ECOLOGICAL AND BIOLOGICAL BEHAVIOR OF NESTING COLONY OF *BUBULCUS IBIS* IN NORTH-WESTERN ALGERIA

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ABSTRACT

Mohammedi, A., Kouidri, M., Mahmoudi, A., & Ababou, A. (2020). Ecological and Biological Behavior of Nesting Colony of *Bubulcus ibis* in North-Western Algeria. *Lebanese Science Journal,* 21(1), 1-11.

We studied a colony of the Western Cattle Egret Bubulcus ibis located in the public garden on the northern outskirts of Chlef, north-western of Algeria, a site with 13 tree species; in this locality Cattle Egrets nested only on Ficus elastica, Jacaranda mimosifolia and Pinus halepensis. We observed the birds, each two weeks during the wintering period and weekly during the breeding season (February to August). To count the colony population, we used the method described by Dragonetti & Giovacchini (2009), called perimeter counts. Egg and nestling were recorded on 20 randomly selected nests and from different locations in each of the three nesting trees until all fledging. The number of Cattle Egrets at this site varied according to season, and was higher during the breeding season (1902 individuals) than during the wintering period (1210 individuals). Depending on the morphology of the trees hosting this colony, numbers of these birds varied from one tree to another. The nests observed are placed at relatively low heights, contrary to what has been described by some authors. Reproductive success is affected by the environmental conditions of the area and also by the physical and perhaps biochemical characteristics of the nest trees, but no difference in the location or orientation of the nests was noticed.

Keywords: *Bubulcus ibis*, nesting colony, breeding, wintering, behavior.

INTRODUCTION

The Western Cattle Egret *Bubulcus ibis* (Linnaeus 1758) is a water bird adapted amazingly to numerous terrestrial and aquatic habitats (Siegfried, 1978; Mora & Miller, 1998). The variety of habitats used for his feeding is consistent with its opportunistic diet (Si Bachir et al., 2012, Kioko et al., 2016). The most natural expansion of this bird has been remarked since the early of 20th century (Lowe et al., 1994; Mc Killigan, 2005) due to diverse factors, such as the availability of suitable habitat for nesting, average size of the clutches and high rate of breeding success (Si Bachir et al., 2000; Setbel, 2008). In addition, the creation of suitable foraging habitats, livestock farming and development of irrigation in desert regions have supported mainly this expansion (Dekeyser & Negrett, 1978).

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In Algeria, the Cattle Egret is distributed throughout the north part of the country, even in the extreme north-east and elsewhere in the Tell (Heim de Balsac & Mayaud, 1962) as well as in the semi-arid and wetter coastal plains (Ledant et al., 1981). This species has become an abundant breeder in several parts of these regions, particularly in the east, center, west and the Highlands (Moali & Isenmann, 1993; Moali, 1999; Isenmann & Moali, 2000; Boukhemza et al., 2004; Mohammedi & Doumandji, 2013) The number of registered colonies increased from 51 to 87 between 1999 and 2007 with, approximately, 31160 breeding pairs in 2007 (Si Bachir et al., 2011). However, this figure is certainly due to the exclusion of important regions.

The biological and ecological behaviour of Cattle Egret colonies varies from one region to another, depending on certain intrinsic factors, but mainly by extrinsic factors, such as the availability of water and prey (Mohammedi et al., 2016) and the quality of nest trees for the safety of nests and chicks (Si Bachir et al., 2011). In this context, we have studied for the first time a colony of *Bubulcus ibis* located in the center of Algeria, in order to examine its ecobiological behaviour depending on the specific surrounding factors mentioned above.

METHODOLOGY

The colony studied is located in the public garden (at about 101 m a.s.l.) in the outskirts of the city of Chlef (Figure 1), North-West Algeria. For colony monitoring, we used non-invasive methods and all surveys and observations were done without disturbing birds. However, to count the colony population, we used the method described by Dragonetti & Giovacchini (2009), called perimeter counts, where two observers are placed on both sides of the colony. Three hours before sunset, they count first herons perched in the colony, then all incoming and outgoing birds. The count stopped one hour after sunset. The result of the algebraic sum of incoming (added) and outgoing (entrenched) birds is added to the initial number. The results obtained by the two observers represent the total population of the heronry. This technique allows birds to be counted without disturbing them.

