

Calling and display by peacocks (*Pavo cristatus*) at Mansion House Historic Reserve, Kawau Island, New Zealand

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Abstract Information was collected on the calling and display behaviour of 3 peacocks in the absence of peahens at Mansion House Historic Reserve, Kawau Island. The peacocks used an exploded lek display structure from late August to late December. Peacocks predominantly used the *eow* and occasionally the *ka* notes during tail displays but were silent during many displays. The overall composition of call notes given during the breeding period differed from those used in a large dense peafowl breeding population in Japan.

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Keywords Peafowl; *Pavo cristatus*; Kawau Island

INTRODUCTION

Peafowl (*Pavo cristatus*) have been studied within their native range (Sharma 1978, 1979; Rands *et al.* 1984) and in a number of countries where they have been introduced (Rands *et al.* 1984). Peafowl are lek breeders and males display within small groups of related individuals (Petrie *et al.* 1999). The area of leks vary from 3-6 ha (Rands *et al.* 1984; Galusha & Hill 1996). In some situations these groups form “exploded leks” where the peacocks are not in visual contact with each other (Galusha & Hill 1996). Groups of peahens move between displaying and calling peacocks (Rands *et al.* 1984). It is likely that both solo birds and groups of peacocks are normal, as both occur in their natural habitat. For example,

Rands *et al.* (1984) reported 48 lone and 3 groups of peacocks, and 5 groups of both sexes in India.

Peafowl are native to south Asia but were introduced to New Zealand in the late 19th century (Long 1981). The current population of peacocks at Mansion House Historic Reserve, Kawau Island, derives from c. 20 birds liberated between 1958 and 1979 (R. Mohring, *pers. comm.*), and a male and white bird of unrecorded sex from Motukioire Island in c.1989 (J. Cook, *pers. comm.*). The 3 peacocks used in this study are the remnants of a small breeding population which lived there between 1989 and 2004 (Beauchamp 2013). During that time they occupied an open parkland (2.5 ha) area surrounded by pine (*Pinus* spp.) forest (Beauchamp 2013).

The loud repetitive sequences of notes given by peacocks have historically be described phonically (Johnsingh & Murali 1978; Glusha & Hill 1996;

Takahashi & Hasegawa 2008) or have been treated as 1 group and assessed without distinguishing to type (Glusha & Hill 1996; Yasmin & Yahya 2000). It is only recently that sonograms of the call note types given during the breeding season have differentiated the courtship calls, and that these have been correlated with display behaviours (Takahashi & Hasegawa 2008). A number of factors have been assessed against display time, including the call sequence rate per minute and the proportion of call sequences with greater than 5 notes given by single birds (Yasmin & Yahya 2000).

In this study I examined the call types use by peacocks in the absence of peahens. I also compared the calling behaviour of an immature peacock with those of adults as he matured, and discuss the note and calls sequence pattern seen on Kawau Island with another introduced population in Japan.

METHODS

I visited Kawau Island for 1 to 4 nights per month for most of the year. The calls, breeding displays and display sites of 3 peacocks were recorded between August 2006 and May 2009 and then 2 of the birds from May 2009 to September 2013 after a dog killed one of the birds. My observations on peafowl on Kawau Island was conducted while I was studying weka (*Gallirallus australis*) and this dictated my movements. However, I was generally in hearing or visual contact with the peacocks, except for an hour in the late morning and half an hour in the early afternoon during each visit, when I was monitoring weka outside the call range of the peacocks.

The time of day, time in the annual cycle (breeding display and non breeding), identity and location of each peacock (tree roost or ground), and the number of call sequences and notes were recorded from 30 minutes before sunrise until 45 minutes after sunset. Collection of call data started before I was aware of the sonogram, notation and behavioral work of Takahashi and Hasegawa (2008). Before 2009 the numbers of notes were recorded within call sequences, but I did not adequately distinguish between the calls sequences comprising one note type from sequences with multiple note types. (i.e., *eow*, *eow eow eow* was scored as a 4 note sequence, while *Keow*, *ka*, *ka*, *eow* was also scored as a 4 note sequence). Consequently, all pre-2009 analysis of call sequences used combined totals of notes as the "trumpet complex", and these comprised the *keow*, *ka*, *eow*, *eon1* and *eon2* call notes (Takahashi & Hasegawa 2008).

