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Original Article

Bioecology and breeding performance of cattle egret (*Bubulcus ibis*) in selected sites at Sharkia Governorate, Egypt

Bioecologia e desempenho reprodutivo da garça-boieira (*Bubulcus ibis*) em locais selecionados na província de Sharkia, Egito

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Abstract

Cattle egret *Bubulcus ibis*, feeds on insect pests in many agro-ecosystems. Thus, there is an urgent need to study the breeding chronology of cattle egret, in order to develop suitable protection programs for this beneficial bird to perform its role as abiological control agent in Egyptian agro-ecosystems. The study was conducted at Sharkia Governorate, Egypt, from December 2018 to December 2020; in different habitats (irrigation canals, drainage canals, garbage collection areas and Abbasa ponds). The mean clutch size ranged from 2-5 eggs/nest with an incubation period ranging between 21-25 days. The mean percentage of hatching success was 90.21%, while the total number of mortality eggs was 47 and the total egg hatching was 433. Also the total number of nests located nearby tree trunks were 73, while nests located in the core of the tree were 47 nests, and nests located at the peripherals were 15 nests.

Keywords: breeding, cattle egret, hatching, incubation, nests, trunks.

Resumo

A garça-vaqueira (*Bubulcus ibis*) alimenta-se de insetos-praga em muitos agroecossistemas. Assim, há uma necessidade urgente de estudar a cronologia reprodutiva da garça bovina, a fim de desenvolver programas de proteção adequados para que esta ave benéfica desempenhe seu papel como agente de controle biológico nos agroecossistemas egípcios. O estudo foi conduzido na província de Sharkia, no Egito, de dezembro de 2018 a dezembro de 2020; em diferentes habitats (canais de irrigação, canais de drenagem, áreas de coleta de lixo e lagoas Abbasa). O tamanho médio da ninhada variou de 2-5 ovos/ninho com um período de incubação variando entre 21-25 dias. A porcentagem média de sucesso de eclosão foi de 90,21%, enquanto o número total de ovos de mortalidade foi de 47 e o total de ovos eclodidos foi de 433. O número total de ninhos localizados próximos aos troncos das árvores foi de 73, enquanto os ninhos localizados no núcleo da árvore foram 47 ninhos, e 15 ninhos localizados nas periferias.

Palavras-chave: criação, garça-boieira, eclosão, incubação, ninhos, troncos.

1. Introduction

The cattle egret, *Bubulcus ibis*, belongs to order: Pelecaniformes (Issa, 2019). It is a cosmopolitan species of heron (Family: Ardeidae) found in tropical, subtropical, and warm temperature zones. It has undergone the most rapid, and wide reaching natural expansion (Dalio, 2018). The worldwide success of cattle egret resulted in its ability to survive, and adapt to different environments, also its ability to feed on a variety of prey items such as fishes, frogs, insects and mollusks (Gochfeld and Burger, 1982; Subramanya, 1996; Kopij, 2008; Choi et al., 2016). It's a common breeding resident bird in Egypt across the Nile Valley, Nile Delta, and Suez Canal areas (Goodman et al., 1989). Egg laid through February and July, but in Upper Egypt, laying extends from January to August (Omar and Hassan, 2019). The Cattle egret, *Bubulcus ibis*, is a seasonal monogamy bird; the pairs start to build the nests at breeding season (Kour and Sahi, 2013). Nests are placed in the forks of the trees, nearby the trunk, the core and the peripheral (Arendt and Arendt, 1988; Kour and Sahi, 2012). But the numbers of nests on the tree are affected by the tree species, and diameter of the trunk, and crown (Sbiki et al., 2015). The nests were

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rough, superficial, bowel shaped, not well lined and simple stage (Abdullah et al., 2017).

The aim of this study is to assess some breeding aspects (i.e. Hatching success, fledging rate, clutch size, incubation period, fate of eggs and nest placement) of cattle egret, *Bubulcus ibis*, in different sites at Sharkia Governorate, Egypt.

2. Materials and Methods

2.1. Study area

The study sites were monitored from December 2018 to December 2020 in some districts of Sharkia Governorate (30°34'N, 31°30'E and 16 meter above sea level). The study was conducted at the following sites.

2.1.1. Irrigation Canal Areas (ICA)

Sites were founded around the sides of the Ismailia Canal Branch, in Belbies district. Several Eucalyptus (*E. tereticornis*) trees were scattered around the Canal sides, varied from eight to fifteen meters high, with several crowns according to tree age.

2.1.2. Drainage Canals (DC)

The drainage canals serving agricultural lands and were chosen at Belbies nearby villages. Many tall trees, mainly Acacia (*A. spp.*), Willows (*Salix spp.*), Mulberry (*Morus spp.*) and Eucalyptus (from four to thirteen meters high) were located at both sides of these canals.

2.1.3. Garbage Collection Areas (GCA)

These were located near villages and rural areas. Eucalyptus and Ficus (*F. benjamina*) trees, ranged from two to thirteen meters in height, were located.

2.1.4. Abbassa Ponds (AP)

Belonging to the Central Laboratory of Aquaculture Research, which measures 1,480 feddans (6,216,000 square meters), with open canals and drainages, runing through the ponds. Eucalyptus trees were found nearby and Reeds were grown on some drainage sides.

The birds were observed with naked eye and through a binocular (Bushnell 7x50) (Issa, 2019).

