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Breeding ecology studies of Collared Pratincoles *Glareola pratincola* in the Central Hauts Plateaux of Algeria

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The breeding biology of Collared Pratincoles *Glareola pratincola* was studied for the first time in Algeria in 2010 at a natural salt lake at Dayet El Kerfa, in the semi-arid Hauts Plateaux. The breeding attempts of 35 pairs on three different islets were monitored. The mean laying date was 13 May (range: 28 April to 2 June). Mean clutch size was 2.0, but 47% of the nests had one or three eggs. Hatching success was 97%; only one nest failed. Clutch size, egg size, nest dimensions and hatching success did not vary between nests placed in the centre of an islet and nests closer to the shore. Our study contrasts with results reported for other Mediterranean breeding areas (in Morocco, France and Spain), showing differences in laying dates, clutch size and laying period. The beginning of egg laying at Dayet El Kerfa was three weeks later than on the N Atlantic coast of Morocco (28 April at Dayet El Kerfa and 7 April in Morocco), three weeks earlier than in Spain and two weeks earlier than in France. Clutch sizes were smaller than in other breeding areas in the Mediterranean basin. The range of hatching dates (25 days) was less than half that reported for a coastal area in Morocco; this is probably related to the almost complete absence of nest predators at Dayet El Kerfa, so no pairs re-nested. The hatching success of 97% was the highest of all breeding sites in the Mediterranean basin.

INTRODUCTION

Collared Pratincoles have a large, fragmented breeding distribution throughout the Palearctic (Cramp & Simmons 1983, Del Hoyo *et al.* 1996). Along the northern shore of the Mediterranean, especially in Spain and France, many studies have been undertaken on the breeding ecology of the species, especially to understand how habitat changes have led to fragmentation of the population (Calvo & Alberto 1990, Calvo & Furness 1995, Tajuelo & Manez 2003, Vincent-Martin 2007). In North Africa, Collared Pratincoles have frequently been recorded breeding in Morocco, in various wetland sites (Cramp & Simmons 1983) and in other habitat types, mainly along the Atlantic coast (El Malki *et al.* 2013, Hanane *et al.* 2010, Thévenot *et al.* 2003).

The species also migrates to the North African shore of the Mediterranean and has been confirmed to breed in Algeria (Isenmann & Moali 2000), where birds were observed during the breeding season at Lake Fetzara (40–50 pairs in April 1963; Steinbacher 1963) and at Mekhada marsh (250 individuals in July 1984; Chalabi *et al.*1985). Other observations of breeding Collared Pratincoles were reported from the Hauts Plateaux: Boughzoul (the nearest site to our study area; 150 individuals in 1977 and 250 in 1978; François 1975, Jacob & Jacob 1980) and La Macta (50–100 individuals in May 1977; Metzmacher 1979).

There have been only three studies on the breeding ecology of Collared Pratincoles in North Africa, all in Morocco (El Malki *et al*. 2013, Hanane *et al*. 2010, Rihane & Aouinty 2006). No such study has been carried out in Algeria, where the species remains poorly known. Therefore there is a need to investigate and to reach an understanding of the population dynamics of this species in other parts of North Africa. In this study, conducted in 2010, we aim to fill gaps in the knowledge of Collared Pratincoles by providing fundamental information on their breeding biology in Algeria. Additionally, we compare the breeding parameters we measured with those from previous studies in other areas of the Mediterranean basin.

METHODS

Study area

The Central Hauts Plateaux are in northern Algeria, in an area consisting of mountains, valleys and plateaus between the Mediterranean Sea and the Sahara Desert. The Central Hauts Plateaux contain more than ten wetlands, all in the three northern *wilayas* (provinces) of Algeria: M'sila, Djelfa and Media. These wetlands are used by a large number of wintering and breeding waterbirds (Bensaci *et al*. in prep.,

