

Nesting habitat and breeding success of *Fulica atra* in tree wetlands in Fez's region, central Morocco



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Abstract The current study was intended to investigate the breeding habitats and ecology of the Eurasian coot *Fulica atra* in Fez region Morocco. To achieve our goals, nests were monitored in three wetlands Oued Al Jawahir river, Mahraz and El Gaada dams. In addition, nesting vegetation and nest's dimensions were analysed to characterise the Eurasian coot nests. As results, 46 nests (74%) were found in Oued al Jawahir, compared with 15 nests (24%) in Mahraz dam. In El Gaada dam only 2 nests were built by the Eurasian coots. On the other hand, all nests were built on the riparian vegetation of the river and dams. Besides, nests were located in the periphery of the river stream. Many plants were used entirely or special parts, such as stems and roots in nesting activity. *Typha angustifolia* is used in 45.3% of nests and *J. acutus* in 38.6% of nests. Other plants are found with a minor presentation in nests, including *P. stratiotes* (9.6 %) of nests, *Phragmites australis* (5.6%), and *Tamaris* sp. (0.9%). These plants form the structure of nests and support. Besides nesting in river's periphery, the nests were constructed at an average height of 14.5 ± 0.05 away from the stream of water. Concerning nest success, nest predation ranged from 57% (2018) to 60% (2019). Nests were lost due to water stream and human disturbance. Finally, Eurasian coots build its nests in the periphery of water ecosystems and in an important high to avoid flooding periods and human disturbances.

Keywords: dam, ecology, Eurasian coots, nests, river, sites

Introduction

Adaptive habitat-selection theory predicts that individuals must select zones with habitat features that optimize their fitness, or breeding success (Orians and Wittenberger 1991; Morris 2011; Gibson et al 2016). Besides, the relationship between habitat selection and fecundity, including breeding success is complex, and can be influenced,

in part, by interspecific (Fretwell and Lucas 1969; Jones 2001) and intraspecific interactions (Morris 1989), climate contrast (Martin 2001), and habitat degradation (Feary et al 2007).

Understanding the dissimilarity between adaptive and maladaptive animal use of habitat is needed for any conservation issue because animal use of inadequate habitat is counter to conservation drives (Case and Taper 2000). Because species conservation worry often occurs in disturbed habitats (Belaire et al 2014), patterns in habitat use in these species may not always be revealing of the habitat conditions vital for population stability, yet "use" is often used as the main metric for delimiting conservation areas (Kautz et al 2006).

Despite its abundance in Europe, Africa and Asia, the Eurasian coot breeding habitats were largely influenced during current years (Walesiak et al 2019). Habitat modification and loss were the most relevant threats to this water bird (Geldmann et al 2013; Cherkaoui et al 2015; Kumar et al 2017). With its gregarious breeding strategies, the loss of nesting habitats, especially in arid zones, such as North Africa (stopover site for Trans-Sahara migrants, an over-wintering site for ducks and waders), the population of Eurasian coots might decline in these areas (Benhoussa et al 2006; Amezian et al 2007). Moreover, data analysing this issues (nesting sites, breeding success, population trends...) are limited in term of habitats, geography and time (Cherkaoui and Lamrani Alaoui 2007; Benhoussa et al 2006; Baaziz et al 2011). Breeding habitats of these birds are less analysed, most studies focused on the signalling the nesting status (Dakki et al 2002; Qninba et al 2008, 2009) without any interest to nesting and breeding success. Therefore, determining the nesting sites, success rates, loss factors with an examination of habitat selection, nest survival, and predator identification will be vital for this species.

The objectives of this study were to investigate the breeding habitats of the Eurasian coots over a tree wetland in

the Fez's region, central Morocco, and then to analyse their nesting ecology throughout the study area. In parallel, breeding success, nesting sites and materials were studied to overview the population trends in this zone.

Materials and Methods

Study Site

The case study was carried out in Saiss plain (Morocco), around the imperial city of Fez (Figure 1). Average rainfall in the Saiss plain is 500 mm/year, enabling rainfed cultivation of cereals and forage crops over extensive areas. Cattle raised for milk and meat exert little pressure on groundwater resources, as cattle raising relies on a mix of rainfed and irrigated forage crops and imported feed concentrate (Ameur et al 2017). Irrigated farming, principally horticulture and fruit trees, is essentially founded on pumping groundwater. The Saiss aquifer system involves two superimposed and connected aquifers, an unconfined shallow phreatic aquifer and a deep Liassic confined aquifer (Laraichi et al 2016). According to Ministry of Agriculture and Fisheries statistics, in 2012, an estimated 45,000 ha of irrigated farmlands in the Saiss plain, representing more than 91% of the surface in the area, depended on groundwater use. Besides, this strategic zone is characterized by the diversity of wetlands, including dams, lakes and Rivers (Quarouch et al

2014, Ouassou et al 2018). These ecosystems shelter an important community of avian and other animal taxa (Ouassou et al 2018).

