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The role of different egg types, the artificial nests and disturbance in nest predation studies

PhD Thesis

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Introduction

Nest predation is one of the most important influencing factors of breeding success, it can affect organisation of bird communities, selection of the birds habitat and nesting site, hereby the development of the populations space-time dynamics too. Hereby, to study nest predation is a main object in ecology. The nest predation studies are the best methods to help the researchers in the reconsidering of the predation processes and the results can help to estimate the endangereness of the bird populations. The important information gained from these studies about the predators can help the researchers to manage effective conservationist steps. The greatest problems in the observation of real nests are the difficulties of the nest explorations and the destruction made in the habitat while a researcher exploring a territory and therefore the disturbance-sensitive species are leaving their nests behind. Artificial nests with real and artificial eggs are an alternative, useful tool to investigate predation rates and to identify predators. The advantage of artificial nests is that we can gain a correct arrangement and sample size according to the examination. The experiment is simply repeatable and we do not disturb neither the real nests nor the nesting birds. Nevertheless, the reliability of artificial nests and eggs is questioned nowadays too, because they do not simulate the same tactile-, visual- and olfactory reaction from predators, as the real nests or real eggs. So the question is: Is their predation rate is the same as the real nests'? Most of the nest predation experiments examines only the real nests or only the artificial nests, but there are relatively few studies about the relation between the two. Few comparative studies had contradictory results. The differences between real- and artificial nest predation can be due to many things such as: examinated species, habitats but there can be differences between studies and methods too. So in addition to survival probabilities of nests we have to examine the influencing factors (e. g.: disturbance) too. The problem is not the nest but its position and the role of artificial eggs placed in the nest, for example plasticine eggs' roles which are mainly used to identify predators.

The rate of nest predation can vary according to the situation of the nests: in what kind of area the nest can be found? For example natural, close-to-natural or agricultural areas? Because of the transformation of the economy, the wide-range spreading of humanity and because of the urbanization the natural habitats are transforming. In whole Europe, and in Hungary too, there are more and more energy plant plantations, and we know a scant of its

biodiversity and predatory relations. Urbanized areas, due to human presence, are characterised of a higher level of disturbance than natural habitats, and the pattern of many resources (e.g.: accessibility of food, nesting opportunities) can change. Different species react a different way to the changes in their habitats. Amongst birds and mammals there are several species who adapted successfully to the synantrop habitat, made and influenced by humans. But we don't know the real price of this supposed success, but we are talking mostly about endangered species.

Aims of the study

1) Whereas, the different egg types in artificial nests can influence their predation rates, the primary aim of our study was to investigate which type of egg (natural plasticine, white lime coloured plasticine, rubber-coated plasticine) is the most useful in nest predation studies.
2) Nevertheless, not only the applied egg type can influence the survival of artificial nests, but human disturbance too. There are several debates on their effect, on the success of breeding; so we used artificial nests to examine how does daily nest monitoring affect the nest survival rates of ground- and shrub nests during the first and the second breeding period?
3) To examine the effects of human disturbance is important too, because due to raising urbanization more and more bird species are migrating to urbanized environment, where they suffer greater disturbance than in their natural habitat. Therefore, we managed our studies in urban environment. To discover how our results obtained from artificial nest studies represent the survival probabilities of real nests we made a comparative study between blackbird (*Turdus merula*) nests and artificial nests, similarly in urban setting.

Materials and methods

Testing practicability of different egg types

For testing the practicability of different egg types we managed a series of examination from which we could test both the real eggs (quail's and chicken's egg) and different types of plasticine eggs (natural-, white lime coloured- and rubber-coated plasticine). The studies were carried out in greater agricultural landscapes, mainly in wheat (*Triticum aestivum*) -, and energy grass (Tall wheatgrass) (*Elymus elongatus* [Host] Runemark subsp. *Ponticus* [Podp.] Melderis cv. Szarvasi-I) fields south from the town of Pécs.

