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Egg measurements and Breeding success of the Black Crowned Crane *Balearica pavonina ceciliae* in the Upper Blue Nile Basin Wetlands, Lake Tana Area, Ethiopia

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Abstract
In this study we investigated the egg and clutch size and nesting success of the Black Crowned Crane *Balearica pavonina ceciliae* in the wild. The study was carried out at Lake Tana area from August 2014 to January 2016. Result showed that the active nesting period was from September to October although extends to December. The average clutch size was two (N=92). The mean length of eggs was 76.9±0.22 mm, and the breadth was measured 54.05±0.07 mm. The mean weight of eggs (N=92) was 112.0±0.65g. There was no significant difference in all measurements at 5% level of significance (length, N=92, df=1, F=0.02, P>0.05; breadth, N=92, df=1, F=0.048, P>0.05; weight, N=92, df=1, P>0.05). There was a positive correlation between egg length and breadth (r_s=0.219, P=0.036, P<0.05, N=92). There was not any significant correlation between egg length and weight (r_s=0−0.019, P=0.857, P>0.05). There was also no significance difference between the egg breadth and weight (r_s=0.04, P=0.694, P>0.05, N=92). The breeding performance was evaluated. From the total of 92 eggs, 84 eggs were hatched (39 in 2014 and 45 in 2015). Therefore, the hatchability percentage was 89% and 94% in 2014 and 2015, respectively (totally 91.3%). The hatching success was not significantly different between 2014 and 2015 (t=4, df=1, P=0.156). The total number of pre-fledged cranes in 2014 to 2015 was only 42 individuals. The mortality and pre-fledged proportion was equivalent (about 50%) which indicates that the overall breeding performance of cranes in the study area is poor. Agricultural encroachment, livestock pressure and human population growth accompanied by absence of alternative livelihood options, and poor awareness creation on the wetland ecosystem are the main threats to the survival of this species.

1. Introduction

All cranes have an extremely limited reproductive potential, resulting from their deferred sexual maturity, low clutch size and limited re-nesting tendencies following the loss of a clutch or hatched young (Johnsgard 1983). The breeding biology of all cranes is characterized by delayed maturity, long-term monogamy, annual breeding with 3−5 months nesting period, small clutch size and extensive pre- and post-fledging parental care (Tacha *et al.* 1989; Drewien *et al.* 1995). These demographic factors result in naturally low recruitment that limits their ability to recover from declines.

The duration of egg incubation in cranes ranges from 28 to 36 days (Perrins & Middleton 1987). The length of the incubation period varies among species and with the climatic regime. The Crowned Cranes usually starts incubation after laying the first or the second egg (Walkinshaw 1965; Urban *et al.* 1986). Unlike most other large waterbirds, cranes have a relatively small clutch size with the majority of species laying two eggs. The exceptions are

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the Crowned Crane which lay two or three eggs and the Wattled Crane *Bugeranus carunculatus* which lays one or two eggs (Konrad 1981). In long-lived species with low reproductive rates and late age at first breeding, such as cranes, population parameters tend to change slowly and their effects on the reproductive success of individuals may be difficult to detect or measure in short duration of study (Gichuki 1993). However, the breeding population of most bird species has a tendency to remain fairly constant unless unpredicted stochastic factor such as intentional extermination practice like poisoning or indefinite killing is happening (Lack 1966).

Crowned Cranes are commonly seen in pairs, and are believed to retain mates throughout their life span (Walkinshaw 1973). Birds of both sexes, occasionally gather on open sites, where adults engage in vigorous courtship display and call. Such aggregations are usually formed prior to breeding and on sites located away from the breeding sites. The species has elaborate courtship displays and calls (Archibald 1977; Johnsgard 1983; Urban *et al.* 1986). The pattern of mate competition, significance of courtship before and after pair bond formation and the influence of mate characteristics on the reproductive success of the species have not been studied well in detail.

The main features of nesting behaviour of cranes, however, are generally similar in all species of living cranes (Johnsgard, 1983). Except Blue Crane *Anthropoides paradisae* and Demoiselle Crane *Anthropoides virgo*, 13 of these species build their nests in shallow wetlands with low emergent vegetation.

Crowned Cranes are known to be resident throughout the western highlands, the western part and in the Rift Valley lakes and rivers of Ethiopia (Aynalem *et al.* 2011).

Black Crowned Cranes are under alarming rate of decline (Beilfuss *et al.* 2007). The ecology of the eastern sub-population is less well-known (Beilfuss *et al.* 2007). Studying the breeding biology in the wild where the species lives can provide essential information to both evolutionary biologists and conservation managers. Some studies on the breeding biology of Black Crowned Crane have been conducted mainly in captivity (Walkinshaw 1965). However, detailed information on eggs, clutch size and breeding performance of the Black Crowned Crane in the wild is lacking. The aim of the present study was to fill this gap.