The heronry site hosts 13 arboreal species, but the Cattle Egret nested on 3 species only, *Ficus elastica* (Moraceae), *Jacaranda mimosifolia* (Bignoniaceae) and *Pinus halepensis* (Pinaceae). From each of these three species, we selected five trees, none adjacent, which we measured different characteristics (height, circumference of the trunk at chest height, diameter of the canopy, shape of the covered of each tree). Observations were carried out over one year with one visit per month during the wintering period and once per week during the breeding season (February to August). Each selected tree was divided vertically into three equal parts (top, middle and bottom) and horizontally into two equal halves (inner and outer) resulting in five cover portions. At each visit the characteristics of nests and eggs, the number of nests per portion and per tree, eggs and nestlings per nest were counted. To nest count, the number of nests per unit volume of tree canopy rather than the number of nests/unit area of land mass was calculated; the last parameter requires sophisticated technologies such as aerial survey, aerial photography and GIS (Hilaluddin et al. 2005). Thus, calculation by hand of the volume of the tree along 3 axes by at least 2 people was adopted in the current study. Nest abundance has

been estimated by counting the number of nests per m³ of canopy volume of each nesting plant species.

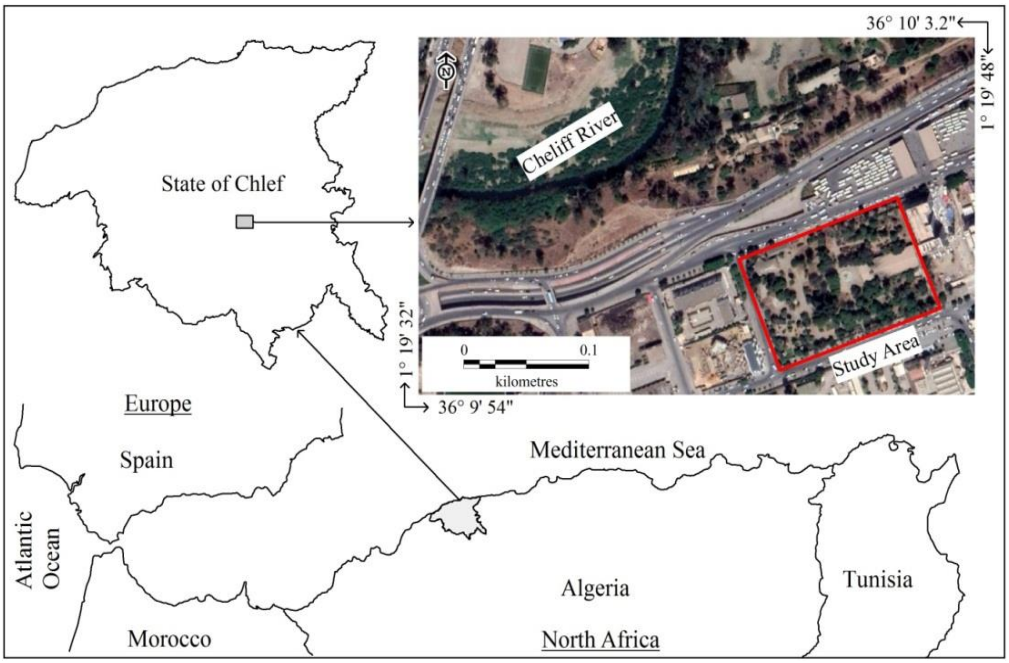

Figure 1. Location of the study area.

Egg and nestling evolution was monitored on 20 randomly selected nests and different locations in each of the three nest trees. Thus, the observations made throughout the year permit to note the different life stages of the species studied as well as the activities of the young and adults of Cattle Egret both inside and outside the heronry. Comparison of tree species effect on the number of eggs, number of hatched eggs and number of chicks was performed using analysis of variance (ANOVA), followed by mean comparison assessed by Duncan and SNK tests.

RESULTS

In the present study, the breeding period was extended from February to August, the post-breeding period from September to October and the wintering period from November to January. Thus, the high population's size of the colony was recorded during the breeding season attaining 1902 individuals, followed by the post-breeding period (1557 individuals); the overwintering period registered the lowest size (1210 individuals) (Table 1).

