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Data on Habitat and Breeding Biology of the Barbary Falcon, *Falco peregrinus pelegrinoides* Temminck, 1829, from South-western Iran

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Abstract: Both ecology and biology of the peregrine falcon are well known throughout its range. However, excepting the data from the Canary Islands, knowledge on the Barbary falcon natural history is scarce. We studied four Barbary falcon nesting sites in South-western Iran between 2011 and 2014. All eyries were located in cavities of cliffs whose average height was 80 m, on average just over 1 km away from roads and villages. Although sample size was small (n = 7 clutches), the mean clutch size (four eggs) and productivity (3.43 fledglings) per eyrie reached the highest values recorded for peregrine falcons.

Key words: Barbary falcon, breeding success, clutch size, Middle East, nest site characteristics, productivity

Introduction

Regardless of the existing controversy about the taxonomic status of the Barbary falcon, current genetic studies suggest that it is a subspecies of peregrine falcon, *Falco peregrinus pelegrinoides* Temminck, 1829, and not a separate species (Wink, Seibold 1996, White *et al*. 2013). Its world range includes the Canary Islands (western limit of its range), several regions of North Africa and the Middle East as well as some areas of Central Asia (Ferguson-Lees, Christie 2001, White *et al*. 2013).

The habitat and breeding biology of the peregrine falcon are well known in many world regions (Olsen, Olsen 1988, Gainzarain *et al*. 2000, Jenkins 2000, Enderson *et al*. 2012). However, knowledge about the natural history of the Barbary falcon is lacking throughout its range, except for the Canary Islands where both the habitat and the reproductive rates have been studied (Rodríguez, Siverio 2006, Rodríguez *et al*. 2007, Siverio *et al*. 2011) and the population is estimated to 143 pairs (Siverio *et al*. 2009). In fact, apart from general summaries on the bird's status (Evans *et al*. 2005), the very few studies from the Middle East have been focused mainly on the distribution of local populations (Scott *et al*. 1975, Shirihai 1996, Khaelghizadeh *et al*. 2011), their foraging pattern (Yosef *et al*. 2011) and diet (Shafaeipour 2014). We aim to increase data availability, through providing information on habitat and reproductive rates of several pairs of Barbary falcon in a mountainous area of Iran.

Materials and Methods

The study area was located in the province of Kohgiloyeh and Buyer-Ahmad, in South-western Iran (Fig. 1). This is mostly a mountainous landscape, with rocky areas, high clay walls and elevations ranging from 990 to 4435 m a. s. l. The climate is temperate, with average annual rainfall of 434 mm and an average annual temperature of 19º C. The most common vegetation is represented by shrubs of the genera *Astragalus*, *Acantholimon* and *Amygdalus*, as well as various species of trees including *Quercus brantii* var. *persica*, *Ziziphus spina-christi*, *Juniperus excelsa* and *Amygdalus elaeagnifolia*.

Data were gathered between March and May during four consecutive breeding seasons (2011-2014). Prior to the months of eyries monitoring, the birds were observed in courtship and showing territorial behaviour. We used GPS to measure the habitat variables (e.g. distance from the nest site to the nearest paved road). We observed the falcons using

binoculars 10 x 40 from a hide located about 60-70 m away from the eyries. For gathering reproductive parameters, the time invested in the whole study period was 40 days (280 hours): one of the nest sites was visited for seven days each year (2011-2014), and three were visited only four days each in 2014. For defined terms of reproductive parameters we followed and modified the definitions of Steenhof, Newton (2007): hatching success, defined as the percentage of eggs hatched from total eggs laid; productivity - as the average number of fledged young per territorial pair; and nesting success - as the proportion of pairs with at least one fledged young. For calculating the average rate of prey delivery to the eyries during nestlings' development, we carried out 150 hours of observation (of these, 91 h with a video camera camouflaged near one of the eyries). For this, we considered each observation station (n = 37) as a sampling unit, i.e. the number of prey deliveries was divided by the number of hours at each station. Differences on prey delivery rates to eyries according to the nestling age were tested using an ANOVA test. All means from 4 or more sampling units are presented with the standard deviation (SD).