2. Materials and Methods

2.1. Study area

The study sites were located in northwestern Ethiopia, Lake Tana area (between 12°18'1.23" and 11°31'14.59" latitude; and 36°42'21.84" and 37°41'56.38" longitude, 1,800±25 m asl). Chimba (Bashadangela and Lamgebya area), Yiganda, Dirma and Infranz wetlands were three main sites (Fig. 1). The Lake Tana area around Bahir Dar receives on average 1,428.9±35.36 mm rainfall annually (based on the 1996−2015 period). The minimum and maximum annual rainfall was 1,163 mm in 2015 and 1,711.6 mm in 2014, respectively with the maximum during July (418.15 mm) and August (394.67 mm) at Lake Tana area (1996−2015). The minimum range temperature was 10.33−13.80°C and the maximum was 26.75−28.77°C, however the average was 20 ±0.14°C during the 1996–2015 years (Bahir Dar Meteorological Station, 2016, unpublished).

2.2. Field procedure

AWS (American Weighing Scale) - 250 Digital Pocket Scale was used to measure eggs at nest site. Adjustment of the weighing scale was performed with a 200 g stone. A six inch 150 mm Carbon Fiber Composite Vernier Digital Electronic Caliper Ruler US with an accuracy of ±0.2 mm was used to measure the length and breadth of eggs. GPS (Global Positioning System) Map (12 model), digital Camera (Sony × 16 optical zoom lens), telescope (25−60 × Swarovski model), binoculars (10 × 50 Nikon), wader and rubber shoes were utilized in the field.

Intensive nest searching was carried out in the study sites using a spotting scope and binoculars, starting from August 2014 to January 2016. The egg weight measurement was adjusted with the correction factor of 199.7 ÷ 200, which every egg weight measurement in the field was multiplied by 0.9985 to get the correct weight of egg. The laid eggs were numbered using permanent marker to indicate first, second and third egg laid, depending on the size of clutches. The age of the clutch size was determined based on the time of eggs laid. It was assigned 'new', 'old', and 'older' stages.

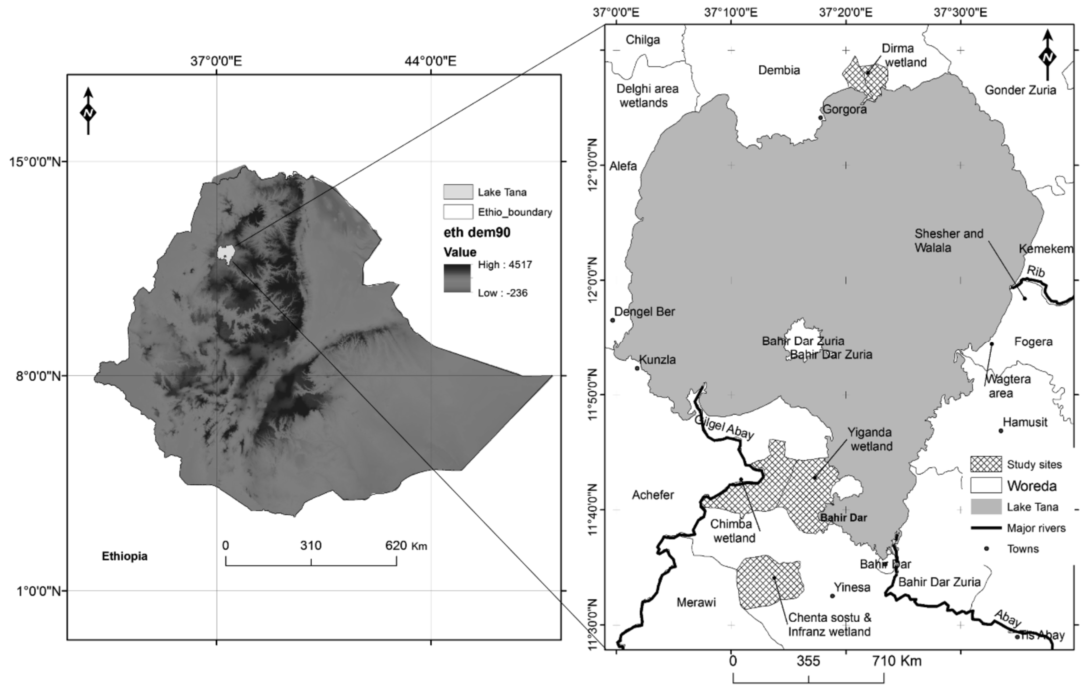

Fig. 1. Map of study sites, Lake Tana area, Ethiopia (Aynalem 2016).