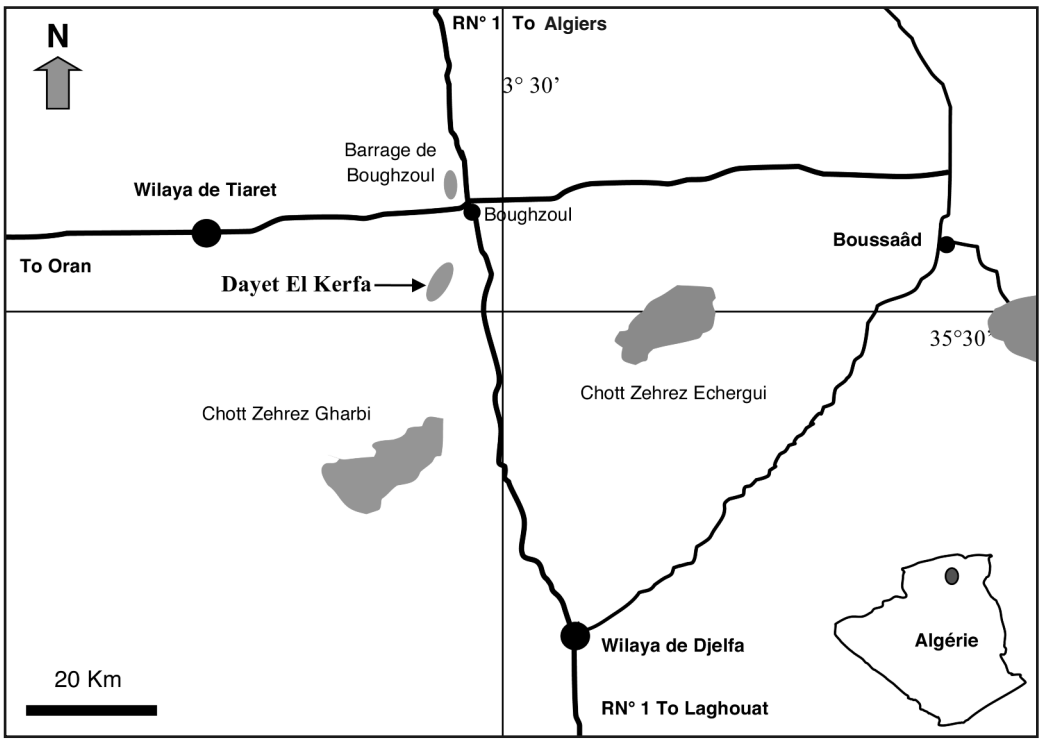

Fig. 1. Location of the study area, Dayet El Kerfa, Algeria.

Jacob & Jacob 1980). Our study site, Dayet El Kerfa (35°37.2'N, 02°52.6'E), is a 600-ha salt lake at 631 m above sea level, adjacent to highway RN01 leading from Algiers to Djelfa city, 10 km to the south of Boughzoul town, and 150 km south of the Mediterranean Sea (Fig. 1). Dayet El Kerfa and the surrounding area of the Central Hauts Plateaux are semi-arid. Annual mean temperature is 18°C and average annual rainfall is <400 mm. The study area is part of an important network of wetlands: Chott Zehrez Gherbi (Ramsar Site), Chott Zehrez Echergui (Ramsar Site) and Boughzoul´s Lake (Fig. 1).

Despite its richness in waterbirds, Dayet El Kerfa has not been selected as a Ramsar site but has been classified as an Important Bird Area (IBA) (Fishpool & Evans 2001). Dayet El Kerfa contains seven small islands or islets of various size and vegetation cover, but all with mainly sandy soil. All the islets are used as breeding sites by a variety of species, including Pied Avocet *Recurvirostra avosetta*, Black-winged Stilt *Himantopus himantopus*, Kentish Plover *Charadrius alexandrinus*, Black-headed Gull *Chroicocephalus ridibundus*, Slender-billed Gull *Chroicocephalus genei*, Gull-billed Tern *Sterna nilotica* and Mallard *Anas platyrhynchos* (Bensaci *et al*. 2012). Breeding Collared Pratincoles were discovered at Dayet El Kerfa during a study of the ecology of other waterbirds (Pied Avocet, Black-winged Stilt, Slender-billed Gull and Gull-billed Tern) breeding on the same islets. The depth of the water in Dayet El Kerfa was about 80 cm when we started fieldwork in April 2010 and it gradually decreased to about 15 cm by the time we finished in July. The depth of the water and the rate of decrease in the water level depends on the amount of the previous winter's rainfall in the watershed of the Daya.

