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Nest survival in the Reed Bunting *Emberiza schoeniclus* in fragmented wetland habitats: the effect of nest-site selection

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Nest survival in fragmented wetlands is usually affected by micro-habitat variables. The main aim of the study was to investigate the factors affecting Reed Bunting *Emberiza schoeniclus* nest survival in wetland habitats within a mosaic Central European landscape. In total, we monitored 95 nests on five separate fishponds in South Bohemia, Czech Republic during a six-year study between 2002 and 2007. In order to determine the effects on nest survival of nest site characteristic, the first egg laying date and nest age, we estimated daily survival rate (DSR) and built models using program MARK. DSR was significantly higher in nests located in Reed Canary Grass *Phalaris arundinacea* and tall vegetation Cattail *Typha latifolia* and Common Reed *Phragmites australis* than in sedges *Carex spp.* Surprisingly, expanding Reed Canary Grass was occupied later in the breeding season and likely less preferred vegetation type than sedges. Structure of sedge tussocks changed due to eutrophication and likely lost its suitability as quality microhabitat of the nest site. Furthermore, we found mild support that DSR increased with the distance from the nearest tree and that the lowest DSR was between 19th and 20th day of the nesting cycle, close after the hatching of the nestlings which can attract potential predators. These findings could indicate the importance of birds as predators on Reed Bunting nests. Nest site selection appears to be a display of anti-predator strategy in the Reed Bunting.

1. Introduction

Breeding success influences both individual fitness and population dynamics of species (Newton 1998, Bennett & Owens 2005). There are two types of factors affecting breeding success: intrinsic factors like age or experience of females (Geslin *et al.* 2004) and extrinsic factors like predation or the timing of breeding (Newton 1998, Bennett & Owens 2005, Kear 2005). Nest predation has been recognised as the main cause of nest failure in many species (Lack 1954, Martin 1995). Birds show various strategies to reduce predation, including the selection of suitable nest sites (Gjerdrum *et al.* 2005, Goławski & Mitrus 2008). Nest-site selection may be important especially in ground-nesting birds, whose nests are usually subject to high rates of predation (Martin 1995, Amar *et al.* 2004, Brickle & Peach 2004, Langgemach & Bellebaum 2005). Nest site microhabitat, vegetation structure (Joern & Jackson 1983, Holway 1991, Thyen & Exo 2005) and nest height (Martin 1993) are considered factors affecting nest predation risk in ground-nesting birds. In addition, nest site selection may depend on local pressure by predators (Wysocki 2005) or opportunities offered by the nesting habitat (Clark & Shutler 1999).

Nest site selection may be similar throughout a species range or it could reflect habitat availability or constraints on nesting success among regions (Gjerdrum *et al.* 2005, Newton 2008). Nevertheless, habitat generalists are supposed to be capable of not only occupying a wider range of habitat, but also exploring a wider range of resources (Brown 1984) including nest sites. The determinants of nest site selection and their subsequent consequences for nesting success are not straightforward and this information could be important for guiding management activities (Gjerdrum *et al.* 2005). Unfortunately, inappropriate management practices such as manuring and dredging have caused considerable changes in the composition of wetland plant species in the study area, i.e. South Bohemian fishponds (Janda *et al.* 1996, van Vessem 1997).

We focused on the Reed Bunting *Emberiza schoeniclus* as an example of an open-nesting wetland passerine using variable types of littoral vegetation (Blümel 1989, Cramp & Perrins 1994, Glutz von Blotzheim & Bauer 1997, Báldi & Kisbenedek 1999). Its population shows highly fragmented (patchy) distribution in a typical Central European landscape. Moreover, to some extent this species is able to occupy agricultural areas (Siriwardena *et al.* 2000, Surmacki 2004), probably due to inclination to live on drier wetland habitats (Martínez-Vilalta *et al.* 2002, Grujbárová *et al.* 2005, Báldi 2006).

In the study area, there is a lack of suitable breeding habitats and therefore territory settlement is associated with the previous experience in males (Musilová *et al.* 2011). Individuals of higher quality are expected to occupy optimal nest sites (Bennett & Owens 2005) and the high fidelity of old experienced males, could indicate the importance of these breeding localities for Reed Buntings (Musilová *et al.* 2011). Moreover, it was shown experimentally that this species is likely capable of choosing their territories according to the actual predation risk (Trnka *et al.* 2011).