Fig. 2. Egg at nests and egg measurements of Black Crowned Crane at Yiganda and Chimba wetlands, October, 2014 (Photo: ©Aynalem).

For clutches two, it has 'new' and 'old' stage; whereas for clutch three, 'new', 'old' and 'older' stages were assigned. Clutches with one egg could be either 'new' or 'old', depending on the time of recording (Fig. 2).

Nest searching was carried out on weekly basis. For clutch one, if nest construction was found to be completed during the time of visit and was found with no egg but one in the next visit, it was recorded as 'old'. However, when two or three clutches were found within a week, the egg stages were assigned based on the size and color of the egg. The dirtier egg was assigned old / older depending on the clutch size; and the whiter was assigned newer laid egg. All egg morphometry measurements were taken at the nesting site.

Breeding performance was evaluated starting from nest initiation to pre-fledging time. During the study period, 90 days of pre-fledging time of Black Crowned Cranes were considered for estimating the pre-fledge success. The pre-fledged cranes were followed up since the time during the first egg-hatched and before fledging. Breeding pairs are territorial and usually stick to their specific site which made it easy for follow up. The time of nest initiation, egg laid, egg hatching and pre-fledged were estimated. The expected and observed fledging percentages were assessed.

To make a statistical decision on the observed data, the null (H_0) and alternative hypotheses (H_1) were proposed for the statistical relationship between the data sets for comparison. Different parameters such as egg measurements (weight, length, breadth) were tested between newly laid eggs and older ones; and between clutch sizes. A null hypothesis stated that the variation of egg measurements and clutch size is due to a chance factor than a real effect, which is the alternative hypothesis. For total egg measurements, H0: $\mu 1 = \mu 2$, which shows there is no difference between means of total egg measurements of the two populations. But H_1 states $\mu 1 \neq \mu 2$. Similarly, the egg shape index and egg volume, the newly laid eggs measurements and hatchability percentage per season/year were also tested against the Ho $\neq$ H1.

2.3. Data analyses

The normality distribution of data were checked using Shapiro-Wilk's test (Shapiro & Wilk, 1965; Razail & Wah 2011). Data with the standard normal distribution criteria were subjected to Analysis of Variance (ANOVA), Student *t*-test and Pearson Correlation. A paired samples *t*-test was run to see the association between egg laid and hatched. Comparison of means was made using Tuckey's HSD (Honest Significant difference) for variables whose F-values showed a significant difference. One tailed significance and differences were considered statistically significant at 5% level. Egg Shape Index (SI) and Egg volume (V) were measured using Hoyt (1979) and Mukherjee (1999), respectively.

SI = B/L* 100, where SI = Egg Shape Index, B= breadth or width of egg, and L= Length of the egg, and $V= 0.51*LB^2$, where V= egg volume, 0.05= scaling constant, L= length, and B= breadth of egg.

To see which egg stage/age has really a significant effect, Post-Hoc test was run. Tukey HSD was used to carry out multiple comparisons of egg ages or stages. The harmonic mean of the group sizes was used since the group sizes were unequal. Pearson Correlation coefficient for egg measurements was run to see the significance level 5%. Spearman's rho was performed to see the season (months) effect on the chick mortality rate.

3. Results

3.1. Egg measurements and clutch size

Among 46 breeding pairs that had eggs, a total of 92 eggs were recorded, 44 eggs in 2014 and 48 eggs in 2015, respectively. The average clutch size was two (*N*=92) (Table 1). The number and the mean weight of each clutch is present in Table 2. The mean length of eggs (*N*=92) was 76.94±0.22 (74.0–82.2) mm. The mean breadth was 54.05±0.07 (51.5–55.8) mm, and the mean weight of all eggs was 112.0±0.65 (101.05–128.6) g (Table 2). There was no significant difference in all measurements at 5% level of significance (*P*>0.05, Table 2).

We rejected the null hypothesis regarding the egg measurements of clutch size at three stages. The first, second and third clutch had different measurements. There was a significant difference between the stages/ages of eggs (Tables 3–4). The mean of egg length, breadth and weight was tested using a Post-Hoc test (Table 5). There was a positive but weak correlation between egg length and egg breadth and statistically significant (r_s=0.219, P=0.036, P<0.05, N=92). There was no correlation between egg length and weight and it was statistically not significant (r_s=0−0.019, P=0.857, P>0.05). There was also no significance difference between the egg breadth and egg weight (r_s=0.04, P=0.694, P>0.05, N=92).

