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Breeding Success of the Cattle Egrets, *Bubulcus Ibis L.* in the Arid Zone of Northeastern Nigeria

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Abstract

The breeding success of cattle egrets, *Bubulcus ibis* L, was monitored over four years, where 1992 and 1993 were preliminary surveys, demarcations, and surveillance, and 2002 and 2003 were actual observations and data capture. The ten year lapse was purposeful, to determine the permanency of the sites, because cattle egrets constantly change breeding sites every two to three years, due to death of colony trees. Mbodewa, Jebra and Konduga were the three permanent breeding sites, located in the Sahel and Sudan Savannah Zone of Northeastern Nigeria, where the birds had nested for over twenty years. These birds are the popular and conspicuously snow-white terrestrial foragers both in feeding behaviour and habits, feeding entirely on animals (99.1%) and removes insect pests (88.4%) from the farmers field making them useful to agriculture in these zones. They have buff coloured plumes on the crown, breast and back during breeding periods. This study therefore, wishes to prove whether environment can affect hatching success and whether egg parameters can affect breeding success. The knowledge of the above will help provide the people of the zones with knowledge of the breeding and feeding behaviours of these birds, their importance to the environment and also to encourage conservation and security of the birds. Double lens, 10 × 50mm Pilkington binoculars were used for field observations, Funki M7383 Model incubators, 512 egg capacity was used for artificial incubation, colour chart ++512 was used in egg-colour comparison and Double barren shot gun was used to obtain birds for diet study. One to four (X = 2.5), light blue (++ 512 colour chart) oval, round to elongated eggs in shape, were laid in the middle of the round to boat –shaped nests at full clutch. Mean hatching success was 80% in all sites within the first 25 days of incubation period and 71.3% chicks became independent young adults in 50 ±6days after hatching. Mean breeding birds populations and Nest numbers varied with site and month, (0 = 1375 and 0 =271) in May and increased by 79% in September, but declined by 33.6% in November as parents abandoned nests sites after chicks fledged. Heronry abandonment left the sites with many dead and defoliated trees, the ground underneath were littered with dead eggs shells, carcasses and nesting materials causing environmental degradation around nest colony sites. Before total nest sites abandonment, juveniles creched together every evening for two weeks in similar age

groups. Breeding success was directly correlated to hatching and fledging success as discussed in the text.

Key words: Cattle egret, clutch size, hatching and fledging success, incubation, heronry abandonment, parental care, environmental condition, diet of cattle egrets.

Introduction

Observations on cattle egret, *Egretta garzetta* revealed that copulation and egg-laying went on simultaneously until maximum clutch size was reached (Mckilligam, 1991). Incubation period (egg-laying to hatching) was 35 $\pm$ 4 days, while in Cattle egret it was 26 $\pm$ 1 day. (Mc Killigan, 1987). In the Red – winged Black –bird, *Agelaius phoeniceus*, smaller clutches were observed earlier in the season and increased rapidly as the season progressed. Food and conducive environment are deciding factors in the clutch size, when to breed and raise off-spring (Power and Rising, 1975 ; Akinpelu, 2002). Food scarcity reduces clutches and late breeders or younger females, may tend to have smaller clutches, thus requiring more parental care in order to compete favourably with the early nesters (Perrins, 1970). Cody (1971) and Ewald and Rohwer (1982) reported similar results after experimenting with food supplement on different species of birds, which resulted in reduced clutch sizes to meet up with food scarcity, but they still raised their young offsprings under good parental care. Again in South Africa, Siegfried (1973), had reported in his research work, that grasshopper eaten by Cattle egrets were on the average 2.0cm (20mm) and weighs 0.125g, he also deduced that a parent feeding 2 chicks must catch a grasshopper every 25 seconds of a 12hour day (1728) to provide enough food for itself and her two chicks.

Fledging success was directly correlated to egg-failure to hatch, asymmetry in hatching and seasonal food fluctuation (Siefried, 1972), parent ability to supply enough food, broad size, starvation, parasites, disease, disasters, lethal aggression (Mock,1982) and parental pre-condition ("Bottle neck") (Fujioka 1987a, b; Maddock, 1986). Dry and wet seasons (Rainfall pattern) according to Sodhi and Khera (1986), had no effect on breeding success of the ardeids, because ardeids unlike the Cattle egrets are not dependent on aquatic fauna (Baxter and Fair weather, 1989).

Nest desertion and abandonment was due to high food demand by offsprings (brood size and age), food scarcity, long breeding season enough for the deserters to remate and death of colony trees due to nesting stress (Belzer and Lombardi 1989, Blaker, 1969). It could also have been due to asynchronous hatching, availability of resting materials safety of the new site and lack of physical intra-sexual conflicts in the new site (Maynard, 1977). It is known that intra-sexual conflicts are common among male polyterritorialism, unless operational sex-ratio is skewed toward female (Fujioka, 1989). This study is therefore set out to investigate the breeding success of the cattle egrets in the arid zone of northeastern Nigeria, and prove whether hatching success in different environment are the same, fledging success in different sites are the same and whether egg-parameters affect breeding success in different sites.

