase rifleman fledglings: (1) territoriality to defend resources, (2) competition for food, and (3) interspecific overlapping of acoustic niches.

Rifleman are sedentary birds that do not disperse far from their natal territories (Gill 1980a) and do not defend strong territory boundaries, while grey warblers are territorial and maintain territories with songs year-round (Gill 1982; Cameron 1990). Grey warblers also settle territorial disputes by chasing intruders (Gill 1980b). The resources that territorial birds defend may range from feeding resources, nests, fledgling groups, mates, and an area of forest. Hence, grey warblers may chase rifleman fledglings that trespass into their territories. It is unclear why grey warblers do not chase adult rifleman. Perhaps adults are less vulnerable or are able to return

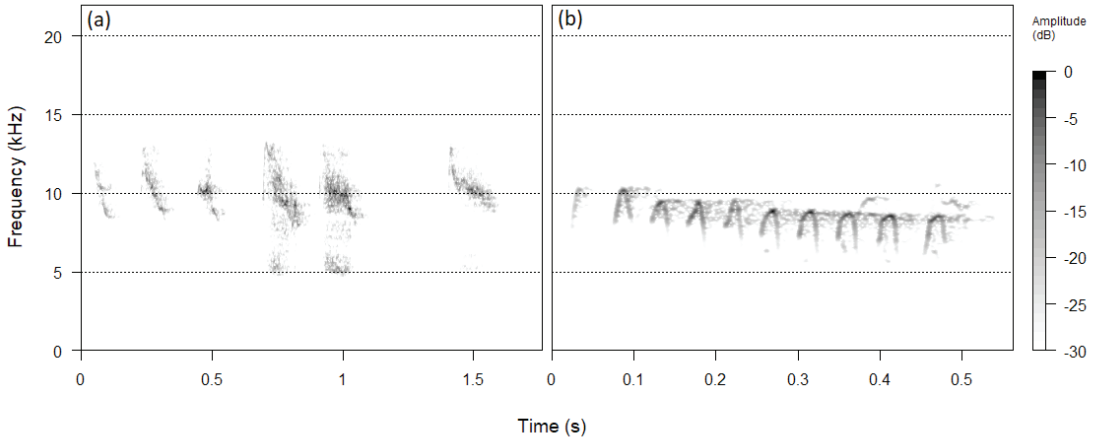

Figure 1. Spectrograms showing the frequency and amplitude of (a) a distress call produced by a juvenile rifleman at two days post-fledgling while being chased by an adult grey warbler, and (b) an alarm trill produced by the female parent rifleman in response to the warbler chasing its fledgling. The sound clip was recorded in Boundary Stream Mainland Island on 30 November 2018 (recordist YYL). The spectrograms were made with Seewave for R (Sueur *et al.* 2008). The recording is available on Xeno-Canto (www.xeno-canto.org, XC475016).

aggression as they are of a similar mass.

Secondly, many bird species have overlapping territories but do not show aggression towards one another. However, competition for similar resources may drive aggression. This may be the case with rifleman and grey warblers that forage the majority of their time on silver beech (*Nothofagus menziesii*) and kamahi (*Weinmannia racemosa*) trees (O'Donnell & Dilk 1994). They also share a similar insectivorous diet of mainly spiders, beetles, caterpillars, and moths (Moeed & Fitzgerald 2012). Consequently, resource competition and partitioning may underlie the agonistic interactions between rifleman and grey warblers. As rifleman fledglings may forage for a few weeks on grey warbler territories (Gill 1978; Sherley 1985), this may trigger grey warblers to be aggressive towards rifleman fledglings.

Thirdly, overlapping acoustic niches can trigger aggressive behaviour between individuals of the same species (Hall *et al.* 2006; Naguib & Mennill 2010). However, no studies to date have tested whether interspecific acoustic overlapping generates interspecific aggressive behaviour, although a few studies have shown that species avoid singing during the song of another species (Popp *et al*. 1985; Brumm 2006). On the other hand, acoustic niche partitioning can occur between species of insects and birds. For example, when cicadas sing, bird species tend to either adjust their vocalisations or avoid vocalising during this period (Hart *et al*. 2015). Our recordings show that the contact calls of rifleman fledglings (8–11 kHz; Fig. 2a) overlap with that of the grey warbler fledglings (8–9 kHz; Fig. 2b; Higgins & Peter 2002). We suggest that interspecific acoustic overlapping may generate interspecific aggression in birds. When grey warblers produce their songs during the breeding season (Gill 1980a), rifleman fledgling vocalisations may overlap temporally with grey warbler songs that function as territorial and mate attraction signals. In addition, the loud and conspicuous rifleman fledgling vocalisations (Higgins *et al*. 2001) may interfere with grey warbler parent-fledgling vocal communication.

In summary, we have observed and documented grey warbler adults chasing rifleman fledglings – a previously undescribed observation. We suggest that this aggressive behaviour may be caused by competition for either territory, resources, or acoustic space, and highlight the importance of describing heterospecific behaviours to further understand the ecological relationship between species.

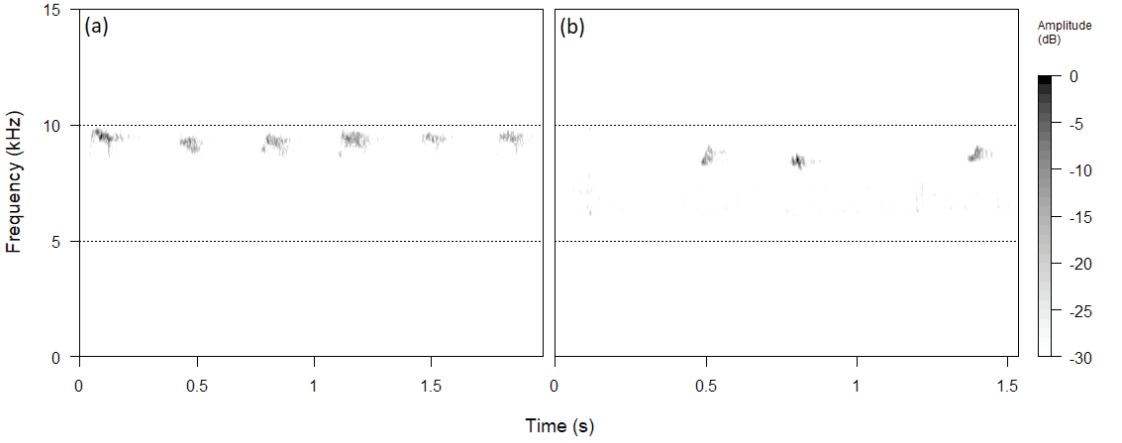

Figure 2. Spectrograms of (a) a rifleman fledgling and (b) a grey warbler fledgling from Boundary Stream Mainland Island. Grey warbler fledgling vocalizations (8–9kHz) overlap with the acoustic niche of rifleman. The sound clips of the rifleman and grey warbler fledglings were recorded in Boundary Stream Mainland Island on 1 December 2018 (recordist YYL) and 5 December 2018 (recordist IGM), respectively. The spectrograms were made with Seewave for R (Sueur *et al*. 2008). These recording are available on Xeno-Canto (rifleman fledgling: XC476225; grey warbler fledgling: XC475017).

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