2.2. Data collection

Before the breeding season, old nests were present in old colonies and the new nests were marked by tying plastic tape with a number around the nearest branch to the nest. The most breeding aspects; like nesting, egg laying and incubation were observed at marked nests from March to August during the breeding seasons of 2019 and 2020. Colonies were inspected twice weekly from starting of nesting. Cattle egrets have no agnostic behavior but leave the nests during nest examination.

2.2.1. Nesting

Nesting colony was defined as a site with an aggregation of more than 5 nests. In the nesting colony, individual birds were sufficiently close in order to communicate vocally and visually with neighboring individuals (Gochfeld, 1980). Each egg, within a tagged nest, was marked by drawing a dot on it for the first laid egg and two dots for the second and so on. Any damage to the egg surface was recorded as crush mark, also non-hatched eggs were recorded.

2.2.2. Clutch size, incubation and fledging period

According to the method of (Drent, 1970) clutch size is the number of eggs laid per nest. The incubation period is the number of days elapsed between the last egg laid and the hatching of that egg (Enemar, 1997). The percentage of hatching success was calculated according to Kour and Sahi (2013), as follow: Hatching success % = (Number of egg hatched/Total egg laid) × 100

While the fledged period is the period when the young could fly and leave the nest (Mostafa et al., 2008). A nest that contains at least one hatchling is considered a successful nest (Klett and Johnson, 1982). The young were considered successfully fledged when they were old enough to fly across open space to trees away from the nests (Pratt and Winkler, 1985). The fledging rate measured according to Soliman et al. (2021) as follow:

Fledging rat% = (Number of chick fledged/Total chicks hatched) × 100

2.2.3. Nest placement

Nests were classified according to their positions on the tree:

Peripheral nests: where nests located at peripheral branches.

Core nests: where nests located in the core.

Trunk nests: where nests located nearby the trunk.

2.3. Statistical analysis

Statistical analysis was executed using one-way analysis of variance (ANOVA) to assess the significant difference between the colony sites (e.g. among IC, DC, GC and AP) treatment groups. While differences between means of the two years (e.g. between 2019 and 2020) were compared using Student t test. The mean is expressed as mean ± standard error (SE). The p-value was considered statistically significant at $p < 0.05$. Analysis of data was carried out in SPSS software version 16 as well as Microsoft Excel (Microsoft office, 2007).

3. Results

The photo in (Figure 1) showing some biological aspects associated with breeding of cattle egret *Bubulcus ibis* at Sharkia Governorate.

3.1. Nests, nest site, hatching rate and fledging rate

Most of the nesting sites of cattle egrets were found near human settlements in rural areas, villages and urban areas where the feeding places were in range. Table 1 showed the number of nests monitored during the two studied years as 135 nests, and the total numbers of eggs laid were 480 eggs. The highest number of eggs laid, was 160 eggs in colonies

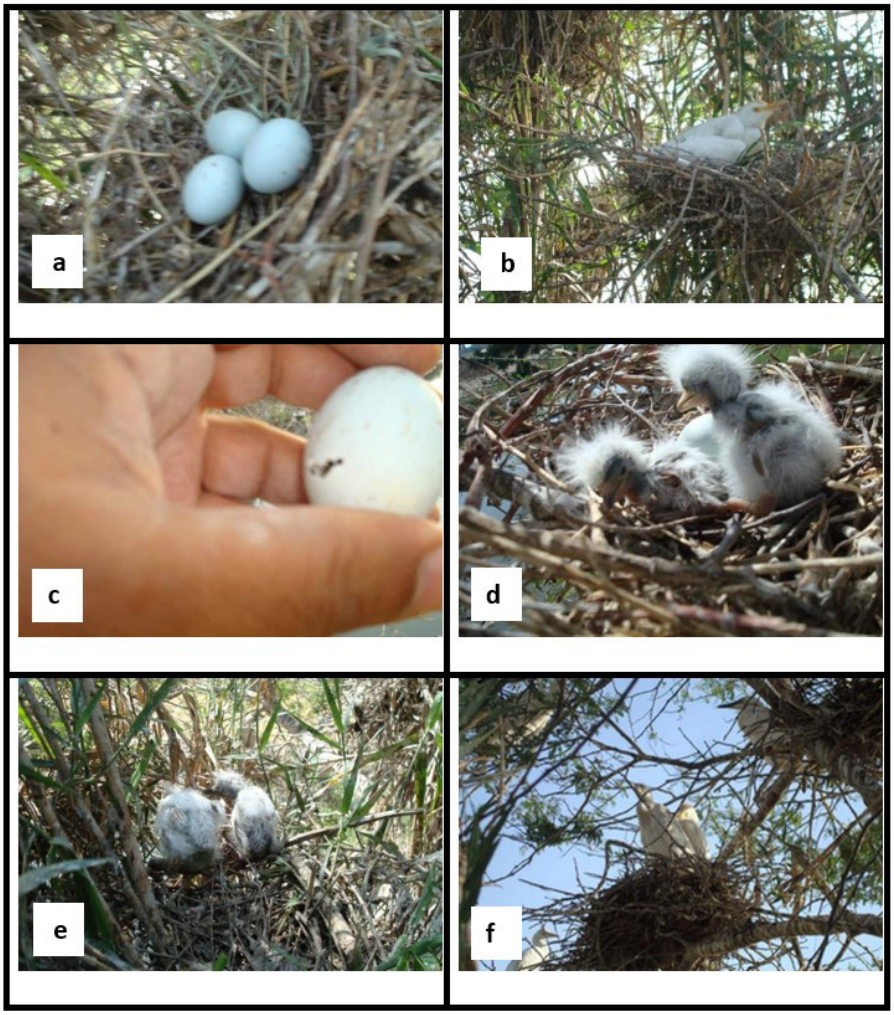

Figure 1. Some biological aspects associated with breeding of cattle egret *Bubulcus ibis* at Sharkia Governorate. (a) Eggs in a nest; (b) Female incubates eggs; (c) Hatching process; (d) Chicks; (e) Fledgling; (f) Adult and immature birds.

