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What is more important: nest-site concealment or aggressive behaviour? A case study of the red-backed shrike, *Lanius collurio*

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A b s t r a c t . The aim of this study was to check what decide about breeding success in red-backed shrike *Lanius collurio*: nest-site concealment or parent's aggressive behaviour. The study was carried out in eastern Poland in 1999–2003, on study plot consisted of 855 ha of extensively agricultural landscape. The effect of nest site concealment and defence of brood by parents on breeding success was determined. In observations only natural nests were used. During the two of 10 days periods after commence of egg laying, no effect of index nest concealment and index of parents aggressiveness was observed. However, in first seven days of life of nestlings, was noticed that breeding success was depended on aggressiveness of parents, in relation to index nest concealment. The results showed behavior (aggression) as an important factor in breeding success of the red-backed shrike.

Key words: breeding success, defence, predation, red-backed shrike

Introduction

Breeding success of birds is affected by many factors, but one of the most important is predation (R i c k l e f s 1969, M a r t i n 1993). Birds show various strategies to reduce predation: breeding in colonies (W i k l u n d & A n d e r s s o n 1980), in holes (N i l s s o n 1984), aggressive behavior i.e. nest defence (M o n t g o m e r i e & W e a t h e r h e a d 1988) and nest concealment (M a r t i n & R o p e r 1988, R a n g e n et al. 1999).

Nest concealment, especially against other birds, mainly corvids, is a main factor affecting predation risk (B a y n e & H o b s o n 1999, W e i d i n g e r 2002). Breeding success of many birds' species increases with nest concealment (W r a y & W h i t m o r e 1979, T u o m e n p u r o 1991, H a t c h w e l l et al. 1996) and for this reason birds choose nest sites in non-random ways as regards concealment (K e l l y 1993, C h a s e 2002). Nest concealment can also determinate type of predators robbing the nests (birds vs. rodents) (R e m e š 2005). Although the nest site can be dependent on real pressure by predators (W y s o c k i 2005) or opportunities offered by nesting habitat (J a k o b e r & S t a u b e r 2002). However, not all species use only concealment as their tactic against nest losses due to predation. C r e s s w e l l (1997a) observed that blackbirds *Turdus merula* can compensate for the probability of nest predation in poorly hidden nests by active nest defence. Also studies which compared predation rates between artificial nests (without parents) and natural nest (with parents) suggested that nest defence can play an important role in breeding success (C r e s s w e l l 1997b).

The red-backed shrike *Lanius collurio* is a small passerine bird species (L e f r a n c & W o r f o l k 1997, H a r r i s & F r a n k l i n 2000). In eastern Poland, the majority of the population inhabits agricultural landscapes, breeding on the edge of woods, in tree clusters,

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orchards and in the vicinity of villages (Dombrowski et al. 2000). The nest is an open cup, 100–190 mm in diameter and 50–110 mm tall, made mainly from grass and usually placed et heights of ca 1.3 m in various parts of bushes or trees (Tryjanowski 1999, Goławski 2007). The breeding season usually starts in the middle of May and goes through to August. Some individuals show strong defence of broods, and they achieve higher breeding success (Tryjanowski & Goławski 2004). On the one hand, it was shown that red-backed shrikes build nests in dense cover of bushes (Harris & Franklin 2000), but on the other hand, some individuals actively attack potential predators (Kuźniak & Tryjanowski 2003). So far, no study has focused on simultaneous effects of nest-site concealment and parental behaviour on nest success.
The aim of this study was to determine the interactions between nest site concealment and defence of the brood by parents on breeding success. From among characters describing nest location only concealment of nest was used, because this factor was very often announced as most important in determination of the nest lot (Martin & Roper 1988, Mankin & Warner 1992, Huhta et al. 1998). In contrast to other similar works (e.g. Grégoire et al. 2003), only natural nests were used.

Methods

The study was carried out in eastern Poland, near Siedlce (52°12' N, 22°17' E) in 1999–2003. The study area consisted of 855 ha of extensively agricultural landscape. Arable fields predominated in this area (54%), mainly with crops of rye and potatoes. Meadows and pastures covered 21%. The proportion of set-aside was 2%. Woodlands and apple orchards were also present in addition to these open habitats. The red-backed shrikes occupied open habitats at the edges of woodlands and orchards. The study area was characterised by a range of tree and bush species, the most common of which were willow *Salix* sp., alder *Alnus glutinosa* and pear *Pyrus* sp.

