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NEST CHARACTERISTICS AND BREEDING SUCCESS OF BLACK KITES (*MILVUS MIGRANS MIGRANS*) IN THE HIGH PLATEAU (ALGERIA)

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Abstract. The breeding ecology of the Black Kite *Milvus migrans migrans* in Algeria was first studied in 2014 and 2015 on Tarf Mountain in the semi-arid High Plateaus region. The nearest-neighbour nest distance was found to range from 130 to 550 m for colonial pairs and from 1,730 to 2,390 m for the solitary ones. All 12 monitored nests were placed on cliffs at different heights ranging from149 to 155 m. The mean egg laying period was 15 days, and the mean clutch size was 2.83 ± 0.31 and 3 ± 00 eggs per nest in 2014 and 2015, respectively. The mean hatching success was 83% and that of fledging 75%. Only 2 nests were predated. Our results disagree with those of the previous studies that were carried out mainly in the Mediterranean basin and Asia, differing in such nest characteristics as the nearest-neighbour nest distance, cliff and nesting heights, egg laying period and hatching success. Otherwise, no consistent differences in clutch size and fledging success were revealed. Finally, we determined that Black Kites tend to build their nest on the eastern side of cliffs. However, our analysis showed no effect of nest placement on breeding parameters and success.

INTRODUCTION

The Black Kite is possibly the most common raptor in the world, except for the Nearctic and the Neotropic regions (Ferguson-Lees and Christie 2001). It is a widespread species in Palearctic, Afro-Malagasy, Indomalayan and Australian regions (Panuccio et al. 2013; Nunes et al. 2015). The global population size is in the range of 1,470,000 – 1,980,000 mature individuals, the European population representing 11% of this number, with 81,200–109,000 breeding pairs (BirdLife International 2016). From six known sub-species (Cramp and Simmons 1983), *Milvus migrans migrans* is the only one to live and breed in the region of North Africa (Heim DeBalsac and Mayaud 1962).

In Morocco, it is an abundant migrant and a common species breeding from the Mediterranean coast to the southern High Atlas (Thévenot, Vernon, and Bergier 2003). In Algeria, it is distributed from the coast to the northern edge of the Sahara (Isenmann and Moali 2000). It is also very common both in the Tell (Ledant et al. 1981) and Ksours Mounts (Blondel 1962a).

In Europe and Asia, the Black Kite's breeding ecology and its breeding success have been widely studied (Desai and Malhotra 1979; Koga, Siraishi, and Uchida 1989; Viñuela and Veiga 1992; Sergio and Boto 1999). However, no study on the Black Kite's breeding ecology and its breeding success has been carried out in North Africa.

In Algeria, raptors have received very little attention from ornithologists. The main studies that were carried out were based on observations intermittently conducted in limited geographical areas (Balsac and Mayaud 1962; François 1975; Blondel 1962a, b, c; Ledant et al. 1981; Roché 1982). Recent papers have provided an update on the status and distribution of some raptor species on the Algerian coastline (Moali and Gaci 1992; Telailia et al. 2013; Touati et al. 2017).

The present study aimed to monitor the Black Kite during its breeding season and provide information on some aspects of its breeding ecology and nest site selection in Algeria.

MATERIAL AND METHODS

Study area

The High Plateau is located between the Saharan Atlas mountain range and narrow coastal plains of Algeria. This transitional area contains a large diversity of habitats such as mountains, valleys and plateaus, with the landscape dominated by steppe vegetation.

The Black Kite breeds on Tarf Mountain (35°50' N, 07°10' E) located in the eastern High Plateau of Algeria (Figure 1). The monitored breeding site was located approximately at a distance of 1 km from the road, and 4 km from the wild dump of the nearest slaughterhouse.