nearby the garbage collection area, in 41 nests, while the lowest number of eggs found in colonies nearby irrigation canals (99 eggs), in 29 nests. The total eggs hatched were 433 eggs, which yield 90.21% hatching success. The highest hatching success was in nests at the trees nearby Abbassa Ponds (91.45% hatchability) followed by nests in trees nearby GC (91.25%), then nests located on trees nearby Drainage Canals (89.42%) and finally in nests on trees nearby Irrigation Canals (87.88%). The number of fledged birds was 216 birds (49.88%). The fledging rate at nests in the trees nearby Irrigation Canals was 55.17%, followed by nests located in trees nearby Drainage Canals (51.61%).

3.2. Clutch size

Data in Table 2 revealed that the highest number of nests were 60 with 3eggs/nest, followed by 51 nests with 4 eggs/nest, and the number of eggs per cultch varied from 2-5 eggs/nest. The nests located on trees nearby Garbage Collection Areas received 160 eggs in 41 nests with an average of 3.9eggs/nest, with the highest mean compared with other sites. The average clutch size differed according to the colony site in descending order i.e. 3.59, 3.41 and 3.25 egg/nest at trees nearby Drainage Canals, Irrigation Canals and Abbassa Ponds, respectively.

3.3. Incubation period

Data in Table 3 showed that the incubation period varied from 21-25 days. The highest number of nests (35) recorded 22 days of incubation period during the two years of the study. But the lowest number of nests (9 nests) recorded 25 days of incubation period from a total of 135 monitored nests. The longest days of incubation period was 538 days (equal sum of the multiplication of the number of days in the number of nests, (e.g., 8x21 + 6x22 + 5x23 + 2x24 + 3x25) obtained from 24 nests in year 2019 in the location nearby Abbassa Ponds, with an average of 22.42 days. The grand mean of incubation period of cattle egret was 22.55 days resulting from 135 nests.

Table 1. Parameters of breeding biology of cattle egret *Bubulcus ibis* at Sharkia Governorate during 2019-2020.

Colony site nearby		Nest monitored	Total eggs laid	Total egg hatching	% hatching success	Chick hatching	Chick fledging	% Fledging rate
IC	2019	19	67	59	88.06	59	33	55.93
	2020	10	32	28	87.5	28	15	53.57
	Total	29	99	87	-	87	48	-
	M ± SE	14.5 ± 4.5	49.5 ± 17.5	43.5 ± 15.5	87.78	43.5 ± 15.5	24 ± 9	54.75
	t-value		0.984	1.435	-	1.435	1.056	-
	P		0.341	0.179	-	0.179	0.302	-
	Sig		NS	NS	-	NS	NS	-
DC	2019	14	55	51	92.73	51	23	45.1
	2020	15	49	42	85.71	42	25	59.52
	Total	29	104	93	-	93	48	-
	M ± SE	14.5 ± 0.5	52 ± 3	46.5 ± 4.5	89.42	46.5 ± 4.5	24 ± 1	52.31
	t-value		2.901	4.942	-	4.942	0.081	-
	P		0.008	0	-	0	0.936	-
	Sig		S	S	-	S	NS	-
GC	2019	23	83	76	91.57	76	39	51.32
	2020	18	77	70	90.91	70	28	40
	Total	41	160	146	-	146	67	-
	M ± SE	20.5 ± 2.5	80 ± 3	73 ± 3	91.25	73 ± 3	33.5 ± 5.5	45.66
	t-value		3.068	4.198	-	-	0.761	-
	P		0.003	0.0001	-	-	0.451	-
	Sig		S	S	-	-	NS	-
AP	2019	24	79	74	93.67	74	35	47.3
	2020	12	38	33	86.84	33	18	54.55
	Total	36	117	107	-	107	53	-
	M ± SE	18 ± 6	58.5 ± 20.5	53.5 ± 20.5	91.45	53.5 ± 20.5	26.5 ± 8.5	50.92
	t-value		0.485	1.886	-	1.886	0.157	-
	P		0.632	0.069	-	0.069	0.875	-
	Sig		NS	NS	-	NS	NS	-
Total		135	480	433	90.21	433	216	49.88
F value			5.368	9.170	-	9.170	0.405	-
P			0.001	0.00001	-	0.00001	0.749	-
Sig			S	S	-	S	NS	-

Note. IC = Irrigation Canal; DC = Drainage Canals; GC = Garbage Collection; AP = Abbassa Ponds; *F* value = value on the F distribution; *P* = P-value; Sig = probability significance; S refers to Significant difference at P ≤ 0.05; NS refers to no significant at P > 0.05; M ± SE refers to mean ± standard error.

3.4. Fate of eggs

Data in Table 4 showed that, the addled (infertile) eggs were 21 eggs, while the eggs with dead embryos were 17 eggs. The numbers with broken eggs (cracked shells) were 9 eggs. Thus the total failures were 47 eggs during the two study years at different locations.

