

Correlation between the Choice of Partner and the Individual Nesting Territory in the Lesser Kestrel, *Falco naumanni* Fleischer, 1818, and Preconditions for Polyandry

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Abstract: In 2015-2016, within a project for recovering the population of the Lesser Kestrel (*Falco naumanni*) in Bulgaria, we carried out daily observations and closely monitored the nesting process in a newly formed colony. From the observations during the breeding season of 2016, it was recorded a correlation between the ratio of the male and female birds returned from migration, the choice of a partner and the occupation of the individual nesting territory. This dependence was revealed in a situation of shortage of breeding female birds and excess of male birds, in which the roles of males and females in choosing the nest and partner were clearly visible. In contrast, in 2015, the sex ratio was more balanced, which contributed to the rapid formation of couples and occupation of the territory. The observations showed that on the day of the appearance of a new returned female, she had a choice between several free males with already established nesting territories. She formed a short-term pairs with them until she found the male with the most favourable nesting territory. This indicated a priority of the nest site when selecting the breeding partner. The sex ratio in 2016 created a prerequisite for polyandry, which further enhanced the above view.

Key words: Lesser Kestrel, *Falco naumanni*, behaviour, nesting territory, polyandry

Introduction

The Lesser Kestrel (*Falco naumanni* Fleischer, 1818) is a colonial, in general monogamous species, for which the extra pair copulations are not rare (PENADES 2007, NEGRO *et al.* 1992, ALCAIDE *et al.* 2005). A case of an unsuccessful polygyny in the Lesser Kestrel has been recorded (HIRALDO *et al.* 1991), and such cases are observed in many species of birds of prey (Accipitridae and Falconidae) (CARTER 2008, GONZALES *et al.* 2006, SPOTTISWOODE *et al.* 2009, KORPIMAKI 1988, FAARBORG *et al.* 1995). There are however no records for polyandry in the Lesser Kestrel until now.

In the described unsuccessful case of polygyny in Lesser Kestrels by HIRALDO *et al.* (1991), they supposed that it was caused by insufficient breeding males and excess of females. On the hand, excess

of males and insufficient females are considered a prerequisite for polyandry (MØLLER 1992). In this article, we describe the interactions between sexes in a newly-formed nesting colony of the Lesser Kestrel in years with varying sex ratio.

Materials and Methods

The study was done in the frame of the “Lesser Kestrel Recovery” LIFE11 NAT/BG/360 project in Levka village in Special Protection Area Sakar BG0002021. The newly-established Lesser Kestrel colony breeds entirely within the territory of the Lesser Kestrel Release and Adaptation Module (LKRAM), especially developed for that purpose,

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equipped with 50 artificial nest boxes and an adaptation aviary for adult birds. Artificial feeding is performed on top of the aviary daily, for the purpose of monitoring of birds returning to the colony after migration (GRADEV *et al.* 2016).

The observations were carried out daily in the light part of the day from maximum distance of 57 m away from the objects observed. The length of the individual observation depended on the birds' activities, and the current stage of the nesting season, starting from 2 hrs per day (in the morning and in the evening), up to 13 hrs (all day long observation). A SWAROWSKI HD 25-50x65 field scope, 10x30, 8x42 binoculars and a camera were used, detailed observation notes in field notebooks. All birds in the colony were marked with one metal and one PVC orange ring with black marking (GRADEV *et al.* 2016). This helped in distinguishing the individuals and tracking their specific behaviour. For indication of all individual birds in text and tables, we used the codes of their individual PVC rings (combinations of three letters or of letters and numbers, e.g. BSV, BDS, BKS, etc.) plus a sign for the sex of the bird (♀ for a female and ♂ for a male). In the polyandry description, the participating individuals were coded with F1 and F2 for the females and M1 and M2 for the males in attempt to ease the reader.

Results

Occupation of individual nesting territories

The colony's nesting territory was concentrated around the Lesser Kestrel Release and Adaptation Module. All known pairs nested in artificial nest boxes, placed on the Module building and the neighbouring barn. All of the boxes were numbered (from 1 to 60) and the nest boxes, at which birds were interested in the study period, were with numbers 1-36. The Individual Nesting Territory (INT) of a certain

pair were placed in such an area, as the pair (or the male, if he had no female to form a pair with yet) was successful in guarding against other birds interested in it. INT might profess in the occupation of a single nest box, or in a whole part of the building with several nest boxes. The most common case was the initial occupation of territory that included the whole wall with several nesting boxes on it but, with the increase of the nesting pairs, this number was reduced to one or two guarded nest boxes. There were 5 main Nesting Territories (NT) differentiated in the Module area in 2016, marked with Roman numerals from I to VI. Three of them had split up to several smaller INT, according to the number of occupied nest boxes (marked as NT I, II, and IV in Fig. 1).