Results

In 2011 we found a Barbary falcon eyrie in Dena National Park and in 2014 another three in the protected areas of Khaeiz and Kuh-e-Sorkh (Fig. 1). The mean height of the nesting cliffs was 80 m (range 40-120) and the mean height of eyries above ground was 61.3 m (range 30-95). The average distances of eyries to the nearest paved or unpaved road were 1478.5 m (range 480-2400) and 932.5 m (range 230-1900), correspondingly. The average distance of the eyries to the nearest village was 2237.5 m (range 1250-4180). Two of the eyries were facing south and the other two - southwest. The average width of the cavities where the eyries were situated was 2.25 m (range 2-2.5), the height 0.64 m (range 0.6-0.7), and the depth 0.66 m (range 0.6-0.7). The eggs were laid at an average distance of 0.45 m (range 0.4-0.5) from the entrance of the cavity.

Laying began between 1 and 5 March and we estimated that it was completed between 5 and 9 March, which was when the respective females showed continuous incubation behaviour. The average clutch size was four eggs (n = 7 clutches; Table 1), the incubation period lasted 28-30 days, and the hatching success was 89.3% (n = 28 eggs; Table 1). Young nestlings (n = 24) fledged when they were 41-42 days old, resulting in a mean productivity of 3.43 ± 0.79 (n = 7 pairs). Nesting success was 100% (Table 1).

During the development of nestlings, the average rate of prey deliveries per hour to the eyrie was 0.47 ± 0.16 (range 0.25-0.86). The prey delivery rate increased with increasing of the age of the nestlings (≤ 5 days old: 0.38 ± 0.16, n = 12; between 13-27 days: 0.49 ± 0.14, n = 14; ≥ 30 days: 0.51 ± 0.19, n = 15), although no significant differences were detected (ANOVA, $F_{2,34} = 1.862$, P = 0.17). Moreover, the 57 feeding events that we observed lasted an average of 6.16 ± 1.16 min (range 4-8).

Discussion

Though the Barbary falcon appears to be distributed over much of Iran, until now the available published information was referred to a single eyrie (Khaelghizadeh *et al*. 2011). This single eyrie probably was also considered in the present study.

The four eyries we studied were located on high cliffs and in the context of a landscape little transformed by man, i.e. away from roads and towns. The average height of these nesting cliffs (80 m) is lower than that of those occupied by the Barbary falcon on the islands of El Hierro (225 m) and Tenerife (142 m), in the Canary archipelago (Rodríguez, Siverio 2006, Rodríguez *et al*. 2007), although it is very similar to the cliff heights chosen by the peregrine falcon in other regions (Gainzarain *et al*. 2000, Wightman, Fuller 2005). In any case,

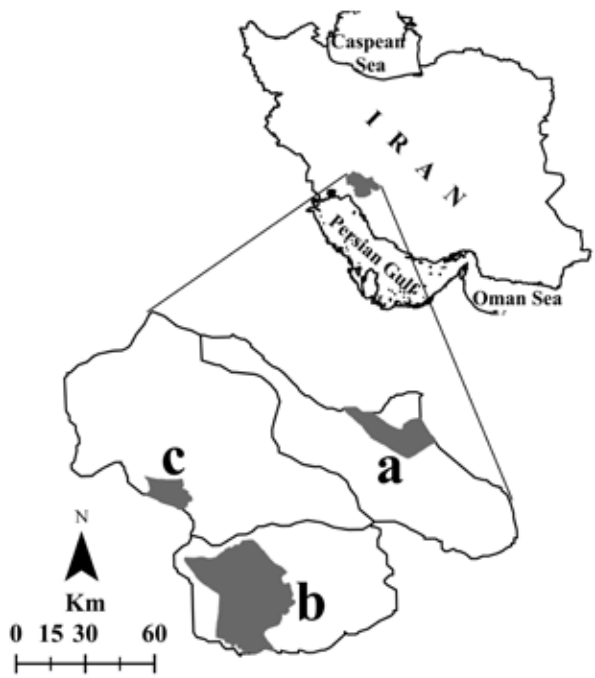

Fig. 1. Areas with Barbary falcon nest sites, province of Kohgiloyeh and Buyer-Ahmad, South-western Iran (a: Dena National Park, b: Kuh-e-Sorkh protected area, c: Khaeiz protected area)