At the first time (in May 2005), 25 artificial ground nests were located in the energy grass field and another 25 in the adjacent wheat field. Nests were distributed along a linear transect at 20 m intervals. One chicken egg, one quail egg and one natural coloured plasticine egg (size of a quail egg) (Produced by KOH-I-NOOR, Czech Republic) were placed in each of the nests. We controlled nests on days 1, 2, 3 and 4 after the setting up of the experiment.
At the same time the nest predation experiment proceeded, small mammal live traps were also set up in both plots: their numbers and spatial arrangement was as for the artificial nests. For four nights the traps contained quail eggs, and for four other nights plasticine eggs were used as bait.

In the next experiment (in June 2006) altogether 78 artificial ground nests were exposed in the wheat filed (south from the study area of the previous experiment) along three transect lines. A pair of eggs were placed in each of the nests, comprising in an alternating sequence, two quail eggs (Q+Q), one quail egg and one natural coloured plasticine egg (Q+NP), as well as one quail egg and one plasticine egg covered with lime containing paint (white coloured) (Q+WP) – to imitate the real eggshell. After setting up the artificial nest experiment, the nests were controlled daily for a period of seven days.
Like the previous study, simultaneously with the nest predation experiments, small mammal live traps were also set up: their numbers and spatial arrangement was as for the artificial nests, but we used a different part of the wheat field. Accordingly, 26 traps were baited with quail eggs, 26 with plasticine and another 26 with white coloured plasticine eggs. The traps were operated for seven nights.

Finally (in June 2010), 15-15 artificial ground nests were located in each one of the ten independent wheat fields, along three transect lines. Every nest contained two eggs using the following combination: quail+quail (Q+Q), quail+natural plasticine (Q+NP), quail+rubber-

coated plasticine egg (coated with PlastiDip®) (Produced by PlastiDip® Deutschland GmbH, Germany) (Q+CP). In each experimental plot there were 5-5-5 nests from every egg combination, with randomly order. We controlled nests during two weeks, on every fourth day after the setting up of the experiment.

Effect of daily nest monitoring on breeding success

In May 2010 a total of 100 artificial nests were placed along ten transect lines in a forest edge – turkey oak forest (*Potentillo micranthae – Quercetum daleschampii* Horvát A.O. 1981), herbaceous vegetation and bushes – placed on the southern slope of Mecsek, situated north-eastern outskirts of town Pécs. In each transect there were five ground and five shrub nests, in a varying order, 10 m apart from each other. Every nest contained one quail and one plasticine egg. With the calculations of the vegetation's coverage we estimated the visibility of artificial nests on a three-unit scale and the height of shrub nests was measured, too. The half of the transects (every second) was checked daily through seven days, in the same time, we assured the disturbance by handing the eggs. The rest of the transects only checked the seventh day, so it remained undisturbed for a long time. We repeated the study one month later (in June), this time we exchanged the places of ground and shrub nests as well as the disturbed and undisturbed transects. The meteorological data (average temperature, precipitation, rainy days and global radiation) source is the Meteorological sampling station of University of Pécs.

Survival probabilities of shrub nests in an urban environment

We started the examination of the survival probabilities of nests being in urban environment in the Botanical Garden of the University of Pécs. We investigated the potential breeding success of blackbirds and its changing in time using artificial shrub nests in April and June of two consecutive years (2008, 2009). Altogether 25 artificial nests were placed in the ivy (*Hedera helix*) growth covering the garden wall and another set of 25 artificial nests were put on deciduous and evergreen shrubs. One quail egg and one plasticine egg was placed in each of the nests, which were monitored for two weeks, a period similar in duration to blackbird incubation. Checking was performed on days 1, 2, 4, 7 and 14 after the setting up of the experiment. The height of artificial nests was measured.

During the comparative study of real and artificial nests, we were searching for blackbird nests in potential nesting sites in Pécs (quarters Belváros, Ispitaalja, Havihegy, Kertváros, Megyer, Balokány, Uránváros), from March to July in 2009 and 2010. At about 15-20 m distance from every discovered real nest, an artificial nest was set up, placed to a similar spot and similar height as the real one. One quail egg and one plasticine egg was left in each of the artificial nests. The already existing nests were checked weekly until it was possible to clearly determine the fate of the nest, and on every occasion were searched new nests until we did not discover further more.

