Strategy against predation of distantly located Azure-winged Magpie (*Cyanopica cyanus* Pallas, 1776) breeding groups in Northern Mongolia.

Report for Natural Research Ltd.

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Introduction

This research project is a part of the PhD research of Gantulga Bayandonoi at the Georg-August University of Göttingen. Research is funded by Mike Madder's Field Research Award from Natural Research Ltd and German Academic Exchange Service (DAAD). The project was run between 15.04.2013 and 27.07.2013 in Northern Mongolia.

Nest predators of the Azure-winged magpies are varied in populations which are far from each other. The Great spotted cuckoo (*Clamator glandarius*) is common nest predator and nest parasite in Iberian Azure-winged magpie's population (Aviles *et al.,* 2006), while Jungle Crows (*Corvus macrorhynchos*) are the main nest predator in the Japanese population (Hosono 1983; Komeda *et al.,* 1987) and Carrion Crows (*Corvus corone*) in some breeding groups in the Mongolian population (Gantulga, B pers.comm). Seeing from our previous study, we strongly suspect that breeding success of the Azure-winged Magpie depends on the distance between their nests and Carrion Crow nests. No prior study has been conducted to reveal the relation between predation rate and distance between nests of predator and breeding site of predated species. Nest predators could also be different within local populations depending on the avian community of potential predators. Predation, cooperative breeding of the Azure-winged Magpie have been well studied on the Iberian Peninsula and in Japan, but there has been little research elsewhere in Asia and no prior study in the taiga forests of Northern Mongolia or Southern Siberian which constitute the northern and western edges of their Asian range. Within this region the Azure-winged Magpie is restricted to areas south and east of Lake Baikal. Within northern Mongolia the species is present in the Yuruu (Eruu), Orkhon, Selenge river basins (Tugarinov 1929; Kozlova 1930; Bold 1973, 1977; Boldbaatar 1999, 2006). This species is highly gregarious throughout the year, and breeds in sparse colonies (Cramp and Perrins 1994).

In the last seven years, studies on the cooperative breeding of the Azure-winged Magpie have been conducted on one breeding group, called Khonin Nuga, in Northern Mongolia. Our previous studies provide a baseline for further research of the lesser-known Asian subspecies of *C.c. cyanus* in this region. We intended to conduct this research project on the several breeding groups in northern Mongolia in order to recognize differences in predators, adaptation for predation between such breeding groups and their causes.

The objectives of this study are to answer the following questions:

- Do breeding groups have their own special adaptation/strategy for breeding and against predators? Does a small breeding group tend to hide (to be silent) and big groups tend to attack predators when they occur?
- Does predation rate increase if nests of the main predators, Carrion Crow, are close to the Azure-winged Magpie's nests?
- Does each breeding group of the Azure-winged Magpie respond to Carrion Crows (common predator) in different ways?
- Will the response of the Azure-winged magpie be high and aggressive during incubating and the beginning of the chick rearing stages, conversely, will it be low and calm during second half of the chick rearing?

Methods

Study area

We studied the breeding biology of the Azure-winged Magpie at the Khonin Nuga field station (49°05'N, 107°17'E) near the Yuruu (Eruu) river in West Khentii, Northern Mongolia between May and August in 2007-2013, and breeding groups of the Azure-winged magpies in Terelj, Sugnugur, Tuul (Songino) river basins in 2013. We found seven breeding groups along those river basins (Fig. 1). We conducted study at 5 of them except for Bugant breeding group due to logistic problem and Songino 1 breeding group. At Khonin Nuga the single known group of magpies is further restricted to a core area of about 20 ha, just a small portion of the area surrounding the research station. The climate in Khonin Nuga is continental with hot summers and cold, severe winters. Average annual temperature is 0.7^0C. In the coldest month, January, the average temperature is -22.1^0C (min -40.1^0C). In July, the warmest month, the average temperature is 19^0C (max 36.4^0C) (von Velsen-Zerweck 2002). Snow covers the ground from early October to mid-April. Annual precipitation is 290 mm (between June 2005 and May 2006; Hauck *et al.*, 2007). Khonin Nuga is located in the Southern Siberian mountain taiga forest, along the Yuruu River in the riparian woodland. The riparian woodland is surrounded by mountain dry steppe, meadow steppe and wet grassland (Mühlenberg *et al*., 2000). Habitats of the Khonin Nuga, Khandgai Lake, Terelj and Sugnugur are similar to each other that open river flats, riparian woodland and scrubland inhabited by the magpies is dominated by the trees *Larix sibirica* and *Betula platyphylla* with shrubs including *Padus asiatica, Salix spp, Betula fructicosa, Crataegus sanguinea, Rosa acicularis,*

Dasiphora fructicosa and *Ribes rubrum*. Whereas, habitat of the Songino1 and Songino-2 breeding groups is open river flats, riparian woodland and scrubland dominated by the tree *Populus laurifolia*, with shrubs mostly *Malus baccata* (Siberian crabapple), *Padus asiatica* and *Salix spp*. This habitat is affected by intense grazing and human presence.

