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PREDATION SURVIVAL OF GROUND NESTING BIRDS IN GRASS AND WHEAT FIELDS: EXPERIMENT WITH PLASTICINE EGGS AND ARTIFICIAL NESTS

ABSTRACT: There are no agricultural activities in Hungarian energy grass plantations (*Elymus elongatus* (Host) Runemark before harvesting in August, so the breeding success of the ground-nesting Common pheasant (*Phasianus colchicus* L.) and Common quail (*Coturnix coturnix* (L.)) is probably higher than in the neighbouring intensively managed grain fields. The dominant nest predators of these bird species (e.g. Red fox *Vulpes vulpes* L.) prey mostly on small mammals, thus the abundance of small mammals can influence the survival rates of ground-nesting birds. These assumptions were tested using artificial ground-nests and small mammal live traps in late May 2005. Of the nests, 25 were placed in the energy grass field which covered 60 ha and another 25 in the wheat field which area was 20 ha. Each of the nests contained one chicken egg, one quail egg and one plasticine dummy-egg. Real eggs were placed for the evaluation of nest predation rates and artificial plasticine eggs for predator identification from tooth and bill imprints. Following the placement of artificial nests, they were checked repeatedly between 16.00 and 18.00 every day. In both plots, 25 traps were set up, baited for 4 nights with quail egg and for another 4 nights with plasticine egg. Artificial nests lasted for 3 days in the wheat field and for 4 days in the energy grass field. The major predators in wheat were birds (16%) and mammals (84%), whereas in energy grass all predation (100%) was caused by mammals. There was no significant difference between types of predators in the two habitats. On-spot observations, traces and marks left on plasticine eggs, several droppings and the patterns of nest predation all suggested that the majority of nests were destroyed by Red fox. A significantly higher proportion of plasticine eggs were damaged in wheat (80%) than in energy grass (48%). Based on marks left on plasticine eggs, small mammal abundance was higher in wheat (80%) than in energy grass (33%), the latter habitat not yielding any small mammal captures at all. Traps in the wheat field caught significantly more small mammals with plasticine eggs (14) than with quail eggs (5). Plasticine eggs had greater attraction effect on small mammals, thus could negatively influence experiments with artificial ground nests.

KEY WORDS: *Phasianus colchicus, Coturnix coturnix,* nesting success, small mammals, tall wheatgrass, Hungary

1. INTRODUCTION

The development and use of biomass resources for bioenergy has become critical priority in Europe. Energy grass fields change the character of agricultural lands (Kálmán *et al.* 2006). Little is known about the biodiversity of energy grass fields (Semere and Slater 2004, 2007, Sage *et al.* 2006), and their predation relations have not been studied either. Until the harvest in autumn, no activities are performed in Hungarian energy grass fields, therefore the breeding success of ground-nesting birds in these plots is probably higher than in the neighbouring, intensively managed agricultural lands. The nesting success of ground nesting birds may vary strongly from year to year depending on the cycle phase of small mammals, the main prey of dominant predators (Šálek *et al.* 2004). Artificial nests are useful, non-destructive tool for testing ecological and behavioural mechanisms that influence predation risk in nesting birds (Major and Kendal 1996, Bayne and Hobson 1999, Batáry and Báldi 2005). Several investigators have used artificial nests containing either natural eggs (e.g. from Zebra finches, House sparrows, quails, hens etc.) or synthetic eggs usually made with clay or plasteline, wax or paraffin-filled eggs (Major and Kendal 1996, Svagelj *et al.* 2003). Egg type is one factor that is likely to influence to results from artificial nest experiments (Lindell 2000).

Nests containing plasticine eggs are usually sooner discovered by small mammals than those having only real eggs in them (e.g. Rangen *et al.* 2000, Maier and DeGraaf 2001). Major (1991) and also Bayne and Hobson (1999), however, claim that plasticine eggs do not attract predators better than real eggs. Our own earlier experience suggests that predation on real and plasticine eggs is more or less similar in nests located in shrubs (Purger *et al.* 2004a), whereas in ground nests of open areas a lot more plasticine eggs were damaged (Purger *et al.* 2004b).

The aim of our studies has been to find answers, by using artificial ground nests and small mammal live-traps, to the following questions: 1) What are the survival chances of larger-bodied birds in nests located in energy grass and wheat, respectively? 2) Can we infer to the abundance of small mammals, based on marks preserved on plasticine eggs in the nests? 3) Which of them, plasticine eggs or true quail eggs have higher attraction to predators when used in small mammal live traps?

2. STUDY AREA AND METHODS

The Hungarian cultivar „Szarvas-1" of the energy grass or Tall wheatgrass (*Elymus elongates* (Host) Runemark), as a renewable energy resource has been produced since 2003 on 993 hectares (on 19 sites) in the South-Transdanubian region (Baranya county, Hungary). The energy grass plot bordered by agricultural lands, is located 15 km south of the city of Pécs. Common pheasant (*Phasianus colchicus* L.) and Common quail (*Coturnix coturnix* (L.) are typical nesting birds in the neighbouring areas. During walking surveys in 2004, a pheasant and a quail nests were found, with remains of egg shells. During May and June, the call of quails was continuously heard in the morning hours in several parts of the energy grass plot, and pheasants also often called. Among their potential predators, we noted the frequent presence of Western marsh-harrier (*Circus aeruginosus* (L.)) and Red fox (*Vulpes vulpes* L.).