Basing on early field prospectations during 2015 and literature citing The Eurasian coot breeding sites in the Fez's region, three wetlands were fixed. El Mahraz dam (33°57'57.54"N, 4°58'10.95"W), El Gaada dam (34°1'3.86"N, 4°57'12.40"W) and Oued Al Jawahir River (34°1'12.05"N, 5°5'54.71"W). All sites are between 310–494 m altitude and are surrounded by agricultural farmlands, including main cereals (~ 50%), olives (~ 35%) and others (~ 15%), but they differ in topography and the vegetal cover. Oued Al Jawahir River has a 15 km distance and dominated by *Juncus acutus* (25%), *Typha angustifolia* (22%), *Tamarix* sp. (15%), coniferous (10%), Reed (*Phragmites australis*) (9%), *Accacia* sp. (8%), *Eucalyptus* spp. (5%), and other semi-aquatic plants (e.g. *Pistia stratiotes*, *Ranunculus aquatilis*, *Lemna minor*, *L. gibba*, *Typha angustifolia*, *Salix* spp.). In El Mahraz dam *Tamarix* sp. Dominate 70% of the surface, followed by *Typha angustifolia* with 18% and *Phragmites australis* with 12%. On the contrary, El Gaada dam was poor in vegetation, only 12% of the periphery was covered by *Typha angustifolia*. This characteristic is supposed to be key in determining breeding attempts of the Eurasian coots, with an offer of nesting materials and supports.

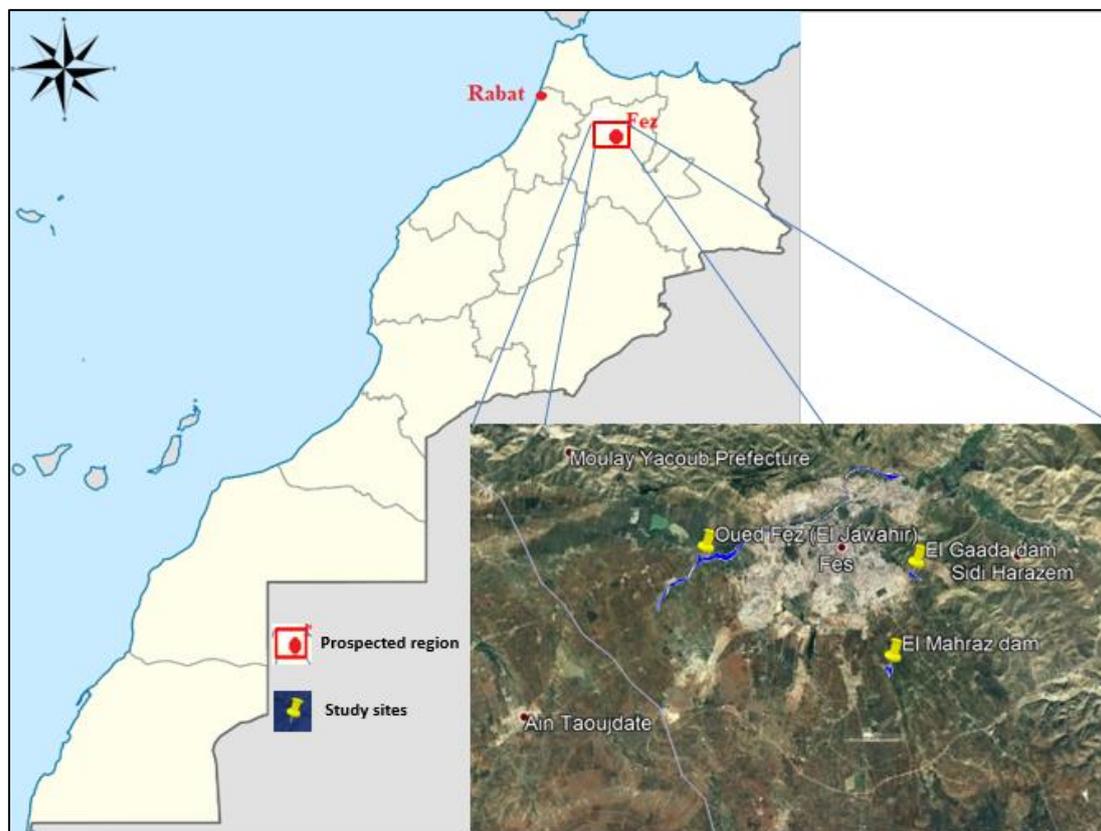


Figure 1 Geographical location of the tree wetlands of the Fez's region (Saiss plain, Morocco).