Habitat of the Khonin Nuga, Khandgai lake

Habitat of the Terelj

Habitat of the Sugnugur

Habitat of the Songino 1

Habitat of the Songino-2

Bugant

Predatory species recorded at Khonin Nuga that may take Azure-winged Magpies or their eggs or chicks include the Short-eared Owl (*Asio flammeus*), Sparrow Hawk (*Accipiter nisus*), Goshawk (*A. gentilis*), Common Cuckoo (*Cuculus canorus*), Oriental Cuckoo (*C. saturatus*), Hobby (*Falco subbuteo*), Halys Pit Viper (*Gloydius halys*), Steppe's Rat Snake (*Elaphe dione*), Red Fox (*Vulpes vulpes*), Sable (*Martes zibellina*), other small mustelids (*Mustelidae*), Red Squirrel (*Scirius vularis*) and Siberian Chipmunk (*Tamias sibiricus*). The area has a rich invertebrate fauna thus potential food items are varied.

Data collection

Between 2006 and 2013, 226 birds were banded, each with a unique combination of one metal and several coloured plastic leg bands in the Khonin Nuga breeding group, and 154 individuals from other breeding groups in 2013. During the 2008, 2009, 2011 and 2013 breeding

seasons we systematically observed the nests in Khonin Nuga breeding group and recorded that Azure-winged magpie's response against predators when they penetrate into Azure-winged magpie's breeding site, activities of each breeding pair, any other birds that visited each nest. The duration of each observation period was 2 hours, unless observations were curtailed due to adverse weather or other unforeseen circumstances. Observations took place in the morning (between 07:00 and 10:00), the middle of the day (between 11:00 and 14:00) and afternoon (between 16:00 and 19:00) throughout the egg laying, incubation and chick rearing stages.

Experiments

We conducted experiments in order to discover the relationship between predators and Azure-winged Magpies, and predation and breeding success of the Azure-winged Magpie.

Experiment No.1 with artificial nests is conducted in order to substantiate the hypothesis "Predation rate will increase, if nests of the main predators, Carrion Crow, are close to the Azure-winged Magpie's nests" at the Khonin Nuga breeding group.

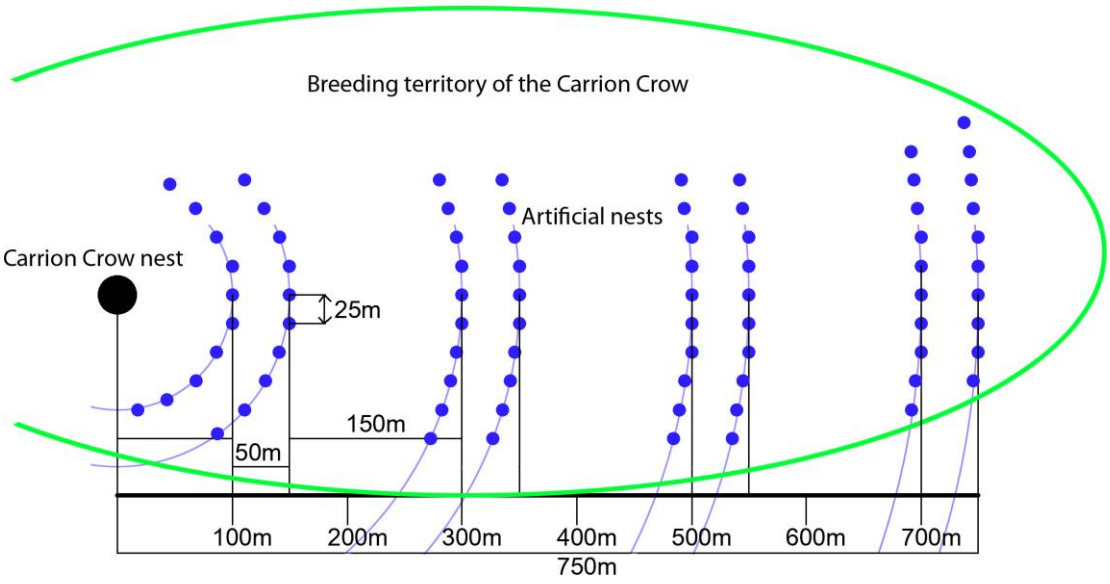

Figure 1. Experiment-1 design.