During the study period, 159 red-backed shrike nests (built in a 31 tree and bush species) were found. Within those nests, 119 were found in laying or incubation and 40 in the nestling's stage. At this time, several species of corvids, the most important predators of the red-backed shrike's nests (Cramp & Perrins 1993), bred in the study area. The numbers of breeding pairs of jays *Garrulus glandarius* varied from three to seven pairs, magpies *Pica pica* from three to six pairs and crows *Corvus corone* from zero to one pair. The mammalian predators also were recorded, i.e. red fox *Vulpes vulpes*, marten *Martes* sp., weasel *Mustella nivalis* and also dogs and cats. More details on the studied population, including aspects of breeding ecology and densities, were published elsewhere (Goławski 2006).

The nests of the red-backed shrike were looked for between mid-May and the end of July, checking all possible locations favourable for nesting. The number of visits to each nest was reduced to the necessary minimum, because this species is especially vulnerable to disturbance and it often abandons broods (Tryjanowski & Kuźniak 1999). The nests were studied during incubation, hatching period, and nestlings' period and after the predicted fledging time (14th day of life). The first day of life was defined as the day when the first nestling was hatched. If the date of hatching was not known, then the age of nestlings was estimated on the basis of body mass (Diehl 1971). If at least one nestling was observed just before the expected fledging date, the nest was considered to be successful.

Breeding success for all population was calculated using Mayfield's method (1975). Of failed nests, only those which finished as total losses caused by predators were analysed. The data from broods lost because of other factors then predation were excluded. To the losses were classified to: weather, when in consecutive controls, during rainy days dead nestlings were found, agricultural activities (destroyed by agricultural machines during haymaking) or parental (female) abandonment.

The degree of concealment of nests by assessment of visibility for 75 nests was determined. The visibility of nests was estimated from 1 m distance and height of ca 1.6 m (eyes level of observer standing on the ground in distance 1m from the nests, Holway 1991). The concealment of nests was checked from four compass directions using a scale from 1 to 5 (1 = 0–20% visibility, 2 = 21–40%, etc., Holway 1991). In the analysis, the sum of the measurements and treated it as an index of visibility was used. Describing nest concealment was done a few days after fledging or after the nest was robbed. In this period (from the middle of May to July), in the eastern Poland, all species of bushes and trees have fully developed leaves and crowns. Thus results of measure of the nest concealment done after fledglings leaving the nest or failure agree with nest site concealment on the start of breeding season.

Aggressive behaviour of adult birds, separately for males and females, against the observer visiting the nest was classified as three scores: (1) 0 – lack of reaction, (2) 1 – weak reaction, birds (one or both) mob from a distance at least 5 m, but do not fly in the direction of the observer, (3) 2 – birds mob (sometime swoop) intensively and fly to the observer to the distance closer than 5 m. In the analysis, aggressiveness was pooled for each pair (male and female) of adult birds for the first visit to the nest at each given stage of the breeding cycle (Tryjanowski & Goławski 2004). Because of increasing aggressiveness with advancing age of the brood (Tryjanowski & Goławski 2004), the cycle of breeding was divided into four stages. The laying and incubation period in the study population lasted about 20 days (Goławski 2006) and was divided into two 10 day stages. The nestling period lasted 14 days and was split into two equal parts (by 7 days). Next, the effect of aggressive behaviour on breeding success at different stages of the brood was analyzed. The last stage (nestlings 8–14 days old) was not analysed, because at this time only two from 36 nests were lost. Nests were checked only during bright weather (Tryjanowski & Goławski 2004), always by one observer (AG), from one side, short time only needed for data collection. Thus controls all nest were similar and their course not differed significantly between individual broods.

The logistic regression to assess variation in breeding success in relation to nest-site concealment and aggressive behaviour of parents was used (Sokal & Rohlf 2001). Probability of $P < 0.05$ was taken to indicate significance. Effect that the values reported in the Results sections are means ± SE. Statistics were calculated with the program Statistica for Windows v. 6.0 (StatSoft 2003).