During the 2009 and 2010 breeding seasons I recorded the notes given within sequences using the notation of Takahashi and Hasegawa (2008), and I also recorded the behaviour of the calling bird at that time. In all instances the behaviour

matched that given by Takahashi and Hasegawa (2008), except in most instances the intense head bobs seen with rendition of *Keow* notes in the videos referenced in the appendices to that paper, were not seen on Kawau Island.

In 2011-13, I recorded representative calls of the remaining peacock with and without 2 newly introduced peahens, using an Olympus LS-10 linear recorder (44.1 kHz 16-bit sample size). I then checked the accuracy of my field assignment of call type (for frequently (kHz), note duration and note spacing), using the sonograms generated from Kawau I in Raven Lite® (Cornell University Laboratory of Ornithology, Ithaca, NY, USA) against the representative sonograms in Takahashi & Hasegawa (2008). All assignments were accurate.

Each peacock could be individually identified using plumage and physical attributes. One peacock was an autosomal recessive white (cohort before 1987), the second was a heterozygote (Marchant & Higgins 1993) with a white chin and other white feathers and lacked his right middle front toe (cohort 1989), and the third bird lacked any white plumage (cohort 2002). They are referred to here as "White", "Two-toes" and "Solo", respectively. In the breeding season, the identity of an individual could be assigned accurately when the location of the caller was known, and because each male had distinct display sites (Beauchamp 2013). If I could not ascertain which individual(s) called I still recorded the time, number of notes and the number of participants.

Data was analysed using SYSTAT 10. All ANOVAs were one way unless specified and were tested for variance assumptions. In 2-way ANOVAs, if the interaction term was not significant the main effects model was generated.

RESULTS

Peacocks gave soft clucking notes during feeding and when in close association throughout the year, and uttered distress calls from roost trees and the ground. All other calls were associated with the breeding season including call notes given in sequences that were audible up to 500 m (Figs. 1, 2 & 3, Table 1).

Dawn tree-roost calling

The *eow* call type predominated (Table 1), given as 1 or 2 notes ($\bar{x} = 1.73$, $se = 0.11$, $n = 90$) by roosting peacocks from dawn until they descended from the trees. The *A* call was also given from roost trees in the early morning on its own ($n = 7$) or preceding *eow* notes ($n = 5$). The number of notes per call sequence given by the 3 peacocks from roost sites during the 2006 - 2008 breeding seasons did not differ significantly ($F = 0.48$, $df = 2, 117$, $P = 0.45$).

Fig. 1. The diurnal distribution of peacock call sequences during the breeding seasons 2006-2010 at Mansion House Historic Reserve, Kawau Island. Calls from roosts and from the ground are plotted separately.

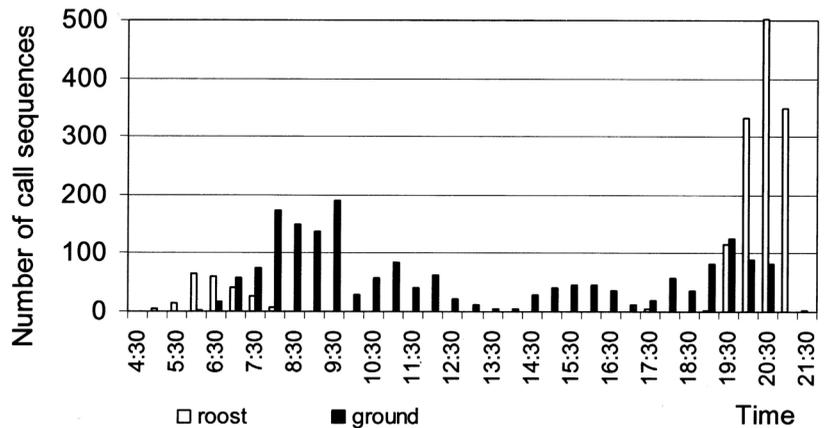


Table 1. The number of notes of each call type from 257 daytime call sequences, and the frequency of calls comprising >5 notes for the repetitive call types for peacock in the 2009 and 2010 breeding seasons ($n = 2$ peacocks). SD = standard deviation.