The elevation of the mountain is 1,134 m a.s.l. and the area covered is around 37.57 km^2 (Rekkab, Ziari, and Lamri 2008). The climate is semi-arid, with the annual mean temperature of 15.5°C and the average annual rainfall of less than 400 mm. This fissured calcareous rock mountain (Karst) is rich in boulders, cliffs and degraded formations of gorse. Cliffs and shrubs (mainly *Pistacia lentiscus*) growing on cliff faces provide shelter and refuge for Black Kites. The landscape is dominated by xerophilous aridity-adapted vegetation. Trees are scattered among steppe plants that are mainly represented by Diss *Ampelodesmos mauritanicus* and White wormwood *Atemisia herba-alba.*

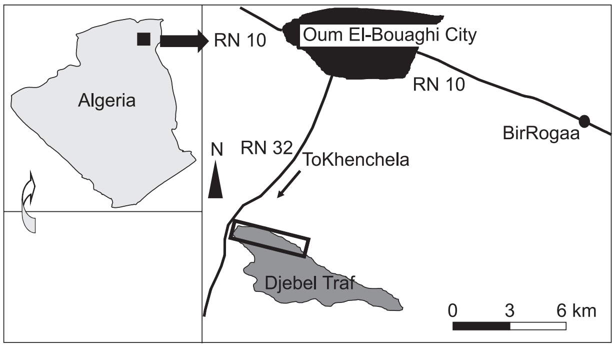

Figure 1. Location of the study area.

Data collection

The total duration of the surveys conducted over 2014 and 2015 for the purpose of locating breeding and nesting sites of the Black Kite was 180 days. Search for raptors and observation of their flight and display in March were conducted employing the on-foot survey method (Fuller and Mosher 1987), which allows accessing roadless tracts (Burnham and Mattox 1984), and rugged fields (Forsman 1983). Nest locations were recorded using a Garmin GPS. The geographic position of each nest was calculated from the nearest accessible point. A laser telemeter was used to calculate both cliff and nest heights. The orientation of nests was measured using a Garmin GPS with a Compass. After the geographic position of a nest had been determined, we estimated inter-nest distances using Google earth software.

The observation of egg and chick numbers in inaccessible nests was carried out with a perched Endoscopic Camera or binoculars and a high zoom camera (Canon ×46).

The pairs nesting at a distance of 700 m from the nearest nest were defined as solitary, while those nesting within a 700 m distance from the nearest nest (Sergio and Boto 1999) as colonial. To minimize the risk of disturbance and desertion, during incubation or hatching periods nests were inspected briefly. The age of nestlings was estimated approximately according to their feathering and behavioral characteristics with an error of ±3 days (Minganti 2012).

Egg laying and hatching dates were estimated by backdating, assuming that the mean incubation period is 29 days and the mean raising period is 47 days long (Cramp and Simmons 1983).

We defined hatching success as the proportion of hatched eggs to hatched + unhatched ones, and fledging success as the proportion of fledged chicks to hatched eggs.

Data analyses

Statistical tests were performed using SPSS 18.0 with a significance level of $p \leq 0.05$. The main aim was to investigate the possible effects of nest placement on the following breeding parameters: clutch size, hatching and fledging successes. All variables were tested for normality using probability plots and the Kolmogorov-Smirnov test. Data were analyzed using both parametric and non-parametric tests (Chi-squared test, sample *t*-test, Mann-Whitney test and one-way ANOVA Spearman Rank correlation). All means are presented ± standard error unless stated otherwise.

RESULTS

Nest placement characteristics and site utilization

Eight nests were studied in 2014 and four in 2015. The mean of the nearest nest distance (NND) increased from 352 ± 197.77 m in 2014 to 812.5 ± 529.4 m in 2015. The average NND did not differ significantly between years (t = 1.01, df = 10, p = 0.337). NNDs varied between 130 m and 550 m for colonial pairs and between 1,730 m and 2,390 m for solitary pairs. The nest altitude ranged from 998 m to 1004 m. No significant difference was found in nest altitude between 2014 and 2015 (t = 1.91, df = 10, p = 0.856). All the nests were located in 3 different places on cliffs: 50% of the nests were placed on bare rock ledges, 33% in holes and 17% on cliff faces covered by shrub vegetation. Cliff heights ranging from 149 m to 155 m did not differ significantly between the years of survey (t = 0. 202, df = 10, p = 0.844) and neither did nest heights (t = 0. 202, df = 10, p = 0.847), which were in the range 18.59–20.25 m (Table 1). Therefore, significant correlations were revealed between NND and cliff height (rs = 0.835, N = 12, p < 0.05), nest height (rs = 0.761, N = 12, p < 0.05) and cliff height (rs = 0.835, N = 12, p < 0.05) (Table 2).

Laying period

The egg laying period lasted for 14 and 16 days in 2014 and 2015, respectively, with the first recorded egg laid on 7 April in 2014 and on 5 April in 2015 (Figure 2).