The main aim of this study is to investigate factors affecting nest survival in the Reed Bunting *Emberiza schoeniclus* in a patchy environment of fishponds in Central Europe. We focused on analyses of intrinsic and extrinsic factors affecting the breeding success as determined by nest predation risk. In particular, we aimed to find out whether our data support the following hypotheses:

- Daily survival rate (DSR) is affected by timing of breeding with the presumption of strong effect of timing of breeding to breeding success (Newton 1998, Peak 2007). We test if there is a linear or quadratic trend in nest survival during the breeding season, and consequently, if early breeding reduces predation (Thyen & Exo 2005).
- Higher DSR for nests located in sedges, which is considered the most preferred vegetation type for this species (Hudec 1983, Blümel 1989, Okulewicz 1989, Cramp & Perrins 1994, Glutz von Blotzheim & Bauer 1997).
- The decrease of use of old vegetation during the breeding cycle due to the vegetation development and thus low importance of this factor for DSR of the nest.
- Daily nest survival rate increases with the distance of the nest from the nearest tree (Honza *et al.* 1998, Pasinelli & Schiegg 2006, Reidy *et al.* 2009). The effect of distance from these elevated points (used by avian predators) on nest survival was shown in previous studies (Berg 1996, Sheldon *et al.* 2007). In this case, predators may use multiple visual cues to locate nets (Santisteban *et al.* 2002).
- Lower DSR with increasing visibility of the nest and the nest height above the ground (Tuomenpuro 1991, Brickle & Peach 2004, Traylor *et al.* 2004, Pasinelli & Schiegg 2006). Nest concealment is a common adaptation that usually reduces predation risk (Martin 1992), with the probability of predation declining with increasing nest concealment (Brickle & Peak 2004) and nest height (Pasinelli &

Schiegg 2006) in the Reed Bunting. On the contrary, well-concealed nests may decrease the surrounding view for the incubating female (Götmark *et al.* 1995, Magaña *et al.* 2010).

- DSR of many altricial species varies in relation to nest age (Martin *et al.* 2000, Lloyd & Martin 2005, Hannon *et al.* 2009, Segura & Reboreda 2012). Especially, DSR may decline due to higher frequency of visits by parents when feeding nestlings (Skutch 1949). Therefore we consider the effect of nest age.

2. Methods

2.1. Study species and study area

Reed Bunting is a small granivorous passerine species breeding on the ground in open wetland habitats (Blümel 1982, Hudec 1983). They are short-distance migrants and are sexually dimorphic (Cramp & Perrins 1994, Glutz von Blotzheim & Bauer 1997). Reed Buntings have a highly fragmented (patchy) distribution pattern throughout central Europe due to specific habitat requirements. They are usually able to breed twice during one breeding season (Blümel 1982, Glutz von Blotzheim & Bauer 1997). Re-nesting usually follows an unsuccessful breeding attempt (Musilová unpubl. data).

The study was carried out on five fishponds in South Bohemia (Jindřichův Hradec district, the Czech Republic) located close to Kardašova Řečice town (49°11’–49°13’ E, 14°51’–14°54’ N, 443–480 m a.s.l.; fishponds: Hejtmánků – 4.5 ha, Špitálský – 2.1 ha, Obecní – 2.4 ha, Šlechtův ponds – 0.7 ha) and close to Lužnice village (Černičný fishpond – 49°05’ E, 14°45’ N, 7.6 ha, 425 m a.s.l.). Reed Buntings occupy the edge of fishponds dominated by Common Reed *Phragmites australis*, Narrow Leaf Cattail *Typha angustifolia*, Reed Canary Grass *Phalaris arundinacea*, Mannagrass *Glyceria spp.*, Wood Small Reed *Calamagrostis epigeios* and sedges *Carex spp*. Trees and bushes occurring in the study area wetlands are mainly White Willow *Salix alba* and Black Elder *Sambucus nigra* (for more details of the habitat see Janda *et al.* 1996). Individual fishponds were isolated without wetlands corridors, surrounded by a mixture of forest patches, fields and villages. The number of breeding territories varied between 2 and 9 on individual fishponds. The study area is inhabited by the following potential nest predators: Marsh Harrier *Circus aeruginosus*, corvids *Corvus* spp., Wood Mice *Apodemus* spp., Harvest Mouse *Micrimys minutus*, Red Fox *Vulpes vulpes*, American Mink, *Mustela vison* and martens *Martes* spp. (Šálek & Šmilauer 2002, Kurz & Musil 2003).

