GLOBAL JOURNAL OF PURE AND APPLIED SCIENCES VOL 14, NO. 2, 2008: 157 - 163

 ISSN 1118-0579

BREEDING LOSSES IN CATTLE EGRET, *Bubulcus ibis L.* CAUSES AND REPERCUSSION ON GENERATIONAL PROPAGATION IN ARID ECOLOGY

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(Received 6, September 2007; Revision Accepted 19, December 2007)

ABSTRACT

The study was carried out in three sites, (Mbodewa, in the Sahel Savannah zone and Jebra and Konduga in Sudan Savannah zone of Northeastern Nigeria) in 2002 and 2003. The aim was to study the causes of breeding losses of the nestling Cattle egrets and its effect on the generational propagation of these birds in the zone. Counting of losses of all stages began the first week nest construction started and continued at weekly intervals until nest site abandonment at ten (10) weeks by both parents and offspring at the end of fledging (67-70 days) from nest construction. Total of 45,421 nests were involved in the three heronries, with a total of 17,714 losses recorded; 10,850 (61.3%) in Mbodewa, 5,701 (32.2%) in Jebra and 1,163 (6.61%) Konduga. Mean egg losses accounted for 9,078 (51.3%), nestlings 6,662(37.6%) and adults 1,974(11.1%) of the total losses for the two breeding seasons. The main causes of losses were storms, egg failure to hatch, poaching, aggression, predation and starvation. Losses were higher in Sahelian zone with few and little tree canopy cover in the nesting colony trees and where wind speed was high (69km/hr), than Jebra (54.4km/hr.) and Konduga (58.5km/hr.) in the Sudan Savannah with good colony tree canopy cover and low ($\bar{x}$ = 56.5km/hr) wind speed. Nests and breeding birds population on each site reduced with years due to reduced and even spread of rainfall in subsequent years. Account of other salient mortality factors are described.

KEYWORDS: Storms, aggression, infanticide, starvation, predators, egg failure to hatch, poaching, generational propagation.

INTRODUCTION

Early findings were of the view that lack of food was the only population limiting factor (Lack 1954, 1968). Infectious diseases has since been reported by Holmes (1982), and May (1983). Suicide, Fratricide, Competition and Infanticide are also probably as important as other mortality factors among breeding wading birds(Mock 1982, Burger 1978). Pre-conditions (situation parent birds find themselves) cause parents to kill chicks deliberately through willfully pecking the chicks, in a way reducing brood size (Blaker 1969). Fujioka (1985) reported food monopolization by older Cattle egrets chicks during feeding (bottle-neck-effect) and redirected food begging activity bill- grabbing) when parents are far away from the chicks, caused competitive disparities among them resulting in aggressive feeding. Among the cranes, genetic unrelatedness may be due to extra-pair copulation (EPC) result in chick divide during feeding and bolus delivery. Siblicide activities among the parent Cattle egret (facultative siblicide) to silence aggressive siblings are among some mortality factors reported by (Ploger and Mock 1986). Inuoe (1980) also reported that pecking order is high among inter-specific variations when there is asymmetry among offsprings due to asynchronous hatching. This cause siblings to compete for food and peak each other and sometimes becomes fatal among the younger ones. McKilligan (1987), also reported that, egg failure to hatch among the nesting Cattle egrets in Queensland Australia, was 5-12%, hail storms 5.5% and predation 9.4%.

In the Sahel Savannah however, there may be many unreported factors which may militate against breeding activity of wading bird. This study would therefore, elucidate on the salient mortality factors and how they have affected the generational propagation of these agriculturally beneficial birds in the arid zone of Nigeria.

MATERIALS AND METHODS

Mbodewa (12°24'N, 11°36' E) located in the Sahel Savannah zone of Yobe State, Jebra (11°24'N, 13°54' E) and Konduga (11°67'N 13°43' E), located in the Sudan Savannah zone of Borno State of Nigeria, were the study sites during the 2002 and 2003 breeding seasons. The mean annual rainfall were Mbodewa 572mm, with mean wind speed of 69km/hr., Jebra 709.9mm with wind speed of 54.4 km/hr. and Konduga 692.9m with wind speed of 58.5km/hr. Most of the nest colony trees were *Acacia* spp., *Balanitis aegyptica*, *Azadiratchta indica* and *Ficus carica*.