Materials and methods

Site Selection

We described the breeding success of the Cattle egrets, *B. ibis* in 2002 and 2003 breeding seasons (May to October) in three breeding sites, (Mbodewa $12^0 24'$ N, $13^0 36'$ E, mean annual rainfall 572.6mm and wind spread of 69km/hr.; Jebra $11^0 67'$ N, $13^0 42'$ E, mean annual rainfall 709.7mm and wind speed of 54.4km/hr. and Konduga $11^0 24'$ N, $13^0 54'$ E, mean annual rainfall 692.9mm and windspeed of 58.5km/hr) for four years. These sites are located in the Sahel and Sudan Savannah Zones of the Northeastern Nigeria with mean daily temperatures of 37^0C, (29^0C , October to February) and (45^0C March to May). The sites are located in a vast open sandy loam soils carpeted with short grasses and dotted with shrubs to the Sahelian zone. The Sudan zone have lateritic soils largely covered with tall gamba grasses with big and thick shrubs and tall trees (x = 7.5m) with thick canopy tops, decorated with scattered water ponds, making these zones conducive for breeding activities, for the cattle egrets.

Sampling

A total of thirty six , round , oval to boat- shaped nests made up of twelve nests per site, each containing two (2) eggs at full clutch were selected. These were monitored from 6am to 6pm daily in 2002 and 2003 breeding seasons. Completed clutch size was determined by counting egg numbers per nest after the six stipulated days oviposition period. Details of egg parameters (clutch, hatching, colour, length, width, volume and weights) were determined using another nine (9) nests from the earlier thirty six (36) nests. One observation post was built at a strategic position in each site from which the nests could be viewed without obstruction or detection. Since breeding activities were going on simultaneously at all sites, three co- observers were employed to assist in data capture, using 10 x 50 mm Regent Chance- Pilkington coated glass binoculars.

Egg Parameters and Hatching

Egg parameters were measured using vernier calippers, egg volume by the formula $V= b^2x L$ (B=breath, L= length) (Coulson *et al.*, 1982), egg weight by top loading of electronic laboratory beam scale, Model : Vecto lever balance, maximum load 1000gm and Colour was by colour chart comparison (De Santo *et. al.*, 1990).

Incubation and hatching were determined by marking another 30 nests per site immediately after incubation had began and from which one egg each was removed for laboratory incubation. The eggs removed were immediately transported and were placed in Funki M7283 Model incubator with egg capacity of 512. A standby generator was provided in case of power outages from the mains. The remaining thirty eggs were left in the field for the parent birds to incubate under natural conditions. Daily record were made of the field temperatures (^{0}C). Relative humidity (RH) , egg breakages, and egg losses until hatching for both field and laboratory conditions. Percentage of eggs hatched and number of hatchlings counted per nest until all eggs were

hatched and maximum hatching success reached. Eggs were obtained for laboratory hatching only after maximum clutch was reached and incubation had began to ensure that no additional egg was laid.

Fledging success

Fledging success was determined by counting of hatched chicks on weekly intervals until fledging. Daily records were made of chick numbers per nest through shaking of trees holding the nests to stimulate the chicks to raise their heads in quest for feeding in which case counting become easier through binocular observations.

Diet type and Birds population

Diet type and diet inference were determined by obtaining 36 birds per developmental stages and per site. Dissections of each bird were made and gut contents removed, counted and separated in like species of preys. Their numbers determined and recorded per bird and for each developmental stage. Birds and nest populations were counted using the quadrant method and stripe (line transect) on monthly basis to ensure if there were any change in nest number which could be correlated to the birds population (Whitesides *et al.,* 1988, Belzer and Lombardi, 1989). Statistical analysis of data collected was by ANOVA (Sokal and Rohlf, 1969).

Results

Nest building began on the 20th May 2002 and 21st May 2003 and were completed on the 26 and 27th May, except for late nesters whose nests were not considered in this study. The first egg was laid on 27th and 28th May and maximum clutch (X = 2.5) reached by 4th and 5th June

Table 1. Mean egg length , width , weight and volume for twelve eggs observed per site

	Site				
Parameter	Mbodewa	Jebra	Koduga	Mean	$\alpha = 0.05$
Length (cm)	4.68	4.56	5.07	4.77	*
Width (cm)	3.49	3.37	3.70	3.52	NS
Weigth (gm)	59.28	57.53	57.71	58.17	NS
Volume (cm^3)	28.63	29.63	28.95	29.07	NS

LSD = 0.362
Df = 22
* = Significant

2002 and 2003 respectively. Table 1, shows the egg parameters (length, width weight and volume) were significantly ($P<0.05$) difference with site. Mean egg- length were also significant ($P< 0.05$) with site, however width, weight and volume were not significantly ($P> 0.05$) with site. LSD = 0.362, DF =22. Egg colour was light-blue (colour chart ++ 512), oval, round to elongated in shape. Significant ($P < 0.05$) differences in egg length by site could be attributed to differences in the availability of protein giving diet among sites and individual intrinsic factors.