2.2. Nest data

In total, we monitored 95 nests of the study species between 2002 and 2007 from March to the beginning of July. Nest searching was done using active searching and/or direct monitoring of parents. Nests were discovered at various stages of development, including nest building, incubation and brood rearing and were repeatedly controlled every seven days. The following components of each brood were sampled: (a) date that first egg was laid (assuming one-day interval of egg laying, Blümel 1982, Sutherland *et al.* 2004), (b) the day of the nesting season on which the nest was found (the first day of the nesting season was classified as the day when the earliest nest was found from April to the beginning of July between 2002 and 2007; Dinsmore *et al.* 2002, Cooch & White 2009), (c) the last day the nest was checked when alive, (d) the last day the nest was checked, (e) the fate of the nest (success vs. failure) (Cooch & White 2009) and (f) the age of the nest on the first day of the nesting season – see above (day 0 = day the first egg of the clutch was laid) (Cooch & White 2009, see also Segura & Reboreda 2012).

When nestling age was not known accurately from observation of hatching, it could be estimated by comparing the degree of development (feather, weight, body measurements) with known-age broods. Age estimates allowed back-calculation of first-egg laying date for the nest (e.g. Weidinger 2001), assuming egg laying dates, 13-day incubation period and 2-day hatching period (Blümel 1982, Hudec 1983, Okulewicz 1989, Cramp & Perrins 1994, Glütz von Blotzheim & Bauer 1997). A nest was considered successful if at least one nestling fledged. A nest was considered predated when eggs or nestlings had disappeared with no signs of another type of failure or successful fledging (Sutherland *et al*. 2005).

When the nest was found the following environmental parameters were recorded close to the nest (in a circle 30 cm around the nest and the nest as a centre): (1) vegetation type (see below), (2) proportion of old (previous year) vegetation (in %), (3) height of the nest above ground (cm), (4) estimation of visibility of the nest (the proportion of the nest seen from above the nest, e.g. Brickle & Peach 2004) and (5) the distance of the nest from the nearest tree (m). Vegetation was classified in four types using dominant (more than 70%) plant species (Reed Canary Grass *Phalaris arundinacea,* sedges *Carex spp.,* Wood Small Reed *Calamagrostis epigeios* and both Cattail *Typha latifolia* and Common Reed *Phragmites australis*), in a circle 30 cm around the nest.

2.3. Statistical analyses

We used program MARK (White & Burnham 1999) to model DSR across the 25-day nesting period and across the 92-day breeding interval when nests were checked each season (Dinsmore *et al.* 2002, Shaffer 2004, Cooch & White 2009). We standardized 12th April as day 1 and numbered all nest check dates sequentially thereafter. The conventional logit link function was applied in all regressions to map the linear combination of covariates to the DSR (Lebreton *et al.* 1992).

In our discussion above, we identified seven plausible DSR-influencing factors, namely day of the season (time trend), vegetation type, proportion of old vegetation, distance from the nearest tree, nest height, nest visibility and nest age. Because nest-site variables were not significantly correlated, we could use them all as individual covariates (White & Burnham 1999). However, together with our limited sample size, this posed a major model selection problem.

To compare models in the candidate set, we relied on information-theoretic criteria, namely the Akaike information criterion corrected for small-sample bias, AIC_c (Burnham & Anderson 2002), and used the following two-stage procedure in our analysis. In the first stage, we carried out an exploratory analysis of the relative support for individual covariates in our data, using the approach adopted by Tipton *et al.* (2008) and recommended also by Arnold (2010), which finds relative variable importance based on Akaike weights of candidate models. In this stage, we used quadratic terms of time-varying variables to account for a possible turning point in the influence of date and/or nest age, but we did not use any interactions so as to keep the number of both models and estimated parameters reasonable.

Table 1. Relative variable importance, based on Akaike weights (w_i)

	M	Σw_i	$\overline{w}_i$
Vegetation type	144	0.75	0.0052
Nest height	144	0.56	0.0039
Tree distance	144	0.51	0.0036
Nest age, quadratic	96	0.33	0.0034
Nest age, linear	96	0.31	0.0032
Time trend, linear	96	0.27	0.0028
Old vegetation	144	0.37	0.0026
Visibility	144	0.31	0.0022
Time trend, quadratic	96	0.11	0.0011

M = no. of models that included the particular variable, Σw_i = the sum of AIC_c weights of these models, $\overline{w}_i = \Sigma w_i / M$ = average AIC_c weight.