On 30th May 2005, 25 artificial ground nests were located in the energy grass field which covered 60 ha, and another 25 in the adjacent wheat (*Triticum aestivum* L.) field which area was 20 ha. The height of vegetation was measured at the location of each of the nests. Energy grass was (105.96 cm ± 15.72, average ± S.D.), significantly higher ($t = 8.57$, $df = 48$, $P < 0.0001$) than wheat (76.96 cm ± 6.23). Nests were distributed along a linear transect at 20 m intervals and they were positioned 2–10 m from the transect line (Bayne *et al.* 1997). The two transects were 300 metres apart. Ground nests were formed by creating a depression in the soil using our heel (Marini *et al.* 1995, Fenske-Crawford and Niemi 1997). One chicken egg (52 × 39 mm), one quail egg (33 × 26 mm) and one natural coloured plasticine egg (size of a quail egg) was placed in each of the nests. The nests contained real eggs for the evaluation of nest predation rates, and artificial plasticine eggs for predator identification from tooth and bill imprints (Niehaus *et al.* 2003). The simultaneous use of quail and plasticine eggs is not usual in nest predation studies (Batáry and Báldi 2004). It seemed likely that small mammals discovering the plasticine eggs can even open or roll away quail or pheasant eggs. To test this we decided to use two different sized real eggs. Following the placement of artificial nests, they were checked repeatedly between 16.00 and 18.00 every day.

At the same time the nest predation experiments proceeded, small mammal live traps were set up in both plots. The numbers and arrangement of these traps were identical with those of the artificial ground nests (25–25), but these transects were located about 50 m further away from the nests. For four nights (30 May–3 June) the traps contained quail eggs, and for four other nights (3 June–7 June) plasticine eggs were used as bait. Traps were activated from 17.00 to 18.00 each day, then checked and closed from 6.00 to 7.00 each morning. Traps that had caught any small mammal by the morning were taken away from the plot for cleaning, then they were placed back in the afternoon after thorough washing and drying, and were then re-activated. New, plastic box traps were used for the studies.

In the statistical analysis t-test and chi-quadrate test with Yates correction for continuity was applied (Zar 1999). Survival rates of plasticine eggs were calculated with the Mayfield (1975) method and compared using the test proposed by Johnson (1979). A minimum probability level of $P < 0.05$ was accepted for all the statistics and all P values are two-tailed.

3. RESULTS AND DISCUSSION

During the four days the predators discovered and destroyed all of the artificial nests in both habitats (Fig. 1). On both the first and the second day after the nests were positioned, two nests were discovered and destroyed in the wheat field by birds (n = 4, 16%), as shown by missing or broken real eggs and beak marks on plasticine eggs. Based on these marks, however, it was not possible to identify the bird predator. One or two individuals of Western marsh-harrier were seen flying low above both study areas almost continuously. It is well known that this species is frequently found eating eggs of larger ground-nesting birds across Europe (Cramp and Simmons 1979, Opermanis 2001). Mammals, mostly foxes, destroyed the rest of 21 nests (84%) in the wheat field, and all 25 nests (100%) of those in the energy grass field. There were no significant difference between type of predators in the two habitats (Chi-squares with Yates correction = 2.45 df = 1, $P > 0.05$). This was supported by a number of droppings found in situ, as well as observations and tooth marks found on the plasticine eggs. The pattern of nest destruction suggested that predators arrived from the forest and proceeded along the transect (1–25), destroying the nests in succession. Mammalian predators have been known to concentrate search in nesting habitats in response to high nest densities or high alternative prey densities (Larivière and Messier 1998). Red foxes are generalist predators that tend to subsist opportunistically on many prey groups (Jędrzejewski and Jędrzejewska 1992, Dell'Arte *et al.* 2007). In the wheat field, 11 nests were destroyed by the fox on the second day after nest placement, and continued with the remaining 10 on the third day (Fig. 1).

In the energy grass field, nest destruction went on in a systematic order, on the second (6), third (13) and fourth (12) days after nest placement (Fig. 1). During nest predation studies, it can happen that the predator becomes "addicted" to destroying the clutches, thus negatively influencing the results of the experiment (Báldi 1999), as it was the situation in our case. If the study area is large enough, this error factor can be reduced by increasing the distance between artificial nests (Báldi 1999). Nests in larger patches will have a much greater chance of surviving

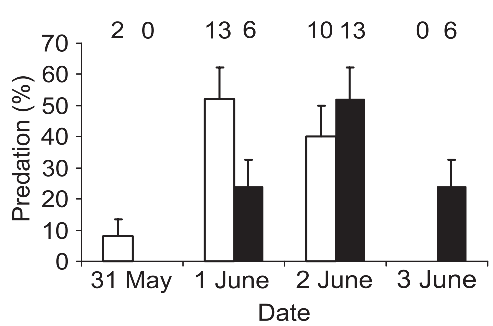

Fig. 1. Predation rate (%) on artificial nests mounted in wheat (n = 25, white bars) and in energy grass (n = 25, black bars). The numbers above the bars indicate the numbers of predated nests.