Incubation began on the 6th and 7th June for both years and first chick appeared on the 27th June until all eggs asynchronously hatched by the 1st of July in both years and for the two and environments (Table 2) except those with problems. The result was significantly ($P < 0.05$) different with time lapse for both sites and there was high hatching success beginning from the 27th June and was fluctuating until zero hatching by the 2nd July: Mean clutch size were 3.0, 2.92 and 2.83 (0 = 2.92) and mean hatching success were 2.3, 2.4 and 2.3 (0 = 2.33) for Mbodewa, Jebra and Konduga (Table 3).

The trend of increase of hatching success was 3.83 per day (Fig 1) and was positively correlated to the trend of increase in clutch size of 4.76 eggs per day (Fig 2). The correlation coefficient = 0.0 indicating that most eggs laid hatched by over 50%. Of the failed eggs from filed, Mbodewa had the highest number of 7 (23.3%) and Jebra had the lowest (6.7%) in the field and Konduga had the lowest (13.3%) egg failure from the laboratory hatching.

Fledging success were 1.96, 2.32 and 2.0 (0 = 2.08) for Mbodewa, Jebra and Konduga respectively , which was high for all sites but not significantly ($P > 0.05$) different (Table 3) by sites. The trend gave 5.49 chicks fledged per day (Fig. 3), and with low correlation coefficient (0.169) between hatching and fledging success. Site means however were significantly ($P < 0.05$) different from each other. Most fledged birds were snow –white and dusty plumes, forming

Table 2. Mean hatching success, egg-loss, egg-breakage and egg-failure to hatch for 30 cattle egrets eggs in 2002 and 2003, incubated in the field and laboratory

Time in Days	Mbodewa	Field	Lab.	Jebra	Field	Lab.	Konduga	Field	Lab.	
27th June	21		4	12		11	11		15	$\alpha = 0.05$
28th June	0		1	3		1	3		1	
29th June	0		5	4		4	4		0	
30th June	2		6	5		3	3		0	
1st July	0		0	0		0	3		0	
2nd July	0		0	0		0	0		0	
% Hatched	76.7		53.3	82		63.3	81		53.3	*
% Failure	23.3		36.7	6.7		33.3	15.7		13.3	*
% Lost	0		0	3.3		0	0		0	*
% Broken	0		10	8		3.3	3.3		23.3	*
	*		*	*		*	*		*	

* = Significant

Table 3. Clutch size, hatching and fledging successes for cattle egrets in Mbodewa, Jebra and Konduga. Percentage hatching and fledging success in brackets (correlation coefficient = 0.169). n = 12 nest, t = 6 days per site

Time	Mbodewa			Jebra			Konduga		
In Day	Egg Laid	No Hatching Success	Fledging Success	Egg Laid	No Hatching Success	Fledging Success	Egg Laid	No Hatching Success	Fledging Success
27th June	6	3.0 (50)	2.4 (40)	4	1.8 (45)	1.2(52.5)	3	1.8 (60)	1.2 (40)
28th June	11	9.0 (82)	3.0 (27.3)	10	7.8 (78)	6.0 (60)	8	6.0 (75)	4.2 (52.5)
29th June	20	15.0 (75)	12.6 (63)	19	13.8 (73)	12.6(66.3)	17	12.0 (71)	11.4 (67.1)
30th June	27	18.0 (67)	13.8 (51.1)	26	21.0 (81)	18.0 (69.3)	25	19.2 (77)	18.0 (72)
1st July	30	24.0 (80)	21.0 (70)	31	24.0 (77)	23.4(75.5)	30	21.0 (70)	21.0 (70)
2nd July	36	27.5 (76)	23.0(63.9)	35	38.8 (82)	27.8 (79.4)	34	27.6 (81)	24.0 (70.5)
Clutch Size	3.0	2.3(76.7)	1.96(64)	2.92	2.4(82.2)	2.32(79.5)	2.83	2.3(81.3)	2.0(70.5) *

LSD = 0.0814
DF = 10
α = 0.05*
t = time
n = number
* = Significant for hatching success