In the second stage, we retained only four variables that received most support, and focused on a restricted candidate set, this time including interactions of nest-site variables. Here we used Arnold's (2010) procedure of discarding models with uninformative parameters: we discarded all models that were outperformed (AIC_c-wise) by an alternative with a subset of covariates. This procedure helped identify a reasonably-sized set of the most parsimonious models; we report on the covariate effects estimated both from the AIC_c-best model (referred to as the top model henceforth) and using AIC-based model averaging across the whole set.

To see if the timing of breeding varies by vegetation type, we used standard ANOVA, and the variation of survival rate between individual ponds was tested using Pearson's χ^2 for contingency tables.

3. Results

Of the 95 Reed Bunting nests monitored, 62 were successful (65.3%). We found the following nesting success on individual fishponds: Černičný – 68.2%, Hejtmánků – 65.0%, Špitálský – 60.0%, Obecní – 65.2% and Šlechtův – 70.0%; the varia-

Table 2. Candidate models of DSR retained after the exploratory analysis and elimination of models with uninformative parameters.

Model	*p*	Δ AIC$_c$	w_i	– ln *L*
$S_{\text{veg. type + tree distance + nest age quadratic}}$	7	0.000	0.226	80.12
$S_{\text{veg. type + tree distance}}$	5	0.261	0.198	82.28
$S_{\text{veg. type + nest height}}$	5	0.268	0.197	82.29
$S_{\text{veg. type}}$	4	0.269	0.197	83.30
$S_{\text{nest height}}$	2	1.969	0.084	86.17
$S_{\text{intercept only}}$	1	3.058	0.049	87.72
$S_{\text{tree distance}}$	2	4.098	0.029	87.23
$S_{\text{nest age quadratic}}$	3	4.901	0.019	86.63

p = no. of parameters, Δ AIC$_c$ = difference in AIC$_c$ from the top model, w_i = Akaike (AIC$_c$) weight, –ln *L* = log-likelihood; see Dinsmore *et al.* 2002 for the specification of the likelihood function, S = DSR.

tion in nesting success across the fishponds is not statistically significant ($\chi^2 = 0.427$, df = 4, *p*-value = 0.98). Average DSR for 81 Reed Bunting nests, calculated from the intercept-only model, was 0.97 ± 0.01 SE (95% CI 0.95–0.98).

Table 1 contains the results of the exploratory analysis of relative variable importance. The usual procedure, as described in (Tipton *et al.* 2008, Arnold 2010), requires that all variables are included in an equal number of estimated models. In our analysis, this was not the case: each model that contained a time-varying variable was calculated with both a linear and a quadratic specification; as a result, the number of models that include a nest-site variable differs from that of a time-varying variable (see Table 1). Therefore, we decided to rank variables based on the average, rather than total, AIC$_c$ weights. As seen in Table 1, vegetation type stands out as the most important predictor of DSR, followed by nest height, distance from the nearest tree and nest age. These were the variables that entered the second stage of our analysis; quadratic shape was used for the nest age variable.

In the second stage, we analyzed models that contained the selected variables, this time including the interactions of nest-site variables. The retained candidates are shown in Table 2. The results confirmed the position of vegetation type as the predictor with the strongest support in our data: the evidence ratio (w_i / w_j) for any model *i* containing vegetation type versus any model *j* not containing it was greater than 2. Among the four vegetation types, the estimated DSR is the lowest in sedges and the highest in Reed Canary Grass and both Cattail and Common Reed (Fig. 1); the effect of vegetation type does not substantially vary with other nest-site characteristics (no interaction terms in any of the retained candidates).

