*International Research Journal of Environment Sciences*_____ E-ISSN 2319–1414
Vol. **5(9),** 10-21, September **(2016)** *Int. Res. J. Environment Sci.*

Some Observations on Breeding Behaviour of the Asian Open-Billed Stork (*Anastomus Oscitans*) in the Raiganj Wildlife Sanctuary, West Bengal, India

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Available online at: www.isca.in, www.isca.me
Received 7th June 2016, revised 23rd August 2016, accepted 15th September 2016

Abstract

The breeding behaviour of the Open-billed stork, Anastomus oscitans was studied in the Raiganj Wildlife Sanctuary, Raiganj, Uttar Dinajpur, West Bengal, India. The storks assembled in the sanctuary from the last week of the month of May of the year 2007 and 2008. During breeding season they foraged singly. They visited foraging areas 10 Km away from the sanctuary. The main food species of the adult Open-billed stork were Pila globosa and Bellamya bengalensis. They also took lamelidens and crabs as food. Aerial displays of Open –billed stork observed through the breeding season in the sanctuary from the last week of the month of May to the last week of the month of December of the year. Peak activity was between 8.00 hr to 13.00 hr of the day before pair formation. They performed this behavior in the sky in a group with more than hundred birds for about 45 to 60 minutes. The Open-billed storks choose their mate within 5 to 7 days of aerial display. After mate choice, they occupied a fixed nesting place and stood side by side. A typical paired birds showed up and down standing position and sometimes at opposite direction. The mated birds touched each other's bill and pecked their mates check , head region , neck , body and also wing feathers by their bills. Allopreening preceded copulation in 87% of the cases. High frequency of copulation (5.5±0.032 times/pair/day) were seen in newly formed pairs. The copulation occurred either on the nest or on the branch of nesting trees from the first week of the month of June to the last-week of the month of August of the year. The copulatory behaviour was more in the morning and noon (10.00 – 12.00 hrs) than afternoon (14.00 – 16.00 hrs) of the day. The time was taken for cloacal contact upto 30% of the time engaged in copulation (2.66±0.040 seconds in 2007 and 2.71±0.042 seconds in 2008). Copulation also occurred after 1 to 4 eggs laid. The copulatory behaviour of storks basically ceased after hatching.

Keywords: Open-billed stork, Foraging, Aerial display, Allopreening, Copulation.

Introduction

The Asian Open-billed stork, *Anastomus oscitans* is a large wading bird in the stork family Ciconiidae. They breed amidst or near water bodies[1]. High breeding densities are found near rivers, with regular flooded grass land[2]. Ornithologically, Raiganj Wildlife Sanctuary is a very important heronry, which supports a high percentage of Asian Open bills, is not only a nationally important heronry but also an internationally important heronry. At the Raiganj Wildlife Sanctuary this stork species, *Anastomus oscitans* breeds together with five other members of the order Ciconiformes forming one of the World's largest concentrations of this group[3]. Every year large number of this bird species come in the sanctuary only for breeding purpose[4].

The Open-billed storks performed aerial display behavior after coming to the nesting zone. Aerial display is related to mate choice[5]. Only after having a mate and territory a bird may be regarded as contributor to its population. The paired storks immediately involved in allopreening and copulation started on the branch of nesting trees. Male and female birds have different reproductive options and different potential reproductive success. These differences result in different mating systems and behavioral differences in birds. According to Oring[6], both the duration and number of sexual partners help to define differences among various mating systems. Open- billed storks are generally monogamous, so this is not a crucial factor as in polygamous birds.

Both the sexes of Open-billed stork participated in pair forming displays quite successfully at the age of 2 years[3]. This sort of breeding attempt by sub-adults has been reported in other Ciconiiformes[7] and also in Open-billed stork[8].

Nest building behaviour may signal the reproductive performance of individuals and physiologically stimulate a partner[9], but there is very scanty information on the importance of the nest itself and its role in mate choice[10]. Nest building behaviour is often associated with courtship and pair formation in birds.

The degree to which this behaviour is used in courtship varies from mere manipulation of a piece of nest material or display of

a potential nest site to the building of an entire nest by the male individual[11].

The natural history and morphology of Open-billed stork is well known[12]. Very few research works on the breeding biology of the Open-billed stork exist[3,4] in India. For scientific management of the Open-billed stork population and their conservation, it is imperative to study breeding ecology, survival and mortality and factors that influence their breeding success.