Clutch size

Clutch size ranged from 1 to 4 eggs (Figure 3). The mean clutch size was 2.83 ± 0.31 eggs per nest, with no difference noted between the years ($t = 0.542$, df = 10, $p = 0.599$) and no clutch replacement observed in the same nest after breeding failures.

Hatching and fledging success

The hatching period started on 11 May in 2014 and on 7 May in 2015 and lasted for 14 and 16 days, respectively. The peak of egg hatching was observed between 13 and 18 May in 2014 (Figure 4). The nests, which were monitored from laying until hatching and fledging, had a high hatching (73%) and fledging success (75%). Two nests proved to have been predated, the Northern Raven *Corvus corax* being the main egg and chick predator. There was no significant difference recorded in hatching success between the survey years (Mann-Whitney *U*-test, $U = 4$, $p = 0.215$), the percentage of hatching success ranging between 62% and 85%. The percentage of fledging success varied from 60% to 91% both in 2015 and 2014, respectively, with no significant difference between these years recorded (Mann-Whitney *U*-test, $U = 16$, $p = 0.99$).

Nest-site selection and breeding success

No significant correlations were revealed between nest placement parameters (nest height, cliff height and altitude) and those of breeding success (hatching success and fledging success) (Table 3). However, there was a significant

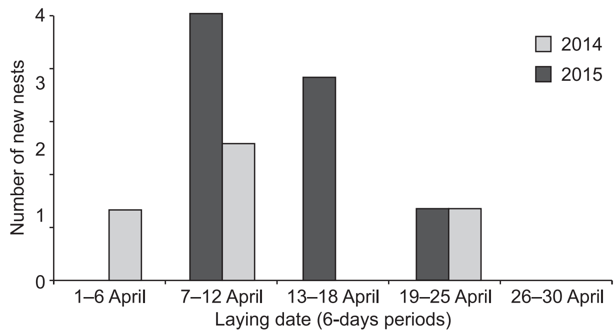

Figure 2. Evolution of egg-laying in 6-day periods at/on Tarf Mountain, Algeria in 2014 and 2015.

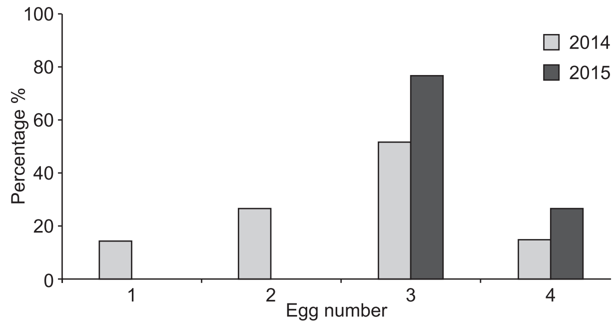

Figure 3. Frequency distribution of clutch size in 2014 and 2015.

Table 1. Nest placement and breeding parameters (mean ± 1SE) of the Black Kite breeding on Tarf Mountain, Algeria 2014 and 2015.

Parameters (m)	Year		*t*	*p*
	2014	2015		
Clutch size	2.63 ± 0.32	3.25 ± 0.25	0.542	0.599
Hatching rate	46.63 ± 10.61	85.25 ± 8.71	12	0.94
NND	352.50 ± 197.77	812.50 ± 529.4	1.01	0.337
Cliff height	149.13 ± 16.63	155.25 ± 27.45	0.202	0.844
Altitude	998.13 ± 16	1004.25 ± 27.45	1.91	0.856
Nest height	18.58 ± 4.44	20.25 ± 6.95	0.202	0.847

NND = Nearest-neighbour nest distance (the nearest nest).

Table 2. Correlations between measured nest placement parameters.

		Cliff height (m)	Altitude (m)	Nest height (m)	NND (m)
Cliff height	Pearson Correlation	1	1.000**	.532	.835**
	Sig. (2-tailed)		.000	.075	.001
	N	12	12	12	12
Altitude	Pearson Correlation	1.000**	1	.532	.835**
	Sig. (2-tailed)	.000		.075	.001
	N	12	12	12	12
Nest height (m)	Pearson Correlation	.532	.532	1	.761**
	Sig. (2-tailed)	.075	.075		.004
	N	12	12	12	12
NND	Pearson Correlation	.835**	.835**	.761**	1
	Sig. (2-tailed)	.001	.001	.004	
	N	12	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

negative correlation found to exist between the inter-nest distance and the rate of hatching success (rs = –0. 66, N = 12, *p* = 0. 022), and that of fledging success (rs = –0. 67, N = 12, *p* = 0. 011). Also, our study showed that clutch size was strongly dependent on nest exposure (X (12) = 21.07, *p* = 0.049) (Table 4). However, nest exposure (X (4) = 1.8, *p* = 0.772) was not found to affect either hatching or fledging success (X (4) = 4.44, *p* = 0.349).