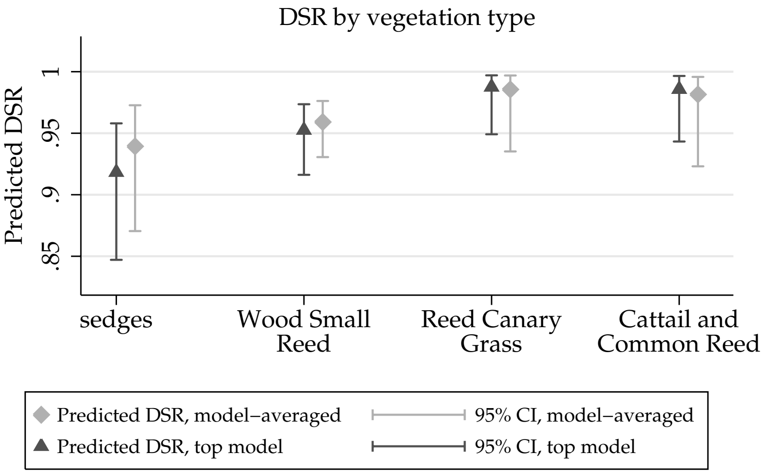

Fig. 1. DSR by vegetation type. (DSR estimates and 95% CI at mean values of the remaining covariates, top model.)

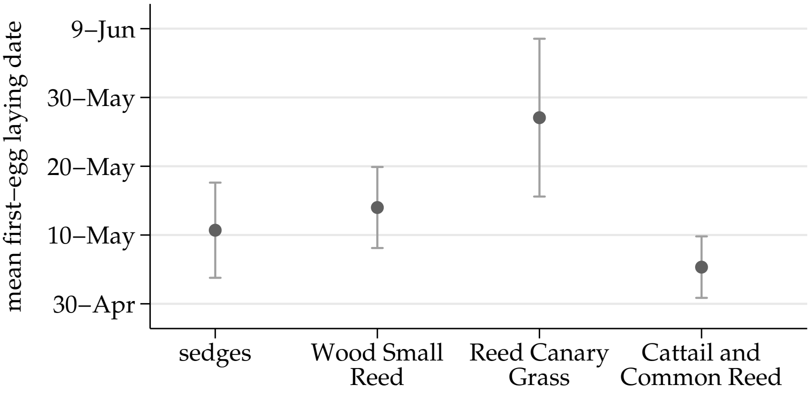

Fig. 2. Mean first-egg laying date in four vegetation types and 95% CI for the mean. (Estimates based on ANOVA regression, with robust SE.)

In all candidate models that contained distance from the nearest tree among the covariates, the predicted DSR increased with the distance (as expected). It can be noted that support for this variable increases when combined with vegetation type. This has a simple explanation: there was a systematic variation in tree distance with respect to vegetation type; for instance, nests located in sedges (vegetation with the lowest predicted DSR) were, on average, the furthest from a tree, while Reed Canary Grass (with the highest predicted DSR) had the second lowest average tree distance. Therefore, in the models that do not contain vegetation type, the estimated effect of tree distance is likely biased towards zero, and receives less support.

There is modest support for the effect of nest height; even though the variable is not included in the top model, the evidence ratio of the top model versus the model $S_{\text{veg. type + nest height}}$ is only 1.15. The estimated effect of nest height is positive in both models containing nest height, and the model-averaged coefficient indicates that with each additional centimeter above the ground, the odds of daily survival increase by 0.3 per cent.

Even though support for the effect of nest age is rather weak, the results from both models that contained the variable are consistent. Both indicate a u-shaped relationship between DSR and the nest age, with the minimum DSR being estimated between the 19th and the 20th day of the nest's existence (top model estimate = 19.41, model-averaged estimate = 19.30). This nest age coincides with the time shortly after hatching.

Timing of breeding differed in the four vegetation types ($n = 85$, $F_{3,81} = 4.16$, p-value = 0.0085). The earliest clutches were found in Cattail and Common Reed and the latest in Reed Canary Grass (Fig. 2).

4. Discussion

Nest site selection seems to be a crucial factor affecting breeding success and consequently population dynamics of bird species (Newton 1998). This study emphasizes the importance of nest site selection on breeding success of open nesting passerines. Above all, we found that vegetation type selection could significantly affect nest survival in Reed Bunting. Correspondingly, the vegetation structure around the nest could considerably influence the nesting success of birds (Seitz & Zegers 1993, Thompson & Burnhans 2003, Thyen & Exo 2005) and the effect of habitat variables on nest survival of passerines was shown also in earlier studies (Knutson *et al.* 2004, Arriero *et al.* 2006, Trnka *et al.* 2009). This effect could be revealed especially in heterogeneous habitats which differ in quality (Petit & Petit 1996, Pärt 2001).