Data collection

Fieldwork was conducted between April and mid-July 2010. Nests were located through systematic searches of the area. Most were monitored from the laying of the first egg to the hatching of the last egg by means of regular visits, every four days. Each nest was marked using small, individually numbered pegs placed close to the nest. The nest parameters we measured were *nest placement* (distance between nest and the shore of the islet) and *nest diameters* (internal, the 'cup' in which the eggs are placed, and external, the extent of the nest materials).

Table 1. Distribution of nests of Collared Pratincoles and identity of other colonial waterbird species present on the islets at Dayet El Kerfa, Algeria, in 2010.

Islet	Number of Collared Pratincole nests	Other breeding waterbirds present
2	2	Pied Avocet, Black-winged Stilt, Kentish Plover
3	28	Pied Avocet, Black-winged Stilt, Black-headed Gull
6	5	Pied Avocet, Black-winged Stilt, Mallard, Slender-billed Gull, Black-headed Gull, Gull-billed Tern

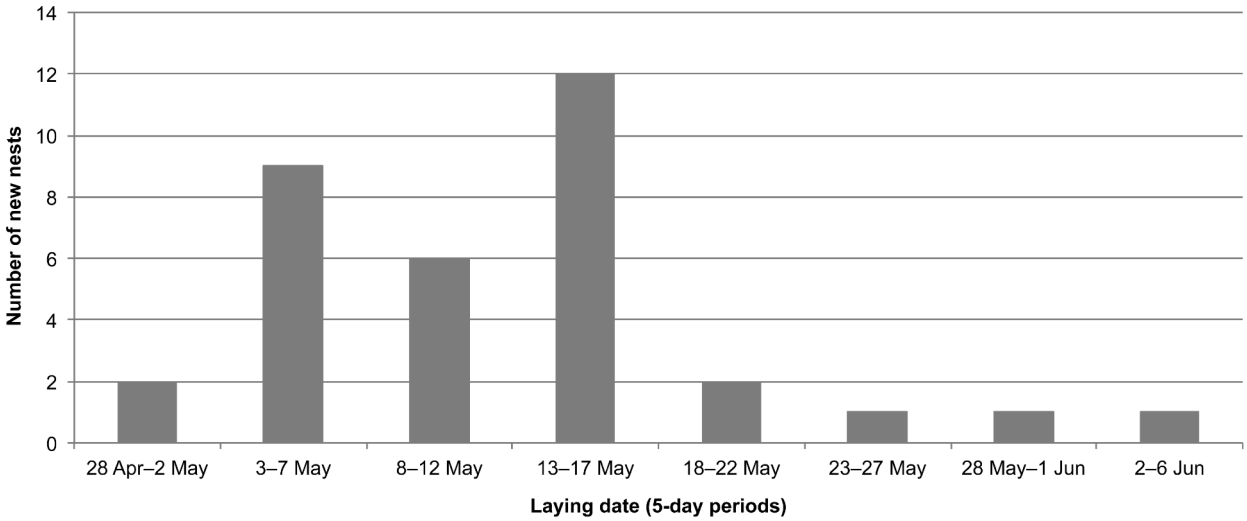

Fig. 2. Number of new Collared Pratincole nests completed in 5-day periods of 2010 at Dayet El Kerfa, Algeria.

For each nest monitored, we noted clutch size and determined laying date. Clutch size was determined for complete clutches only. Laying date was calculated by backdating from the known hatching date, assuming the incubation period is 18 days (Cramp & Simmons 1983), and one day laying intervals between consecutive eggs in a clutch (Colwell 2006). A nest was considered successful if at least one egg hatched, otherwise the nest was considered to have failed. When the same number of eggs remained in a nest after the expected date of hatching it was considered deserted. When eggs disappeared before the expected hatching date they were considered depredated.