DISCUSSION

One of the main aims of this study was to provide preliminary information on ecological aspects of the Black Kite breeding in Algeria and, particularly, in the High Plateau region. Although the study area is dominated by the steppe, it is considered to be a representative sample of the High Plateau. However, Tarf Mountain, is the main habitat suitable for eagles and raptors of this region and is used for breeding by most species. This species is the most adaptable, numerous, opportunistic and the most successful raptor in the world, greatly benefiting from its closer association with man and human environment (Zocchi and Lacroix 2004; Tanferna et al. 2013; Naoroji and Sangha 2013). It often nests in loose colonies, but sometimes solitarily in couples (Thévenot, Vernon, and Bergier 2003; Sergio et al. 2005; Panuccio et al. 2013), which was also the case in our study.

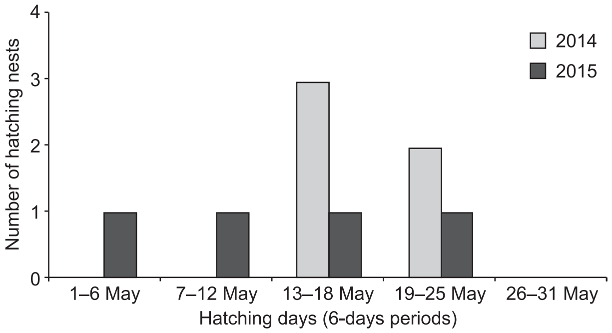

Figure 4. Evolution of hatching in 6-day periods at/on Tarf Mountain, Algeria in 2014 and 2015.

Throughout our survey we found 2 loose colonies and 2 solitary couples. The mean of the nearest-neighbor nest distance of the Black Kite breeding on Tarf Mountain (MNND = 582.5 ± 363.6 m) was approximately the same as the one found in the Tolfa mountains, Italy (MNND = 611 ± 94 m) (Minganti 2012), but much shorter than the one recorded by Seelig et al. (1996) in Dromling, Germany (MNND = 2330 m), by Koga and Shiraishi (1994a) in Nagasaki Peninsula, Japan (MNND = 80 m), and much longer than the one recorded in Costel Porziano, Italy (MNND = 103 m) (De Giacomo, Martucci, and Tinelli 1993), in Delhi, India (MNND = 133 m) (Kumar et al. 2014) and in Donana, Spain (MNND = 206 m) (Hiraldo, Veiga, and Manez 1990). These variations in NNDs may be related to food abundance (Koga, Siraishi, and Uchida 1989; Sergio and Boto

Table 3. Correlations between measured nest placement parameters and breeding success.

		Nest height (m)	Cliff height (m)	Altitude (m)	Hatching success (%)	Fledging success (%)
Nest height	Pearson Correlation	1	.532	1.000**	.293	.389
	Sig. (2-tailed)		.075	.000	.356	.212
	N	12	12	12	12	12
Cliff height (m)	Pearson Correlation	.532	1	.532	–.249	–.098
	Sig. (2-tailed)	.075		.075	.436	.761
	N	12	12	12	12	12
Altitude	Pearson Correlation	1.000**	.532	1	.293	.389
	Sig. (2-tailed)	.000	.075		.356	.212
	N	12	12	12	12	12
Hatching success %	Pearson Correlation	.293	–.249	.293	1	.775**
	Sig. (2-tailed)	.356	.436	.356		.003
	N	12	12	12	12	12
Fledging success %	Pearson Correlation	.389	–.098	.389	.775**	1
	Sig. (2-tailed)	.212	.761	.212	.003	
	N	12	12	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Main data on breeding success.