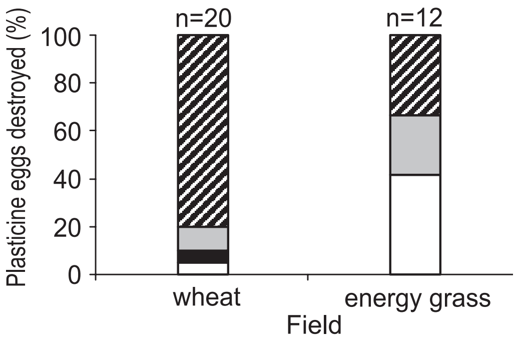

Fig. 2. Proportion of plasticine eggs removed (disappeared) or marked by different predators in two habitats (white bars – removed (disappeared) from the nest, black bars – marked by avian predator, grey bars – marked by large mammal predators (e.g. Red fox), hatched bars – marked by small mammals).

predation than nests in smaller patches for realistic foraging effort, assuming that the search time is equal in all patches (Seymour *et al.* 2004).

Comparing the wheat field and the energy grass field, the proportions of damaged or missing (80% *vs.* 48%) and intact plasticine eggs (20% *vs.* 52%) were significantly different (Chi-squares with Yates correction = 4.25 df = 1, P <0.05). As inferred from marks left on plasticine eggs, small mammal abundance (Fig. 2) was higher in the wheat field (80%) than in the energy grass field (33%) where small mammal trapping did not yield any captures at all. After the nest predation experiment, between June and October, a capture-recapture survey was done in this energy grass field and neighbouring plots (Horváth 2006, Kálmán *et al.* 2006). Being the dominant species there, the Common vole (*Microtus arvalis* (Pallas)) showed similar habitat use in energy grass and neighbouring wheat field in the summer months (Horváth 2006) which seems to contradict our results. This may be caused by differences in the seasonal dynamics and reproductive biology of small mammals.

Traps located in the wheat field caught significantly more small mammals when baited with plasticine eggs (14) than with quail eggs (5) (Chi-squares with Yates correction = 4.26 df = 1, P <0.05). Quail eggs attracted only 3 Common voles and 2 Wood mice (*Apodemus sylvaticus* (L.)) to the traps, and all eggs remained intact. Size and shell-thickness of eggs used in artificial nest studies can affect predation frequency, as well as the predator species detected (Maier and DeGraaf 2000.). Small mammals can cause damage to ground nesting smaller-bodied birds mostly, since they can manage breaking their eggs (Maxson and Oring 1978). They are unable, however, to break the eggs of larger birds, but their presence can still call the attention of other large predators to the nests.

Baited with plasticine eggs, traps captured 11 Common voles, 1 Wood mouse, 1 Yellow-necked mouse (*Apodemus flavicollis* (Melchior)) and 1 Steppe mouse (*Mus spicilegus* Petényi). There was no significant difference (z = 0.957, P = 0.339) in the daily survival rates of plasticine eggs in ground nests (83%, 95% confidence limits: 77–90) and in traps (88%, c.l. 82–94). The results suggest that there are more small mammals in the wheat field and that plasticine eggs are more attractive to them than real eggs. It appears that artificial ground nests – provided that they contain plasticine egg too – are more subject to damage caused by predators. The higher predation of nests with plasticine eggs may have resulted because small mammals, relying on olfactory cues, comprised a large portion of the predator assemblage (Rangen *et al.* 2000). Where small mammals are more abundant, it is more likely that their predators will also discover the nests (Ackerman 2002, Šálek *et al.* 2004). Partially or completely destroyed nests may attract scavengers and secondary predators (Larivière 1999). Lanszki *et al.* (1999) have found that from autumn to spring small mammals dominated in the diet of Red fox (38–49%), and the most important prey was Common vole. Just like with small mammals, plasticine eggs can attract larger predators too, e.g. Red fox, Pine marten (*Martes martes* (L.)), Wild boar (*Sus scrofa* L.) etc. The urine, droppings and scent marks of small mammals discovering plasticine eggs can assist larger predators in discovering ground nests.

4. CONCLUSIONS

The impact of large regional energy crop development on birds is not known (Sage *et al.* 2006). It is possible that such fields provide more favourable conditions for a number of species than intensively managed agricultural areas. The species richness of energy grass plots should be surveyed as soon as possible, and the monitoring of their biodiversity launched. Important information could be revealed by measuring ground nest densities, investigating and comparing the actual nesting success of birds with nests in other intensively managed fields. The application of plasticine eggs in artificial ground nests should be reconsidered and its method improved, because the results suggest that minor differences in the methodology (e.g. size of eggs applied, the use of plasticine) can significantly influence the results of nest predation studies (e.g.: Bayne *et al.* 1997, Lindell 2000).

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