To reduce experimental errors, each site was divided into quadrant to prevent overlapping and duplication of data. The experimental design was a split plot where the sites were the plots splited into 6(50m ×33 3m) quadrants on each site to make a total of 18 sub-plots. Qudrants results from each plot were added together and means calculated on weekly intervals. Counting of whole eggs which fell to the ground, dead chicks on the ground, and dead adults hanged on trees or under the colony trees were done on weekly intervals where each site was allocated specific day for the data capture. Large polythene bags were used to collect all fallen eggs dead chicks and adults. Nest and bird population were estimated monthly so as to include late nesters. Nests found with whole eggs, dead chicks and juveniles by end of breeding seasons were counted and added to the main data as losses. Whole eggs and life chicks and juveniles found under colony trees were examined to determine the causes of displacements. Dead as well as live chicks, which were displaced, were examined for tick infestation to ascertain cause of death. Dead egrets without tick infestation were classified under other causes of mortality and losses. For study on clutch size, hatching and fledging successes and egg parameters, Twelve (12) nests were marked per site in each year. Losses from stormy and rainy days were specifically recorded and marked for comparison to ordinary days. The results obtained were analysed using Analysis Of Variance (ANOVA) and Duncan's Multiple Range Test (DMRT) (Sokal & Rohlf 1969).

RESULTS

Breeding by the Cattle egrets started in May in Jebra site and June in the other two sites in 2002 and 2003 seasons

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No serious natural disasters enough to disrupt breeding were recorded during the study. Mean clutch were Mbodewa 3.0, Jebra 2.92 and Konduga 2.83 ($\bar{x}$ = 2.92), hatching success, Mbodewa 2.3, Jebra 2.4 and Konduga 2.32 ($\bar{x}$ = 2.33). Fledging success were Mbodewa 1.96, Jebra 2.32 and Konduga 2.0 ($\bar{x}$ = 2.1). Clutch sizes increased significantly ($P < 0.05$) with site and time lapse, for the three (3) sites. LSD = 0.844, DF = 10. Similar trends were observed in Jebra and Konduga sites. Percent hatching successes were fluctuating in these sites, although the number of chicks recorded on daily basis increased steadily during the hatching period (asynchronous hatching). The differences were not significant ($P > 0.05$) with site. LSD = 0.0814, DF = 10. Fledging successes were significantly ($P < 0.05$) different with time lapse, but not with site. LSD = 0.0148, DF = 10 (Table 1).

Mean egg parameters for the Cattle egret eggs are presented in Table 2. Egg length ($\bar{x}$ = 4.77cm), was significantly ($P < 0.05$) different with site, while mean width ($\bar{x}$= 3.52cm), egg weight ($\bar{x}$ = 58.17gm) and egg volume ($\bar{x}$ = 29.07cm^3) were not significantly ($P > 0.05$) with site. LSD = 0.362, DF = 22.

Table 1 : Cumulative data of clutch size, hatching and fledging successes for Cattle egrets in Mbodewa, Jebra and Konduga. Data is for twelve nests per each of the site and for six days observation period

Time	Mbodewa			Jebra			Konduga			
In Day +	Egg no laid	Hatching Success	Fledging Success	Egg no laid	Hatching Success	Fledging Success	Egg no laid	Hatching Success	Fledging Success	P = 0.05
1	6	3.0(50)	2.4(80)	4	1.8(45)	1.2(66.3)	3	1.8(60)	1.2(66.3)	NS
2	11	9.0(82)	3.0(33.3)	10	7.8(78)	6.0(76.9)	8	6.0(75)	4.2(70.0)	NS
3	20	15.0(75)	12.6(89)	19	13.8(73)	12.6(91.3)	17	12.0(71)	11.4(95.0)	NS
4	27	18.0(67)	13.8(76.7)	26	21.0(81)	18.0(85.7)	25	19.2(77)	18.0(93.8)	NS
5	30	24.0(80)	21.0(87.5)	31	24.0(77)	23.4(97.5)	30	21.0(70)	21.0(100)	NS
6	36	27.5(76)	23.0(83.6)	35	28.8(82)	27.8(96.5)	34	27.6(81)	24.0(86.9)	NS
Clutch size	3 *	2.3(6.7) *	1.96 *	2.92 *	2.4(82.2) *	2.32 *	2.83 *	2.3(81.3) *	2.0 *	NS

