Host alarm calls attract the unwanted attention of the brood parasitic common cuckoo

– Supplementary Material –

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Abstract

It is well known that avian brood parasites lay their eggs in the nests of other bird species, called hosts. It remains less clear, however, just how parasites are able to recognize their hosts and identify the exact location of the appropriate nests to lay their egg in. While previous studies attributed high importance to visual signals in finding the hosts' nests (e.g. nest building activity or the distance and direct sight of the nest from vantage points used by the brood parasites), the role of host acoustic signals during the nest searching stage has been largely neglected. We present experimental evidence that both female and 35 common cuckoos *Cuculus canorus* pay attention to their host's, the great reed warbler *Acrocephalus arundinaceus* alarm calls, relative to the calls of an unparasitized species used as controls. Parallel to this, we found no difference between the visibility of parasitized and unparasitized nests during drone flights, but great reed warblers that alarmed more frequently experienced higher rates of parasitism. We conclude that alarm calls might be advantageous for the hosts when used against enemies or for alerting conspecifics, but can act in a detrimental manner by providing important nest location cues for eavesdropping brood parasites. Our results suggest that host alarm calls may constitute a suitable trait on which cuckoo nestlings can imprint on to recognize their primary host species later in life. Our study contributes to the growing body of knowledge regarding the context-dependency of animal signals, by providing a novel example of a beneficial acoustic trait intercepted by a heterospecific and used against the emitter.

This supplementary material contains:

- Table S1: Results of the full model showing all of the predictors measured of the probability of brood parasitism of great reed warbler *Acrocephalus arundinaceus* nests by common cuckoos *Cuculus canorus*.

- Table S2: Contingency table with the responses of female and male common cuckoos *Cuculus canorus* in the 2 minutes prior and 2 minutes during the mobbing display and alarm calls of their host.

- Table S3: Contingency table with the number of individual female and male common cuckoos *Cuculus canorus* which approached the playback device playing their host' alarm call or the call of the collared dove *Streptopelia* decaocto, used as a control.

- Table S4: Measured nest site characteristics and their predicted effect on brood parasitism (as described in Moskát and Honza 2000).

- data regarding the correlative study, experiments and drone flights in csv formats

- R markdown script of the data analyses in html format

- sample video of great reed warblers mobbing the 3D cuckoo decoy

Table S1. Results of the full model showing all the potential predictors of the probability of brood parasitism of great reed warbler nests by common cuckoos. Values for the fixed factor, 'alarm call', indicate the difference of alarming hosts compared to non-alarming great reed warblers, 'laying stage' is a two-level factor of nests in their first 3 days of egg laying or second 3 days of egg laying, 'time of nest visit' is a scaled continuous variable which measures the number of elapsed minutes since midnight standardized with a Z transformation (mean = 0 and SD = 1).

	Estimate	SE	z value	Wald χ^2	df	*p*	Variance
FIXED EFFECTS							
(Intercept)	-10.746	1.474	-7.286	53.089	1	<0.001	
Alarm call	3.543	2.199	1.611	2.595	1	0.107	
Laying stage	0,306	1.255	0.244	0.059	1	0.870	
Time of nest visit	-1.025	0,539	-1.903	3.620	1	0.057	
Alarm call × Laying stage	-1.561	2.480	-0.630	0.529	1	0.529	
Alarm call × Time of nest visit	1.151	1.346	0.855	0.730	1	0.392	
RANDOM EFFECTS							
Site : Nest identity							439.700
Observer identity							0.000

Table S2. Responses of female and male common cuckoos in the 2 minutes prior and during the 2 minutes of alarm calls and mobbing display of their host, the great reed warbler. The response of the cuckoos was scored on a four-level scale, as follows: 0 - no reaction; 1- characteristic female bubbling call or male call on a perch closer than 100 m; 2 - flight towards the great reed warbler nest; 3 - flight towards the nest coupled with characteristic female or male call.

Sex	Group	0	1	2	3
females	before playback	8	5	1	0
	during playback	4	1	2	7
males	before playback	17	9	3	1
	during playback	5	8	4	13

Table S3. Number individual female and male common cuckoos which approached the playback device playing their host' alarm call (experimental trials; n = 16) and the sound of the collared dove (control trials; n = 16). The response of the cuckoos was considered positive if they approached the playback device compared to the distance they were initially observed, and neutral if the focal birds did not react or increased their distance (i.e. flew away) from the playback device compared to their initial position.

Sex	Response	Experimental trials	Control trials
females	positive	5	0
	neutral	11	16
males	positive	7	1
	neutral	9	15

Table S4. Measured nest site characteristics and their predicted effect on brood parasitism (as described in Moskát and Honza 2000) of non-parasitized (n = 8) and parasitized (n = 8) great reed warbler nests. Nest volume was calculated as the volume of a cylinder with of the height of the nest (in cm) and base diameter equal to the width of the nest (in cm).

		Non-parasitized					Parasitized					
Fixed effect	**Predicted effect on parasitism**	**Mean**	**SD**	**CV**	**Median**	**Range**	**Mean**	**SD**	**CV**	**Median**	**Range**	***p***
Nest volume (cm^3)	positive	1184.4	488.6	0.41	1059.75	785-2279	1241.77	400.59	0.32	1127.65	763-1899	0.370
Distance from water (cm)	negative	70	20.35	0.29	62.5	50-110	78.12	26.98	0.34	80	40-115	0.739
Distance from bank (cm)	negative	238.75	72.19	0.3	245	100-320	178.12	39.27	0.22	170	125-240	0.025
Nest height above water (cm)	positive	82.87	29.12	0.35	83.5	40-120	79.62	25.76	0.32	82.5	42-118	0.571
Vegetation height above nest (cm)	negative	178.75	25.31	0.14	190	140-200	200	45.66	0.22	200	140-280	0.853
Distance from closest perch (m)	positive	11.75	5.57	0.47	12	3-20	10.75	6.92	0.64	8	5-25	0.688

Bibliography

Moskát C, Honza M. 2000. Effect of nest and nest site characteristics on the risk of cuckoo Cuculus canorus parasitism in the great reed warbler Acrocephalus arundinaceus. Ecography 23:335–341.