The mean length (mm), breadth (mm) and weight (g) of eggs at Chenta Sostu and Dirma area, Yiganda, Chimba Bashadangela, and Chimba Lamgebya are present in Table 6. The egg shape index (ESI) and egg volume were also analyzed using fresh laid eggs (Table 7). We accepted the null hypothesis of egg measurements of the fresh laid eggs because the mean difference of the length, breadth, ESI, and volume of eggs were not significantly different, P>0.05 (n=40) (Table 7).

Table 1. Black Crowned Cranes clutch size and eggs laid during 2014 to 2015, at Lake Tana

Year	Clutch 1	Clutch 2	Clutch 3	Total clutch	Total eggs
2014	2	15	4	21	44
2015	5	17	3	25	48
Total nests	7	32	7	46	92
Total mean egg weight (g)±SD	109.9±2.04	226.2±2.00	327.9±6.84	-	-
Total mean egg length (mm) ±SD	79.64±2.3	77.15±2.1	75.89±1.5		
Total mean egg breadth (mm)±SD	54.23±0.51	54.05±0.69	54.00±0.66		

Table 2. Statistics of One-way ANOVA for the mean length, breadth and weight of eggs of Black Crowned Crane (N=92).

Variables all season	Mean±S.E	Maximum	Minimum	*df*	*F*	Sig.
Egg length (mm)	76.94±.22	74.0	82.2	1	0.020	0.887
Egg breadth (mm)	54.05±.07	51.5	55.8	1	0.048	0.827
Egg weight (g)	111.99±.65	101.05	128.6	1	2.052	0.155

Table 3. Mean length, breadth and weight of 1st, 2nd and 3rd laid eggs.

Measurements	Egg stage/age	N	Mean±S.E
Egg length (mm)	new	40	77.55±0.32
	old	45	76.60±0.34
	older	7	75.64±0.51
Egg breadth (mm)	new	40	54.39±0.07
	old	45	53.83±0.11
	older	7	53.50±0.11
Egg weight (g)	new	40	114.27±0.94
	old	45	110.86±0.86
	older	7	106.21±2.35

Table 4. One-way ANOVA for egg length, breadth and weight, based on egg stages (1st, 2nd, and 3rd laid).

Variable	Sum of Squares	*df*	Mean Square	*F*	Sig.
Egg length between egg stages	31.607	2	15.804	3.604	0.031
Egg breadth between egg stages	9.054	2	4.527	12.8	0.000
Egg weight between egg stages	499.506	2	249.753	7.212	0.001

Table 5. Multiple comparison of egg stages using Tukey HSD test.

Dependent Variable	(I) egg stage	(J) egg stage	Mean Difference (I-J)	S.E	Sig.
Egg length	new	old	0.943	0.455	0.101
		older	1.905	0.858	0.073
	old	new	−0.943	0.455	0.101
		older	0.962	0.851	0.498
	older	new	−1.905	0.858	0.073
		old	−0.962	0.851	0.498
Egg breadth	new	old	0.56583*	0.129	0.000*
		older	0.89250*	0.244	0.001*
	old	new	−.56583*	0.129	0.000*
		older	0.327	0.242	0.371
	older	new	−0.89250*	0.244	0.001*
		old	−0.327	0.242	0.371
Egg weight	new	Old	3.41136*	1.279	0.024*
		older	8.06139*	2.411	0.003*
	old	new	−3.41136*	1.279	0.024*
		older	4.650	2.391	0.132
	older	new	−8.06139*	2.411	0.003*
		old	−4.650	2.391	0.13

Table 6. The mean length (mm), breadth (mm) and weight (g) of laid eggs in the study sites.

Egg measurements	Study sites	N	Mean±S.E
Egg length	Infranz	30	77.12±0.42
	Yiganda	18	77.22±0.62
	Chimba Bashadangela	32	76.91±0.35
	Chimba Lamgebya	12	76.17±0.37
	Total	**92**	**76.94±0.22**
Egg breadth	Infranz	30	54.18±0.08
	Yiganda	18	53.73±0.15
	Chimba Bashadangela	32	54.03±0.14
	Chimba Lamgebya	12	54.25±0.17
	Total	**92**	**54.05±0.07**
Egg weight	Infranz	30	112.94±1.26
	Yiganda	18	113.51±1.50
	Chimba Bashadangela	32	111.54±1.08
	Chimba Lamgebya	12	108.55±0.99
	Total	**92**	**111.99±0.65**

Table 7. Independent Sample *t*-test for equality of means between 2014 and 2015 fresh laid eggs.