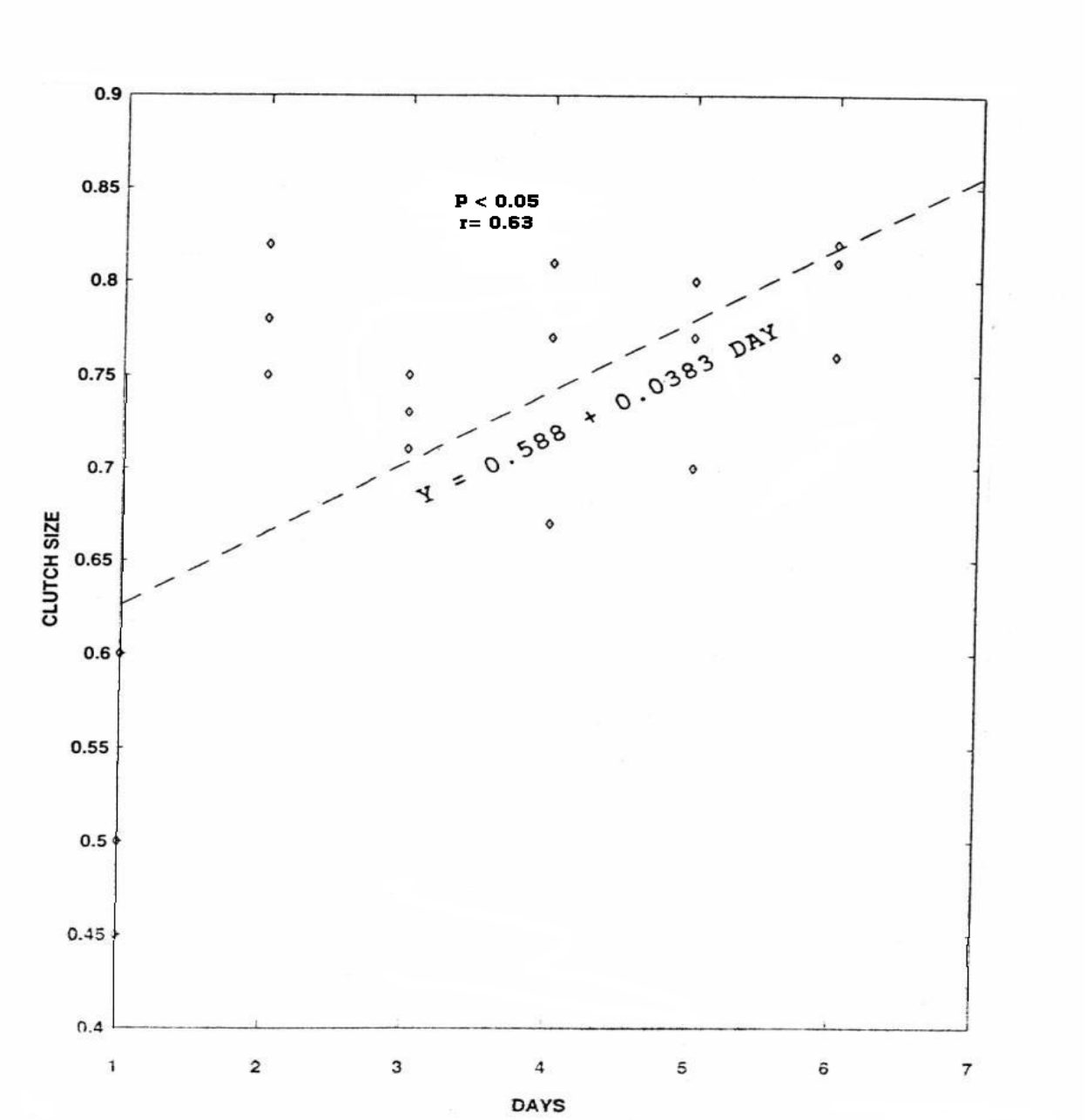

Figure 1. Regression line of hatching success for cattle egrets. Correlation coefficient between clutch and hatching success = 0.0