A nest was considered to be predated, if one of the eggs was either missing or damaged (bite, chewing, treading). We categorised nest predators based on marks left on the plasticine eggs (for example small mammals, large-bodied mammals, birds). True nests were categorised as successful when at least one chick fledged and left the nest. When eggs or chicks were found to be missing during the breeding, predation was concluded. The nest was recorded to be abandoned if intact but cold eggs or dead nestlings were found and no adult bird was seen at the nest at two consecutive checking sessions. For statistical analysis t-test, χ^2-test, j-test, GLMM, Tukey post hoc test were used. Calculations were made using R 2.11.1 software (R Development Core Team 2010), contingency tables, the test proposed by Johnson (1979. *Auk 96: 651-661.*), and the descriptions by Zar (1999. *Prentice Hall, London, pp. 663.*).

Results and discussion

Testing practicability of different egg types

In case of the first study (in 2005) during the four days the predators destroyed all of the artificial nests in both habitats, by mammals (84%) and birds (16%) in the wheat fields and by mammals certainly (100%), mostly by foxes in the energy grass field. This was supported by missing or broken real eggs, a number of droppings found in situ, as well as beak- and tooth marks found on the plasticine eggs. The high predation rate suggested that nests with plasticine eggs are discovered easily and quickly by small mammals having sensible smelling. We displayed the negative effect of plasticine with small mammal traps too, because the traps with plasticine eggs captured much more small mammals than with quail eggs (χ^2 with Yates correction = 4.26, df = 1, p = 0.039). In the energy grass field the small mammal trapping did not yield any captures at all. Comparing the wheat field and the

energy grass field, the proportions of intact (20% vs. 52%) and damaged or missing plasticine eggs (80% vs. 48%) were significantly different (χ^2 with Yates correction = 4.25, df = 1, p = 0.039). It is possible that energy grass fields provide more favourable conditions for a number of species than intensively managed agricultural areas.

In the next year (in 2006), comparing the daily survival rates of nests with different egg combinations in pairs we found that nests with quail and plasticine eggs (Q+NP) experienced higher predation than those containing two quail eggs (Q+Q), but the difference was not significant (z = 2.27, p = 0.059). Similarly, there was not significant difference between survival of nests with quail and plasticine eggs (Q+NP) and nests with quail and white plasticine eggs (Q+WP) (z = 1.56, p = 0.261). However, nests with quail and white plasticine eggs (Q+WP) experienced significant higher predation than those containing only real eggs (Q+Q) (z = 3.59, p < 0.001). Conversely our assumption, plasticine eggs covered with lime containing paint didn't become similar to real eggs. Trend of capture success of traps was similar with results of nest predation experiment, nevertheless significant differences could not be shown (NP - Q: z = 1.16, p = 0.475; WP - Q: z = 2.32, p = 0.054; WP - NP: z = 1.19, p = 0.461). The white lime coloured plasticine (WP) is more attracting for mammals, than natural plasticine (NP), probably due to its smell or white colour. The pattern of nest destruction suggested that small mammals discovered the eggs at first, but they are not necessarily able to break the hard shell of birds' eggs. So they are not real predators of larger ground nesting birds, but might well, with their presence, attract larger predators to the nests.

In the third study (in 2010), nests with quail and plasticine eggs (Q+NP) experienced significantly higher predation than those containing two quail eggs (Q+Q) (z = 6.12, p < 0.001) or those with quail and coated plasticine eggs (Q+CP) (z = 5.07, p < 0.001). The latter two combinations did not differ significantly (z = -1.49, p = 0.289). The rubber layer reduced unnatural smell of plasticine, at the same time it remained enough soft to recording the marks of the predators and its colour is not so white like the white lime coloured plasticine. From the tooth marks left on the plasticine eggs in our experiment it can be concluded that mostly small mammals discovered the nests, the proportion of bird or larger mammals was little. Like the previous experiments, large-bodied mammals discovered artificial nests following up scent of the small mammals.