Variable	Year	Mean	*t*	*df*	Sig.	Mean Difference	S.E Difference	95% CI of the Difference	
								Lower	Upper
Length	2014	7.8±0.04	0.031	38	0.975	0.002	0.064	−0.128	0.131
	2015	7.75±0.05							
	Average	7.69±0.22							
Breadth	2014	5.4±0.01	0.097	38	0.923	0.001	0.015	−0.028	0.031
	2015	5.4±0.01							
	Average	5.4±0.01							
ESI	2014	70.2±0.39	−0.016	38	0.987	−0.009	0.58	−1.184	1.165
	2015	70.2±0.42							
	Average	70.2±0.40							
Volume	2014	117.1±0.92	0.09	38	0.929	0.107	1.192	−2.306	2.52
	2015	117.0±0.77							
	Average	117.1±0.85							

3.2. Breeding performance

The first early nest was initiated on 14–15 September in 2014 and lasted by the first two weeks of December in 2015. The duration of egg laying was from the 3rd and 4th week of September to the second week of December; however the last hatched egg was stayed up to the second week of January 2015. Those cranes that had late nest initiation had also poor breeding performance (Fig. 5).

From the total of 92 eggs, only 84 eggs were hatched (39 in 2014 and 45 in 2015). Therefore, the hatchability percentage was 89% and 94% in 2014 and 2015, respectively (total 91.3%). The hatching success was not significantly different between 2014 and 2015 (t=4, df=1, P=0.156). The destroyed eggs were mainly from Chimba area, and one egg from Chenta Sostu. In 2015, three eggs were also destroyed from Chimba area and from Chenta.

Only 23 cranes were pre-fledged in 2014 (58.8%) and 19 (42.2%) in 2015, and about 50% on average. The distribution of pre-fledged cranes in the study sites was different (Fig. 4).

The total number of pre-fledged cranes in 2014 to 2015 was only 42 individuals. The mortality and pre-fledged proportion was equivalent, which indicates that the overall breeding performance of cranes in the study area is poor (Fig. 6).

Regarding effect of season on chick mortality, the expected pre-fledged and the actual pre-fledged cranes were six (actual) out of nine (expected) in December, 16 out of 26 in January, 17 out of 35 in February, 3 out of 10 in March and none out of four were pre-fledged in April. The proportion of death rate in these months was 33.3%, 38.5%, 51.4%, 70%, and 100%. There was strong positive correlation between the months and pre-fledged juvenile mortality at 0.01 level (one-tailed) (Spearman's rho=1, months=5, P<0.01). The mean death proportion of months (December, January, February, and April) was 0.59±0.12. A one-sample test was also performed to compare the mean death proportion of cranes during the pre-fledging stage, and there was a significant difference of the mortality rate of cranes between specified months at which cranes were supposed to be fledged (t=4.84, df= 4, P=0.008).