3.5. Nests placement

The cattle egret nests in colonies, which are often but not always, found around bodies of water. Data in Table 5 cleared that cattle egret nests were located on the tree crown in three strata i.e. nests nearby the trunk, nests in the core of the tree and nest at the peripheral of the tree crown, represented

Table 2. Frequency distribution of clutch size for cattle egret *Bubulcus ibis* in different locations at Sharkia Governorate during 2019-2020.

Colony site nearby		No. of nests	Number of nests containing (X) number of eggs				Total No. of eggs / nests	Mean No. of eggs / nests
			X= 2	X= 3	X= 4	X= 5		
IC	2019	19	0	11	6	2	67	3.53
	2020	10	2	5	2	1	32	3.2
	Total	29	2	16	8	3	99	-
	M ± SE	14.5 ± 4.5	1 ± 1	8 ± 3	4 ± 2	1.5 ± 0.5	49.5	3.41
	t-value			0.984			-	-
	P			0.341			-	-
	Sig			NS			-	-
DC	2019	14	0	4	7	3	55	3.93
	2020	15	0	11	4	0	49	3.27
	Total	29	0	15	11	3	104	-
	M ± SE	14.5 ± 0.5	0	7.5 ± 3.5	5.5 ± 1.5	1.5 ± 1.5	52	3.59
	t-value			2.902			-	-
	P			0.008			-	-
	Sig			S				
GC	2019	23	1	9	11	2	83	3.61
	2020	18	0	2	9	7	77	4.28
	Total	41	1	11	20	9	160	-
	M ± SE	20.5 ± 2.5	0.5 ± 0.5	5.5 ± 3.5	10 ± 1	4.5 ± 2.5	80	3.9
	t-value			3.068			-	-
	P			0.003			-	-
	Sig			S			-	-
AP	2019	24	3	12	8	1	79	3.29
	2020	12	2	6	4	0	38	3.17
	Total	36	5	18	12	1	117	-
	M ± SE	18 ± 6	2.5 ± 0.5	9 ± 3	6 ± 2	0.5 ± 0.5	58.5	3.25
	t-value			0.485			-	-
	P			0.632			-	-
	Sig			NS			-	-
Total		135	8	60	51	16	480	3.56
F value				5.368			-	-
P				0.001			-	-
Sig				S			-	-

Note. IC = Irrigation Canal; DC = Drainage Canals; GC = Garbage Collection; AP = Abbassa Ponds; *F* value = value on the F distribution; *P* = P-value; Sig = probability significance; S refers to Significant difference at P ≤ 0.05; NS refers to no significant at P > 0.05; M ± SE refers to mean ± standard error.

54.07%, 34.81% and 11.11%, respectively. The primary branches of the tree crown received 83 nests (61.48% of total nests), but the secondary branches received 52 nests (38.52%).

4. Discussions

Total of 135 nests, of cattle egret, were found in this study. Cattle egret colony nearby the garbage collection areas gives the highest number of nests (41 nests, including 160 eggs). The suitability of these sites for cattle egret breeding attribute to the presence of trees for building nests and the specific needs of valuable foraging habitats especially during chick rearing.

The hatching success of cattle egret during the study period was 90.21%, while the fledging rate was 49.88%, these results agree with previous studies. For example, the hatching success of cattle egret in northeast Texas

Table 3. Frequency distribution of incubation period for cattle egret *Bubulcus ibis* under field condition at Sharkia Governorate during 2019-2020.

Colony site nearby		Total nests	No. of nests/Days of incubation period						
			21	22	23	24	25	Total	Incubation duration in days
IC	2019	19	6	5	6	2	0	422	22.21
	2020	10	2	4	2	2	0	224	22.4
	Total	29	8	9	8	4	0	646	-
	M ± SE	14.5 ± 4.5	4 ± 2	4.5 ± 0.5	4 ± 2	2 ± 0	0	323	22.28
	t-value				0.457			-	-
	P				0.652			-	-
	Sig				NS			-	-
DC	2019	14	6	4	2	2	0	308	22
	2020	15	0	4	5	3	3	350	23.33
	Total	29	6	8	7	5	3	658	-
	M ± SE	14.5 ± 0.5	3 ± 3	4 ± 0	3.5 ± 1.5	2.5 ± 0.9	1.5 ± 1.5	329	22.69
	t-value				3.229			-	-
	P				0.003			-	-
	Sig				S			-	-
GC	2019	23	6	7	4	5	1	517	22.48
	2020	18	3	2	7	6	0	412	22.89
	Total	41	9	9	11	11	1	929	-
	M ± SE	20.5 ± 2.5	4.5 ± 1.5	4.5 ± 2.5	5.5 ± 1.5	5.5 ± 0.5	0.5 ± 0.5	464.5	22.66
	t-value				1.134			-	-
	P				0.264			-	-
	Sig				NS			-	-
AP	2019	24	8	6	5	2	3	538	22.42
	2020	12	3	3	2	2	2	273	22.75
	Total	36	11	9	7	4	5	811	-
	M ± SE	18 ± 6	5.5 ± 2.5	4.5 ± 1.5	3.5 ± 1.5	2 ± 0	2.5 ± 0.5	405.5	22.53
	t-value				0.649			-	-
	P				0.523			-	-
	Sig				NS			-	-
Total		135	34	35	33	24	9	3044	22.55
F value					0.708			-	-
P					0.548			-	-
Sig					NS			-	-

Note. IC = Irrigation Canal; DC = Drainage Canals; GC = Garbage Collection; AP = Abbassa Ponds; *F* value = value on the F distribution; *P* = P-value; Sig = probability significance; S refers to Significant difference at P ≤ 0.05; NS refers to no significant at P > 0.05; M ± SE refers to mean ± standard error.