We did artificial nest experiment between May 29, just after Crow's eggs are hatched, and June 8, 2013 in Khonin Nuga valley. We established 80 artificial nests with 2 eggs of the Japanese Quail (*Coturnix japonica*), similar to Azure-winged Magpies eggs and sold in markets, and one artificial plasticine egg in four distances that 100-150m, 300-350m, 500-550m and 700-750m far from the Carrion Crow nest during the Azure-winged magpie's egg laying stage (Fig. 2). Our

previous studies showed that the average distance from predated Azure-winged Magpie nests to Crow nest was 386±85m (SD), whereas it was 670±290m (SD) for the successful nests. Therefore, we have chosen a distance of 100-750m. Plasticine eggs are used to detect which animal preyed on it. Each group consisted of 20 artificial nests.

All artificial nests are located in the selected Crow's territory. The idea is that the selected Crow will deter neighboring Crows from entering its territory to get the eggs. Artificial nests are placed next to bushes and installed on a wooden pole equipped with obstacles to prevent mammal predators from climbing the poles and taking the eggs.

At each distance, three nests are placed parallel 20 m from each other. Artificial nests are placed during the 10 days following the 8 days after the first Azure-winged Magpie has laid an egg. We checked the artificial nests every day to record which nest is predated.

Picture 1. Installed artificial nest for the experiment.

Picture 2. Crow fledglings in movable temporary cage.

Experiment No.2 with captured Crows is conducted to answer the hypothesis "Each breeding group of the Azure-winged Magpie respond to Carrion Crow in different intensity, if Crow is present in breeding site of the Azure-winged Magpie"; in other words, response of some groups will be aggressive, but it will be calm in other groups. The reason behind this is that the main predator could be different or could be harmful or harmless to nests in far located breeding groups due to some reasons, such as their habitat, Crow's experience to prey on eggs, food source or animal community. This experiment also supposed to give an answer to the hypothesis that "Response of the Azure-winged Magpie against predators will be aggressive during incubating and the beginning

of the chick rearing stages; conversely, it will be calm during second half of the chick rearing. If so, what is the cause of it?".

We conducted the experiments with 2 hour intervals and each experiment continued until Magpies attack the Crow and in case they didn't attack, it continued for 10 minutes. We placed the Crow 15m far from the Azure-winged magpie's nests on the open branches or on the ground. First, we placed Crow in 3m from the magpie's nest. But it was too close that Crow was attacked aggressively by magpies in all cases. Therefore, we gradually increased the distance between Crow and magpie's nest until we find a suitable distance, which is 15m, to differentiate the magpie's responses against Crow in breeding groups. We costumed the Crow with a soft belt made by black coloured cotton to keep Crow at the fixed experiment places. During experiment, Crows were not injured from the belt or by the attacking magpies.

We recorded the response to the Crow according to the method of Aviles *et al.*, (2006), the intensity of the response, the number of recruits and the response latency are recorded.

The intensity of the response is categorized from 1 to 4 points.

1 - "no reaction" towards the Crow: hosts and/or helpers, other group members are near the nest during the experiment but do not pay attention to the Crow

2 - "alarm calling": magpies perform alarm calls in response to the presence of the Crow and magpies gather near the Crow

3 - "mobbing": magpies fly around the Crow or dive close to it once or several times, but without touching it.

4 - "attacking": magpies vigorously attack to the Crow and touch its body. Once the Crow is attacked we will remove the Crow immediately and terminate the experiment.

Last few years we tested the stuffed and plastic Crows for such experiment. Unfortunately, Azure-winged magpies easily recognized that they are not live and started to ignore them. Therefore, we used real Carrion Crows for our experiment. We used compartment walk-in trap, Australia Crow trap, Bow net trap, Wilster net trap, and individual Hoop traps, all made by ourselves, to catch Crows. Crows were suspicious to the Compartment walk-in trap and Australia Crow traps. Other traps were less suspicious. A crow caught by bow net trap, but escaped before we reach to the trap. However, we caught several Common magpies, Rooks and Daurian Jackdaws. We couldn't catch any other Carrion Crow during the breeding season by traps, perhaps, due to inexperienced crew and inappropriate traps we made.

Picture 3. Bow net trap used to catch a Carrion Crow.

Picture 4. Australia Crow trap (ladder trap) and Artificial nests are in construction.

We took two fledged Carrion Crows from the branches near their nests in night, June 24, 2013. We used these two juvenile Crows for the Crow experiment. Crows were kept in 2x2x1.8m cage and 50x80x60cm temporary movable cages. The age of these Crows might have affected our results. We couldn't conduct experiments according to our plan, which was supposed to conduct experiment three times at the each nest during incubation stage between 5th and 15th days and three times again during the chick rearing stage between 5th and 15th days. However, we did manage to conduct Crow experiment at the four breeding groups during the second half of the chick rearing stages. Therefore, our collected sample size was small to get confident enough results. But it could show some tendency about the relation between Magpies and Crows.