As can be seen from the Table 2, the highest number of Cattle Egret pairs was remarked in *Ficus elastica*, in the other hand the species *Jacaranda mimosifolia* and *Pinus halepensis* showed the lowest number of pairs. The averages of eggs per nest, remarked during the current study, were 4.7 ± 1.18, 3.8 ± 0.87 and 3.4 ± 1.11 eggs per nest on *Ficus elastica*, *Jacaranda mimosifolia* and *Pinus halepensis* respectively. These findings showed that *Ficus elastica* is more attractive than other trees for Cattle Egret's breeding. However, the highest survival rate after egg hatch has been noted in *Pinus halepensis* with 91.2% followed by *Ficus elastica* (89.4%) and *Jacaranda mimosifolia* (84.21).

Based on our observation, the most important survival rate after fledging has been 83.0% on *Ficus elastica*, succeeded by 73.5% on *Pinus halepensis* and lastly by 63.2% on *Jacaranda mimosifolia*.

Table 1. Average number and total number of *B. ibis* on the three nesting trees in the heronry.

Caracters	Breeding period	Post-breeding period	Wintering period
	II – VIII	IX – X	XI – I
Ficus elastica (N= 10)	750 (75)	600 (60)	520 (52)
Jaracanda mimosifolia (N=15)	870 (58)	675(45)	540 (36)
Pinus halepensis (N=6)	282 (47)	282 (38)	150 (47)
Total	1902 (61.35)	1557 (50.22)	1210 (39.03)

Table 2. Reproduction data of *B. ibis* in Chlef area.

Parameters	Number of nests	Number and average of eggs	Number of hatched eggs	% of hatched eggs	Number of chicks	% of survival
Ficus elastica	20	94 (4.7 ± 1.18)	84	89.36	78	82.98
Jacaranda mimosifolia	20	76 (3.8 ± 0.87)	64	84.21	48	63.16
Pinus halepensis	20	68 (3.4 ± 1.11)	62	91.17	50	73.53

The variation of different parameters depending on the trees harbouring the nests is related to the morphometric characteristics of each species, especially the height. The most attractive species for the Cattle Egret was *Ficus elastica*; is characterized by height between 5 and 8 m, the nests are placed between 4 and 7.5 m from ground level (average number of nests per tree estimating at 23 nests). Each nest includes an average of 4.7 eggs with a total of 108.1 eggs per tree. From this total, 96.6 eggs hatched in each tree representing 4.2 eggs hatched/nest and 3.9 fledglings per nest that is 89.7 chicks per tree.

Jacaranda mimosifolia has a height between 6 and 10 m, but heron's nests are between 5 and 9 m with average number of nests estimated at 15 nests per tree; these results represent an average of 3.8 eggs/nest (57 eggs/tree). The hatched eggs averaged 3.2 nestlings/nest that represent 48 hatched eggs/tree whereas the average number of fledglings was 2.4/nest (36 young birds per tree). In the case of *Pinus halepensis*, characterized by a height ranging from 10 to 15 m, an average of 9 nests/tree were noted between 7 and 13 m high; each nest contained an average of 3.4 eggs for a total of 30.6 eggs per tree. Only 3.1 eggs/nest hatched (27.9 eggs hatched per tree) and its fledglings amounted to 2.5/nest (22.5 chicks/tree) (Table 3).

Table 3. Eco-biological characters of the colony of *B. ibis.*

Species	***F.elastica***	***J.mimosifolia***	***P.halepensis***
Tree height (m)	5-8 m	6-10 m	10-15
Nest height/ground (m)	4-7.5	5-9	7-13
Average number of nests/tree	23	15	9
Average number of eggs/tree	108.1	57	30.6
Number of eggs hatched/tree	96.6	48	27.9
Number of chicks/tree	89.7	36	22.5

Analysis of variance ANOVA

The ANOVA analysis between the three species of trees showed that means are significantly different ($P < 0.05$) in term of number of eggs and number of hatched eggs and highly significantly different ($P < 0.0001$) in term of number of chicks according to Duncan and SNK tests. The highest means were always found in *Ficus elastica* while the lowest in *Pinus halepensis* (Table 4). Furthermore, almost 21% of the number of eggs (R2=0.21), 23% of hatched eggs (R2=0.23) and 53% (R2=0.53) of number of chicks were explained by the habitat (type of tree).