Results

Breeding success of shrikes was 32.9% ($N = 159$). The mean visibility index of nests measured at 1.6 m height was 8.2 ± 0.60 (range = 0–20, $N = 75$). The index of parental aggressiveness, in the first 10 days after the commencement of egg laying was, on average, 0.2 ± 0.08 (range 0–2, $N = 36$) and was similar to that in the second 10 day part of the incubation period, i.e.

0.2 ± 0.04 (range = 0–2, *N* = 27). In the first 7 days of life of the nestlings, the average index of parental aggressiveness was 1.2 ± 0.31 (range = 0–4, *N* = 34).

For the stage of the first 10 days after the commencement of egg laying, no effect of the index of nest concealment, nor of the index of parental aggressiveness, on nest predation was observed (logistic regression; $\chi^2 = 2.73$, P = 0.256, Table 1). The same result of no effect of nest visibility and parental aggressiveness (logistic regression; $\chi^2 = 0.77$, P = 0.678, Table 1) was also observed for the next stage of breeding, i.e. the last 10 days of incubation. However, in the first seven days of life of the nestlings, breeding success was determined by the aggressiveness of parents (logistic regression; $\chi^2 = 8.04$, P = 0.017, Fig. 1) and an index of nest concealment not significantly influenced breeding success (P = 0.781, Table 1).

Table 1. Results of logistic regression analysis of factor determining breeding success of red-backed shrike during three breeding periods.

Variable	Estimate	SE	P	± 95%
first 10 days after the commencement of egg laying, n = 36				
index of parental aggressiveness	-1.303	0.817	0.120	-2.965-0.359
visibility index of nests	-0.036	0.075	0.663	-0.190-0.117
second 10 day part of the incubation period, n = 27				
index of parental aggressiveness	-0.204	1.181	0.864	-2.642-2.234
visibility index of nests	0.077	0.095	0.425	-0.119-0.273
first 7 days of life of the nestlings, n = 34				
index of parental aggressiveness	0.841	0.338	0.018	0.151-1.151
visibility index of nests	0.023	0.082	0.781	-0.144-0.189

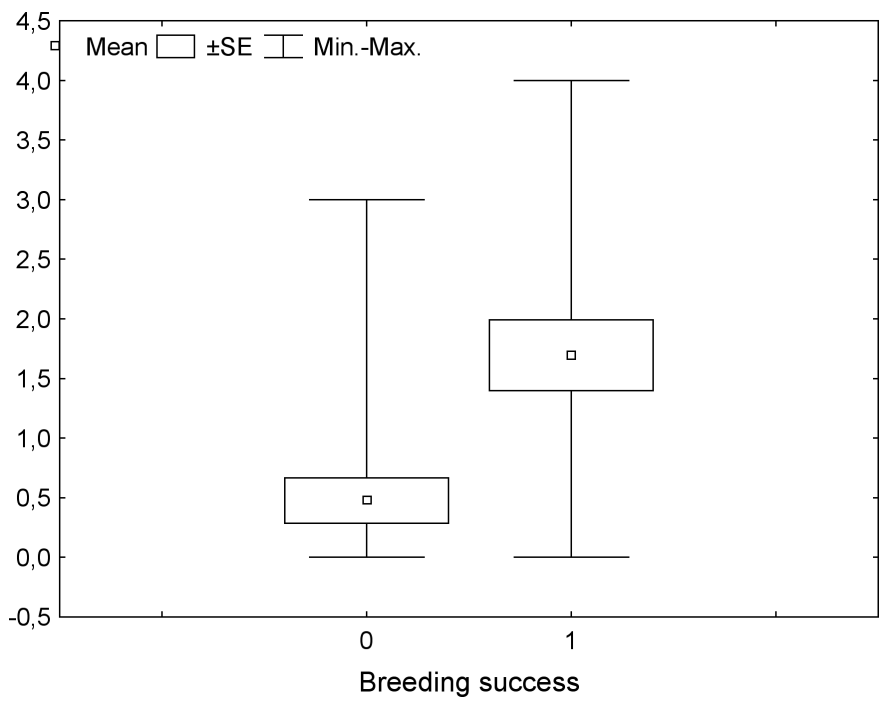

Fig. 1. Differences (Mean, SE, Min.-Max.) in breeding success and index of parental aggressiveness pairs of the red-backed shrike in the first seven days of life of the nestlings.