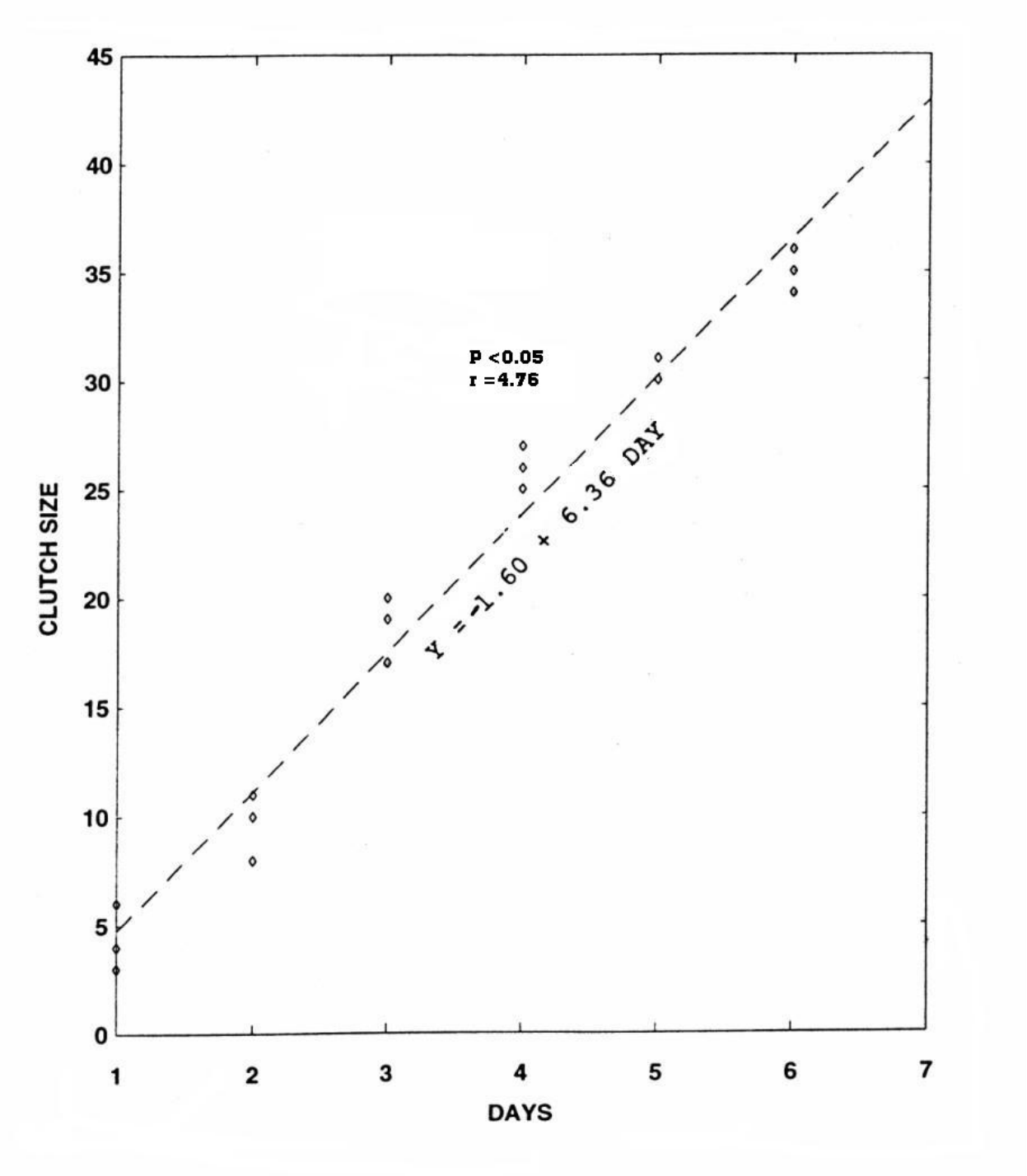

Figure 2. Regression line for clutch size for breeding cattle egrets.