Note	Total	Number of notes in a call sequence				In sequences > 5 notes*	
		Range	Mode	Mean	SD	Frequency trumpet call complex (%)	Months
<i>Keow</i>	32	1-6	1	2.66	1.82	3.6	Aug-Dec
<i>Ka</i>	78	2-6	5	4.33	1.97	20.0	Nov-Dec
<i>Eow</i>	474	1-8	1	2.86	1.86	61.8	Sep-Dec
<i>Bu</i>	29	1	1	-	-	-	Jul-Jan
Other including <i>Eon1</i> , <i>Eon2</i>	111	1-6	1	2.45	1.77	14.5	Oct-Feb
<i>Hoot</i>	30	1	1	-	-	-	Sep-Dec

* $n = 55$ sequences

Daytime terrestrial calling activity

Trumpet call sequences (comprising the *eow*, *ka*, and *keow* notes, as well as the *eon1*, and *eon2* notes; Takahashi & Hasegawa 2008) were given on average 1.80 ($se = 0.29$, $n = 29$ days) times hour⁻¹ peacock⁻¹ in the breeding season (Table 2) and were absent between February and July (Figs. 2 & 3). Between 2006 and 2008, 70% ($n = 486$) of trumpet call sequences were given by individual ground-active peacocks and had no response (Table 2). One bird answered these calls 25.5% ($n = 177$) of the time, and all birds called 4.5% ($n = 30$) of the time. Generally the notes in a call sequences were the same type. However, different notes could comprise a single call sequence, and in 2009 and 2010 were tabulated separately (Table 1).

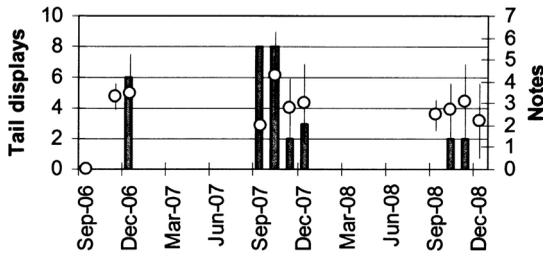
Two notes, the *A* note and the alarm *bu-girk* note preceded some trumpet sequences. During the entire period of data collection (2006-10, $n = 1604$ call sequences), the *A* note and the *bu-girk* note led sequences 4.8% and 2.6% of the time, respectively.

Three alarm calls notes were recognised, the *bu*, *bu-girk* and *kokok*. Alarm calls occurred during only 57.5% of the days throughout the year ($n = 80$ days

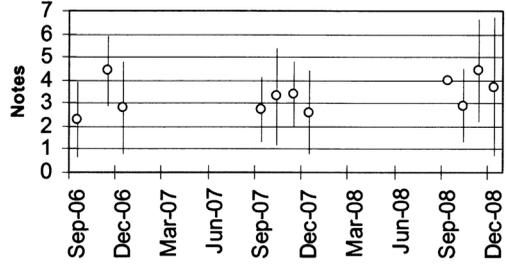
August 2008 to December 2010), probably because avian and mammalian predators were uncommon in the study area. They were given from trees (46%) as well as the ground (52 %). The *kokok* call was given when unfamiliar human disturbances occurred or when the birds were less accustomed with human presence in the grounds. Between April and September, sequences comprised on average 9.7 notes ($se = 6.7$, mode = 1, range 1- 78, $n = 9$) that were given every *c.*15 seconds.

Most tail-fan breeding displays occurred without calling (60.2% $n = 68$), and the others included trumpet sequences of between 1 and 8 notes and single note *hoot* calls. The *ka* note was heard on days where displaying occurred but comprised only 8.9% of the notes heard in the 2009 and 2010 breeding seasons. It was scored on 41% ($n = 12$) of the days when peacocks were seen displaying. The single note *hoot* call was only given during 25% ($n = 48$) of tail displays and was heard during 73% of the days ($n = 12$) that displaying was seen. The main notes used during the display period were *eow* notes (Table 1), however, *keow* notes were occasionally given in call sequences in response to loud noises