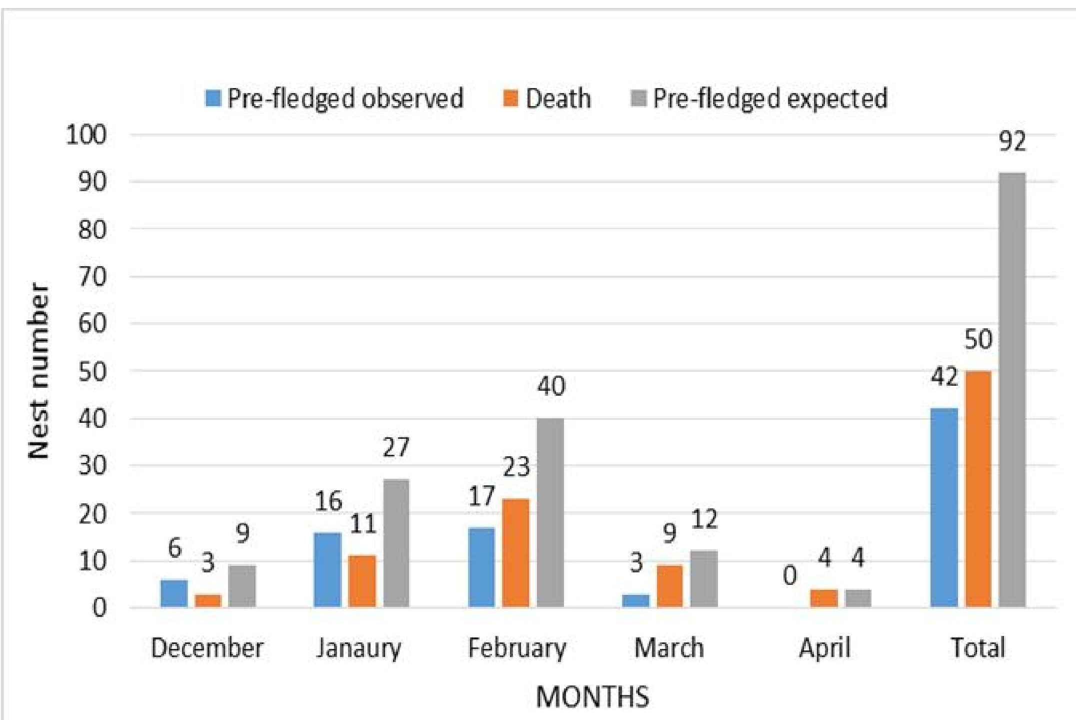

Fig. 3. Expected and observed pre-fledged cranes in the study sites.

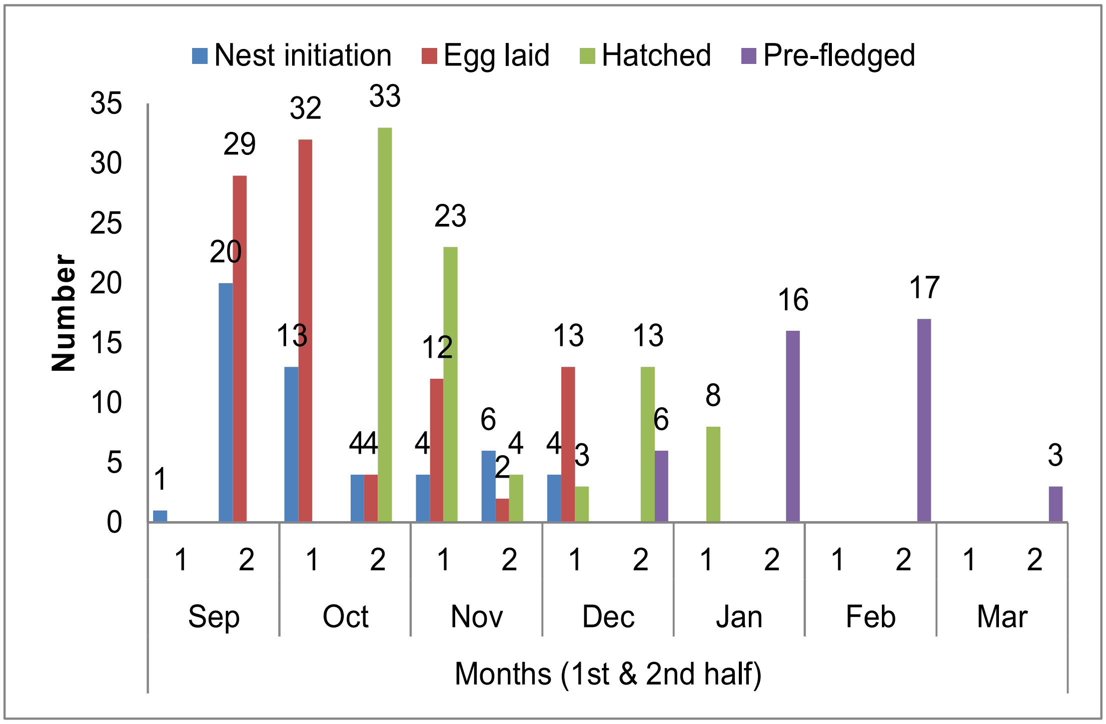

Fig. 4. Breeding performance of cranes in Lake Tana area. Numbers 1 and 2 of months indicates first and second half of each month.

