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Degradation of song in a species using nesting holes: the Pied Flycatcher *Ficedula hypoleuca*

HELENE M. LAMPE[1], TORBEN DABELSTEEN[2], OLE N. LARSEN[3] and SIMON B. PEDERSEN[2]

[1]Department of Biology, Div. of Zoology, University of Oslo
P.O. Box 1050, Blindern, N-0316 Oslo, Norway
[2]Animal Behaviour and Centre for Sound Communication, Biological Institute
University of Copenhagen, Tagensvej 16, DK-2200 Copenhagen N, Denmark
[3]Centre for Sound Communication, Institute of Biology, University of Southern Denmark
Campusvej 55, DK-5230 Odense M, Denmark

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ABSTRACT

The habitat, but also the nest hole of a hole-nesting species, will degrade the song during transmission. We investigated how the sounds degrade in a sound transmission experiment with the song of the Pied Flycatcher *Ficedula hypoleuca* (Muscicapidae). Ten different song elements were transmitted to microphones placed inside and outside a nest box. On average, song degradation was much greater inside than outside the nest boxes, especially with respect to excess attenuation and blurring of the song elements. Being inside a nest box therefore strongly reduces a Pied Flycatcher's possibility of detecting and recognizing songs or eavesdropping on singing interactions.

Key words: sound degradation, hole nesting, Pied Flycatcher, *Ficedula hypoleuca*.

INTRODUCTION

Bird sounds are inevitably degraded during transmission through the habitat from a sender to a receiver. Time and frequency patterns are degraded due to reverberation and attenuation (e.g. Wiley and Richards 1982, Dabelsteen et al. 1993, Balsby et al. 2003). For hole-nesting species sounds are predicted to be further degraded for a receiver inside a nest hole compared to a receiver outside the nest. Exactly how much the signal is degraded will depend on factors such as the shape of the nest cavity, type and condition of the nest hole tree or nest box, position of the bird inside the nest cavity, and the nature of the sound signals.

We investigated these factors in a sound transmission experiment with the song of the Pied Flycatcher *Ficedula hypoleuca* (Muscicapidae). Males defend nest holes and try to attract more than one female on separate, distant territories, i.e. they are polyterritorial (Lundberg and Alatalo 1992). The first female to pair with the male will try to evict a subsequent female if she finds her on the second territory (Slagsvold et al. 1992). Females recognize their mate's song (Lampe and Slagsvold 1998), and may use song as a less costly way to keep track of their mate instead of following him around.

To test if the song degrades more inside the nest hole than outside and hence if it is more difficult for the female to track her mate when she is inside, we transmitted song elements of the Pied Flycatcher in a Danish mixed-deciduous forest, to microphones placed inside and outside nest boxes.

Correspondence to: Helene Lampe
E-mail: h.m.lampe@bio.uio.no

MATERIALS AND METHODS

The sound transmission experiment was carried out on 27th and 28th May 1999 in a typical Danish Pied Flycatcher habitat at Strødam near Copenhagen. The sound signals were generated from a Zitech-computer using the Digital Signal Emitter (Dabelsteen 1992) and the custom-made program FLYPROP and played back via an amplifier built at University of Southern Denmark and a VIFA speaker placed at the top of a telescopic Clark Mast 5.8 m above ground. The speaker was placed 10, 20, and 40 m away from a nest box situated 1.4 m above ground. The speaker height represents the average height of singing Pied Flycatchers, while the receiver height is about the usual height of the nest boxes in the habitat.

A Brüel & Kjær microphone (type 4133) with Falcon 2669 amplifier and wind protection was placed 1.4 m above ground 1.2 m to the right of the nest box as seen from the speaker position. A similar microphone was placed inside the nest box, which was made of either cement or wood and contained nesting material. The sounds were recorded using a two-channel HHB Portadat (model PDR1000) recorder with a HP-filter.

The same equipment was used for recording model sounds, but now the speaker was placed 4.5 m above ground on a road. The two microphones were placed successively at a distance of 1.25 m from the speaker and the non-degraded sound elements were recorded.

Ten song elements that are commonly used by Pied Flycatcher males were selected as test sounds. The 10 sounds were digitized and processed using Sigpro (Pedersen 1998). All elements were band-pass filtered based on each element's maximum and minimum frequency. The elements were played back in five blocks of 10 elements in a randomized block design.