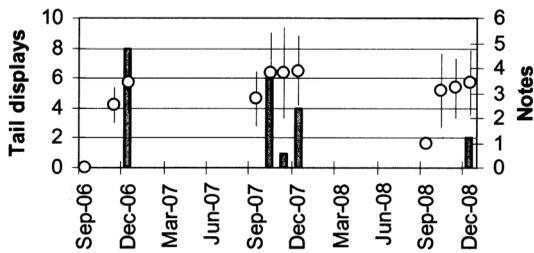
Two-toes



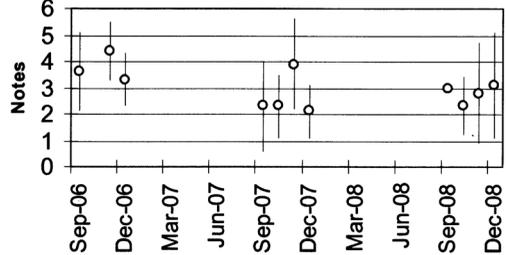
Two-toes



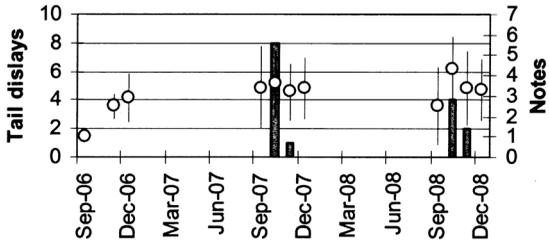
White



White



Solo



Solo

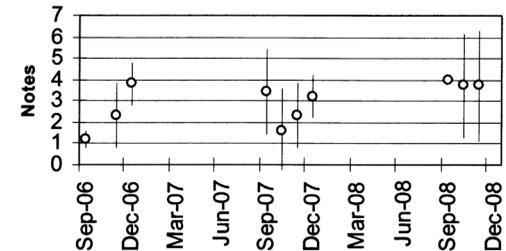


Fig. 2. Notes given per trumpet call sequence (*keow*, *ka* and *ew* calls combined) by 3 peacocks between September 2006 and December 2008 when peacocks were on the ground in the 2 hours before roosting. Notes per calls are mean \pm *se*. Bars are the number of tail displays seen in that visit.

Fig. 3. Notes given per trumpet call sequence (*keow*, *ka* and *ew* calls combined) by 3 peacocks between September 2006 and December 2008 when the peacocks were roosting in trees in the hour after sunset. Notes per calls are mean \pm *se*.

and other disturbances. The average number of notes per call sequence was 3.35 (*se* = 0.07).

In the 2006 - 2008 breeding seasons, the number of notes in each trumpet call sequence given by each peacock during daylight did not differ significantly (2 way ANOVA, $F = 1.756$, $df = 2$, $P = 0.17$); however, the number of notes per call sequence given by each bird when displaying was significantly higher than at other times during the breeding season (2 way ANOVA, $F = 17.419$, $df = 1$, $P < 0.001$, Fig 2). In the 2009 and 2010 breeding seasons, 104 trumpet call sequences (11%) given from the ground comprised 6 or more notes.

Evening roosting

The *ew* note predominated in evening call sequences. The average number of notes per call sequence did not differ significantly while at roost sites ($x = 3.34$, $se = 0.06$) from those during daylight on the ground (unequal variance $t = 1.96$, $df = 1$, 973, $P = 0.083$). The number of notes per call sequence given from evening roost sites differed significantly throughout the breeding season (2 way ANOVA, $F = 4.555$, $df = 4$, $P = 0.002$; Fig. 2), but the number of notes per sequence given by each peacock did not differ significantly (2 way ANOVA, $F = 1.150$, $df = 2$, $P = 0.32$).

Table 2. The single and multi-peacock call sequences per hour at Mansion House Historic Reserve, Kawau Island. All call rates were for birds calling from the ground. * breeding season from 20 August to 31 December.