We used parametric (ANOVA, matched pairs *t*-test) and non-parametric (Mann-Whitney *U* test, Fisher's exact test, chi-square) tests to determine the statistical differences between independent samples. All statistical tests were conducted by using STATISTICA 10.0 program. For all tests a probability of $p \leq 0.05$ was considered to be significant.

Results

The nests close to other nests of group/subgroup were less likely predated than nests which are distant located from other nests during 5 breeding seasons in Khonin Nuga breeding group ($F_{1,42} = 4.15$, $P = 0.04799$; Fig. 3).

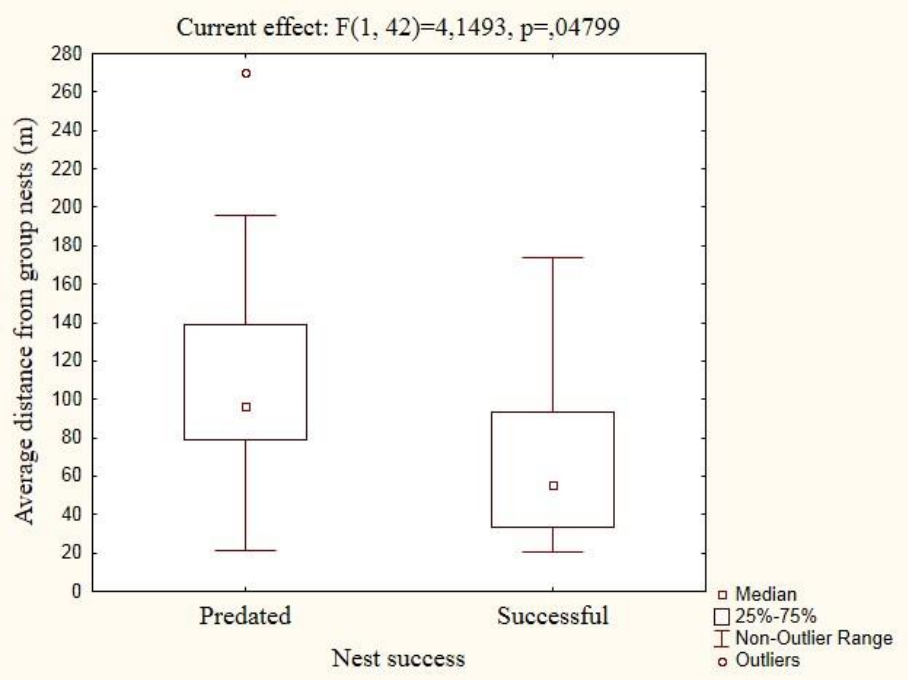

Figure 2. Relation between nest success of the Azure-winged magpies and average distance of nests from group nests in Khonin Nuga breeding group during 2008-2013 breeding seasons.

In 2008-2010 breeding seasons, the magpies nested in subgroups. Nesting in subgroups, close to each other appeared to be a strategy for detecting and defending against nest predators (at least for aerial predators) in our study.

A pair of Carrion Crows bred about 418m from the Azure-winged Magpie's core area in 2008 and about 476m from their core area in 2009, 468m in 2010, 1123m in 2011, 456m in 2012 and 585m in 2013. That pair is likely the main nest predator for the Khonin Nuga breeding group that often penetrate into Azure-winged magpies breeding site, 6 confirmed predation on magpie nests and once a Crow was seen flying off with an Azure-winged Magpie's egg in its beak, followed by 7 magpies. Successful nests of the Azure-winged magpie were much further located from the Crow nests than predated nests of the Azure-winged magpie during 6 breeding seasons in Khonin Nuga breeding group ($F_{1,50} = 18.33$, $P = 0.00008$; Fig. 4).