Key: Percent hatching and fledging successes in bracket
Mean clutch size =2.92
Mean hatching success = 2.33
Mean fledging success = 2.08
LSD = 0.0814
DF= 10
α = 0.05
* = Significant
+ = Hatching period in days

Table 2: Mean length, width, weight and volume for twelve eggs measured per site in 2002 and 2003 breeding seasons

Parament =0.05	Mbodewa	Jebra	Konduga	Mean	P= 0.05
Length (cm) S	4.68	4.56	5.07	4.77 ± 0.30	*
Width (cm) NS	3.49	3.37	3.70	3.52 ± 0.24	NS
Weight (gm) NS	59.28	57.58	57.71	58.17 ± 0.57	NS
Volume (cm^3) NS	28.63	29.63	28.95	29.07 ± 0.45	NS

LSD = 0.362 for comparing site means
DF = 22
*Significant

Effect of Storm: The effects of wind and rainstorms were observed to dislodge many eggs, displaced chicks and juveniles, from nests and bashed adults egrets against nesting colony trees killing many in the process. Windy days were observed to cause more losses in all stages of egret breeding cycle than non-windy days in all the sites and were significantly ($P < 0.05$) different with site and stages of development in the breeding cycle (Table 3). By estimation, 69.5% of the total losses were due to wind and rainstorms as against only 5% reported by McKilligan (1987), in Australia. The remaining 30.5% was due to other salient mortality factors discussed below.

Predatory birds: Out of the total loss of 17,714 (Table 3), 9078 (51.3%) were egg losses and 3,075 of these eggs were devoured by Pied crow, *Corvus albus*, which picked up 1891 (10.68%) in 2002 and 1682 (9.5%) in 2003 seasons. Only on two occasions (0.02%) did snakes swallowed whole eggs, while alligator lizards ate dead carcasses on the ground. The Black Kite, *Milvus migrans;* Shikra, *Accipiter badius* and Black shouldered kite, *Elanus caeruleus* picked dead chicks. Shikra also picked five (5) (0.08%) life chicks.

Poaching: Poaching was one of the important salient morbidity factors, carried out by children mostly on eggs (241) (2.7%) for frying. Adults, climbed colony trees to pick chicks and juveniles (90) (1.4%) and adults 200 (10.1%) for commercial purposes (delicacies). These were all added to the total loss in Table 3.

Foster parents: Abandoned chicks on nests died from starvation, because even those parents close to the unattended (abandoned) nests would not feed the chicks on them. The chicks gradually lost weight (Table 4) and all died at ten (10) days of age, at the full view of the other parents the mean weight of 25.6g. Those chicks cared for (attended) by

Table 3: Mean losses observed in breeding cattle Egret eggs, nestling and adults population in 2002 and 2003 seasons for the three sites. Data was collected for Windy (W) and Non –windy days. NLG = Nestling, AD= adult