Methods

Fieldwork was carried out twice a week, and nests were explored inside river and dams vegetation. Recorded nests were mapped and labelled with a distinct code, besides the height of the nest (cm) above water and its diameter (external and internal, cm) were measured (Figure 2). To investigate

nesting site preferences (distance to water stream) in relation with water body, nest distances to the centre and periphery of wetlands water body were estimated visually. In parallel, at the end of breeding periods (Mai 2018, 2019), Nests were taken and analysed in the laboratory to identify their composition concerning the vegetation and used twigs.

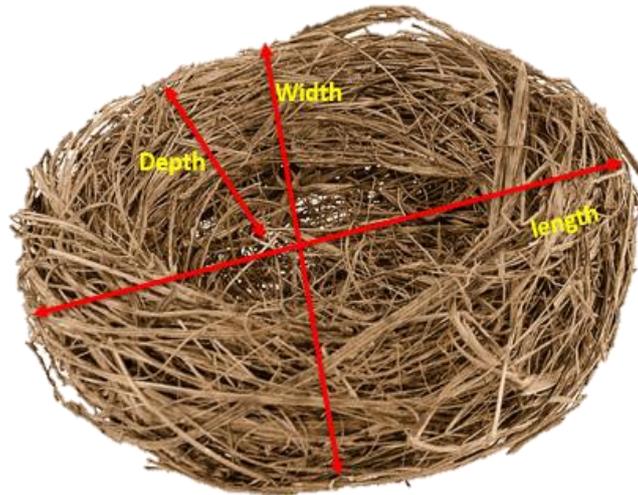


Figure 2 Nest's dimensions.

Statistics

Descriptive statistics were used to analyze data. Statistical tests were done in R software, version R2.12.2 (R Core Development Team 2009). The breeding success was analysed in Percentage and graphs were created with GraphPad Prism 6.01. Similarly, nesting twigs were recognised for each nest (stems-based twigs, twigs of mixed nature and root of plants) and the vegetation was identified (percentage). On the other hand, nest dimensions were calculated and results were given as mean \pm SD. Additionally, the correlations between great axis (length), width (small axis) and depth (thickness) were analysed with Spearman's correlation.

Results

Nesting habitats

The survey recorded tree breeding sites of The Eurasian coot in wetlands surrounding Fez (Table 1). Oued Al Jawahir river counts 46 nests and El Mahraz dam counts 15 nests. El Gaada dam was inhabited by the study species. In parallel, the vegetation cover was important in Oued Al Jawahir and El Mahraz, while El Gaada was only 12 % covered with vegetation. Moreover, high nesting rates were located in habitats with high vegetation density. On the other hand, human activities, including fishing, pollution and urbanism were intense in Oued Al Jawahir, where nesting rate was high.

Breeding success

In total, 63 of the nest were monitored for two years. 58.5% of them were a success, while 41.5% failed (Figure 3). The breeding success was high in Oued Al Jawahir River compared to El Mahraz dam.

The majority of nests were lost due to water stream and human disturbance, which cause the loss of 41.5% of nests (43% of the nest during 2018 and 40% in 2019). Moreover, all nests were built at the periphery of the habitats, to avoid the variation of the water stream.

Nest composition

Nests were built in peripheries of wetlands. The majority of nests are constructed by stems-based twigs (59.8%) and twigs of mixed nature (31.38%), while the minor part of nests (8.82%) are built only by the root of plants (Figure 4). However, the composition of the nest (twig type) influences the nest size of the bird. The stems based nests were much higher compared to the nests built by the roots (Table x). Different plants are used in nest structures. *Typha* (*Typha angustifolia*) and spiny rush (*Juncus acutus*) were the most common plants in the nest structures. *Typha angustifolia* is used in 45.3% of nests and *J. acutus* in 38.6% of nests. Other plants are found in nests, *P. stratiotes* 9.6 % of nests, *Phragmites australis* (5.6%), and *Tamaris* sp. (0.9%). These plants form the structure of nests and support eggs and checks.

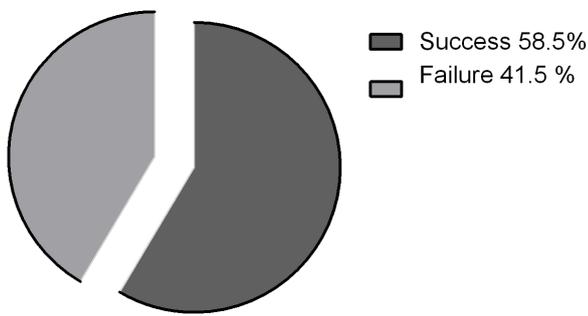
Nests of the Eurasian coot were characterized by a large diameter of an average of 33.9, small diameter of 31.2 on average and an average thickness of 11.6 cm. Besides, the

correlation presented in Table 2 shows that there is no significant correlation between the different dimensions of the

nests. Indeed, the correlation coefficients were very low between all the sizes of the nests.