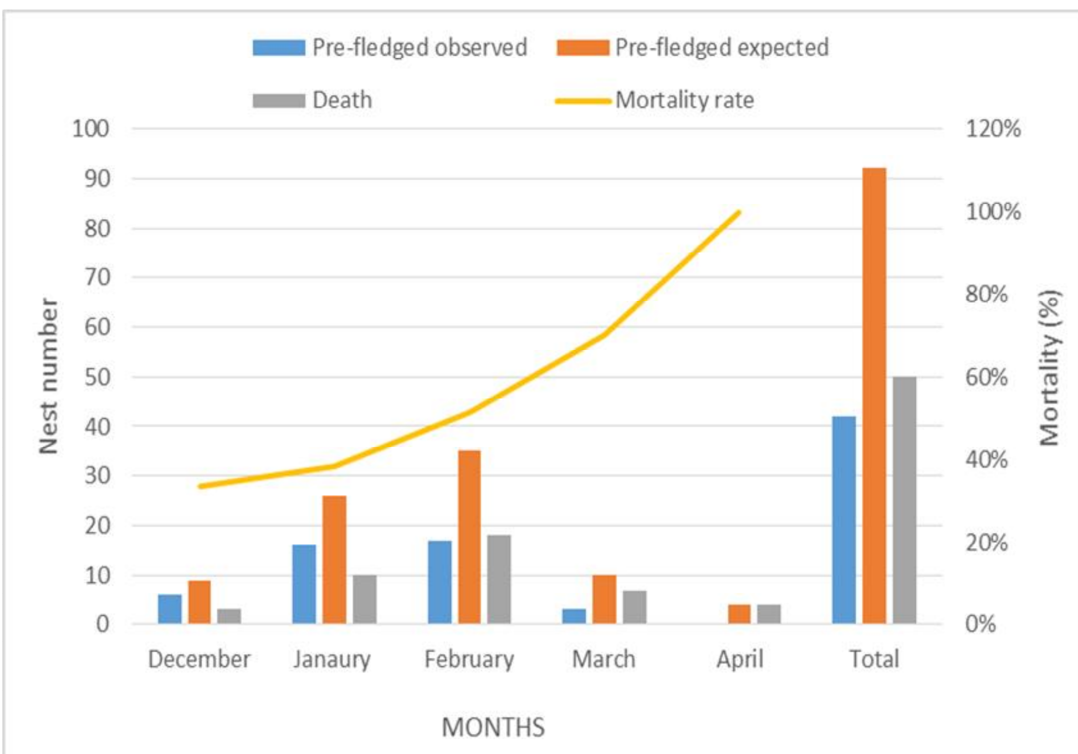

Fig. 5. The number of pre-fledged expected, pre-fledged and mortality of juveniles on monthly basis.

4. Discussion

Nests of Black Crowned Crane are usually oblong. Nests having eggs showed depressed shape at the centre of the nest, but not for nests without eggs. Oblong type of nest architecture is similar across wetland nesting cranes (Johnsgard 1983; Mukherjee *et al.* 2000).

It is doubtful that significant difference exist in the clutch size of Grey Crowned Cranes *Balearica regulorum* (Pomeroy 1980a). Pomeroy (1980b) noted, however, that clutch seems to vary with altitude; in that 12 nests from areas of generally below 1,500 meters averaged 2.17 eggs, while 29 nests from highland areas above 1,500 meters averaged 2.72 eggs. Records of 17 West African Crane nests provided by Walkinshaw (1973) indicate an average clutch size of 2.47 eggs. At Lake Tana area, however, average clutch sizes of 2 eggs were recorded, similar to findings of Aynalem *et al.* (2011) while it was different with findings of Gichuki (1993) who indicated average clutch size of 2.4 eggs (89 nests) for Crowned Cranes in Kitale area, Kenya. This variation could be due to the species specific genetic character of Grey and Black Crowned Cranes.

The size of bird eggs may be important in determining body size and condition of fledglings, their probability of survival and ultimately their reproductive success (Schifferli 1973; Williams 1994). In addition, it was reported that egg dimensions affect the size of nestlings and thus may have an influence on their survival (Smith & Bruun 1998; Risch & Rohwer 2000). The egg measurements of Black Crowned Crane showed that there were low variations in egg breadth than length and weight. Romanoff and Romanoff (1963) have also reported that eggs in oviduct whose cross sectional area has a limited extensibility and the egg breadth, was the most constant of all the parameters. Similarly, in the Sarus Crane *Antigone antigone*, egg breadth was found to be the most consistent parameter (Mukherjee *et al.* 2000). The variation observed in egg diameter within a clutch was very small, compared to the variation noted between clutches in Black Crowned Cranes. This was also reported in the Sarus Crane as well (Mukherjee *et al.* 2000).

Variation in egg dimensions results from both genetic determination and impact of environmental conditions on these features (Surmacki *et al.* 2003). Pomeroy (1980) showed that eggs weight ranged from 122 g (*regulorum*) to 156 g (*pavonina*) but at Lake Tana it was 128 g. Egg measurements can also differ in their within-clutch variation (Surmacki *et al.* 2003). In the Black Crowned Cranes, the variation was observed in the egg breadth (between new and old eggs, and between new and older eggs). In addition, egg weight variation existed between new and old, and between new and older eggs. The variations noted in the egg weight may be attributed to the date of observation after egg laying and also to its sequence error within the clutch during data collection. However, this observation seems to represent a more general rule and has been reported as a variable for many bird species (Ojanen 1983; Tryjanowski *et al.* 2001).