	Mbodewa						Jebra						Konduga						P =
	Egg		NLG		AD		Egg		NLG		AD		Egg		NLG		AD		
	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	W	NW	0.05
	-	133	-	261	-	51	-	100	-	100	-	41	-	10	-	20	-	10	
	-	420	-	360	-	80	-	120	-	81	-	32	-	16	-	16	-	9	
	-	480	-	291	-	48	-	102	-	50	-	6	-	23	-	20	-	3	
	870	-	749	-	308	-	1448	-	1099	-	39	-	93	-	58	-	29	-	*
	693	-	509	-	0	0	-	-	-	-	79	-	207	-	77	-	23	-	*
	-	422	-	421	-	85	-	170	-	101	-	21	-	60	-	16	-	5	
	548	-	412	-	93	-	349	-	277	-	74	-	110	-	30	-	39	-	*
	510	-	437	-	450	-	690	-	137	-	85	-	76	-	49	-	41	-	*
	702	-	510	-	93	-	103	-	141	-	22	-	42	-	13	-	16	-	*
	-	469	-	327	-	52	-	101	-	117	-	16	-	11	-	37	-	4	
Total	3269	1978	2617	1606	944	436	2590	593	1654	449	249	116	528	120	227	109	148	31	
S/T	5247		4223		1380		3183		2103		415		648		336		179		
%GT	29.6		23.8		7.8		18.0		11.9		2.3		3.7		1.9		1.0		
G/T	10850(61.2%)						5701(32.2%)						1163(6.6%)						= 17714

* = Significant at 5%

Table 4: Weight (gm) of attended (Att.) and Unattended (Unatt.) chicks from a pair of nests in Mbodewa, Jebra and Konduga sites. Data collected over a period of 10 days until all abandoned (unattended) chicks were dead.

	Mbodewa			Jebra			Konduga			
Chick age	Attended	Unattended	Weight	Attended	Unattended	Weight	Attended	Unattended	Weight	P =
in Days	chicks	chicks	loss	chicks	chicks	loss	chicks	chicks	loss	0.05
1	36.50	36.50	0.0	36.50	32.50	4.0	36.00	33.10	2.9	NS
2	50.30	35.50	14.8	59.2	28.50	30.7	54.30	30.10	24.2	NS
3	68.90	34.50	34.4	70.0	28.30	41.7	66.20	30.10	36.2	NS
4	77.90	33.50	44.4	80.30	28.00	52.3	76.20	26.10	50.1	NS
5	99.80	32.50	67.3	79.50	27.30	52.2	78.80	24.00	54.8	NS
6	105.30	30.00	75.3	98.50	26.30	72.2	97.30	24.00	73.3	NS
7	106.30	28.30	78.0	100.30	24.20	76.1	105.30	20.00	85.3	NS
8	128.30	22.50	105.8	103.50	20.50	83.0	113.30	20.60	92.7	NS
9	130.10	22.50	107.6	108.50	16.00	92.5	118.30	15.30	103.0	NS
10	135.50	14.50	121.0	109.50	12.50	97.0	128.50	12.00	116.5	NS
Mean	94.09	29.03	64.86	91.48	24.41	60.17	87.80	23.52	64.28	NS
			*			*			*	

parents gained weight to mean of 91.12g (Table 5) at the same age. Differences in the two categories of chicks weights were significantly ($P< 0.05$) different, but not among sites.

Aggression: Fujioka (1985) reported competitive disparities among chicks of different age for food where older chicks peck on younger ones resulting in deaths of younger chicks. Inuoe (1980) attributed this action to asynchronous hatching in Cattle egret eggs because of egg-laying intervals. Chick suicide and fratricide were common as a result of such antagonistic behaviour at the watchful eyes of the parents. Some parents were observed to intentionally kill chicks, suggesting brood reduction tactics (infanticide) to a manageable size, which they can cater for (Mock and Lamey, 1991). Total of five (5) that is 0.08% deaths were recorded and were added to the number which make Table 3.

Extra – pair- Copulation (EPC): Cuckuldry males carry out such abnormal sexual behaviour on another unsuspecting female mate (McKilligan 1990), as the males fly from higher nests and directly landing on top of such females which lie below them in the nest hierarchy. On one occasion did an unsuspecting female mate put stiff resistance, gave hard peck with the robbost and strong bill killing the cuckoldry male. This struggle accidentally dislodged two (2) eggs and two (2) chicks and some nest materials. The one (1) cuckoldry male killed was observed to occur in 100 (0.01%) nests observed. Interestingly, the dislodged eggs, chicks and nest materials could not be recovered back to the nests, because the Cattle egrets are not known to carry eggs in their bill (mouth) like the Pied crow, *C. albus* but were left to rot on the ground. These losses were also added to those recorded in Table 3.