The most attractive were the nest boxes situated around the aviary (NT I, II, III) and they were, usually, the first to be occupied (Table 1).

There were three patterns observe in occupying INT: (1) The rule of the conqueror: the first male or pair that occupied the INT started to guard it from other birds and signalled their possession; (2) Actively fighting for the INT: if another pair or bird manifested claims to one of the unoccupied nest boxes in NT, it was met with constant attacks by the birds that had been there first, sometimes continuing until the eggs were being incubated, because this was the time the priorities shifted from territory protection to offspring rearing (intensive incubation); (3) Passive fighting form INT: slowly attaching to the territory. The newcomer stood in the periphery of the territory it had chosen, far enough so not to cause an attack by the dominating birds. Slowly, within several days, the newcomer came closer and closer to the nest boxes, and at certain moment the dominants were no longer considering it as a threat, and the newcomer might occupy one of the near nest boxes.

In 2015, 62 birds in total were registered in the LKRAM after wintering. Out of them, 60 were mature

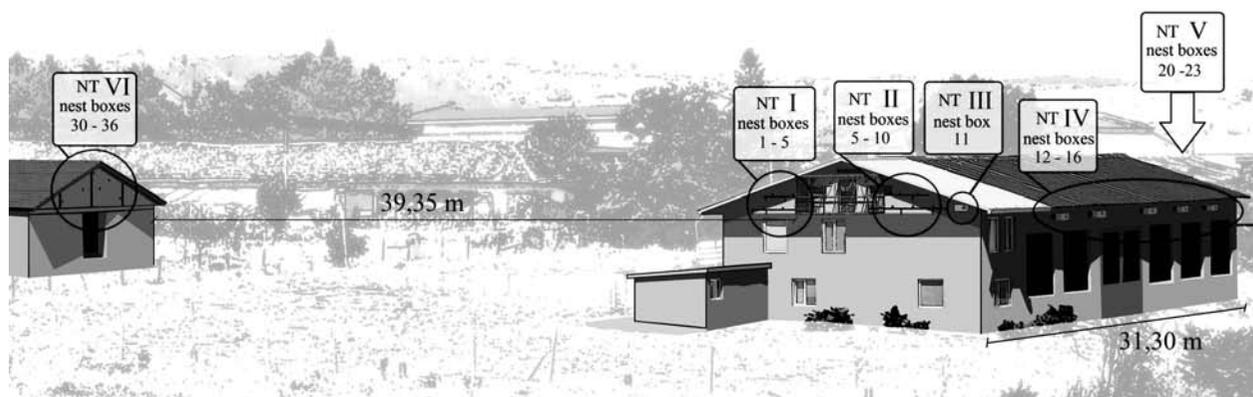


Fig. 1. Nest territories and nest boxes in the Lesser Kestrel Release and Adaptation Module (NT – Nesting Territory)

Table 1. Nesting Territories (NT), placement and distances from the cage and between the entrances

NT	Placement	Nest boxes №	Distance from the cage, m	Distance between nest box entrances in the NT, m	Nest box entrance exposition
I	inner	1-5	0.4 - 3.5	1 m	S
II	inner	6-10	0.4 - 3.5	1m	S
III	outer	11	3.4	1.5 m	S
IV	outer	12-16	7.9 - 25.5	3.6–5.6 m	E
V	outer	20-23	31.3	3.6 m	N
VI	outer	30-36	39.4	1.5 m	E

(25 females and 35 males), after the nesting period two young 0-years-old wild birds with no identification rings were registered. In total, 11 females and 9 males started nesting, forming 11 pairs in 7 of which the partners were constant during the whole nesting period (Table 2). In two pairs, the female birds died in the initial stages of the nesting period as a result of intraspecific competition, in fights with other birds. In both cases, the males of these pairs formed new pairs with new-comer females in the next day.

In 2016, 58 birds were registered in the LKRAM after wintering, 52 of them mature and 6 0-year old birds, visiting the colony after the end of the nesting season. Of the 52 adults, only 18 were females (both wild and with rings), and 12 female and 13 male birds began breeding. From the 12 females, one left the colony before nesting, one died after fighting for territory with another female, and one was electrocuted during the incubation period; six started nesting and reared chicks with the first male they mated, 6 made one or more changes of territories and partners (Table 3). Ten pairs were successful (up to incubation).