The length and width of each egg was measured to the nearest 0.05 mm using vernier callipers. Egg volume (V_e, in cm^3) and Shape Index (SI) were calculated using Coulson's formulae: (V_e (cm^3) = K x L x B^2) and SI = B / L x100 (Coulson 1963), where K = 0.482 (Bertolero & Martinez-Vilalta 1999, Calvo 1994), L = egg length (cm) and B = egg width (cm).

Data analyses

Statistical tests were performed using SPSS 17.0 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: nest dimensions, egg dimensions, egg laying period and clutch size. Data were analysed using both parametric and non-parametric tests (chi-squared test, t-test, Mann-Whitney test and one-way ANOVA). All means are shown ± standard error unless stated otherwise.

RESULTS

The population of Collared Pratincoles at Dayet El Kerfa varied from 42 adults at the end of March 2010 to 120 adults and fledglings in June 2010.

Nest characteristics and site utilization

We searched all seven islets at Dayet El Kerfa and located 35 active Collared Pratincole nests (containing at least one egg) dispersed over three islets (2, 3 and 6, Table 1). On each of the three islets where we found pratincoles, other waterbird species were also nesting: Pied Avocet and Black-winged Stilt (on all three islets), Black-headed Gull (on two islets), Kentish Plover, Mallard, Slender-billed Gull and Gull-billed Tern (on one islet) (Table 1). By far the majority of nests (28/35) were on islet 3, the smallest islet with an area of 0.8 ha, 20% vegetation cover and located in the southern part of Dayet El Kerfa (Table 2). The nests were placed under tufts of *Salicornia europea* (71%) or *Suaeda fruticosa* (17%) or *Salsola vercimulata* (12%). All of the vegetation on the three islets consisted of the same group of halophytic plants (Table 2). Nests were mainly placed in the central part of the islets. The mean distance from each nest to the edge of the islet was 23.0 ± 9.3 m; 26 (74%) of the nests were >20 m from the islet shore, and only 9 (26%) were 7–20 m from the shore. No nests were placed <7 m from the shore.

Table 2. Characteristics of the three (of seven) islets in Dayet El Kerfa, Algeria, used as nesting sites by Collared Pratincoles in 2010. The list of dominant plant species applies to all three islets.

Islet	Geographic location	Size	Vegetation cover	Islet height	Dominant plant species
2	35°37.170'N, 2°52.502'E	1.5 ha	20%	90 cm	*Salicornia europea* *Suaeda fruticosa* *Salsola vercimulata* *Frankenia pulverilenta* *Holocnemum strobilaceum* *Launaea nudicaulis*
3	35°37.180'N, 2°52.582'E	0.8 ha	20%	110 cm	
6	35°37.429'N, 2°52.656'E	0.96 ha	5%	140 cm	