Table 5: Mean difference in weight (g) of attended and unattended chicks from a pair of nests at the three sites. Data collected over a period of ten (10) days until unattended chicks were all dead

Site	Attended	Unattended	Mean difference	0.05
Mbodewa	94.09	29.03	64.86	*
Jebra	91.48	24.41	60.17	*
Konduga	87.8	23.52	64.28	*
Mean	91.12	25.65	63.1	*
SD	3.16	2.96	2.56	
SE	1.82	1.71	1.48	
CV%	2	6.66	2.34	
0.05	NS	NS	NS	

LSD (Weight differences) = 32.98
DF = 27
* = Significant

Pesticides: In Konduga site, we observed dead birds in irrigated farmlands this support the work of Hardy (1987), where chemicals such as organophosphorus and organochlorines and other chemicals were indiscriminately used to control insects in some gardens and irrigated lands. Lindane, DDT and other chemicals were indiscriminately used to control pests in some gardens and irrigated farms in this area. It is speculated that these chemicals could have been the reason behind these deaths. However, the observed figures were not included in this study because it needed more elucidation and scientific investigation and proof. Young (1993) also, reported the effects of DDT on hatchability of birds eggs, and the environmental hazards it posses due to length of time it takes to degenerate in the soil.

Birds strike: The three sites, being close to inter-State trunk 'A' road, vehicular movement killed many adults and juveniles flying across the roads. The total losses recorded due to this incidence was 375 (4.34%) of the 8636, adults and juveniles losses put together (Table 3).

Generational Propagation: Table 6 shows estimate of nest and birds population for the two years. There was reduction in birds population from 155,035 in 2002 to a mere 34,491 in 2003 (65.8%) in Mbodewa, 96% in Jebra and 63% in Konduga). There was no death of colony trees nor dearth in nesting materials to buttress such reduction. The only tangeable reason may be the even distribution and spread of rains in 2003 over the region. This might have increased prey population all over the region, hence the insect dependent birds could have found good havens in other areas to nest, so as to prevent competition for nest site. The total losses of 17,714 could by estimation reduce the number of birds.

Table 6: Population estimate for Cattle egret at each breeding site for 2002 and 2003 breeding seasons

Site	Parameter	Month							
		June 1	July 2	August 3	Sept. 4	Oct. 5	Nov. 6	Total	
MBODEWA									
SITE - A									
2002	Tree/with nest	32	26	30	45	43	50		
	Av. Nest/tree	50	84	122	78	80	64		
	Total nest/ quadrat	1586	2200	3662	3522	3425	3210		
	Parent/nest	2	2	2	2	2	2		
	Av. Egg/chick/nest	1.75	2	1.95	2				
	Total population estimate	8723	8800	14280	14086	16000	9360	71250	
2003	Tree/with nest	32	26	50	30	43	45		
	Av. Nest/tree	15.8	19.8	23.5	24	18.9	16		
	Total nest/ quadrat	507.7	514	1099	1055	703	691		
	Parent/nest	2	2	2	2	2	2		
	Av.egg/chick/nest	2.96	2.56	3.5	2.2				
	Total population estimate	3000	2632	7620	4646	3227	3126	24352	
JEBRA									
SITE - B		May	June	July	August	Sept.	Oct.	Nov.	
2002	Tree/with nest	44	57	66	53	84	34	31	
	Total nest/ quadrat	1600	1761	1767	2140	2056	2003	2001	
	Parent/nest	2	2	2	2	2	2	2	
	Av. Egg/chick/nest	2.5	2.5	2.5	2.1				
	Total population estimate	8001	8805	8837	8989	9098	9645	9694	63071
2003	Tree/with nest	44	57	66	53	84	34		
	Total nest/ quadrat	133	175	200	190	176	135		
	Parent/nest	2	2	2	2	2	2		
	Av. Egg/chick/nest	1.2	1	1.5	1.5				
	Total population estimate	320	350	600	570	351	308	2499	
KONDUGA									
SITE - C		June	July	August	Sept.	Oct.	Nov.		
2002	Tree/with nest	13	15	18	16	15	17		
	Total nest/ quadrat	524	546	575	885	1088	896		
	Parent/nest	2	2	2	2	2	2		
	Av. Egg/chick/nest	2	2	2	3.5				
	Total population estimate	2095	2184	2300	6200	4350	3585	20714	
2003	Tree/with nest	15	13	18	16	15	17		
	Total nest/ quadrat	180	168	400	235	222	201		
	Parent/nest	2	2	2	2	2	2		
	Av. Egg/chick/nest	1.95	2.3	3	1.95				
	Total population estimate	702	773	2400	1623	1328	814	7640	
Grand Total population								= 189,526	