Based on our results, the egg type used in nest predation experiments has an effect on the results of experiments. Neither natural nor white coloured plasticine eggs are not practicable in case of the ground nests, because they experienced significant higher predation rate than quail eggs. Because of predator identification, usage of plasticine eggs is essential in

many experiment, we suggest the usage of rubber coated plasticine eggs for nest predation investigations in the future rather than natural or painted plasticine eggs, because the survival rates of nests with quail eggs and nests with coated plasticine eggs were similar.

Effect of daily nest monitoring on breeding success

During the experiment 44% of the nests were predated among the total of nests. Nest predation rate was independent of month ($z = 0.21$, $p = 0.834$), or disturbance ($z = -1.73$, $p = 0.084$), but it did depend on interaction of them ($z = 2.25$, $p < 0.05$) and on nest type ($z = 3.91$, $p < 0.001$). Significantly more ground nests (58%) were depredated than shrub nests (31%), and different predators have discovered them ($\chi^2 = 9.49$, $df = 3$, $p = 0.023$). Relation of predator communities did not change due to disturbance, but the activity of them was affected by weather. The significant interaction between month and disturbance means that the disturbance affected the nest predation inversely: decreased that in May (ground nests: disturbed 44%, undisturbed 48%; shrub nests: disturbed 12%, undisturbed 40%), but increased or did not modify it in June (ground nests: disturbed 84%, undisturbed 56%; shrub nests: disturbed 36%, undisturbed 36%). This reversed effect can be due to the weather; in May there was more precipitation, for a longer period, and there were less sunshine according to June and the activity of predators was affected by weather: in sunshine the predation rate was higher. The greater part of eggs was removed from the artificial nests, mainly by corvids. So we managed to identify predators in half of cases only. Based on the marks left on plasticine eggs mostly small mammals (55%), small-bodied birds (31%), large-bodied mammals (10%) and large-bodied birds (4%) discovered the nests. Our experiments were considerably affected by the extreme weather, which exact effects are still unknown. If possible we should avoid the daily visits and controls of the real nests, because disturbance has an effect on survival rate, or increases even decreases it.

Survival probabilities of shrub nests in an urban environment

The examination made in the Botanical Garden for both of the study years, the number of artificial nests discovered and depredated was higher in June than in April, but this difference was significant only in 2008 (χ^2 with Yates correction = 5.92, $df = 1$, $p = 0.015$), whereas it was not significant in 2009 (χ^2 with Yates correction = 0.34, $df = 1$, $p = 0.559$). To ascertain the reason of this divergence, we analysed the difference between the two months separately on nest types. In case of the nests that were positioned in bushes the numerical values were

similar in both years (in 2008 and in 2009: χ^2 with Yates correction = 1.25, df = 1, p = 0.264). In case of the nests that were positioned along the garden boundary wall, the predation rate was significant higher in June than in April only in 2008 (χ^2 with Yates correction = 4.5, df = 1, p = 0.034); in 2009 the predation rates were similar in both months (χ^2 with Yates correction = 0.00, df = 1, p = 1.000). Probably the increased predation pressure could be caused by changes in the habitat, because In spring 2009, mulched plant material was deposited in a heap against the wall bordering the garden, making the nests positioned here more exposed to predators. Nests that were positioned along the wall were located significantly higher up than those placed in bushes (t = 4.17, df = 48, p < 0.001), yet there was no significant difference between the predation rates of the two pools of artificial nests either in 2008 (χ^2 with Yates correction = 0.03, df = 1, p = 0.863), or in 2009 (χ^2 with Yates correction = 0.76, df = 1, p = 0.383). So the position of nests does not affect success of them. There was no significant difference between the predation of quail and plasticine eggs in 2008 (χ^2 with Yates correction = 0.19, df = 1, p = 0.663). In 2009, however, the number of quail eggs damaged was much higher than that of plasticine eggs (χ^2 with Yates correction = 24.45, df = 1, p < 0.001). Based on marks left on the plasticine eggs the nests were discovered by small-bodied birds and small mammals. Probably jays were responsible for losses to a considerable amount of eggs – their density in the Botanical Garden was found to be around 0.4 pairs/ha (own observations) – who are important predators of the area. Our studies have shown that for blackbirds living in urban environments the first breeding in the season is more successful, irrespective of the location of the nests, although this can be influenced considerably by disturbance factors.