In captivity, the hatchability percentage of the West African Crowned Cranes was reported 100% (Johnsgard 1983). In the wild, the hatchability percentage of cranes at Lake Tana was greater than a study of Crowned Cranes in Kenya, which was 83.6% (Guchiki 1993). However, the nesting success and hatchability was very high (93%). The result agrees with Johnsgard (1983), who reported that the percentage of eggs hatched in cranes is similar to that of the percentage of nests successfully terminated, suggesting a very low number of eggs that fail to hatch as a result of infertility, dead embryos, or other factors that might reduce hatchability. Effective nest defense could be accounted for high rate of nesting success in cranes (Johnsgard 1983).

Pomeroy (1980) estimated that fledging occurred at about 100 days of age, and Walkinshaw (1973) stated that hand-reared West African Cranes may not fly until they are four months old. However, Steel (1977) estimated that hand-reared East African birds were virtually fledged at eight weeks of age, and Archibald & Viess (1979) reported fledging in hand-reared birds at only 63 days after hatching. Clearly, these wide divergences in estimated fledging times must indicate an unknown source of considerable variation, perhaps in the amount of food available to the young cranes. The pre-fledged cranes at Lake Tana, however, were almost half way from the number of hatched ones. The late nest initiation time, disturbance, competition for resources, predation of juveniles and sibling strife could be accounted for low breeding performance. Beside the predation, Fox (2011) reported that specifically, if a colt was one of a pair and had a living sibling, the probability of fledging was 50.9%.

The proportion of pre-fledged cranes decreases as time advances from December to April, because the crane death rate increased from 33.3% in December to 100% in April. The fledging time and pre-fledged juvenile mortality were strongly positively correlated. Late initiation of nesting, egg laying and hatching time increased the risk of chick mortality. But, Fox (2011) reported that experienced breeders nest early in larger wetland habitats. Nesbitt (1988) and Ivey & Dugger (2008) have also reported that increased breeding experience has been correlated with early nesting, selection of larger wetland habitats and greater nesting and fledging success. Therefore, the fledging success of Black Crowned Cranes at Lake Tana area can be associated with breeding experience of the crane pairs and late nest initiation time.

Nesting and fledging success rates of various crane populations showed that there was a variable nesting and fledging success among species and from year to year in the same species (Johnsgard 1983, Nesbitt 1988). Weather conditions and degrees of local disturbance or predation are main causes; however, in many cases that the nesting success of wild crane populations is rather surprisingly high, occasionally as many as 70% to 80%. This remarkably high rate of nesting success is probably associated with effective nest defense (Johnsgard 1983). A certain study on fledging success suggested that anywhere from about 44% to 71% of the eggs laid may result in successfully fledged young under natural conditions. No more than one of the two crane young that normally hatch from a clutch, will be fledged successfully, owing to inter-sibling strife.

The destroyed eggs at Lake Tana were mainly because of human factors. It is also important to note that other factors affect fledging success such as human disturbance, deliberate killing, wetland shrinkage, and poor environmental education and poor awareness towards cranes. The attitude towards cranes is becoming negative because they sometimes associate with crop foraging. The absence of environmental education for local people could be accounted for the nesting site and eggs loss.

Conclusion

The morphometric measurement of eggs and clutch size of Crowned Cranes could be genetically species specific. The mean weight of eggs could vary depending on the clutch size. Nevertheless, there was no variation in the overall mean of egg weight, egg length and breadth in the present study. The study suggested that the time of nesting influenced the breeding performance of the Black Crowned Cranes in a range of different ways. Early initiation of nest construction, egg laying and hatching in a secure breeding site during the post-rainy time, particularly September to October resulted in the highest pre-fledging success of cranes than that of cranes initiated nest construction lately during December. The presence of adequate vegetation cover, water depth, availability of food for juveniles, and less chance of human disturbance due to water level around the nest accounted for historical success of cranes during the specified season. Therefore, protection and conservation of cranes and their habitats should be synchronized and associated with the peak time of nesting during the post-rainy times.

The loss of wetlands worldwide, particularly in developing countries has been exacerbated from time to time. As agricultural activities have been expanded and intensified over the past decades, landscapes have been substantially altered in nearly all regions. Chimba and Yiganda wetlands are main breeding and feeding sites of cranes. During the 30 years period, more than 700 hectares (ha) of wetland in Chimba and 130 ha in Yiganda have been converted into other forms of land uses (Aynalem 2017). As a result, habitats of the crane have been shrunk down to a level that requires recovery and protection to save the remaining patch of wetlands. If this scenario continues, the crane habitat can be diminished in the near future together with their cranes.

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