ranged from 71-96% (Telfair II and Bister, 2004). In Algeria Metallaoui et al. (2020) stated that the hatching success of cattle egret was 80, 90 and 100%, while the fledging success was 93.1 and 100%. On the other hand, hatching success was higher than that described in India (58.85%) (Kour and Sahi, 2013). The difference in hatchability percentage and fledging rates could originate from the genetic variation of phenotypic response to environmental condition. The fledging rate in our study is probably to the death of siblings due to competition, starvation and predators, as we saw chick's downfall nests and hooded crow (*Corvuse corone*) attack adults. As mentioned by Blaker (1969), that death of chicks resulting from competition and starvation. In Australia, McKilligan (1987) revealed that causes of

Table 4. Fate of eggs during incubation period for cattle egret *Bubulcus ibis* in different locations at Sharkia Governorate.

Nest monitored	Total nest	Total eggs laid	Addled eggs	Broken eggs	Dead embryo	Total failed eggs	% failed eggs
IC	29	99	5	3	4	12	12.12
DC	29	104	6	2	3	11	10.58
GC	41	160	6	3	5	14	8.75
AP	36	117	4	1	5	10	8.55
Total	135	480	21	9	17	47	9.8
M ± SE	33.75 ± 4.14	120 ± 19.60	5.25 ± 0.68	2.25 ± 0.68	4.25 ± 0.68	11.75 ± 1.21	10 ± 1.19
F value		5.368	0.395	0.502	0.075	0.344	-
P		0.001	0.756	0.681	0.973	0.793	-
Sig		S	NS	NS	NS	NS	-

Note. IC = Irrigation Canal; DC = Drainage Canals; GC = Garbage Collection; AP = Abbassa Ponds; *F* value = value on the F distribution; *P* = P-value; Sig = probability significance; S refers to Significant difference at P ≤ 0.05; NS refers to no significant at P > 0.05; M ± SE refers to mean ± standard error.

fledgling mortality were starvation and tick infestation of nestlings. In Algeria, Si Bachir et al. (2008) cleared that losses of cattle egret chicks were due to chick's downfall from nests, or by either aerial and terrestrial predators, or by scavenge for chicks that fallen under nests.

The average clutch size of cattle egret in our study was 3.56 eggs per nest which is quite similar to that reported by Omar and Hassan (2019) in Sohage governorate, Egypt; they found that the average clutch size of cattle egret varied from 2.90 to 3.80 eggs, whereas El-Danasoury (2002) indicated an average of 3.5 eggs per nest in El-Minoufia governorate, Egypt. It's also in range of recorded by Abdullah et al. (2017) in Faisalabad, Pakistan, where the clutch size of cattle egret was 3 to 4 eggs, 3 eggs being the prevailing and uncommonly 5 eggs. In northern Algeria Metallaoui et al. (2020) find that clutch size was an average 3.43 ± 0.91 eggs. But our results were slightly higher than that of Samraoui et al. (2007), they reported that clutch size of cattle egret was 3.10 ± 0.13 eggs/nest. Clutch size variations in the different habitat are a response of the bird to the surrounding environment and often related to the parents age with too older parents or too younger laying smaller number of eggs (Klomp, 1970). Burger (1978) assigns that larger clutch size of cattle egret in New Jersey, USA, than other places according to the sufficient of food resources. The clutch size variations at different locations are a response to feeding area, type of food supply and food abundance per unit area (Van Noordwijk et al., 1980). Kazantzidis et al. (1996) revealed that feeding condition are reflected to clutch size of little egret in Camargue, Greece and Macedonia, France.

Variation in the incubation period, seem to be depend on the environmental conditions with parental traits (Higgott et al., 2020). Our results revealed that incubation period of cattle egret ranged from 21 to 25, with grand mean of 22.55 days resulted from 135 nests. This reporting was not significantly different from that of Abdullah et al. (2017) in Pakistan they revealed that the incubation period varied from 22-25 days. In India, Kour and Sahi (2012) reported that Incubation period was from 21-24 day. The same trend was found in the United States and southern Canada, from 23 to 25 days (Weber, 1975). But in central Japan FUJIOKA (1984) found that the average of incubation period ranged from 22 to 27 days. On the other hand, our result was slightly higher than that found by Kour and Sahi (2013). They reported that incubation periods were from 21-23 day, in the same trend Omar and Hassan (2019) in Upper Egypt, noticed that incubation period varied from 19 to 22 days, that's differences in Upper Egypt may be due to temperature degrees as described by El-Danasoury (2002) who revealed that, incubation period of Cattle egrets decreased when temperature increased, as our study sites at Sharkia Governorate which located in North Egypt, where's the weather is colder than Upper Egypt.

The total unhatched eggs were 47 eggs, which make up about 9.8% of the total eggs laid, theses failure eggs were distributed as follows: addled (infertile) eggs 44.7%, dead embryo eggs 36.2% and 19.1% with cracked shells. These results were in accordance with Sharah and Ali (2008) in Nigeria, they found that about 7.5% of eggs unhatched were broken shells, rotten, smelly embryos and 1% to undefined factors. In Florida about 25% of egg and nestling losses was due to infertile or addled eggs while 75% is due to predation (Maxwell II and Kale II, 1977). In southeast Queensland, Australia, McKilligan (1987) revealed that about 34% of cattle egret eggs were broken or failed to hatch.