Table 1. Breeding rates of Barbary falcon in South-western Iran

Parameters	Year			
	2011	2012	2013	2014
Breeding pairs	1	1	1	4
Mean clutch size	4	4	4	4
Hatching success (%)	100	100	75	87.5
Nestling mortality	0	0	0	1
Nesting success (%)	100	100	100	100
Number of fledging	4	4	3	13
Mean productivity	4	4	3	3.25

both the Barbary and the peregrine falcon usually select the highest cliffs available for security against predators (Ratcliffe 1993, Zuberogoitia *et al*. 2002, Rodríguez, Siverio 2006, Rodríguez *et al*. 2007). In fact, in our study area, three of the four nesting cliffs were higher than other potential cliffs located within a radius of 2 km around the eyries. As with the four eyries of this study, peregrine falcons often breed away from roads and towns (Gainzarain *et al*. 2000, Brambilla *et al*. 2006, Rodríguez, Siverio 2006, Rodríguez *et al*. 2007), though these variables do not always influence the choice of nest site. Some populations of peregrine falcon can also breed in urban areas (Gahbauer *et al*. 2015).

Given that clutch size in European peregrine falcons usually varies between three and four eggs, with mean values generally less than four eggs (see Zuberogoitia *et al*. 2002), it is rather interesting that in this study the mean was four. In a study of peregrine falcons conducted in mainland Spain, with a similar number of clutches (n = 6) as evaluated here, the mean size was 3.17 eggs (Verdejo, López-López 2008), while the mean clutch size of 22 clutches of Barbary falcons in Lanzarote, Canary Islands (Delgado *et al*. 1999) was 3.6 eggs, which is much closer to our value. The incubation period and fledging age of the young recorded in our study are slightly shorter than these of the peregrine falcon (see Zuberogoitia *et al*. 2002).The incubation period we recorded was much more alike to the quite short period (27-29 days) estimated for the Barbary falcon from Lanzarote (see Delgado *et al*. 1999). We found one of the highest average productivity ever recorded for the peregrine falcon (see Zuberogoitia *et al*. 2002, Rizzoli *et al*. 2005). The mean productivity of Barbary falcons in a high quality area of Tenerife (Canary Islands) was also much lower (1.92 fledged young; Siverio *et al*. 2011). Generally, productivity in raptors may depend on factors such as density (Carrete *et al*. 2006, Bretagnolle *et al*. 2008), rainy days (Zuberogoitia *et al*. 2013, Anctil *et al*. 2014), the prey size (López-López *et al*. 2009) and individual qualities (Zabala, Zuberogoitia 2014). Even though in our study area the actual density was not recorded, it is likely that the individual quality, particularly that of males (measure as the number of prey deliveries to the eyries), is related to the high productivity (see below). This individual quality was not necessarily owing to the contribution of large prey, since the prey captured from this area most often varied between 50 and 120 g (Shafaeipour 2014). However, what seems clear is that the rainfall in our study area (207 mm) during the incubation and nestlings development periods did not affect productivity, probably owing also to the fact that all eyries were inside the cavities, i.e. under a cover.

The average rate of prey delivery to the eyrie obtained in this study was enough to bring up large broods, although no reduction in deliveries was noticed when the nestlings were about to fly. Olsen *et al*. (1998) noted a reduction in the rate of prey deliveries by the Australian peregrine (*F. p. macropus*). We could speculate that these differences might have resulted from the sample size and the employed methodology.