We found that Cattail and Common Reed are the preferred vegetation types for our Reed Bunting population based in timing. It is generally known that timing of breeding is closely connected to vegetation preference with earlier breeding in the preferred vegetation type (Lack 1968, Owen & Black 1990, Bennett & Owens 2005). Cattail and Common Reed represent a tall vegetation type structure that is quite different from the remaining three types and likely provides better nest concealment especially in the beginning of the breeding season. This trait of Cattail and Common

Reed has high importance for the study species especially in April and beginning of May when the vegetation has low proportion of green leaves and previous year's vegetation is weatherworn. This strategy seems to be successful because the survival of nests located in Cattail and Common Reed was found to be among the highest. The increase in areas of Common Reed stands and stability of Cattail areas which was found between 1971 and 1997 (Hroudová & Zákravský 1999) likely facilitate the accessibility of Cattail and Common Reed vegetation.

Our data revealed lower DSR of the nests located in sedges. Indeed, sedges were identified as the most preferred vegetation type of the Reed Bunting nests according to the proportion of occupied vegetation types in previous studies (Hudec 1983, Blümel 1989, Okulewicz 1989, Cramp & Perrins 1994, Glutz von Blotzheim & Bauer 1997). But stands of sedges have disappeared in the study area between 1971 and 1997 (Hroudová & Zákravský 1999) and there has been a general decrease in the area of sedges in peatlands and salt marshes in the Czech Republic that is also documented by Münzbergová & Rybka (2005).

As was previously mentioned in the introduction, management practices such as manuring and dredging have caused marked changes in the composition of wetland plant species in the study area. Both the area and species richness decreased for littoral vegetation (represented by stands of tall sedges) and some types of soft littoral vegetation have expanded (Janda *et al.* 1996, van Vessem *et al.* 1997). Moreover, eutrophication of fishponds caused remarkable change in structure of sedge vegetation (Hroudová & Zákravský 1999, Janda *et al.* 1996, van Vessem *et al.* 1997, Musil 2006), which can considerably affect its suitability for nest cover and possible predators could find it easier to discover the nests. The majority of sedge species are retreating and e.g. Reed Canary Grass quickly invades free niches (Janda *et al.* 1996, van Vessem *et al.* 1997). According to the changes in sedge structure and distribution in previous decades, this vegetation type seems to offer lower quality breeding microhabitat presently. Moreover, sedges were occupied earlier than Reed Canary Grass in our study. Therefore, there is likely mismatch between preference of sedges and lower nest survival linked to individual fitness (see also Arlt & Pärt 2007). This observed deviation from ideal habitat selection (non-ideal habitat selection) could be caused by limited knowledge of cues caused by poor choice (Orians & Wittenberger 1991).

Reed Canary Grass was the least preferred vegetation type occupied later than the remaining vegetation types. But nests in this vegetation had high DSR (similarly to Cattail and Common Reed). Reed Canary Grass could provide a nest site with lower visibility (concealment) later in the breeding season due to the rapid structural development of this vegetation. Similarly, the effect of vegetation structure on timing of breeding was shown in the Great Reed Warbler in South Slovakia (Trnka *et al.* 2009). Moreover, vegetation of sedges and Wood Small Reed with lesser survival rate forms tussocks and on the contrary Reed Canary Grass and both Cattail and Common Reed forms more homogenous vegetation in the study area (Janda *et al.* 1996). These results could indicate that possible predators could find it easier to discover the nests in tussocks.

Our prediction of increasing DSR with increasing distance from the nearest tree was weakly supported. These findings seem to point towards birds as important predators of Reed Bunting nests (Cramp & Perrins 1994, Passinelli & Shiegg 2006) due to their use of elevated points (Berg 1996, Sheldon *et al.* 2007). Batáry *et al.* (2004) experimentally showed birds as potential predators in reed habitats and Trnka *et al.* (2011) showed using artificial nests that Reed Buntings may be capable of choosing their territories according to the actual predation risk relative to mainly avian predators and nest site selection thus could serve as part of an anti-predator strategy (Henrioux 2002). Moreover, higher occurrence of Crows *Corvus corone* was shown close to fishponds in the study area between March and May in comparison with the rest of the season (Kurz & Musil 2003). We found mild support that DSR increased with decreasing nest height. Conversely, Passinelli & Shiegg (2006) showed that the probability of predation increased with decreasing nest height in the Reed Bunting in Switzerland. We can explain the different results to emphasize the different habitat structure with "old reed patches" which have not been cut for several years in Switzerland (Passinelli & Shiegg 2006) and conversely the presence of lower vegetation types with the minority of reed patches in our study area.