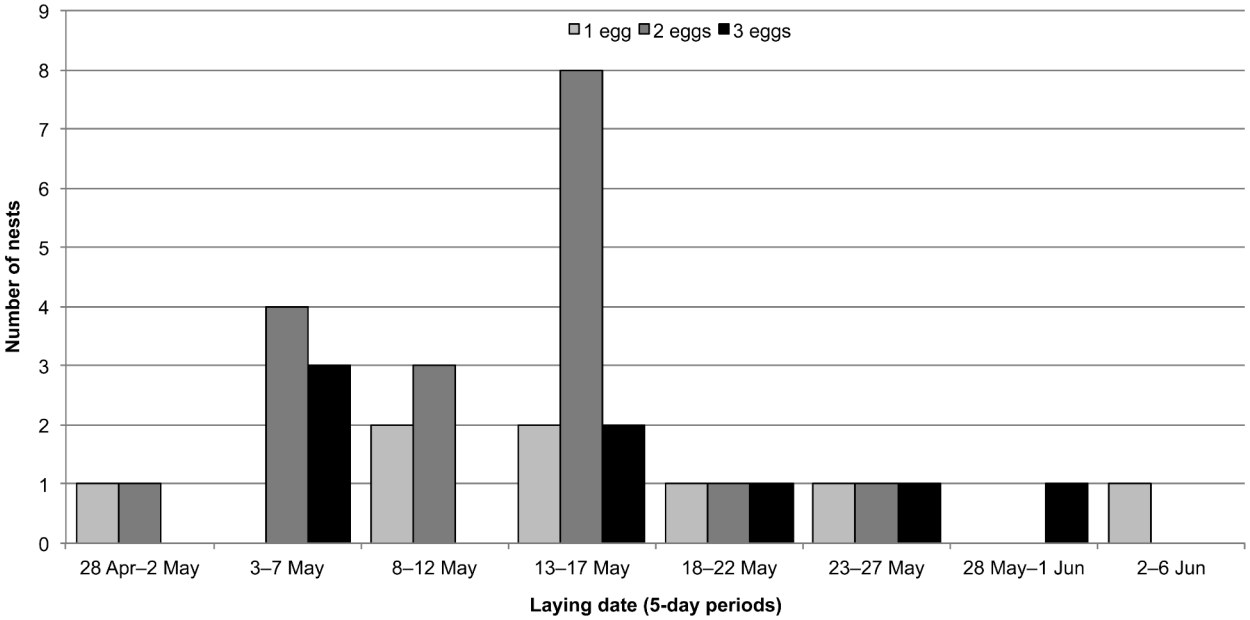

Fig. 3. Frequency distribution of clutch size in relation to laying date of Collared Pratincole nests at Dayet El Kerfa, Algeria, in 2010.

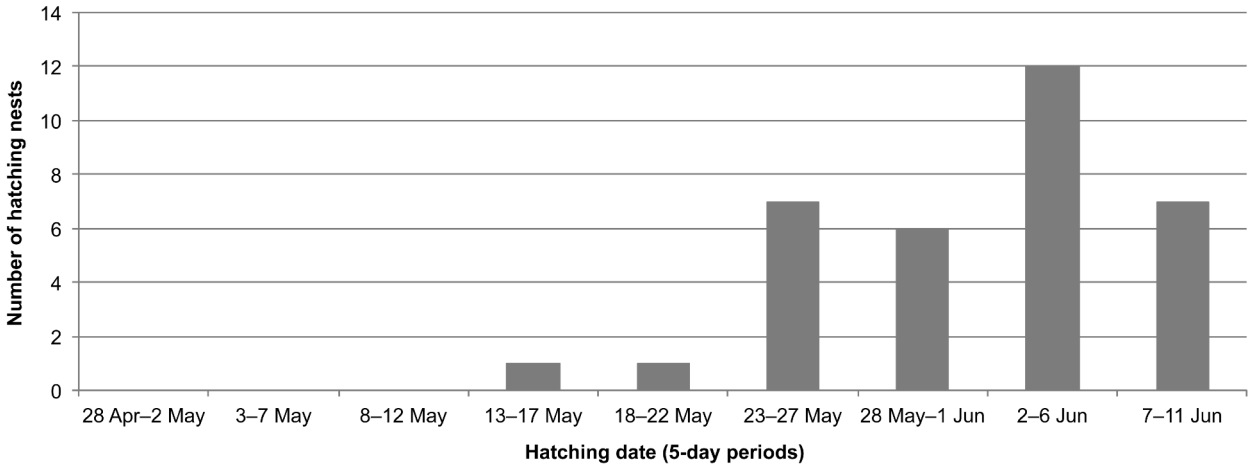

Fig. 4. Number of Collared Pratincole nests hatching per 5-day period at Dayet El Kerfa, Algeria, in 2010.

The mean external diameter of the 35 nests was 12.5 ± 2.3 cm, and the mean internal diameter was 5.9 ± 2.2 cm. No significant difference was found in external diameter (Mann-Whitney U-test, U = 4.5, P = 0.008) or internal diameter (Mann-Whitney U-test, U = 16.5, P = 1.98) between nests >20 m from the shore and those 7–20 m from the shore.