In the text below, the six cases with changes are described, as some of them have happened in the same time.

The first birds, returning in 2016 from migration, were three males. The first group returning female lesser kestrels consisted of 4 birds coming in the colony a week later in the span of a day. One of these four females (♀**BCC**) formed, for a third year in a row, a pair considerably later than the other birds, according to its return to the colony. The other three females quickly formed pairs with the 3 males (occupying NT I, II and V). Out of the three females, two stayed with their partners in the initially occupied nest territories, and the third one (♀**BSV**) manifested interesting behaviour that led to successful polyandry. After the first three pairs formed in the beginning of March, there was a month in which there were only one- and two-year-old male birds, arrived after migration in the colony's territory. All the two-year-old males occupied nest territories and were actively guarding them via noise signals and

physical attacks to chase other birds. The female birds, that replenished the colony from that moment onwards, were gradually returning to the LKRAM's territory in the span of the whole month of April.

The ♀**BCC** case was a female set free via the Module in 2013. In three consecutive years, this female formed pairs late compared to other females and in view of the time of her return to the colony. The first two years occupied one and the same nesting territory but with different partners. The last two years, she nested with the same partner but in different places.

BSV: The **BSV (F1)** came to the Module's territory with three more females and, to that moment, there were only three males returned to the colony. Three pairs were formed in the first days after the females have returned, as **F1** changed two partners (**M1**, **M2**), two NT and three INT, and by circumstances formed a polygamy relation with her second and third partner (**M2**, **M3**), that proved to be successful. The initial pair **F1&M2** occupied the whole I NT, and **F1** showed positive signs to nest box №2. The **M3** male was successful in adding himself, slowly in the span of weeks, to this exact nest box №2, and the pair was used to his presence and did not guard the nest box from him. Two weeks before the laying of the eggs, **F1** left the colony for two days, because of wounds sustained in fights with another lesser kestrel. During this time, **M3** ascertained his rights to №2 nest box, occupying it with another female (**F2**). After the return of **F1**, **F2** left the colony and **M3** kept №2 nest box as his own INT. **F1** formed a pair with **M3** with no interruption of the relations with **M1**. Until the hatching of the eggs, she copulated and accepted gifts from both males, as their INT were about 1 m apart. There was a conflict between the males when they entered one another's territory. In spite of her preference toward **M3**'s INT, copulations with **M2** were more intensive than those with **M3**, with 4:1 ratio in the pre-incubation period and 13:1 after the beginning of the incubation. The female's behaviour was very interesting even during the incubation period: unlike other females that stayed in the nest box until the male did not enter to replace them in the incubation, **F1** left

Table 2. Pair forming for 2015 (PVC ring –the individuals’ PVC-ring combination; NT – Nesting Territory; X* - died bird; X – bird changing their partners)

♀			♂			Date of pair formation	Date of nest-box occupying	NT	Nest-box №
Date of return	PVC	Year of birth	Date of return	PVC	Year of birth				
12.04	BDS	2013	11.03	BFZ	2013	12.04	12.04	I	1
20.04	BPK*	2014	26.03	<u>BFA</u>	<u>2013</u>	17.04	17.04	I	5
14.04	BLA	2014	30.03	BAH	2013	19.04	19.04	V	22
5.04	Wild ♀*	NA	12.03	<u>BCH</u>	<u>2013</u>	21.04	21.04	IV	12
18.04	BPC	2014	14.03	0C	2014	26.04	26.04	II	6
27.04	BSB	2014	26.03	<u>BFA</u>	<u>2013</u>	28.04	28.04	I	5
29.04	4B	2014	2.05	BSF	2014	2.05	2.05	IV	13
2.05	BND	2014	30.04	0B	2014	2.05	2.05	VI	30
5.03	BCC	2013	27.04	1B	2014	7.05	7.05	II	7
8.05	BSN	2014	18.04	BJS	2014	13.05	18.05	II	8
24.05	BSC	2014	12.03	<u>BCH</u>	<u>2013</u>	27.05	21.04	IV	12

Table 3. Females that have changed their partners and nest territories in 2016 (X* - individuals leaving the colony before nesting or died; PVC – the individuals’ PVC-ring combination; NT – Nesting territory)