Nest site selection is important for rearing offspring, therefore the cattle egret locate their nests position to get more secure features (Ye et al., 2021). Cattle egret choose the tree with specific characteristics (the solidity of branches, trunk) which are suitable conditions for nesting site gave birds protection against predators, abundant materials to backup and construct the nest (Metallaoui et al., 2020). Our results cleared that the primary branches of the tree crown received 61.48% of cattle egret nests, while the secondary branches received 38.52%. These results agreed with Sbiki et al. (2015), they stated that cattle egret builds their nests mainly on the strong elementary branches of trees (30%)

Table 5. Stratifications of cattle egret *Bubulcus ibis* nest sites on the crown of different trees at Sharkia Governorate during 2019-2020.

Colony site nearby		Total nest	Nest nearby trunk		Nest in the core		Peripheral nests		Branches	
			No.	%	No.	%	No.	%	Primary	Secondary
IC	2019	19	8	42.11	8	42.11	3	15.79	11	8
	2020	10	6	60	3	30	1	10	6	4
	Total	29	14	-	11	-	4	-	17	12
	M ± SE	14.5 ± 4.5	7 ± 1	48.28	5.5 ± 2.5	37.93	2 ± 1	13.79	8.5 ± 2.5	6 ± 2
	t-value		0.892		0.630		0.439		0.105	0.105
	P		0.384		0.536		0.665		0.917	0.917
	Sig		NS		NS		NS		NS	NS
DC	2019	14	7	50	6	42.86	1	7.14	8	6
	2020	15	9	60	4	26.67	2	13.33	9	6
	Total	29	16	-	10	-	3	-	17	12
	M ± SE	14.5 ± 0.5	8 ± 1	55.17	5 ± 1	34.48	1.5 ± 0.5	10.34	8.5 ± 0.5	6 ± 0
	t-value		0.524		0.893		0.535		0.151	0.151
	P		0.604		0.379		0.596		0.881	0.881
	Sig		NS		NS		NS		NS	NS
GC	2019	23	13	56.52	8	34.78	2	8.7	14	9
	2020	18	11	61.11	5	27.78	2	11.11	12	6
	Total	41	24	-	13	-	4	-	26	15
	M ± SE	20.5 ± 2.5	12 ± 1	58.54	6.5 ± 1.5	31.71	2 ± 0	9.76	13 ± 1	7.5 ± 1.5
	t-value		0.289		0.471		0.248		0.375	0.375
	P		0.773		0.640		0.804		0.709	0.709
	Sig		NS		NS		NS		NS	NS
AP	2019	24	12	50	10	41.67	2	8.33	15	9
	2020	12	7	58.33	3	25	2	16.67	8	4
	Total	36	19	-	13	-	4	-	23	13
	M ± SE	18 ± 6	9.5 ± 2.5	52.78	6.5 ± 3.5	36.11	2 ± 0	11.11	11.5 ± 3.5	6.5 ± 2.5
	t-value		0.458		1.002		0.659		0.239	0.239
	P		0.650		0.325		0.518		0.813	0.813
	Sig		NS		NS		NS		NS	NS
Total		135	73	54.07	47	34.81	15	11.11	83	52
F value			0.247		0.105		0.098		0.114	0.114
P			0.863		0.956		0.960		0.951	0.951
Sig			NS		NS		NS		NS	NS

Note. IC = Irrigation Canal; DC = Drainage Canals; GC = Garbage Collection; AP = Abbassa Ponds; *F* value = value on the F distribution; *P* = P-value; Sig = probability significance; S refers to Significant difference at P ≤ 0.05; NS refers to no significant at P > 0.05; M ± SE refers to mean ± standard error. *P ≤ 0.05

or minor branches at the periphery of the tree's crown (29%). In addition, cattle egret nests' were located nearby the trunk (54.07%), in the core of the tree (34.81%) and at the peripheral of the tree crown (11.11%). The cattle egret nested closer to the main trunk than the peripheral branches, but the peripheral nests wide distributed at varying distances from the trunk (Arendt and Arendt, 1988). The main explication of the peripheral nests widely distributed, is that central nests position were taken by old and experienced birds, thus young and inexperienced pairs are forced to take peripheral positions (Klomp, 1970). The higher fledging success of cattle egrets was close to the trunks of the trees (Si Bachir et al., 2008), because the central nests of cattle egret were safer than peripheral nests (Metallaoui et al., 2020). In contrast Patankar et al. (2007) revealed that, the majority of cattle egret nests (96%) were located on peripheral and only 4% were on core.

5. Conclusion

To summarize, our study provided breeding biology aspects for the cattle egret at Sharkia Governorate, Egypt, in four sites. Incubation period for cattle egret was higher than those reported from other districts in Egypt; this may be attributed to geographic variations. The fledging rate was influenced by several factors including competition, starvation and predators. The fate of eggs was due to disturbed parents, whom may break eggs, produce infertile eggs and bad aspect of incubation, which resulted from predators and competition between neighbors. The majority of nests were found to be nearby the trunk and in the core of the trees. These findings can contribute in understanding the mechanism of choosing nesting location. Future studies should be encouraged to gain more knowledge about the importance of geographic variation in breeding biology parameters and to describe the factors responsible for that variation.

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References

ABDULLAH, M., KHAN, R.A., RAFAY, M., HUSSAIN, T., RUBY, T., REHMAN, F., KHALIL, S. and AKHTAR, S., 2017. Habitat ecology and breeding performance of cattle egret (*Bubulcus ibis*) in Faisalabad, Pakistan. *Pakistan Journal of Zoology*, vol. 49, no. 5, pp. 1863-1870. http://dx.doi.org/10.17582/journal.pjz/2017.49.5.1863.1870.