Laying period

The laying period was spread over 36 days (late April to early June); the first recorded egg was laid on 28 April and the last on 2 June. The distribution of newly initiated Collared Pratincole nests suggests two laying periods, one in the first half and the other in the second half of May (Fig. 2). The mean laying date and the median were respectively 13 and 17 May. There was no significant difference in the five-day laying period between nests placed close to the centre of the island (>20 m from the shore) and those closer to the shore (within 7–20 m of the shore) (t = 1.17, df = 17, P <0.05).

Clutch size and egg measurements

The mean clutch size of Collared Pratincoles nesting at Dayet El Kerfa in 2010 (including a three-egg clutch that was abandoned) was 2.0 ± 0.7 eggs per nest (n = 35 complete clutches). The majority of nests contained two eggs (53%) and there were equal numbers of nests with one and three eggs (23.5% each). In general, clutches with two eggs appeared to be completed early in the laying period, but mean clutch size did not vary significantly among five-day laying periods (Fig. 3; one-way ANOVA, $F_{2, 15} = 1.48$, P = 0.25).

There was no significant difference in the proportions of nests with different clutch sizes between nests placed in the centre of an islet (>20 m from the shore) and those closer to the shore (within 7–20 m of the shore) ($\chi^2 = 0.184$, P = 0.912). There also was no significant difference in the measurements of eggs from nests >20 m from the shore and those closer to the shore (egg weight: Mann-Whitney U-test, U = 15, P = 0.217; egg volume: Mann-Whitney U-test, U = 15, P = 0.221). The egg measurements are summarized in Table 3.

Table 3. Egg and nest measurements of Collared Pratincoles breeding at Dayet El Kerfa, Algeria in 2010.

	Maximum	Minimum	Meam ± SE	N
Egg length (mm)	31	27.1	28.9 ±1.2	10
Egg width (mm)	23.2	19.8	21.2 ±1.4	10
Egg volume(cm²)	7.31	5.22	6.30 ±0.70	10
Mean shape index	84.4	63.9	73.7 ±7.1	10
Nest internal diameter (cm)	10	4	5.9 ±2.2	16
Nest external diameter (cm)	17	10	12.5 ±2.3	16
Distance of nest to islet shore (m)	36	7.2	23.0 ±9.3	16

Hatching period and hatching success

Hatching started on 15 May and extended over 25 days (Fig. 4, page 6). The peak of nest hatching was between 2 and 6 June (12 nests). The 35 active nests that were monitored from laying till hatching had a very high hatching success of 97%. Only one nest abandonment was observed; the reason could not be determined.

DISCUSSION

One of the important aims of this investigation was to provide preliminary information on the reproductive biology of Collared Pratincoles in Algeria and in the Hauts Plateaux. This species is widespread in North Africa but has only rarely been recorded as breeding in Algeria.

The high density of Collared Pratincole nests found on the smallest islet at Dayet El Kerfa may be explained as a strategy for protection from predators. Most nests were in the centre of the islets where they may be better protected from flooding or the strong winds that are characteristic of the region.

The colonial breeding of Collared Pratincoles alongside other bird species using the same islets (Pied Avocet, Black-winged Stilt, Kentish Plover, Slender-billed Gull, Gull-billed Tern, Mallard and Black-headed Gull) might reflect a strategy of cooperation amongst species to, for example, provide better early warning of the approach of predators or intruders, or aid in defence against predators (Brown 1987). During our field monitoring no Collared Pratincole nests were depredated. However, on one islet we found three dead sand rats *Psammomys obesus* that we assumed to be potential egg predators that had been attacked by the breeding waterbirds. The absence of common nest predators, such as Yellow-legged Gull *Larus michahellis*, may mean that the risk of predation is much lower in inland habitats, such as those at Dayet El Kerfa, compared with coastal habitats, as observed in several waterbird species (Goutner 1997) and particularly in Collared Pratincoles in coastal habitats in Morocco (Hanane *et al.* 2010).