♀			♂			Date of pair formation	Date of nest-box occupying	NT	Nest-box №
Date of return	PVC	Year of birth	Date of return	PVC	Year of birth				
1.03	BSV	2014	26.02	BSJ	2014	3.03	3.03	II	6
			26.02	BJS	2014	5.03	5.03	I	2
			11.03	0C	2014	10.04	5.04	I	2
1.04	BSC	2014	20.03	BSK	2014	1.04	22.03	VI	30
			13.03	BPN	2014	4.04	4.04	IV	15
			29.03	0B	2014	4.04	4.04	IV	13
4.04	8S*	NA	20.03	BSK	2014	4.04	4.04	VI	33
			11.03	0C	2014	7.04	7.04	I	2
6.04	BKB	2014	11.03	0C	2014	6.04	6.04	I	2
			20.03	6H	2014	6.04	6.04	I	3
			12.03	7A	2014	7.04	7.04	III	11
			18.03	7A	2014	7.04	8.04	IV	14
			23.03	BPH	2014	10.04	8.04	III	11
12.04	BDS	2013	20.03	BSK	2014	12.04	22.03	VI	30
			20.03	6H	2014	15.04	2.04	I	3
28.04	0J*	2015	15.04	2N	2015	2.05	1.05	II	8
			1.04	BSL	2014	3.05	2.05	II	10

her eggs when **M2** called her from the entrance or the tunnel of the nest box in the absence of **M3**. Thus, the eggs were left uncovered until the return of **M3**. Nevertheless, all 5 eggs hatched. Both males took part in their feeding and, if they were in the same time in or in front of the nest box, there was a conflict between them. In the period before fledging, **M3** was the first to stop delivering food.

BSC: The ♀**BSC** came to the colony when there were 15 birds, with three formed pairs, one solitary female (♀**BCC**) and 8 solitary males, most of which

had occupied territories and expecting females. She changed three partners and two nesting territories (three INTs) and finally nested in a nest box neighbouring to the one she used in the previous year.

8S: In the day when ♀**8S** came to the colony, there were four formed mating pairs and seven free males with occupied individual territories and expecting a partner. She changed two partners and correspondingly two nesting territories, as for the first change we considered that the stress of human intervention was the major factor.

BKB: When ♀**BKB** arrived in the colony, there were five nesting pairs and six free males with occupied nesting territories and waiting the appearance of a female. She formed a pair with four of them and undertook five changes of the INT until she finally chose one.

BDS: At the time of the return of ♀**BDS** in the colony, there were six formed pairs and four free males with occupied individual territories. She formed pairs with two males and changed two territories, respectively, until she finally chose the same one she nested in the previous two years.

0J: The last female to nest in the colony in 2016 was ♀**0J**. When she arrived, she could choose between 2 males, which after her appearance occupied two closely spaced INTs and she started to maintain polyandry relation with them similar to those exhibited in NT I between **F1** (♀**BSV**), **M1** and **M2**. Unfortunately, ♀**0J** and one of her partners were electrocuted on an electrical post near the colony during the incubation of the eggs, so there was no way to follow the development of the second polyandry pair in the colony for 2016.

Out of the female birds breeding in the colony in 2014–2016, only 2 birds (♀**BCC**, ♀**BDS** – hatched in 2013) were breeding every year and three birds (♀**BLA**, ♀**BPC**, ♀**BSC** – hatched in 2014) were breeding two consecutive years. Four out of the five birds nested in the same nesting territories or nest boxes, and the fifth (♀**BCC**), changed its choice in the third year of her breeding history, after two consecutive unsuccessful nesting seasons (Table 4).

Out of the male birds nesting in the colony for more than one season, there is only one three-year-old (♂**BFZ**) that has not been breeding in the first calendar year; all the other birds have only two consecutive breeding seasons. Only ♂**BFA** had repeated usage of NT but we cannot be sure that this was due to the attachment to a certain NT and not a random fact (Table 5).

Discussion

Nest territory choice

The female may change few partners until she finds her final INT (MØLLER 1992) as it is possible to maintain copulating with males from the territories she hesitates between. The males resort to changing their partner only in case of her death or her leaving the colony, or she leaves them for another partner (Table 2) (TELLA *et al.* 1996). There are two hypotheses: (1) the female occupies the same nesting territories each year, and (2) the female chooses her partner according to his nest territory; it cannot be excluded that both hypotheses are valid in certain cases and do not contradict.