During 2009 and 2010, altogether 59 active blackbird nests were observed regularly in the city of Pécs. Despite we searched blackbird nests regularly, most of active nests (63%) were found in April, after which the number of nests decreased gradually with the advancement of the breeding season. During the two study years somewhat more nests were lost (56%) than the amount that stayed intact (44%). The main cause of nest failure was the abandonment of the nest by the parents (58%), however, can be caused by predation. More than half of the eggs laid in the observed blackbird nests did not hatch (53%) – because of abandonment of the nest by the parents. However, almost all nestlings successfully fledged (91%). The death of nestlings, however, was caused mainly by predation (78%) and only to a lesser degree by abandonment by the parents (22%), which occurs more frequently during incubation than after hatching. There was no significant difference between the survival rates of blackbird nests and artificial nests (z = 1.69, p = 0.091). Our results suggest that predators

in the case of real (quail) eggs were probably larger birds capable of carrying the eggs away. 21% of the plasticine eggs were disappeared from the nests, that indicate presence of bird predators, but the marks preserved on the surface of plasticine eggs left in the nest originated mostly from smaller birds and small mammals. An important conclusion from our studies is that the results obtained from artificial bush nest experiment truly represent the survival probabilities of real blackbird nests; therefore our artificial shrub nests represent a suitable investigation technique in nest predation studies. One of the main problems of the nest predation studies is the interpretability on local scales only, because the study area usually is a hunting field of only one or two predators. The study area usually is a hunting field of only one or two predators, so the local scale interpretability of the results is one of the main problems of the nest predation studies. At different areas there are different bird and predator communities, which react different way to different effects. Probably, the many opposing result of nest predation studies is the consequence of local effects, too.

Summary

For summary based on our results neither natural nor white coloured plasticine eggs are not practicable in case of the ground nests, because they experienced significant higher predation rate than quail eggs. The best solution is the usage of rubber coated plasticine eggs, because their survival rate does not differs from real eggs survival rates.

The disturbance made by the daily monitoring of artificial nests did not affect the survival probabilities of the nests, but we successfully determinated the month-disturbance joint effect so the breeding success of birds can vary during the season and affected by weather conditions. The survival of the nests did depend on their type, because different predator communities discover ground- and shrub nests, which react a different way to the human presence. The location of the nests does not affect their survival, because with different altitude they had the same survival rate.

By the observation of real and artificial nests we determined that during the breeding season the predational pressure is rising in urban environment. There was no significant difference between the predation rates of quail- and plasticine eggs in the artificial nests made in parallel with blackbird nests, as well as the survival probabilities of real and artificial nests were similar. Therefore our artificial shrub nests proved suitable.

Publications

1. Publications releated to the thesis

Purger J. J., Csuka Sz., **Kurucz K.** 2008. Predation survival of ground nesting birds in grass and wheat fields: experiment with plasticine eggs and artificial nests. *Polish Journal of Ecology* 56 (3): 473-478. **IF: 0,443** Times cited by others: 5

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Cumulative impact factor: 0.799
Times cited by others: 5

2. Conference abstracts releated to the thesis

Purger J. J., Csuka Sz., **Kurucz K.** 2006.Befolyásolják-e a gyurmatojások a mesterséges talajfészkek túlélési esélyeit? *7. Magyar Ökológus Kongresszus,* Budapest, 2006. szeptember 4-6. (poster, abstract book, p. 176.)

Kurucz K., Purger J. J. 2008. Befolyásolják-e a mesterséges talajfészkekbe helyezett gyurmatojások a fészekaljak túlélési esélyeit? *V. Magyar Természetvédelmi Biológiai Konferencia,* Nyíregyháza, 2008. november 6-9. (poster, abstract book, p. 129.)

Kurucz K., Kallenberger H., Szigeti Cs., Purger J. J. 2009. A feketerigó áprilisi és júniusi fészekaljainak túlélési esélyei - egy fészekaljpredációs vizsgálat tanulságai. *8. Magyar Ökológus Kongresszus,* Szeged, 2009. augusztus 26-28. (oral presentation, abstract book, p. 128.)

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