Our results should be taken with caution due to small sample sizes for breeding rates. Future research on habitat selection in the region should focus on the comparison of the variables of the eyries (control) with potential nesting sites chosen at random, and using a greater sample size. Moreover, since the Barbary falcon is protected by the Iranian environmental laws, systematic monitoring of the species will provide valuable knowledge about its population status and reproductive parameters, definitely essential for effective management measures to ensure its stability (Martin *et al*. 2007).

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References

Anctil A., A. Franke and J. Bêty 2014. Heavy rainfall increases nestling mortality of an arctic top predator: experimental evidence and long-term trend in peregrine falcons. – *Oecologia*, **174**: 1033-1043.

Brambilla M., D. Rubolini and F. Guidali 2006. Factors affecting breeding habitat selection in a cliff-nesting peregrine *Falco peregrinus* population. – *Journal of Ornithology*, **147**: 428-435.

Bretagnolle V., F. Mougeot and J.-C. Thibault 2008. Density dependence in a recovering osprey population: demographic and behavioural processes. – *Journal of Animal Ecology*, **77**: 998-1007.

Carrete M., J. A. Donázar and A. Margalida 2006. Density-dependent productivity depression in Pyrenean Bearded Vultures: implications for conservation. – *Ecological Applications*, **16** (5): 1674-1682.

Delgado G., D. Concepción, M. Siverio, E. Hernández, V. Quilis and D. Trujillo 1999. Datos sobre la distribución y biología del Halcón de Berbería (*Falco pelegrinoides*) en las islas Canarias (Aves: Falconidae). – *Vieraea*, **27**: 287-298 (In Spanish, English summary).

Enderson J. H., R. J. Oakleaf, R. R. Rogers and J. S. Sumner 2012. Nesting performance of Peregrine Falcons in Colorado, Montana, and Wyoming, 2005–2009. – *The Wilson Journal of Ornithology*, **124** (1): 127-132.

Evans M., Z. Amr and R. M. Al-Oran 2005. The status of birds in the proposed Rum Wildlife Reserve, Southern Jordan. – *Turkish Journal of Zoology*, **29**: 17-26.

Fergusson-Lees J., D. A. Christie 2001. Raptors of the World. London (Christopher Helm). 992 p.

Gahbauer M. A., D. M. Bird, K. E. Klark, T. French, D. W. Brauning and F. A. Mcmorris 2015. Productivity, mortality, and management of urban peregrine falcons in northeastern North America. – *Journal of Wildlife Management*, **79** (1):10-19.

Gainzarain J. A., R. Arambarri and A. F. Rodríguez 2000. Breeding density, habitat selection and reproductive rates of the Peregrine Falcon *Falco peregrinus* in Álava (northern Spain). – *Bird Study*, **47**: 225-231.

Jenkins A. 2000. Characteristics of Peregrine and Lanner Falcon nesting habitats in South Africa. – *Ostrich*, **71** (3-4): 416-424.

Khaelghizadeh A., A. Zarei and M. Tohidifar 2011. Past and present status of the Barbary Falcon *Falco pelegrinoides* in Iran. – *Falco*, **38**: 12-16.

López-López P., J. Verdejo and E. Barba 2009. The role of pigeon consumption in the population dynamics and breeding performance of a peregrine falcon (*Falco peregrinus*) population: conservation implications. – *European Journal Wildlife Research*, **55**: 125-132.

Martin J., W. M. Kitchens and J. E. Hines 2007. Importance of welldesigned monitoring programs for the conservation of endangered species: case study of the snail kite. – *Conservation Biology*, **21** (2): 472-481.

Olsen P. D., J. Olsen 1988. Breeding of the Peregrine Falcon *Falco peregrinus*: I. Weather, nest spacing and territory occupancy. – *Emu*, **88**: 195-201.

Olsen P., V. Doyle and M. Boulet 1998. Variation in male provisioning in relation to brood size or Peregrine Falcon *Falco peregrinus*. – *Emu*, **98**: 297-304.

Ratcliffe D. 1993. The Peregrine Falcon. London UK (T & AD Poyser). 454 p.