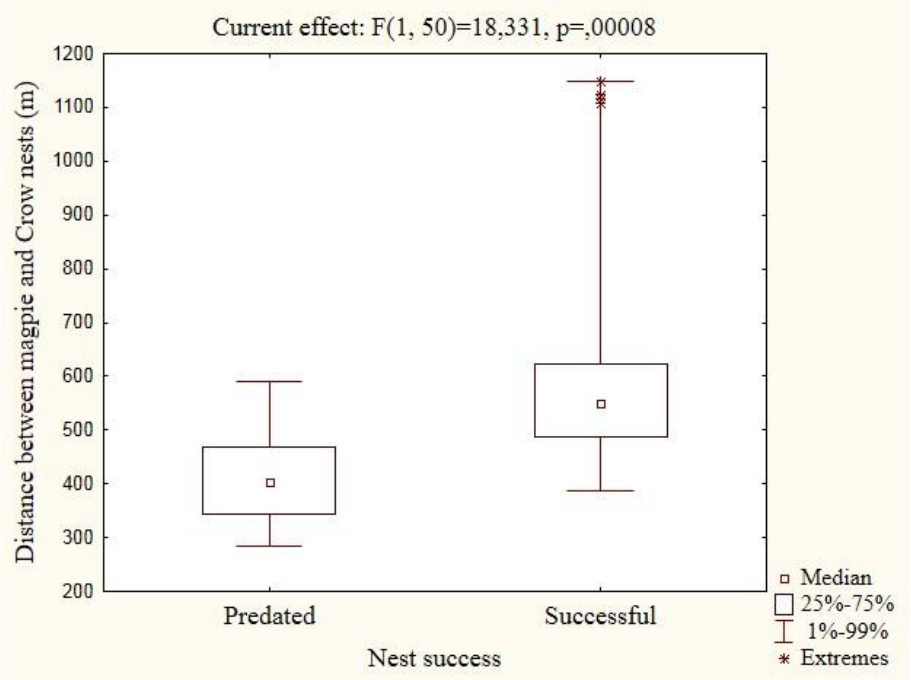

Figure 3. Relation between nest success of the Azure-winged magpies and distance from Azure-winged magpie's nests to Crow nests in Khonin Nuga breeding group during 2008-2013 breeding seasons.

Crows prefer to prey on closest nests instead of far located ones. Therefore, we could say that our result that nests of the Azure-winged magpie located further from the Crow nests was more successful than nests located close to the Crow nest during 6 breeding seasons in Khonin Nuga breeding group is proved.

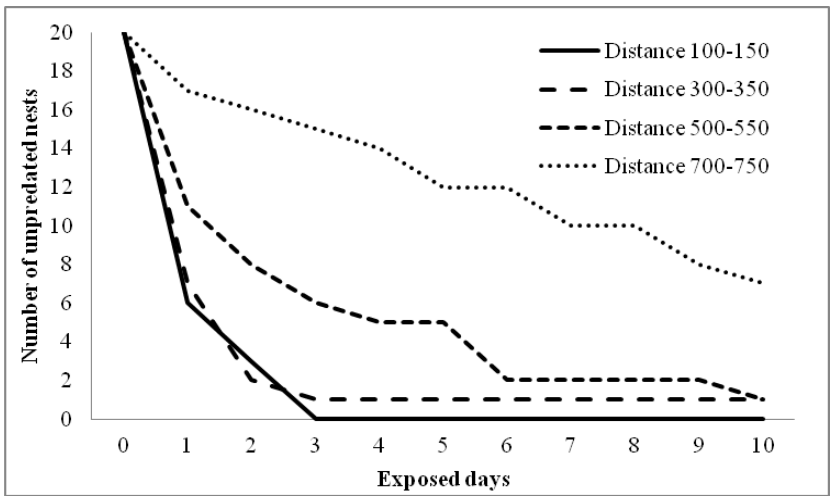

Figure 4. Predation rate of the artificial nest in Khonin Nuga in 2013 breeding season. Distances are measured from the Carrion Crow nest.

Azure-winged Magpie's response against Carrion Crows likely reflects by Magpies group size. Larger group tends to chase Carrion Crows from their breeding territory, conversely, smaller group tends to hide or be silent when Carrion Crows penetrate their breeding site (Fig.5, $R^2 = 0.95$, $P = 0.026$). Seeing 2011 and 2013 results, breeding group changed their strategy completely against predators. Before 2011 magpies usually chase Crow and other potential predators from their breeding site, whereas, they prefer to hide from Crows instead of chasing them and try to do not reveal their breeding core area in 2011. The reason for changing their strategy against predators is perhaps due to breeding group structure and size. There is no non-breeding individuals is appeared in 2011 and 2013, group sizes were small. The role of the non-breeders that presence in chasing predators and guarding breeding site in previous years was lost, cutting benefits from non-breeders and restricting breeding bird's extra mobility against predators because of breeding bird's absence at the nest without leaving anyone near the nest while chasing the predators, or may be because of occurrence of Crows that declined 53% than previous years due to far located new breeding site from Crow nest may allow the magpies to reduce their aggressive behaviour towards Crows or might change Crow's interest towards Azure-winged magpies nests according to their vocal that may inform their intention that do not prey on magpie nests.