Table 1 Description of the nests and their habitats.

	Habitat Type	Status of the habitat	% of hygrophilous vegetation bordering rangeland	Number of nests		Human impact
				2018	2019	
Oued Al Jawahir	River	Site of biological and ecological interest	80%	18	28	-Pollution -Fishing -Urbanism -Tourism
El Mahraz	Dam	Unclassified wetland	65%	5	10	-Tourism
El Gaada	Dam	Unclassified wetland	12%	2	0	-Urbanism -Tourism



Total=63 Nests

Figure 3 Breeding success of the Eurasian coot in Fez’s region.

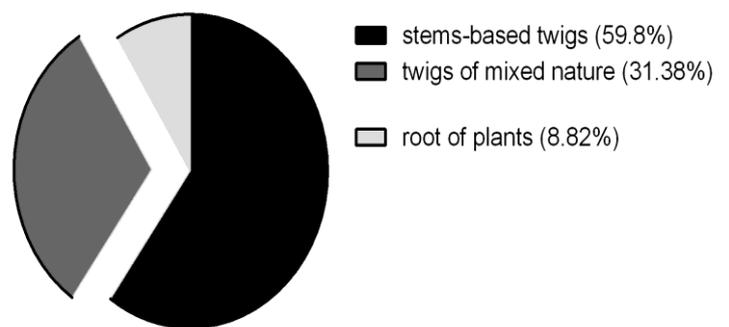


Figure 4 Twigs and nesting materials used by the Eurasian coot.

Discussion

Nest building in wild birds is an important issue to understand one of the most axial phases in avian cycle life (Collias and Collias 1984; Hansell 2000). Unfortunately, this topic wasn’t analysed enough in term of species and term of geographical distribution (Mainwaring and Hartley 2013). In this work, we analysed the nesting ecology of the Eurasian coot in three North African wetlands. The result shows a great tendency in *Fulca atra* to build nests in the river (Oued Al Jawahir in our case). In reality, 74% of nests were found in Oued al Jawahir, compared with 24% of nests in Mahraz dam, while in El Gaada no nest was found. This nest abundance in the river might due to the richness of Oued Fez in vegetation and food availability as noted by Perrin et al (2014) and Khabbach et al (2019). On the other hand, the wide surface and long-distance of Oued al Jawahir River could offer a variety of habitats and location to the Eurasian coot to build a save nests (Olsen et al 2006; Leslie 2001). In particular, these birds are known by their gregarious behaviour (Leslie 2001; Severcan and Yamaç 2011), which require a wide wetland’s habitats for feeding and breeding as the case of many other species that live in flocks (Fortunati 2011; Angelici 2012). In

the studied wetlands, Oued al Jawahir was the largest Ecosystem when compared to El Gaada and Mahraz Dams.

Table 2 Correlation between the different sizes of nests.

	Depth	Length	Width
Depth	-	0.39	0.15
Length	0.10	-	0.00
Width	0.16	0.38	-

The construction of nests in wetland’s peripheries is due to low level and stability of water in these marginal zones. (Klutsen et al 1997) have proved the devastating effect of floods in the Mississippi River on Water nesting birds. As a consequence, water birds prefer marginal zones in rivers to protect their nests. In this case. The Eurasian coots started nesting behaviour during mid-February with collection of small twigs and chose of nesting sites. Additionally, coots search for save and adequate places inside a dense vegetation.

Nest dimensions were poorly analysed in avian species (Small et al 1989; Alabrudzińska et al 2003). However, this paper shows variability in nest sizes. The great

axis (length) across the small axis (width) and thickness (depth). In parallel, these dimensions show an important correlation, which could indicate an apparent design (Álvarez et al 2011) to form a bowl for egg's protection.

The use of only two plant's twigs in nest constructions might due to their abundance in studied zones, as mentioned in White-Winged Dove (*Zenaida asiatica*), which uses the abundant and available materials to build nests in selected breeding habitats (Small et al 1989). Oued Al Jawahir, Mahraz and El Gaada dams are dominated by *Tamarix* sp. *Juncus* and *Typha* sp. On the contrary, many avian species, including great tits *Parus major* use a diversity of construction materials such as aromatic and medicinal plants to protect clutches from parasites, in particular, ectoparasites (Eeva et al 1994; Ttripet et al 2002; Álvarez and Barba 2008; Clayton et al 2010; Cantarero et al 2014).

Conclusions

We are concluded that *Fulca atra* preferred nesting in the Al Jawahir River. Moreover, nests were located in wetland's peripheries, far from water stream. Finally, this study provides an initiation to identify Breeding sites, nesting strategies and breeding success of the Eurasian coots in North African wetlands. In addition, this work can be integrated in a conservative approach to protect this gregarious species and their vulnerable habitats.

Conflict of Interest

The authors declare no conflict of interest.

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