Discussion

In this study, aggressiveness against an observer was a variable which affected breeding success in red-backed shrikes. Although this factor was important only when nestlings were in the nest, more aggressive pairs had higher breeding success than pairs which did not defend broods (T r y j a n o w s k i & G o ł a w s k i 2004). Significance of nest defence was observed also by other researches (G o t z m a n 1967, L e f r a n c 1979). Aggressiveness increased with advancing development of the brood, and this fact may help explain the results. Non-aggressive pairs during incubation come aggressive after nestlings hatching. Because of few data, the lack of variety in aggressiveness female and male was observed. Lack of significant correlations between breeding success and nest concealment during egg laying and incubation, might bee a result of an interaction between both tactics of defence, i.e. concealment vs. aggression. Concealment may be less important after hatching due to the nest visit activity of adults feeding young. A similar explanation was suggested for thrushes *Turdus* sp. (C r e s s w e l l 1997a, W e i d i n g e r 2002).

The aggressive behaviour against predator was commonly observed in red-backed shrike. Many authors described aggressiveness against the jay, the barn owl *Tyto alba*, the domestic cat, the red fox and humans *Homo sapiens* too (G o t z m a n 1967, A s h 1970). In this paper, similar to other authors (e.g. H o g s t a d 1993, V i n u e l a et al. 1995, F i s h e r et al. 2004) aggressiveness of the red-backed shrike against humans was studied. It is possible, that birds react on smaller animals in an other way, stronger, that can be more likely to repel intruder. During studies one pair of the red-backed shrike was observed, which in the first stage of incubation was aggressive against jay and red squirrel *Sciurus vulgaris* and no reacted on observer controlled nests. Thus real level of aggressiveness against predators could be higher then observed against humans. In other hand, birds can be more aggressive against observer because of directionally approaching, whereas natural predators come rather accidentally (B r u n t o n 1990). Should be added, that birds aggressiveness and higher breeding success of them could be result of better condition, due to lack of blood parasites (H a k k a r a i n e n et al. 1998), age and experience, but these factors were not studied in this work. But other study with red-backed shrike suggest also link between parasites and condition, attractiveness, and even level of testosterone, what may affect defence (V o t ý p k a et al. 2003).

These results failed to show that nest site concealment affected breeding success of the red-backed shrike. A lack of relationship between concealment and predation rate might suggest that most losses were due to predators using mainly smell rather than sight, i.e. mammals. The nests found empty were defined as losses due to predators (lack of eggs or nestlings suggesting birds as predators); only in some cases eggshells broken by birds were found. Probable robbers were magpies and jays. Only in one case, was a mammal thought to be the likely perpetrator of a loss. In other papers, birds were found to be the dominant predators of red-backed shrike's nests (L e f r a n c 1979, D i e h l 1995, F a r k a s et al. 1997).

The degree of concealment of nests, measured in similar way to our, was given as a main factor affecting breeding success of the red-backed shrike in Switzerland, where better hidden nests were more successful (M ü l l e r et al. 2005). Also in Poland and Germany, shrikes breeding in less visible places fledged broods more successfully (T r y j a n o w s k i et al. 2000, J a k o b e r & S t a u b e r 2002). Similarly, in other small passerines breeding in open nests, higher breeding success was observed in more concealed nest sites (W r a y &

Whitmore 1979, Tuomenpuro 1991, Hatchwell et al. 1996, Cresswell 1997a, Johnson 1997, Nalwanga et al. 2004). Only a few studies failed to report such findings (e.g. Götmark et al. 1995). Nest defence is other way for achieve breeding success. Even small birds like a red-winged blackbird *Agelaius phoeniceus*, acadian flycatcher *Empidonax virescens* can improve breeding success by aggressive behaviour and nest defence (Knight & Temple 1988, Olendorf & Robinson 2000)

This work is based on observations of natural nests of small bird species. The results showed behaviour (aggression) to be an important factor in breeding success. Our study confirmed that defence of broods plays an important role in nest survival, as has also been found in studies using artificial nests (Cresswell 1997b). However, using artificial nests to determine breeding success may lead, in some cases, to different results from those obtained from natural nests (Berry & Lill 2003).

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