	2014			2015		
	Mean ± SE	Max	Min	Mean ± SE	Max	Min
Number of nestlings fledged per breeding	1.25 ± 0.37	3	0	2 ± 0.71	3	0
Number of nestlings fledged per successful pair	1.67 ± 0.33	3	1	2.67 ± 0.33	3	2

1999; Kumar et al. 2014) and the competition with other raptor species nesting on the same cliffs. Therefore, the aggregation of the Black Kite on the western side of Tarf Mountain is probably due to the closest distance to the road (1.5 km), which provides food for this raptor through road accidents and the closest distance to the waste dump of the slaughterhouse (4.7 km) as the Black Kite tends to build its nests near foraging sites (Sharma and Soni 2016) and in the vicinity of the cliffs suitable for nesting. The Black Kite typically nests in trees (Thiollay 1967; Koga, Siraishi, and Uchida 1989; Zawadzka 1999; Kirwan et al. 2008; Zocchi and Lacroix 2004; Kumar et al. 2014) and also on cliffs, a very common habitat all over the Mediterranean basin (Brosset 1959; Heim DeBalsac and Mayaud 1962; Schifferli, Géroudet, and Winkler 1980; Blanco 1997; Sergio and Boto 1999). However, in the case of our study, nests were built in cavities, on cliff edges or often in shrubs (*Pistacia lentiscus*) growing on cliff faces. In our study, the mean nest height (19.41 ± 5.69 m) was found to be lower than that reported by Sergio, Pedrini, and Marchesi (2003) (29.3 ± 3.7 m) at Lake Lugano (Italian pre-Alps). The choice of cliffs for nesting is probably the tactic used by Black Kites to avoid human disturbance, persecution and terrestrial predators, because nests on cliffs are higher and less accessible than those in trees (Maurizio 2003; Sergio, Pedrini, and Marchesi 2003). In early March, Black Kites started to arrive and display courtship behavior. Egg laying began in the first week of April, which is later than in Japan (first half of March) as reported by Koga and Shiraishi (1994). The egg laying period on Tarf Mountain lasted from 14 to 16 days, but in the Italian Pre-Alps, it lasted for more than 25 days, i.e. it was 9 days longer (Sergio and Boto 1999). Our results showed a shorter laying period than those found in Japan by Koga and Shiraishi (1994b), and in Italy by Sergio, Pedrini, and Marchesi (2003), which is probably due to the Black Kite's strategy for saving energy and shortening egg laying period by reusing its old nests and also those of other species, e.g. the nests of *Buteo rufinus cirtensis, Falco peregrinus, Hieraaetus pennatus, Neophron percnopterus.* The mean clutch size of this raptor on Tarf Mountain was similar to those recorded in Slovakia (Danko 1989, 2.98), France (Thiollay 1967, 2.26), and in Japan (Koga, Siraishi, and Uchida 1989, 2.18).

The present study highlights the hatching success of 83%, which is greater than that found in New Delhi (55%) (Desai and Malhotra 1979), but similar to the results (84%) obtained in Italy (Sergio and Boto 1999). According to Bustamante and Hiraldo (1989), juveniles started their first flights from 42 to 62 days after hatching. In our study, the fledging success was 75%, i.e. almost the same as the one recorded in Japan (Koga, Siraishi, and Uchida 1989), which is due to the availability of food that allowed the parents to be close to the nest and insure adequate protection of their chicks (Sharma and Soni 2016). This study also analyzed the effect of nest location on some breeding parameters. Our results show that there is a clear tendency for Black Kites to build their nests on the northeastern or southeastern sides of cliffs (NE: 33.33%, SW: 25%), which is in agreement with the study results obtained in Spain (Viñuela and Sunyer 1992). Nest orientation can affect its exposure to some climate parameters (Long, Jensen, and With 2009). Although Viñuela and Sunyer (1992) reported that hatching success is affected by nest orientation, results of our study did not confirm that, i.e. nest exposure was not found to affect the rates of either hatching or fledging success. In general, the latitudinal variation in nest orientation is consistent with the conjecture that birds orient their nests either towards the sun or seek shelter from solar radiation (Burton 2007).

Preliminary findings of the study on the breeding aspects of the Black Kite in Algeria are expected to provide the baseline data for further detailed monitoring and investigations aimed to improve the knowledge of environmental preferences and factors affecting nesting site selection by this raptor. Further long-term investigations covering a large range of habitats are needed to identify more factors influencing the Black Kite's breeding success.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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