Table 4. Occupied nesting territories and nest boxes by females, nesting in the colony more than one season. (♀ - the individuals' PVC-ring combination; NT – nesting territory)

Year of birth	♀	2014		2015		2016	
		NT	Nest box	NT	Nest box	NT	Nest box
2013	BCC	III	8	III	7	V	16
2013	BDS	II	4	II	1	II	3
2014	BLA	-	-	VI	22	VI	22
2014	BPC	-	-	III	6	III	6
2014	BSC	-	-	V	12	V	13

Table 5. Occupied nesting territories and nest boxes by males, nesting in the colony more than one season. (♂- the individuals' PVC-ring combination; NT – nesting territory)

Year of birth	♂	2014		2015		2016	
		NT	Nest box	NT	Nest box	NT	Nest box
2013	BCH	III	6	V	12	-	-
2013	BFA	II	1	II	5	-	-
2013	BFZ	-	-	II	1	VI	22
2014	BJS	-	-	III	8	II	2
2014	0B	-	-	I	30	V	13
2014	1B	-	-	III	7	V	16

For the three years of the colony's existence, both lesser kestrel sexes form pairs with new partner each year. In female birds, however, there is a tendency to conform to the same NT or even INT (Table 4) as demonstrated by previous studies (NEGRO & HIRALDO 1993, SWATSCHEK *et al.* 1993). There are no such trends observed in the male birds (Table 5) and we accept also the possibility that this is because the colony is new and small (47-62 birds). Nesting in the same nest boxes through the years is a common practice for lesser kestrels bred in captivity (VASILEVA, *pers. com.*). In South Italy, where the colonies are about 2000 birds, there were observations that male birds occupy the same nest territory in consecutive years (C. S. PELLEGRINO and G. GIGLIO, *pers. com.*).

From the females presented in Table 2, two are nesting in the colony from previous years (♀**BSC** and ♀**BDS**), in 2016 they change 2 and 3 partners, and in the end they occupy NTs, in which they have nested in the previous years. The rest of the females nesting in the colony more than one season (Table 3) occupy their old NT with their first choice.

If the hypothesis that female birds nesting for the first time in the colony and change their partners until they get to the appropriate nesting territory is valid, then what could be the reason for females with previ-

ous positive experience (successful rearing of young in the colony) do not head directly to their old territories but explore others before that? In this survey, both females initially formed pairs with the same male (♂**BSK**) after they headed to their old nesting territories (Table 2). The probable cause for that behaviour is his INT. In 2016, three females formed a short term pairs with ♂**BSK** (NT VI) before the fourth female to form a constant pair with him. We have considered the peculiarities of NT VI and compared them with those of the distant NT V (both are far from the colony's heart (the release and feeding aviary by 39.25 and 31.30 m). Apparently, the distance for the colony's centre is not a factor, for NT V is the third to be occupied in 2016 before the more closely situated NT IV be of any interest. Probably the unattractiveness of NT VI (abandoned three times) is caused by its position near human presence because it is exposed to the habitable part of the building and towards the Visitors Centre, where, in the breeding period, large groups of tourists may be situated at any time. We have no observation of stress in the birds occupying NT VI caused by human presence in the visitor area (just 15 m apart). The only explanation for the behaviour of the females is that if there is a larger possibility of choice of partners and NT, they may survey the variants and chose what best suits them (MØLLER 1992), that in both cases corresponded with their old preferences. The case of ♂**BSK** added more evidence to the thesis, that the priority for the females is the nesting territory, and not the partner, and with that this male distinguished himself as the most productive provider in the colony for 2016.

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Polyandry

The polyandry that occurred between **F1** and the males **M2** and **M3**, may be explained by the insufficient number of females in the colony (MØLLER 1992) as well with the adherence of the female to her territory and the stimulus to rule a larger NT. The correlation between the copulations with both males leads to higher interest and likings to **M2** as her partner. However, her desire to nest in the INT of **M3** is strong enough to make her to form a pair with him too. The interesting thing is that, although the open polyandry, both males were invested in the courting as much as in monogamy relations (WESTNEAT *et al.* 1990.), the dominant by INT, **M3** puts in larger parenting care in the incubation of the eggs than the female, which is unusual for the incubation period of the Lesser Kestrel (MIHTIEVA, *in press*). This occasion supports the thesis that the females prioritise the INT and not the partner. We are considering that the current state was caused by the lack of enough females to form pairs with the free but ready to nest males.

From the observations of the breeding colony in Levka village, several peculiarities in the Lesser Kestrel behaviour became evident in the incubation period: the role of the male and female in choosing nest boxes and partners. Such a detailed clarification of the reasons that led to polyandry in 2016 could be of use for future maintaining the population, if similar conditions are present.

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