In addition, our models predicted the lowest DSR close after hatching, between 19th and 20th day of the nesting cycle, although the effect is mild. A linearly increasing trend of DSR is probably caused by higher defence of nests with older nestlings or due to the earlier predation of the more vulnerable nests (Peak *et al.* 2004, Grant *et al.* 2005, Segura & Reboreda 2012). In contrast, a linearly decreasing trend of DSR is closely connected with increasing frequency of feeding by parents and increasing volume of nestlings' vocalization (Leech & Leonard 197, Briskie *et al.* 1999, Lloyd & Martin 2005). Our finding could indicate the conclusion that nestlings and especially adults feeding nestlings attract predators more than an incubating female (Skutch 1949), especially visually-oriented predators. In the study area, the expansion of shrubs and trees on grass and sedge stands (Hroudová & Zákravský 1999) likely facilitate predator monitoring.

We suggest that Reed Buntings would be less sensitive to habitat changes and degradation due to higher nest survival in expanding vegetation types compared to more specialised reed-nesting passerines e.g. Reed Warbler *Acrocephalus scirpaceus,* Great Reed Warbler *Acrocephalus arundinaceus* and Savi's Warbler *Locustella luscinioides* (Hoi *et al.* 1991, Martínez-Vilalta *et al.* 2002, Neto 2006). The flexibility and success in emerging habitats may be one reason for the stable population trend of Reed Bunting breeding population in the Czech Republic in contrast to decreasing populations of several warbler species (*Acrocephalus spp.* and *Locustella spp.*), see Musil (1999), Musil (2000) and Šťastný *et al.* (2006) for details.

In contrast, decreasing population trends of Reed Bunting are recorded in some Western European countries, e.g. Great Britain (Fuller *et al.* 2002), Belgium and France (Birdlife International 2004), where Reed Buntings are apparently related to agricultural landscape more than to natural wetland habitats (Gregory & Baillie 1998, Siriwardena *et al.* 2000). According to Pasinelli *et al.* (2008), large and small wetland fragments are equally suitable as breeding grounds for Reed Buntings and therefore the patchy environment of South Bohemian fishponds likely represents an important breeding habitat of the study species which is able to flexibly respond to its emerging vegetation structure.

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Pajusirkkujen pesien selviytyvyys pirstoutuneessa kosteikkohabitaatissa: pesäpaikan valinnan merkitys

Pesien selviytyvyys pirstoutuneissa kosteikoissa kytketään usein mikrohabitaattiin. Tämän tutkimuksen päätarkoituksena oli tarkastella mitkä tekijät vaikuttavat pajusirkun (*Emberiza schoeniclus*) pesien selviytyvyyteen kosteikoilla, mosaiikkimaisessa keskieurooppalaisessa maisemassa. Seurasimme 95 pesäpaikkaa viidellä eri kala-altaalla Etelä-Böömissä, Tšekin tasavallassa, vuosina 2002–2007.

Selvittääksemme pesäpaikan ominaisuuksien, munimispäivämäärän ja pesän iän vaikutusta pesän selviytyvyyteen, vertasimme eri päivittäisen selviytyvyyden malleja MARK-ohjelmassa. Selviytyvyys oli merkitsevästi suurempi jos pesä sijaitsi ruokohelven (*Phalaris arundinacea*), osmankäämen (*Typha latifolia*) tai järviruo'on (*Phragmites australis*) kasvustoissa, verrattuna pesiin, jotka sijaitsivat matalammassa sarakasvustossa (*Carex* sp.). Yllättäen, ruokohelvessä sijaitsevat pesinnät olivat sarakasvustojen pesintöjä myöhäisempiä, mikä viittaa siihen, että sara kuitenkin on suositumpi pesäpaikka. Sarakasvustojen rakenne on muuttunut rehevöitymisen myötä ja luultavasti niiden sopivuus lajin pesän mikrohabitaattina on heikentynyt.

Löysimme myös heikkoa tukea sille, että selviytyvyys kasvoi lähimmän puun etäisyyden myötä, ja sille, että selviytyvyys oli matalimmillaan juuri kuoriutumisen jälkeen (pesinnän 19.–20. päivänä), jolloin poikaset saattavat houkutella petoja. Nämä tekijät viittaavat lintujen suureen merkitykseen pajusirkun pesien tuhoajina. Pajusirkun pesäpaikan valinta lienee ennen kaikkea strategia petojen välttämiseen.

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