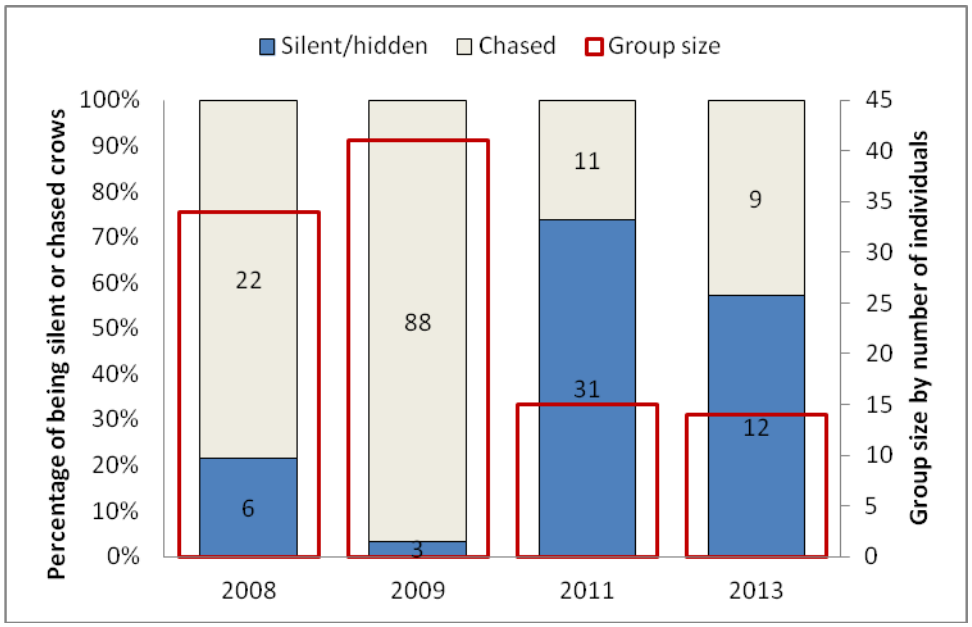

Figure 5. Azure-winged Magpie's response against Crows in Khonin Nuga breeding group.

If Crow make voice while it enters into Azure-winged magpie's breeding site, magpies tend to hide or ignore instead of chasing them (Crows made a voice in 2011 more frequently than those

of in 2009 when they enter into magpies breeding site, Fisher's exact test: P = 0.005). During "silent" strategy in 2011 none of the nests, in 2013 only two nests were predated, showing that effectiveness of the new strategy against predators that more appropriate to the small group size than big crowded group size.

Magpies chased Carrion Crows who penetrated silently more frequently than called Carrion Crows during penetration (Crow was chased 6 out of 20 instances that Crow made a voice versus 93 out of 113 instances that Crow were silent, Fisher's exact test: $P < 0.000006$; Fig. 6).

One of the 14 nests was predated in 2007, nine out of 19 in 2008, four out of 14 in 2009, three out of seven in 2010, none of six in 2011, five out of eight in 2012 and two out of six nests in 2013. Significant difference in predation rates was found between years (χ^2= 156.24, df = 6, P < 0.00001). During 2008, 2009, 2011 and 2013 breeding seasons, Carrion Crows frequently entered the Azure-winged Magpie's core area throughout Crow's chick rearing stage and just before their chicks fledged (141 times in 514 hours nest observation), while, Crows seldom flew over the Azure-winged Magpie's core area after the Crow chicks fledged (12 times in 132 hours nest observation; Yates corrected Chi-square: χ^2 = 11.19, P = 0.0008). The magpies generally disregarded the Crows after the former's own chicks fledged. However, the magpies continued to be wary of sparrow hawks, and other predators.

Figure 6. Azure-winged Magpie's response against silent and called penetration of Carrion Crow into Magpies breeding territory. The numbers inside the columns shows the number of occurrence of the penetration.

Azure-winged magpie's intensity of response against Carrion Crow was not different between 4 breeding groups (Fig. 7). However, response against Crow in Songino-2 breeding group was lower than other breeding groups, there was no statistic difference from other groups likely because of small sample size (Mann-Whitney test, Songino-2 vs Terelj: $U = 34$, $n_1 = 9$, $n_2 = 10$, $P < 0.39$; Songino-2 vs Sugnugur: $U = 15.5$, $n_1 = 5$, $n_2 = 9$, $P < 0.38$; Songino-2 vs Khonin Nuga: $U = 39$, $n_1 = 9$, $n_2 = 12$, $P < 0.30$). The area that Songino-2 breeding group breed is settled by human. Hence, Azure-winged magpies often feed on garbage along with other Corvids. The Rooks (*Corvus frugilegus*), most common in this area, nest in colonies at the trees that surrounding the Songino-2 breeding group's breeding area. Therefore, Azure-winged magpies from Songino-2 breeding group could tolerate more to other Corvids than other breeding groups of the Azure-winged magpie. Moreover, Carrion Crows don't breed near the Songino-2 breeding group likely due to Rooks. We observed that Azure-winged magpies form Songino-2 breeding groups endure the Rooks more than Common magpies, Ravens and Carrion Crows.