ARENDT, W.J. and ARENDT, A.I., 1988. Aspects of the breeding biology of the cattle egret (*Bubulcus ibis*) in Montserrat, West Indies, and its impact on nest vegetation. *Colonial Waterbirds*, vol. 11, no. 1, pp. 72. http://dx.doi.org/10.2307/1521172.

BLAKER, B.R., 1969. Behaviour of the cattle egret *Ardeola ibis. The Ostrich*, vol. 40, no. 3, pp. 75-129. http://dx.doi.org/10.1080/00306525.1969.9634335.

BURGER, J., 1978. Competition between cattle egrets and native North American herons, egrets and ibies. *The Condor*, vol. 80, no. 1, pp. 15-23. http://dx.doi.org/10.2307/1367786.

CHOI, Y.S., KWON, I.K. and YOO, J.C., 2016. Nestling diet of three sympatric egret species: rice fields support breeding egret populations in Korea. *Ornithological Science*, vol. 15, no. 1, pp. 55-62. http://dx.doi.org/10.2326/osj.15.55.

DALIO, J.S., 2018. Biology of *Bubulcus ibis* and alterations in its habits. *IOSR Journal of Pharmacy and Biological Sciences*, vol. 13, no. 2, pp. 9-15. https://doi.org/10.9790/3008-1302010915.

DRENT, R.H., 1970. Functional aspects of incubation in the herring gull. *Behaviour*, no. 17, pp. 1-132.

EL-DANASOURY, M.A.M., 2002 [viewed 31 January 2023]. *Ecological and biological studies on some harmful birds for plants at Minoufia governorate*. Egypt: Faculty of Agriculture, Al-Azhar University. Master Thesis in Zoology and Nematology. Available from: http://thesis.mandumah.com/Record/266029

ENEMAR, A., 1997. The egg size variation of the Treecreeper Certhia familiaris in south-western Sweden. *Ornis Svecica*, vol. 7, no. 3-4, pp. 107-120. http://dx.doi.org/10.34080/os.v7.22964.

FUJIOKA, M., 1984. Asynchronous hatching, growth and survival of chicks of the cattle egret *Bubulcus ibis. Japanese Journal of Ornithology*, vol. 33, no. 1, pp. 1-12. http://dx.doi.org/10.3838/jjo1915.33.1.

GOCHFELD, M., 1980. Mechanisms and adaptive value of reproductive synchrony in colonial seabirds. In: J. BURGER, B.L. Olla and H.E. WINN, eds. *Behavior of marine animals*. Boston: Springer, pp. 207-270. http://dx.doi.org/10.1007/978-1-4684-2988-6_7

GOCHFELD, M. and BURGER, J., 1982. Host selection as an adaptation to host-dependent foraging success in the cattle egret (*Bubulcus ibis*). *Behaviour*, vol. 79, no. 2-4, pp. 212-229. http://dx.doi.org/10.1163/156853982X00265.

GOODMAN, S.M., MEININGER, P.L., BAHA EL DIN, S.M., HOBBS, J.J. and MULLIE, W.C., 1989. *The birds of Egypt*. Oxford: Oxford University Press.

HIGGOTT, C.G., EVANS, K.L. and HATCHWELL, B.J., 2020. Incubation in a temperate passerine: do environmental conditions affect incubation period duration and hatching success? *Frontiers in Ecology and Evolution*, vol. 8, pp. 1-12. http://dx.doi.org/10.3389/fevo.2020.542179.

ISSA, M.A.A., 2019. Diversity and abundance of wild birds species' in two different habitats at Sharkia, Egypt. *Journal of Basic & Applied Zoology*, vol. 80, pp. 34. https://doi.org/10.1186/s41936-019-0103-5.

KAZANTZIDIS, S., HAFNER, H. and GOURNER, V., 1996. Comparative breeding ecology of the little egret (Egretla g. garzetla) in the Axios delta (Greece) and the Camargue (France). *Revue d'Écologie*, vol. 51, no. 4, pp. 313-327. http://dx.doi.org/10.3406/revec.1996.2213.

KLETT, A.T. and JOHNSON, D.H., 1982. Variability in nest survival rates and implications to nesting studies. *The Auk*, vol. 99, no. 1, pp. 77-87. http://dx.doi.org/10.2307/4086023.

KLOMP, H., 1970. The determination of clutch-size in birds: a review. *Ardea*, vol. 58, pp. 1-124. http://dx.doi.org/10.5253/arde.v58.p1.

KOPIJ, G., 2008. Range and population expansion of the Cattle Egret *Bubulcus ibis* in Lesotho. *The Ostrich*, vol. 79, no. 2, pp. 245-248. http://dx.doi.org/10.2989/OSTRICH.2008.79.2.19.593.

KOUR, D.N. and SAHI, D.N., 2012. Studies on the community ecology of cattle egrets *Bubulcus ibis* coromandus (Boddaert) in Jammu (Jammu and Kashmir), India. *International Journal of Biodeversity and Conservation*, vol. 4, no. 13, pp. 439-445. http://dx.doi.org/10.5897/IJBC11.105.

KOUR, D.N. and SAHI, D.N., 2013. Aspects of breeding biology of Cattle Egret, bubulcus ibis coromandus (boddaert) in Jammu, India. *International Journal of Environmental Sciences*, vol. 3, no. 5, pp. 1547-1561. http://dx.doi.org/10.6088/ijes.2013030500025.