Peacock(s) calling	*Sep	Oct	Nov	Dec
2006				
Daylight hours surveyed	18	-	10	36
Two toes	-	-	0.3	0.5
White	-	-	0.2	0.5
Solo	0.1	-	0.4	0.3
Two toes & White	-	-	-	0.2
Two toes & Solo	-	-	-	0.1
White & Solo	-	-	-	0.1
All peacocks	-	-	-	-
2007				
Daylight hours surveyed	22	18	21	41
Two toes	1.0	3.2	0.8	0.3
White	0.7	2.3	1.1	0.6
Solo	0.7	2.3	0.7	0.3
Two toes & White	0.3	1.3	0.3	0.02
Two toes & Solo	0.4	0.9	0.4	0.1
White & Solo	0.4	0.9	0.4	0.1
All peacocks	0.2	0.7	0.1	0.02
2008				
Daylight hours surveyed	9	11	14	58
Two toes	0.1	0.4	1.5	0.2
White	0.1	0.6	1.0	0.4
Solo	0.4	0.6	1.7	0.3
Two toes & White	-	0.2	0.6	0.1
Two toes & Solo	-	0.1	0.7	0.1
White & Solo	-	0.1	0.7	0.1
All peacocks	-	0.1	0.5	0.02
2009				
Daylight hours surveyed	-	14	15	24
Two toes	-	-	2.2	0.1
Solo	-	1.0	1.5	0.5
Two toes & Solo	-	0.1	0.5	0.0
2010				
Daylight hours surveyed	11	13	20	22
Two toes	-	0.2	1.3	0.1
Solo	-	1.9	1.8	0.8
Two toes & Solo	-	0.3	1.2	0.3

Table 3. The number of ocelli in the tails of the 3 peacocks at Mansion House Historic Reserve, Kawau Island.

Year	Two toes		White		Solo	
	Ocelli	Age (Years)	Ocelli	Age (Years)	Ocelli	Age (Years)
2006	149	18	139	27	121	4
2007	152	19	143	28	143	5
2008	154	20	140	29	141	6
2009	153	21	-	-	148	7
2010	150	22	-	-	152	8

Evening roost call changes as Solo matured

In December 2006 the last note in 31% ($n = 16$) of the Solo's *eow* evening call sequences ended with a note that rapidly declined in frequency suggesting 'a loss of control' of the delivery of the note. In December 2007 only the last note of 2.3% ($n = 42$) call sequences, and in December 2008 11.9% ($n = 17$) call sequences were not controlled. After 2008 all calls were controlled and no rapid declines in the last note were heard.

The number of *eow* notes given per call from the roost tree in the evening increased significantly as Solo matured ($F = 13.39$, $df = 2, 101$, $P < 0.01$, Fig. 4) from an average of 3.13 ($se = 0.16$, $n = 23$) when 4 years old, 3.09 ($se = 0.022$, $n = 54$) when 5 years old, and 4.11 ($se = 0.17$, $n = 27$) when 6 years old (Fig. 3). The increase in the number of notes per sequence occurred as the number of tail train ocelli reached and then exceeded those of other mature birds (Table 3) and Solo began calling with the other peacocks (Table 2) and displaying (Fig. 2).

DISCUSSION

Takahashi & Hasegawa (2008) recorded peacocks at 1 site monthly on days lacking rain and wind, and assessed the behaviours associated with each call. Their population comprised a breeding population of 45 territorial adult and 8 sub-adult peacocks and 33 adult and 3 sub-adult peahens at Shizuoka, Japan. The population was at a density of 3.5 peacock ha^{-1} and the overall population was at 5.9 peafowl ha^{-1} . The males were territorial physically defending their calling and display sites. This was in contrast to my study on Kawau Island, where the population comprised only 3 peacocks in an exploded lek at a density of 0.8 peacock ha^{-1} and with display behaviours triggered in the absence of peahens.

There were substantial differences in call type use between the 2 studies with the higher use of territorial defense associated *keow* notes (22.7%) and tail display *ka* notes (26.4%), and the lower proportion of *eow* calls (6.8%) at Shizuoka (Takahashi & Hasegawa 2008), than on Kawau (4.4% *koew*, 10.8% *ka* and 65.6% *eow*, respectively). The lower

proportion of *keow* calls on Kawau Island appears to have been due to the lack of display area boundary disputes (Beauchamp 2013), as the only time when the *keow* call and the associated male behaviour was seen was after one dispute, and when unusual events like very loud ships horns stimulated calling. The breeding *ka* call was more frequently used at Shizuoka where there were peahens.