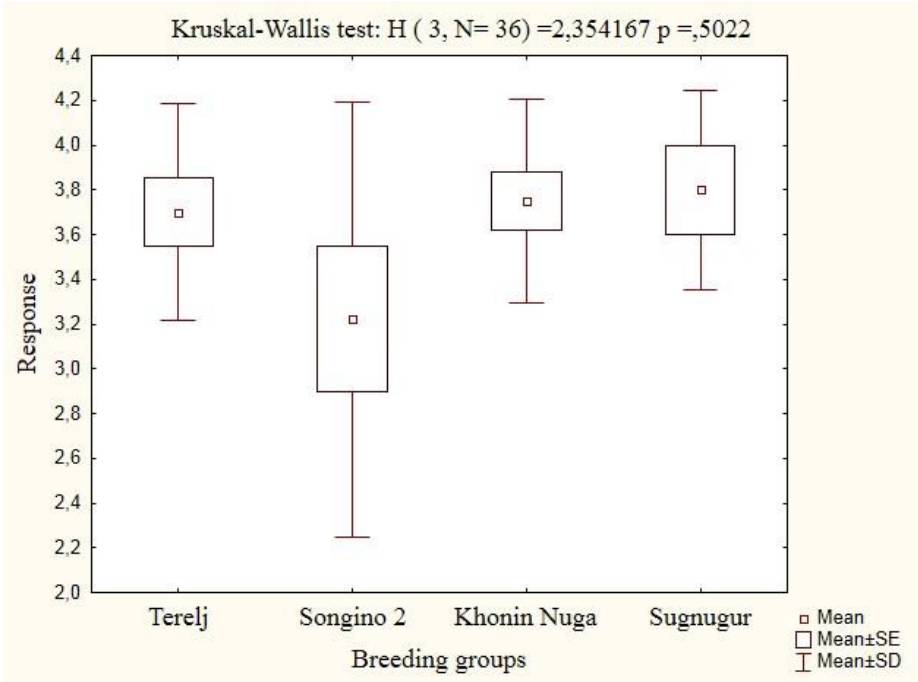

Figure 7. Azure-winged magpie's response against Carrion Crow during chick rearing stage of the 2013 breeding season in four different breeding groups.

The number of responded magpies against Crow and response latency were different among the breeding groups (Fig. 8, 9). Highest number of the Azure-winged magpies responded to the Crow in Songino-2 breeding group; whereas, few magpies responded to Crow in Sugnugur and Terelj breeding group. It is likely because of the breeding group size and the distance between nests.

In Songino-2 breeding group 16 out of 17 nests were relatively close to each other (average distance between nests: 42.8 ± 27m, Mean ± SD) and most of those 16 nests were synchronous. Therefore, at least 32 breeding birds were concentrated in small area, which leads to faster Crow detection and more magpies to respond to Crow than other breeding groups that consist of considerably less breeding birds who could respond against Crows. Magpies from the Khonin Nuga breeding group detected Crow faster than other breeding groups. However, few breeding birds are in Khonin Nuga compared to Songino-2 breeding group they had well detecting ability than magpies in other breeding groups. We could assume that Crows are more common predator in Khonin Nuga than other breeding groups.