Our nest monitoring showed that Collared Pratincoles started egg laying during the last half of April, which is similar to reports from the Atlantic coast of Morocco by El Malki *et al.* (2013), but later than observed in northern coastal Morocco (first half of April; Hanane *et al.* 2010), and earlier than in Spain (second half of May; Bertolero & Martinez-Vilalta 1999) and in France (first half of May; Vincent-Martin 2007). The laying period at Dayet El Kerfa extended over 36 days, but in Morocco was recorded as 53 days (±4.5), 17 days longer (Hanane *et al.* 2010). The hatching period of Collared Pratincoles at Dayet El Kerfa extended over 25 days, which is less than half the time reported for a coastal breeding area in Morocco (El Malki *et al.* 2013, Hanane *et al.* 2010). Probably the reason for both the shorter laying and hatching periods at Dayet El Kerfa is the lack of nest predation; i.e. at the coastal sites where predation rates are much higher, re-nesting following egg loss causes both laying and hatching periods to be longer.

Despite differences in nest location on the islets (central or closer the shore), we did not find a significant difference in clutch size, egg measurements, laying period, nest measurements or hatching success between central islet nests and more peripheral ones. Our results show that Collared Pratincoles at Dayet El Kerfa had smaller mean clutch sizes (2.0 ±0.7) than in other breeding areas in the Mediterranean basin, particularly in Spain (2.6) (Bertolero & Martinez-Vilalta 1999), in France (2.5 ±0.7)(Vincent-Martin 2007) and in a rocky habitat in Morocco (2.3 ±0.7) (Hanane *et al.* 2010), but closer to clutch sizes that were noted in Morocco (2.2 ±0.9 in salinas and 2.1 ±1.0 in marshes) (El Malki *et al.* 2013). The variation in clutch size between Algeria and more northerly breeding areas in Europe fits a general pattern of increasing clutch size with latitude (Ashmole 1963, Baker 1995, Rubolini & Fasola 2008). Mean egg length and egg width of Collared Pratincoles breeding at Dayet El Kerfa were similar to those reported by Hanane *et al.* (2010) and El Malki *et al.* (2013). However, our data do not support a suggested latitudinal gradient in egg size (Baker 1995, Rubolini & Fasola 2008) because egg sizes in Algeria were not similar to those found in Moroccan colonies (Table 3).

Dayet El Kerfa is located in a steppe landscape, frequented by nomadic people and grazing livestock. The domestic animals and dogs potentially present a serious threat to breeding Collared Pratincoles and other birds using this site, especially when the area starts drying up and there is generally less food available for all animals. However, breeding Collared Pratincoles at Dayet El Kerfa had the highest hatching success (97%) of any site around the Mediterranean basin, especially when comparing hatching success in Morocco (El Malki *et al.* 2013, Hanane *et al.* 2010), in the Guadalquivir marshes and Ebro Delta in Spain (Bertolero & Martinez-Vilalta 1999, Calvo 1994) and in the Camargue in France

(Dolz *et al.* 1989, Vincent-Martin 2007). This high success may be an effect of the location of Dayet El Kerfa – far from urban agglomerations and with few nest predators.

In previous studies of Collared Pratincoles in other breeding areas around the Mediterranean, the main causes of nest loss were human disturbance (principally agriculture, domestic animals and egg gathering), flooding and predation, which led to a decline in breeding success (Calvo *et al.* 1993, Cramp & Simmons 1983, Del Hoyo *et al.* 1996, Dolz 1994, Hanane *et al.* 2010, Rihane & Aouinty 2006, Walmsley 1978). In our study area the high hatching success is likely to be due to the location of the breeding area: islets which are inaccessible to terrestrial predators during the breeding season, and far from human disturbance. Probably the association with other breeding species contributes to the high hatching success.

In conclusion, our study on the breeding biology of Collared Pratincoles in an inland semi-arid area in Algeria shows that this ecosystem can offer good-quality environmental conditions leading to high hatching success. This study should be followed by further investigations on all aspects of the species' breeding biology at Dayet El Kerfa and elsewhere in Algeria. These should cover the complete range of habitats and locations used by the species in order to identify the factors that influence hatching and fledging success. It will be especially valuable to establish whether high hatching success is generally characteristic of inland colonies. If this proves to be the case, conservation efforts might be focused on such colonies in order to enhance the status of the species in Algeria as a whole.

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