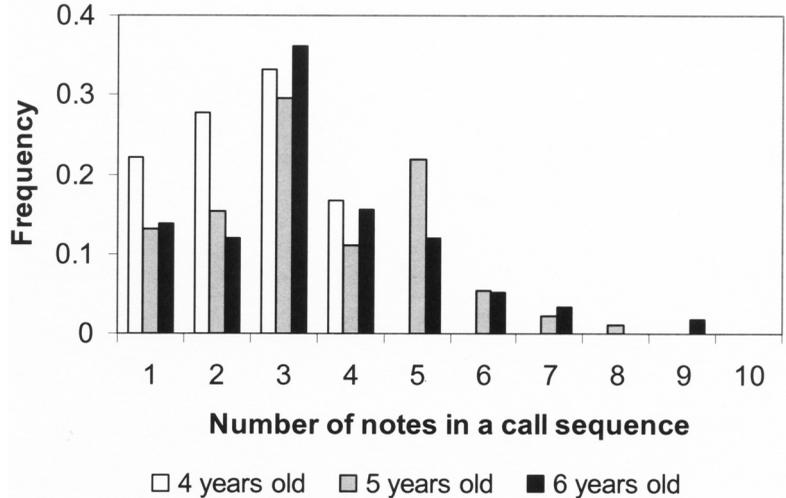
It is possible that some of the difference in note compositions between the 2 populations were also due to environmental conditions under which these data were collected. The data collected at Shizuoka took place during weather conditions that favoured tail displaying, while that collected on Kawau Island included wind conditions less favorable for displaying.

Only 3 of the 6 types of alarm calls described by Takahashi & Hasegawa (2008) were recorded at Mansion House. On Kawau Island, peacocks lived in an area where dogs and other predators were banned. Avian predators such as Australasian harrier (*Circus approximans*) were only recorded on 16.6% of the visits ($n = 42$; Beauchamp, *unpubl. data*) and hawks were never observed hunting in the valley where the peacocks lived.

The exact notes in each call sequence at Mansion House were frequently difficult to ascertain at distances exceeding 500 m. Consequently, using recorders and sonographic analyses to collect data and distinguish the notes in call sequences at closer range would have had its advantages. However, recordings alone may not have allowed documentation of all breeding behaviour. Sixty percent of displays in the 2009 and 2010 breeding seasons took place without any calling. Furthermore, the *ka* call was not heard on 58.4% of the days tail displays were seen, while the *hoot* call not heard on 14.2% of the days tail displays were seen.

The overall average number of notes in call sequences on Kawau I (3.34) was substantially less than the 6 - 8 notes per sequence reported in India and Pakistan (Avi & Ripley 1980). Yasmin & Yahya (2000) found that calling sequence over 6 notes and tail length were significantly associated with mating success of peacocks at Aligarh, India. At Shizuoka, Japan call sequences infrequently

Fig. 4. Changes in the frequency of call sequence lengths given by Solo as he matured.



exceeded 6 notes, and maximum sequences of *eow*, *keow* and *ka* calls were 9, 10 and 13 notes, respectively (Takahashi & Hasegawa 2008). In this study only 11% ($n = 939$) of call sequences in the breeding seasons comprised 6 or more notes, and that the maximum calls per sequence was lower than at Shizuoka. The lesser maximum number of calls in sequences at Mansion House and the lack of *ka* calling during displaying may reflect a lack of stimulus due to one or all of the following; the lack of peahens, the lack of peacocks, and the exploded lek, rather than visual territorial nature of the displaying peacocks.

Marchant & Higgins (1993) indicated that peacocks may take over 5 years to develop adult tail characteristics. Yasmin & Yahya (2000) noted that 2 males that established territories for the first time could not give call sequences greater than 5 notes. During this study Solo was between 4 and 9 years old, and at 4 years old gave no call sequences during the day greater than 5 notes ($n = 36$). Tail length was not measured directly in this study but the birds were photographed displaying, and ocelli numbers indicated that tails were not fully developed until Solo was 5 years old. At 5 years old the number of sequences with greater than 5 notes was 9.3%, similar to the adult males. It is likely that calling, tail length and the number of ocelli are indicative of sexual maturity, which takes 5 years.

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