The observed sounds were all compared to the non-degraded model sounds after being aligned in time by maximizing the cross correlation function between them. In the analysis we quantified signal-to-noise ratio (energy of the observed signal compared with energy of the background noise), tail-to-signal ratio (energy of the tail of the signal compared with energy of the signal), excess attenuation (attenuation that is not caused by spherical spreading), and blur ratio (time distortion in the transmitted signal) (see Dabelsteen et al. 1993, Holland et al. 1998).

RESULTS

On average, song degradation was much greater inside than outside the nest boxes. We found that the excess attenuation was about 10 dB higher inside the nest boxes than outside, and blurring of the song elements almost doubled inside the nest boxes (Fig. 1). Otherwise there were few consistent differences with respect to nest box type (cement or wood) or transect. With one exception, there was little difference between song elements in their degradation. The exception was one short, un-modulated song element that had a consistently higher tail-to-signal ratio and about half the blur ratio of the other song elements.

All the differences that were found showed the same pattern at all three distances. As expected, all song elements degraded with distance, i.e. signal-to-noise ratio decreased, and tail-to-signal ratio, excess attenuation and blur ratio all increased with distance.

DISCUSSION

Our results show that being inside a nest box strongly complicates and reduces a Pied Flycatcher's possibility of detecting and recognizing songs or eavesdropping on singing interactions. Similar results have been obtained with Great Tit *Parus major* song, especially the highly modulated so-called buzz notes (Blumenrath, Dabelsteen and Pedersen, in prep.). Female Pied Flycatchers spend little time inside the nest hole until they begin incubation (see Lundberg and Alatalo 1992), and our results on sound transmission may explain why. If the females use male song to keep track of their mate's activities, they should stay outside the nest box, where song reception is best, as often as possible.

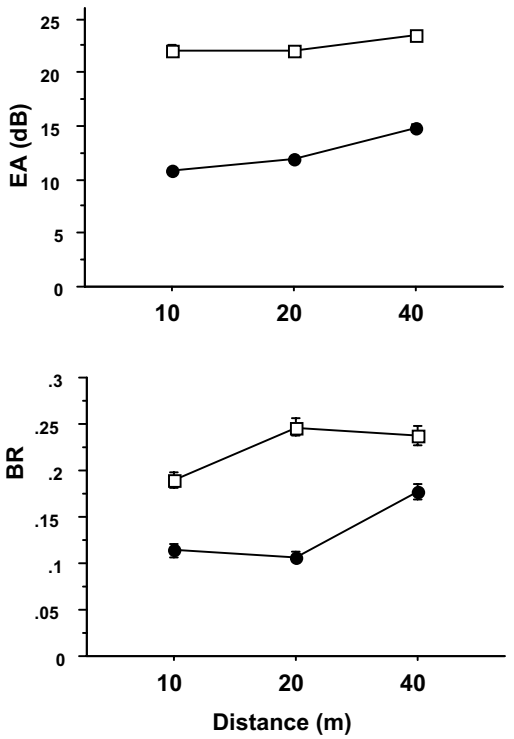

Fig. 1 – Signal degradation (mean±SE) of Pied Flycatcher song elements at three different distances inside (open squares) and outside (filled circles) a nest hole. EA: excess attenuation, BR: blur ratio.

Female reproductive success is higher when they are paired monogamously (Lundberg and Alatalo 1992). The success is also higher the longer they manage to keep other females away, since males will feed the young that hatch first if they have two clutches, and both clutches if they are close in time and space (Lifjeld and Slagsvold 1989).

RESUMO

O habitat, mas também a cavidade do ninho de uma espécie nidificando em ocos, provoca uma degradação do som durante sua transmissão. Pesquisamos como os sons são degradados num experimento de transmissão sonora usando o canto do pássaro *Ficedula hypoleuca* (Muscicapidae). Dez elementos diferentes do canto foram enviados para microfones colocados dentro e fora de uma caixa de nidificação. Em média, a degradação do canto foi muito maior dentro do que fora do ninho, particularmente no que diz respeito ao excesso de atenuação e à borrada dos elementos do canto. Estar dentro de uma cavidade de nidificação, portanto, reduz fortemente a capacidade da espécie de detectar e reconhecer cantos ou de interceptar interações vocais.

Palavras-chave: degradação do som, nidificação em cavidade, Muscicapidae, *Ficedula hypoleuca*.

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