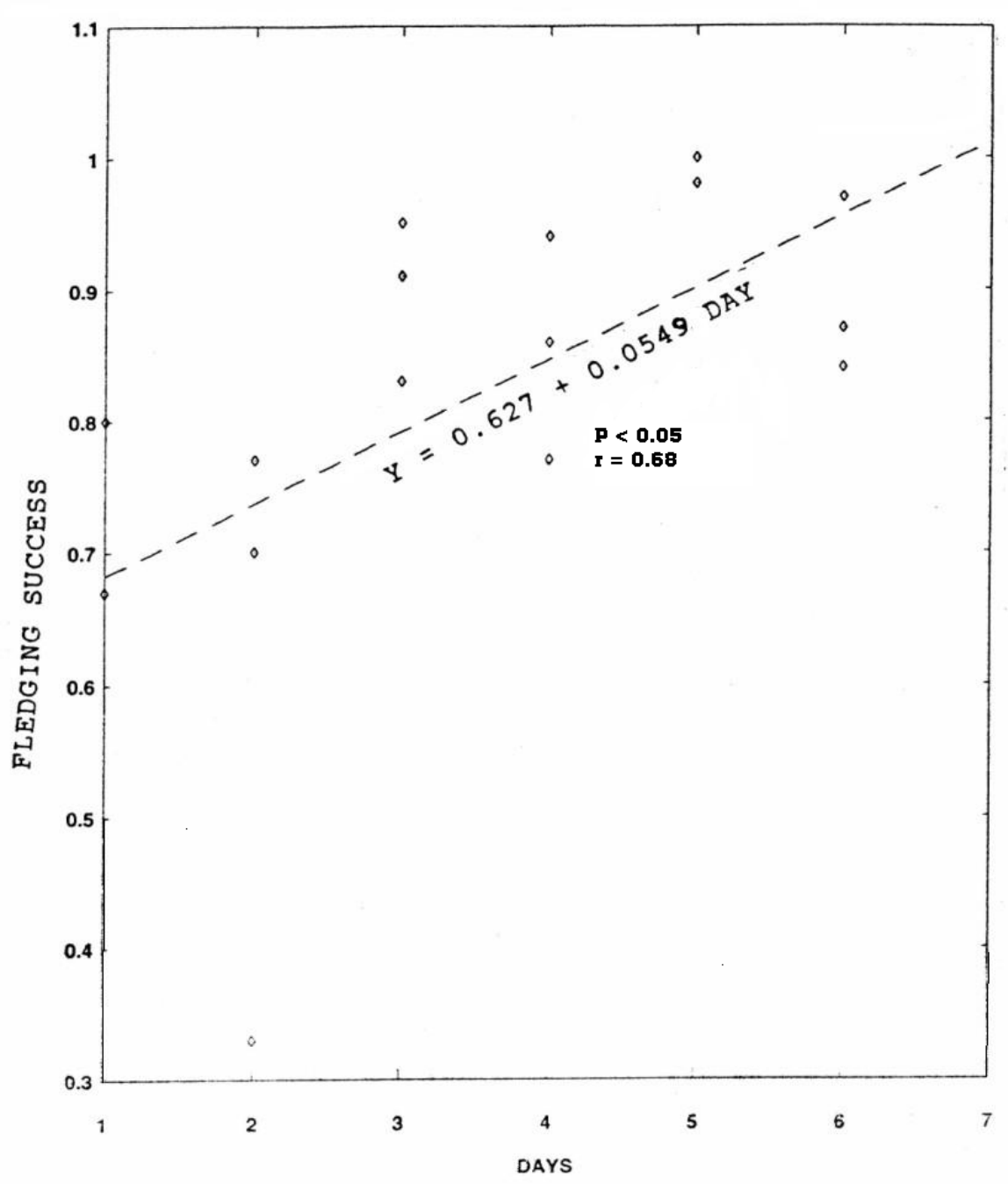

Figure 3. Regression line of fledging success for Cattle egrets. Correlation coefficient between hatching and fledging = 0.169

crèches at breeding sites before passing every night. This took two weeks before the crèches finally deserted sites completely.

Cattle egrets are terrestrial foragers in feeding behavior and habits, feeding entirely on animals (99.1%) and various species of insects (93.3%) and removes 88.4% of animal and insect pests from the farmers' field (Table 4). It is for this reason that the bird is very important to agriculture as an agent of biological pest control method.

There was positive correlation (1.171) between mean breeding birds population (BBP) arriving to breed at the beginning of the rains and nest number (NN) from the months of May to August (Fig 4). Mean nest number dropped by 6.1%, while birds population by 33. 7% in November. The two parameters however had their peaks by the months of September and October, when offsprings had fledged and nest making ceased.

DISCUSSION

Observed mean egg parameters except for the egg length were not significantly different by site from each other which indicates stereotype breeding behavior and physiological make up in the cattle egrets.

Significant ($P< 0.05$) hatching success suggests that not all birds laid eggs at the same time, neither did they start incubation at the same time or day. The trend showed a 3.83% daily increase indicating that most birds were involved in incubation as the breeding season advanced. Chicks need to be hatched quickly to avoid the adversity of the uncertainty of the arid environment, which could render the breeding cycle unsuccessful. The high hatching success in Jebra (82%) and Konduga (81%) may have been due to the good canopy coverage which allowed the birds to stay long hours during incubation than in Mbodewa (76%) which had poor canopy coverage, exposing the birds to intense Sahel heat and high temperatures. In Jebra and

Table 4. Mean prey quantity consumed by each of the four developmental stages of the breeding cattle egrets. UIDR – Unidentified annual remains. (n = 36 birds per stage, t = 18 days observation period)

	Season 1 2002				Season 2 2003						
Prey type	Chicks	Juvenile Adult	Breeding adult	Roosting	Chicks	Juvenile adult	Breeding adult	Roosting	Total Consumption by prey category	% Total Consumption	% Pest Status
Vertebrate	784	1016	5906	1105	692	986	5987	1105	17581	5.8	2
Orthtoptera	7769	6449	50861	13046	7619	6284	50302	13046	155376	51.1	51.1
Other invertebrate	2788	1815	21212	7868	2588	1564	8283	7868	53986	17.7	15.3
Isoptera	4133	4438	18823	0	9111	4208	18815	0	59528	19.6	19.6
Acarina	1131	197	955	381	117	152	957	201	4091	1.4	0.4
Vegetable	113	155	908	213	85	133	910	200	2217	0.9	0
UIDAR	185	1549	3457	202	149	1514	3465	190	10711	3.5	0
Total	16903	15619	102122	22815	20361	14841	88725	22610	303996	100	88.4
Percentage	5.56	5.13	33.59	7.51	6.7	4.88	29.19	7.44			
Mean per bird	469.53		433.86	2836.72	633.75	426.69	412.53	2464.42	628.06		
	*	*	*	*	*	*	*	*			
G/total		3904.3					3931.7	NS			