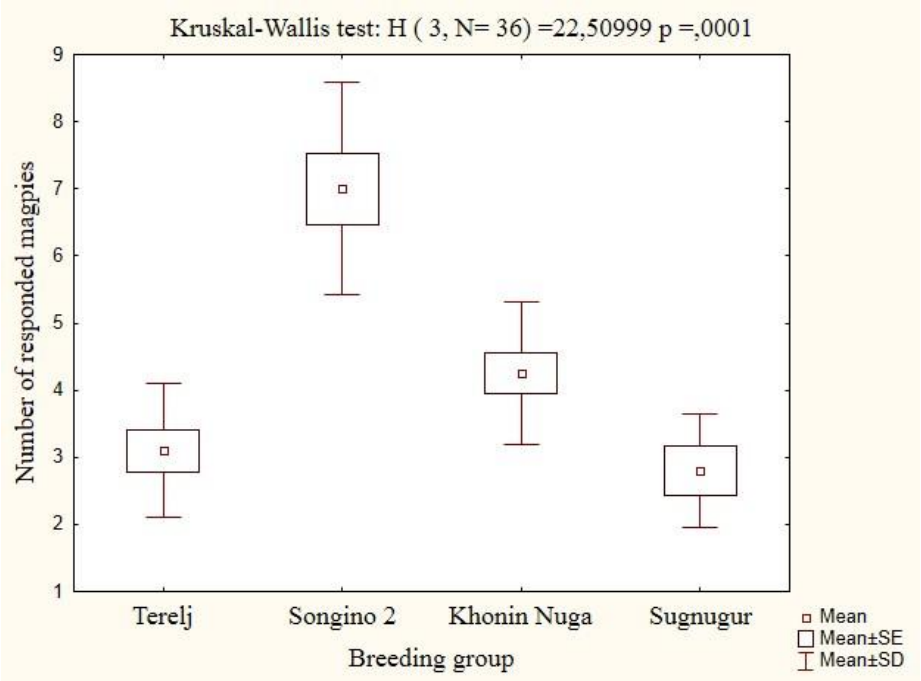

Figure 8. Number of responded Azure-winged magpies against Carrion Crow during chick rearing stage of the 2013 breeding season in four different breeding groups.

In Sugnugur breeding group, breeding birds nested in three subgroups including few nests in each and subgroups were far from each other. Therefore, usually just breeding pairs were next to or near the nests. Absence of the breeding birds at the nest in order to forage may have caused much longer response latency of the Crow detection in Sugnugur breeding group compared to other breeding groups.

Table 1. Predation rate of all 4 distances are tested by Matched pairs *t*-test.

Distances	300-350m			500-550m			700-750m		
	t	df	*P*	t	df	*P*	t	df	*P*
100-150m	4	9	0.0031	6.01	9	0,0002	14	9	<0.0001
300-350m				4.04	9	<0.0029	11.9	9	<0.0001
500-550m							17.2		<0.0001

Artificial nests closer to Crow nests are predated much faster than nests far from the Crow nests (Kruskal-Wallis test: $H_{3,40} = 28.83420$, $P = 0.00001$). All distances were significantly different from each other (Table 9).

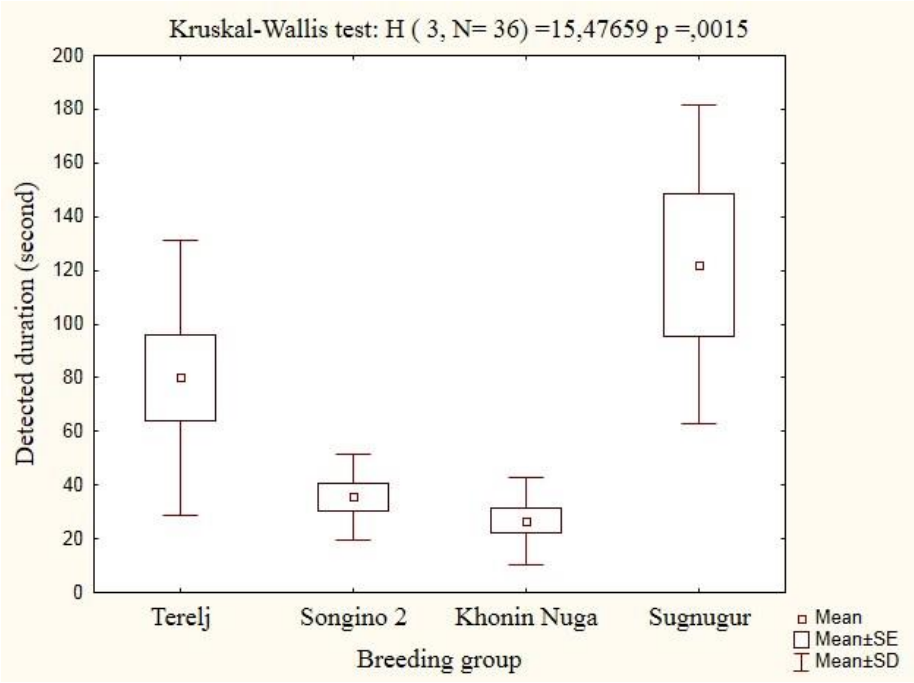

Figure 9. Azure-winged magpie's response latency (detected duration) against Carrion Crow during chick rearing stage of the 2013 breeding season in four different breeding groups.

Plans for 2014

Due to lack of experience to catch a Crow, we couldn't start the Crow experiment in time. Therefore, we didn't collect a data to obtain full answers for the hypothesis that "Does each breeding group of the Azure-winged Magpie respond to Carrion Crows (common predator) in different ways?" and "Will the response of the Azure-winged magpie be high and aggressive during incubating and the beginning of the chick rearing stages, conversely, will it be low and calm during

second half of the chick rearing?" We will conduct the Crow experiment again in 2014 breeding season to achieve the answer for the hypothesis. After 2014 field study, complete report will be sent to the Natural Research Ltd.

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