Table 4. Analysis of variance (ANOVA) of the number of eggs, number of hatched eggs and number of chicks in the three different habitats.

Caracters	**Number of eggs**	**Number of hatched eggs**	**Number of chicks**
Ficus elastic	4.7^{a}	4.2^{a}	3.9^{a}
Jacaranda mimosifolia	3.8^{ab}	3.2^{ab}	2.3^{b}
Pinus halepensis	3.4^{b}	3.1^{b}	2.5^{b}
P-value	0.044	0.027	< 0.0001
R^2	0.21	0.23	0.53

* The indices (a) and (b) in each species of tree. The significantly different averages according to Duncan and Newman-Keuls tests were assigned different indices, whereas the non-significantly different averages were assigned the same index.

Life cycle of the Cattle Egret

The population of Cattle Egret has been monitored for one year into and outside the heronry, to determine its life cycle. This species bred one time per year with a single breeding period (Table 5).

Table 5. Dates of the life cycle of *B. ibis.*

Months	Weeks	Biological stages	Functions provided by adults
I		No sign of breeding	Wintering
II	1st week	Appearance of breeding plumage.	Acquisition of breeding characters
III	2nd week	Appearance of the first pairs	Nest building and mating
IV	1st week	Observation of the first clutches	Incubation of eggs (early April-early May)
V	1st week	First outbreaks	Breeding chicks by parents
VI	2nd semaine :	First flights	
VII		Continuation of flight of chicks	
VIII	2st week	Desertion of nests	
IX		Nests abandoned	Assistance of fledglings in feeding areas
X			
XI			Wintering
XII			

DISCUSSION

Number of *B. ibis* in the heronry

The number of Cattle Egrets varied according to the phenology of the species, with higher numbers during breeding than overwintering. Our results are in agreement with the study mentioned earlier by Chalabi-Belhadj (2008) in the wetland complex of El Kala in eastern Algeria. The decrease in the number of herons during the pre-breeding phase (January-February-March) was caused by the departure of a part of the population to winter in other sites. This reduced the number of the wintering individuals in the study site (Franchimont, 1986). In the post-breeding phase (August-September), the Cattle Egret was characterized by slight decrease; this phase corresponds to the end of nesting period, hence the dispersal of adults and their fledglings (Chalabi-Belhadj, 2008).

Depending on the morphology of trees hosting the colony, the numbers of these birds varied from one tree to another. However, *Ficus elastica* hosted the larger population than *Jacaranda mimosifolia* and even more than *Pinus halepensis*. This may be related to the volume of vegetation cover and probably the large foliage that provides hides and subsequently security.

In the current study, the selection of nest trees by Herons has attracted some interest, where wintering sites have been rarely studied previously. Some factors that influence these choices are cited by some researchers (Hafner, 1982; Fasola & Alieri, 1992; Grussi et al., 2000; Mohammedi, 2015; Mohammedi et Kerrouzi, 2017), but other parameters related to the biochemical and physiological characteristics of the plant may have possible effect and deserve to be studied. Overwintering and breeding populations have been observed on *Phoenix canariensis* and *Schinus molle* (Setbel, 2008), *Fraxinus sp*. (Si Bachir et al., 2000), on *Eucalyptus sempervirens, Platanus orientalis, Fraxinus angustifolia, Cupressus macrocarpa* and *Araucaria sp*. (Boukhemza et al., 2006).

Nest locations

A good nesting site generally provides protection from predators, stability and adequate gear to support and build the nest, in addition to access to foraging areas (Beaver et al., 1980; Gibbs, 1991; Hafner & Fasola, 1992). In addition, nest location also promotes successful hatching and successful rearing of young (Ludwig et al., 1994). The places chosen by the bird for nesting do not seem fortuitous, but probably for more safety during the breeding season. The Cattle Egret places habitually their nests in fork-shaped branches to keep them well protected and to avoid being swept away by storms and thunderstorms (Sharah et al., 2008).