* = significant
t = time
n = birds number

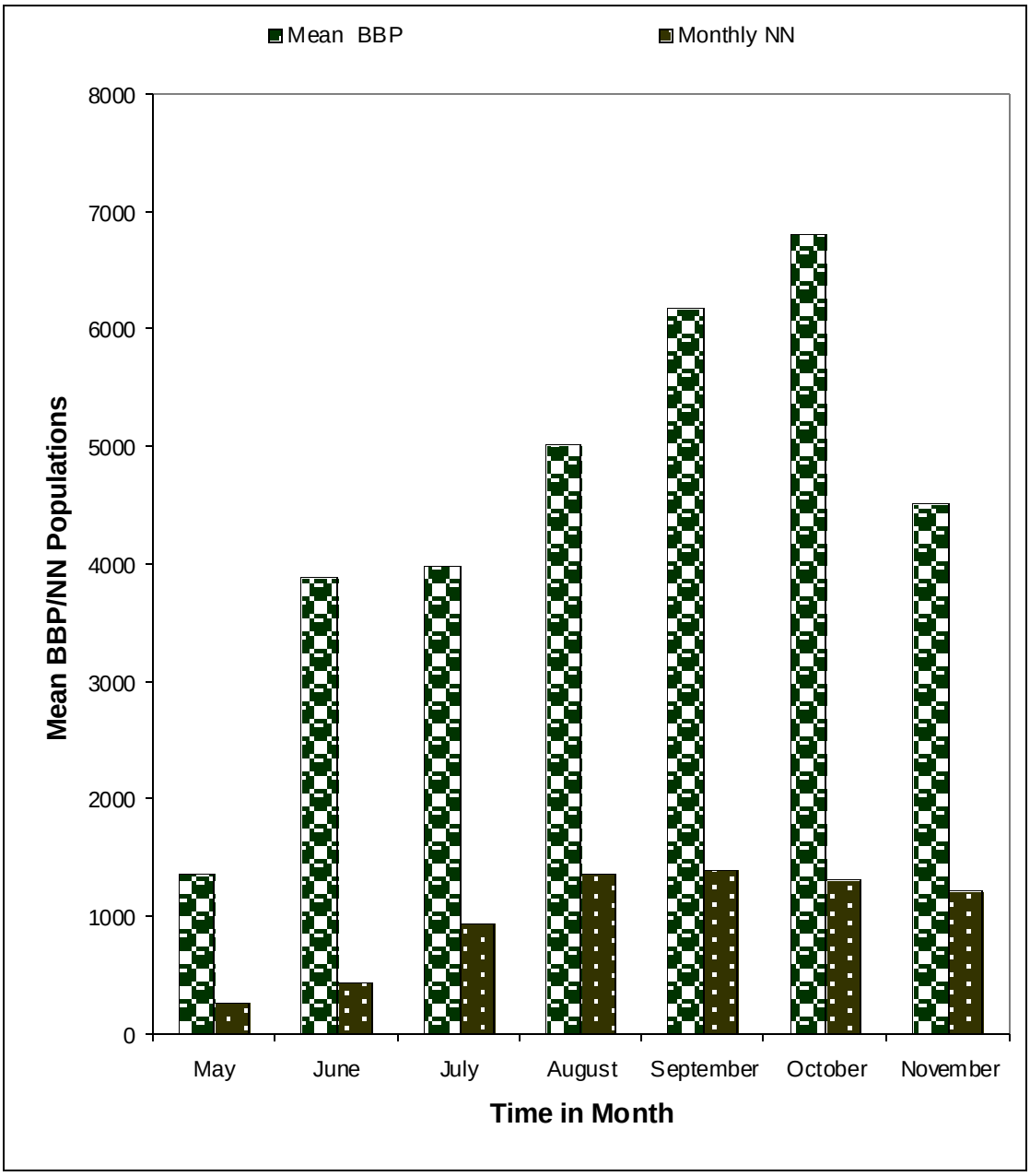

Figure 4. Mean bird Population and nest number per quadrant during cattle egret breeding seasons in Mbodewa, Jebra and Konduga sites. Observations were made on monthly intervals from the day of arrival at nest site and nest –making started (BBP= Breeding birds Population , NN = Nest number).