Rizzolli F., F. Sergio, L. Marchesi and P. Pedrini 2005. Density, productivity, diet and population status of the Peregrine Falcon *Falco peregrinus* in the Italian Alps. – *Bird Study*, **52**: 188-192.

Rodríguez B., M. Siverio 2006. Density and breeding habitat characteristics of an insular population of Barbary Falcon *Falco peregrinus pelegrinoides* (El Hierro, Canary Islands). – *Ardeola*, **53** (2): 325-331.

Rodríguez B., M. Siverio, A. Rodríguez and F. Siverio 2007. Density, habitat selection and breeding success of an insular population of Barbary Falcon *Falco peregrinus pelegrinoides* (Tenerife, Canary Islands). – *Ardea*, **95** (2): 213-223.

Scott D. A., H. Moravej-Hamadani and A. Adhami-Mirhosseyni 1975. The Birds of Iran (1th ed.). Tehran (Department of the Environment). 410 p. (In Persian).

Shafaeipour A. 2014. Prey selection of the Barbary Falcon (*Falco pelegrinoides*) in south-western Iran. – *Zoology in the Middle East*, **60** (1): 13-19.

Shirihai H. 1996. The Birds of Israel. London (Academic Preess / Inipress). 692 p.

Siverio M., B. Rodríguez and F. Siverio 2009. The Barbary Falcon in the Canary Islands. –In: del Moral J. C. (ed.): The Peregrine Falcon in Spain. Breeding population in 2008 and census method. Madrid (SEO/BirdLife), 52-58 p. (In Spanish).

Siverio M., F. Siverio, B. Rodríguez and A. Rodríguez 2011. Long-term monitoring of an insular population of Barbary Falcon *Falco peregrinus pelegrinoides*. – *Ostrich*, **82** (3): 225-230.

Steenhof K., I. Newton 2007. Assessing nesting success and productivity. – In: Bird D. M., K. Bildstein (eds.): Raptor research and management techniques. Blaine, (Hancock House), 181-191 p.

Verdejo J., P. López-López 2008. Long-term monitoring of a Peregrine Falcon population: size, breeding performance and nest-site characteristics. – *Ardeola*, **55** (1): 87-96.

White C. M., T. J. Cade and J. H. Enderson 2013. Peregrine Falcons of the world. Barcelona (Lynx Edicions). 339 p.

White C. M., S. A. Sonsthagen, G. K. Sage, C. Anderson and S. L. Talbot 2013. Genetic relationships among some subspecies of the Peregrine Falcon (*Falco peregrinus* L.), inferred from mitochondrial DNA control-region sequences. – *Auk*, **130** (1): 78-87.

Wightman C. S., M. R Fuller 2005. Spacing and physical habitat selection patterns of Peregrine Falcons in central West Greenland. – *Wilson Bulletin*, **117** (3): 226-236.

Wink M., I. Seibold 1996. Molecular phylogeny of Mediterranean raptors (Families Accipritidae and Falconidae). – In: Muntaner J., J. Mayol (eds.): Biology and conservation of Mediterranean raptors, 1994. Madrid (SEO). 335-344 p.

Yosef R., B. Gołdyn and P. Zduniak 2011. Predation of migratory Little Stint (*Calidris minuta*) by Barbary Falcon (*Falco pelegrinoides*) is dependent on body mass and duration of stopover time. – *Journal of Ethology*, **29**: 257-261.

Zabala J., I. Zuberogoitia 2014. Individual quality explains variations in reproductive success better than territory quality in a long-lived territorial raptor. – *Plos One*, **9**: e90254.

Zuberogoitia I., J. F. Ruiz-Moneo and J. J. Torres 2002. The Peregrine Falcon. Bilbao (Servicio Publicaciones de la Diputación Foral de Bizkaia). 291 p. (In Spanish).

Zuberogoitia I., J. E. Martínez, J. A. González-Oreja, J. F. Calvo and J. Zabala 2013. The relationship between brood size and prey selection in a Peregrine Falcon population located in a strategic region on the Western European Flyway. – *Journal of Ornithology*, **154**: 73-82.

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