The results of the current study showed that the Cattle Egret can nest at relatively low heights of 4 to 5 m, sometimes less depending on the height and shape of the canopy. Previous studies have reported nests between 8 and 18 m on *Phoenix canariensis* and *Schinus molle* in the Hadjout area (Setbel, 2008) and on ash trees in El Kseur (Si Bachir et al., 2000) and over 18 m in Kabylie region on *Eucalyptus sempervirens* (Boukhemza et al., 2006). In addition to choosing the place for security, in an arid zone of Nigeria, herons have a predilection for thorny trees such as *Acacia albida, A. mellifera, A. sayel, Balanitis aegyptica* and *Azadiracta indica* (Shara et al., 2008). The same finding is noted in India for a thorny tree called kikar (*Acacia nilotica*); this can prevent or at least make predation difficult (Abdullah et al., 2017).

Breeding success

In the study area, the reproduction of Cattle Egret breeds was important on *Ficus elastica*, slightly less on *Jacaranda mimosifolia* and lower on *Pinus halepensis*. These broods are higher, compared to those recorded by Setbel (2008) in Mascara and Hadjout regions with an average of 2.62 eggs/nest, in the Soummam with 2.77 eggs per nest (Si Bachir et al., 2000) and in Texas in the USA (Telfair et al. 2000).

In India, clutch size is 3 to 4 eggs (Kour & Sahi, 2012; Kler et al., 2014; Abdullah et al., 2017); however, 3 eggs per nest are common but those with 5 eggs are exceptions (Abdullah et al., 2017). Clutch size varies from year to year for the same colony and from colony to colony in the same year (Parejo et al., 2001).

The physical characteristics of each of these trees can be the cause of this variation. In the case of our study, *Ficus elastica* provided more security to the nests by its solid trunk, almost 2 meters in diameter, which can withstand heavy branches and leathery leaves that protect them from the winds and hide them from predators.

According to Si Bachir et al. (2000), in The Soummam region, Cattle Egrets select the tallest trees to build their nests and selects breeding sites that are less frequented and less disturbed by humans. However, the colony studied have been installed in a public garden frequented by humans and aligned to a national road congested by the machines. The presence of man and the noise of gear can cause repellent effect on predators (Abdullah et al., 2017).

The survival rate after eggs hatching and the survival rate after fledging of chicks, varies between species of trees. This rate depend also on the region (Setbel, 2008), but the frequent rate varies from 70% to just over 80% (Si Bachir et al., 2000; Boukhemza et al., 2006; Patankar et al., 2007).

The reproduction of *Cattle Egret* depend on environmental conditions of the region and also on the physical characteristics and perhaps biochemical characters of trees, but no difference regarding the location or orientation of the nests was noted (Petry & Fonseca, 2005). Mora & Miller (1998) did not even note any difference in breeding success between nesting colonies near a residential area in Bryan (Texas) and other colonies located in non-urban environments. These birds appear to be very tolerant to different disturbances (Hilaluddin et al., 2005), but nest densities are influenced by climatic conditions (Bennets et al., 2000).

Life cycle

The breeding season of the Cattle Egret varies depending on the region; in Algeria it lasts from the first week of February to the second week of August, in India the breeding starts in April (Patankar et al., 2007; Abdullah et al., 2017), sometimes in March (Kour & Sahi, 2012).

The nesting, which began in early April and ended in the second week of August corresponds to those noted by Hafner (1982) in the camargue in France and by Setbel (2008) in Hadjout area of Algeria. although, precocious nestings were noted by Boukhemza et al. (2006) in Kabylie of Algeria and Prosper & Hafner (1996) in the Albufera de Valencia in Spain.

Two breeding periods, in May and June, are noted in Algeria (Si Bachir et al., 2000; Boukhemza et al., 2006) and in Spain (Prosper & Hafner, 1996), our study disagrees with this published data. Some studies suggest that for insectivorous birds such as Cattle Egret, there is a correlation between breeding and the appearance of potential prey in sufficient quantity for feeding females to form eggs and feed their young (Elkins, 2001).

The incubation period lasts one month, but shorter periods of 21 to 25 days are reported in India by Kour & Sahi (2012) and Abdullah et al. (2017). It is the most vulnerable period, when the colony suffers the greatest losses. Young chicks are first raised in their nests by their parents for about 5 weeks and continue to be assisted outside the nests. Shara et al. (2008) report that chicks leave their nests when 56 to 60 days old. They become independents 70 days after hatching. During the transition period to independence, young must not only know where to eat, but how to feed themselves, which may require a long learning period to be able to feed as effectively as adults, and no doubt they improve with age (Espin et al., 1983).

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