Table 5. Breeding birds and nest populations for 2002 and 2003 breeding seasons estimated for three sites on monthly basis before the ending of breeding season BBP = Breeding bird population, NN = Nest number

	Mbodewa				Jebra				Konduga			
Time in Month	2002 BBP	NN	2003 BBP	NN	2002 BBP	NN	2003 BBP	NN	2002 BBP	NN	2003 BBP	NN
May	0	0	0	0	8001	1600	320	133	0	0	0	0
June	8723	1586	3000	507	8805	1761	350	175	2095	524	702	180
July	8800	2200	2632	514	8837	1767	600	200	2184	546	773	168
August	14086	3662	4646	1089	9645	2056	570	190	2300	1088		
	1623	400										
September	14280	3522	7620	1053	9694	2140	351	176	6200	896	2400	235
October	16000	3425	3327	703	9098	2003	308	135	4350	885	1328	222
November	9360	3210	3126	691	8989	2001	0	0	3585	575	814	201
Total	72250	17605	24352	4559	63071	13328	2499	1009	20714	4514	7640	1406

Konduga sites however, where there were tall gamba grass cover, tall trees, scattered water ponds and large farmlands where insects breed more than in Mbodewa site, may have provided abundant food and water supply close to sites (Hafner, 2000). In addition, 7 of the failed eggs, was from Mbodewa eggs left for field hatching and 11 from the laboratory hatching, revealing the problems of the area even in the hatchability of eggs.

The fluctuation in fledging success in Mbodewa site (Table 3) could have been due to asynchronous hatching resulting from time lapse in the egg-laying. Jebra and Konduga sites, had consistent increase except week 5 in Konduga where there was a slight drop and could have been due to similar reason as in Mbodewa. The consistent increase in Jebra site could also indicate the simultaneousity and consistency in egg-laying and hatching, hence the consistent increase in the fledging success. Decline in the fledging success in Mbodewa and Konduga could be attributed to the inability of parents to constantly supply enough food, as there was no chick loss throughout the experiment and may be due to food scarcity as the rainy season was coming to an end and rainy season preys were disappearing.

The study of breeding and feeding behaviors, habits and diet of the cattle egrets revealed that, they are important to the environment (affecting colony site negatively through death of colony trees and soil pollution) and agriculture, particularly to the farmers in this arid zone, where farms are prone to consistent locust and grasshopper attacks every cropping season. The need for conservation, security and provision of conducive breeding and feeding environments for these birds are of paramount importance in this area with its hydro-headed weather and environmental problems affecting agriculture and conservation.

Low correlation coefficient (CE) (0.169) between hatching and fledging success suggest that almost all chicks reached fledging stage. R-squared (the value of regression coefficient which explain the relationships between two or more competing variables) is low 0.365 (36.5%), which indicate that, no one factor, but many (environmental , food, security , water, parental care) were responsible for the high fledging success. This finding however, has opened another area of the effect of tree species on fledging success. The significant difference with time lapse and 5.49% daily increase in fledging success also indicate that most chicks would fledge successfully within the 21days fledging time required. Chicks are said to fledge when they are able to fly from one branch to another, and away from their nests (Maddock, 1980), which the cattle egrets chicks were able to do that within 21 days. In arid environment, therefore, it is believed that Cattle egrets and Aves in general are genetically programmed to lay only two (2) or three (3) eggs (prudential strategy of reproduction) (Colinvaux, 1993), in order to utilize prudently the nutrients and energy reserved prior to egg laying. Particularly, in this arid zone of northeast where the weather and rainy periods are uncertain the birds need to be prudent in clutch size.

Breeding cattle egrets arrive sites contemporaneously in packets, waves and small flocks as rains start, to allow less competition for nesting sites and nesting materials. This probably confirms the reported by Belzer and Lombordi (1989), that cattle egrets need stimulators, like other early nesting birds before they begin nesting activities. Assuring themselves of the proper timing, conducive environment, availability of prey, water, nest materials and canopy coverage for security of nests and nest contents throughout the breeding period. It may also be a ploy to reduce competition for space, mates, proper settlement by the early nesters, for nesting materials and also reduce cockuldry behaviour. Early nesters are believed to be those birds, which are more experienced and aware of the uncertainty in the weather of the arid environment. They nest high up the tree branches and strata, to have full view of the surrounding environment and reduce obstruction from canopy coverage. These high nesters are mostly cockuldry males involved in extra-pair copulation (McKilligan, 1990 ; Hilaluddin *et al.,* 2003), which usually fly downward from above and land straight on the backs of those unsuspecting females lying below and not vice versa. The low correlation coefficient (0.171) for breeding birds population and nest number, indicate that most birds at site nested during the breeding season. However, the negative correlation between birds population and nest number in September suggest that nest – making had stopped in this month; while birds population was increasing, due to the fledging offspring. However, other reason may be adduced (attributed), such as nest losses due to rain and windstorms, pilferation (pillaging) and nest site desertion.

Relationship between the seasons, months, breeding bird and nest populations, indicate positive relationship up to August (Table 5) but negatively correlated as from September due to the population explosion of the developing young adults. There was early nest abandonment in October in Jebra 2003 breeding season, may be due to early fledging and lack of food.

In conclusion, it is proven that breeding success is dependent upon intrinsic (biological) and extrinsic (environmental) factors. It is proven that cattle egret egg can hatch in natural (79.9%) and artificially (56.6%). It is also proven that site does not affect fledging success neither did egg parameters had any effect on breeding success of the Cattle egrets, as most eggs despite shaper, sizes and sites hatched and fledged successfully.

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