MAXWELL II, G.R. and KALE II, H.W., 1977. Breeding Biology of Five Species of Herons in Coastal Florida. *The Auk*, vol. 94, no. 4, pp. 689-700. http://dx.doi.org/10.2307/4085265.

MCKILLIGAN, N., 1987. Causes of nesting losses in the cattle egret Ardeola ibis in eastern Australia with special reference to the pathogenicity of the tick *Argas (Persicargas) robertsi* to nestlings. *Austral Ecology*, vol. 12, no. 1, pp. 9-16. http://dx.doi.org/10.1111/j.1442-9993.1987.tb00922.x.

METALLAOUI, S., DZIRI, H., BOUSSEHEBA, A., HEDDAM, S. and CHENCHOUNI, H., 2020. Breeding ecology of the Cattle Egret (*Bubulcus ibis*) in Guerbes-Sanhadja wetlands of Algeria. *Regional Studies in Marine Science*, vol. 33, pp. 100979. http://dx.doi.org/10.1016/j.rsma.2019.100979.

MOSTAFA, M.A., KHATTAB, M.M.D. and ATTIA, M.A.I., 2008. Biological studies on wild bird crested lark Galerida *Cristata nigricans* in

Sharkia Governorate. *Journal of Agricultural Science*, vol. 33, no. 10, pp. 7543-7548.

OMAR, M. and HASSAN, A., 2019. Monthly, Seasonal Fluctuations and Breeding Season Studies of Cattle Egret, *Bubulcus ibis* ibis (L.) at Tahta District, Sohag Governorate. *Journal of Plant Protection and Pathology Mansoura University*, vol. 10, no. 6, pp. 327-330. http://dx.doi.org/10.21608/jppp.2019.48301.

PATANKAR, P., DESAI, I., SHINDE, K. and SURESH, B., 2007. Ecology and breeding biology of the Cattle Egret *Bubulcus ibis* in an industrial area at Vadodara, Gujarat. *Zoos' Print Journal*, vol. 22, no. 11, pp. 2885-2888. http://dx.doi.org/10.11609/JoTT.ZPJ.1566.2885-8.

PRATT, H.M. and WINKLER, D.W., 1985. Clutch size, timing of laying, and reproductive success in a colony of great blue herons and great egrets. *The Auk*, vol. 102, no. 1, pp. 49-63. http://dx.doi.org/10.2307/4086822.

SAMRAOUI, F., MENAI, R. and SAMRAOUI, B., 2007. Reproductive ecology of the Cattle Egret (*Bubulcus ibis*) at Sidi Achour, north-eastern Algeria. *The Ostrich*, vol. 78, no. 2, pp. 481-487. http://dx.doi.org/10.2989/OSTRICH.2007.78.2.58.172.

SBIKI, M., CHENCHOUNI, H. and BACHIR, A.S., 2015. Population increase and nest-site selection of Cattle Egrets *Bubulcus ibis* at a new colony in drylands of north-east Algeria. *The Ostrich*, vol. 80, no. 3, pp. 231-237. http://dx.doi.org/10.2989/00306525.2015.1067931.

SHARAH, H.A. and ALI, E.A., 2008. Breeding losses in cattle egret, *Bubulcus ibis* L. causes and repercussion on generational propagation in Arid Ecology. *Global Journal of Pure and Applied Sciences*, vol. 14, no. 2, pp. 157-163. http://dx.doi.org/10.4314/gjpas.v14i2.16790.

SI BACHIR, A., BARBRAUD, C., DOUMANDJI, S. and HAFNER, H., 2008. Nest site selection and breeding success in an expanding species, the Cattle Egret *Bubulcus ibis*. *Ardea*, vol. 96, no. 1, pp. 99-107. http://dx.doi.org/10.5253/078.096.0111.

SOLIMAN, K.M., AHMED, H.A.A., RASHAD, H.M., SHOHDI, W.M. and ISSA, M.A., 2021. Breeding ecology of the Graceful Prinia (*Prinia gracilis*) at Akiad Pond, Sharkia Governorate, Egypt. *Egyptian Journal of Aquatic Biology & Fisheries*, vol. 25, no. 3, pp. 411-420. http://dx.doi.org/10.21608/ejabf.2021.177003.

SUBRAMANYA, S., 1996. Distribution, status and conservation of Indian heronries. *Journal of the Bombay Natural History Society*, vol. 93, no. 3, pp. 459-486.

TELFAIR II, R.C. and BISTER, T.J., 2004. Long-term breeding success of the cattle Egret in Texas. *Waterbirds*, vol. 27, no. 1, pp. 69-78. http://dx.doi.org/10.1675/1524-4695(2004)027[0069:LBSOTC]2.0.CO;2.

VAN NOORDWIJK, A.J., VAN BALEN, J.H. and SCHARLOO, W., 1980. Heritability of ecologically important traits in the great tit. *Ardea*, vol. 68, pp. 193-203. http://dx.doi.org/10.5253/arde.v68.p193.

WEBER, W.J., 1975. Notes on cattle egret breeding. *The Auk*, vol. 92, no. 1, pp. 111-117. http://dx.doi.org/10.2307/4084422.

YE, Y., HU, C., JIANG, Y., DAVISON, G.W.H. and DING, C., 2021. Three-dimensional niche partitioning between two colonially nesting ardeid species in central China. *Avian Research*, vol. 12, no. 1, pp. 1-8. http://dx.doi.org/10.1186/s40657-021-00264-7.