transiting and propagating to increase the next generation by 17,714/189,526(9.35%), which is a substantial number.

Egg Failure to hatch: Total of 1,325 (7.5%) whole and unhatched eggs were recovered from all nests from the three (3) sites in the two seasons after heronry abandonment. Random examination showed cracked shells, rotten and smelly embryos and colour changed from the normal light-blue to dirty light-grey. The balance of 180.7(1.0%) losses not tagged to any one factors, could have been due to those unquantified factors.

DISCUSSION

The study investigated and elucidated the causes of breeding losses and how it reduced Cattle egrets future population . They are agriculturally important birds to the Nigerian agrarian population (Sharah 1998), and also important in crop pest control (Snoddy 1969, Long 1979). Thirumurthy and Annamalai (1994), Ali and Ripley (1994) and Shrestha (2001) acknowledged the positive role played by the birds feeding habits in reducing some crop pest population in Nepal. Particularly Cattle egrets which feed on grasshoppers, one of the major crop pests of the arid and semi-arid zones of Nigeria. Any reduction in their population shall spell doom to Resource-poor –farmers, particularly in the semi-arid zone where framers cannot afford chemicals.

Cattle egrets are migratory in behaviour (Maddock 1990) and can change their breeding sites at the slightest prey scarcity and variation in nesting materials (Belzer and Lombordi 1989). Eggs, Clutch size, Hatching and Fledging success are the anchors of birds future population and any factor which disrupt their smooth development, also affect the birds ability reaching maturity stage.

Storms contributed the highest losses (69.5%) in this study, but McKilligan (1987) reported only 5% in Queensland Australia. Probably the colony site had thick canopy cover and low wind speed. Conversely the sites under study are located in arid zone where trees have canopy cover and fierce windstorms during rains. Predatory birds caused 17.4%, poaching 1.45, aggression 0.08, EPC 0.03%, birds strike 2.12% and egg failure to hatch 7.5%. Seasonal variations

particularly rainfall pattern caused birds population to fluctuate. This confirms report by Maddock (1986) that Cattle egret have the capacity to cope and breed successful in harsh condition through behavioural change.

Food supply is very crucial in successful fledging of Cattle egret chicks (Siegfried 1971) and the lack of it can cause 66% failure (Siegfried 1972) and can wipe out the entire clutch in a season (Siegfried 1970, Jenni 1973). These reports support the findings on Table 4, when the entire clutch died at the age of only ten (10) days of starvation due to weight loss.

Effects of pesticides was buttressed by report made in UK, that pesticides contaminated foods killed Bobwhite Quail, *Colinus virginianus* and Mallard, *Anas platyrhynchos* (Hardy *et al.*, 1987) in farmlands.

The hypothesis that breeding losses in the Cattle egrets are not based on only one factor and these factors can reduce subsequent future population is true. This is because the storms, predators, aggression, birds strike, starvation, egg failure to hatch lack of foster parents and extra-pair copulation results underscored these facts. Egg stage is the most vulnerable to losses (69.5%) than all the other stages.

Farmers interviewed exercised fears on the extinction of another agriculturally important bird, the way vultures, an important scanvergers were exterminated in the arid zone.

In conclusion, the uncertainty of weather condition in the arid zone is one major factor, which could have added to the dwindling birds population over the years. Also indirectly through prey scarcity, water shortage, insecurity at nesting sites and harsh weather, which can subsequently reduce future generational propagation.

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