As there is some lacuna in the breeding behavior and reproductive performance of Open-billed stork, this study will highlight various aspects of breeding behavior of this particular species in the Raiganj Wildlife Sanctuary from arrival time of adult birds to fledgling activities. This article describes some detailed information on arrival times to breeding area, aerial display, pair formation, allopreening, copulation and nest site selection of the Open-billed stork in the Raiganj Wildlife Sanctuary, Raiganj, Uttar Dinajpur, West Bengal, India.

Materials and Methods

The study was conducted in the Raiganj Wildlife Sanctuary, Raiganj, Uttar Dinajpur, West Bengal, India for two breeding seasons, 2007 and 2008. The observations were made at daytime (06.00 – 18.00 hrs). Daytime was divided into three periods namely morning (06.00 – 10.00), midday (10.00 – 14.00) and afternoon (14.00 – 18.00). The area was visited twice a week during breeding season and once a week during non-breeding season. The breeding behaviour of active pairs of Open-billed storks was studied by monitoring the nest site from early morning to late evening of the day. Five whole-night observations (18.00 – 6.00 hrs) were also made during the full moons. The foraging area of Open bills was made during daytime (06.00 – 18.00). The observations were carried out from two 20m high tourist watch towers situated nearer to the core region, roof tops of 20m high constructed building made for museum, tourist lodge, forest office, 15m high tall trees in the core region and a boat. The observations were made from a distance of 1m to 20m and the data were recorded. The observations also were done from ground under the nesting trees. In all cases data were recorded only the normal behavior of storks. During our presence at the top of museum building and tower and during walking inside the sanctuary initially the birds became frightened and flew away. After sometime the come back again to their own nests.

Fieldwork was conducted in two colonies one is the core region and other in the buffer region, comprising an average of 500 individuals, 250 breeding pairs, 250 nests, 700 eggs and 250 chicks in one breeding season. The nests of Open-billed stork were observed on 599 trees in 2007 and 615 trees in 2008 out of 645 trees belonging to 29 species. We selected an area of 10 km radius centered around the nest in order to analyze the foraging area of Open-billed stork. Following[13] five foraging area: a) canals inside the sanctuary, b) submerged agricultural land, c) river bank, d) ponds and e) marshes were categorized. The number of food items per square meter area was considered as the abundance for that category of food. Molluscs and fishes were captured by vessel net or khara jal (mesh size 6 x 6 mm), gill net (variable mesh size), crabs and cast net (mesh size 5 x5mm). All samples were captured and preserved in 4% formalin and photographs were taken by Kodak easy share digital camera (C713). The collected molluscs[14] and fishes[15,16] were identified with the help of mentioned standard books and scientific literatures. Scientific names were confirmed by comparing with the specimens in the collections of Zoological Survey of India, Kolkata, West Bengal. The frequency of each food item was calculated based on the number of occasions the food item was collected during the samplings.

All types of activities like aerial display, pair formation, copulation, nest building of the Open-billed stork were recorded using 10 x 50 binocular, 30x telescope, stopwatch, and meter tape (1cm – 50 m) and relevant photographs were taken by Kodak easy share digital camera (C713). Some of the behavioural activities were recorded with a movie camera for analysis later on. Observational data were recorded in the tally sheets prepared separately for different breeding activities and a separate note book was also maintained for special activities of breeding birds which were analysed in details after field work.

Aerial display of Open-bills were recorded during different time of the day as well as different months of the breeding season[17]. Time spent for aerial display in the sky were observed and recorded by a binoculalr and a stopwatch. Pair formation of Open-bills according to arrival time in the sanctuary were recorded in the note book. Copulation were regarded as successful when cloacal contact was recorded[18].

Data of all the parameters were calculated with the help of Windows spread sheet programme Excel – 2007. All the values are provided with the mean ± standard error of the mean.

Results and Discussion

Foraging Area and Food: The Open–billed storks were found to settle on the branch of nesting tree in both core and buffer region of the Raiganj Wildlife Sanctuary as well as nearer human habitation and road side (NH-34) which runs through the forest range. During breeding season they also foraged singly. The storks foraged on open natural water bodies such as i. canals inside the sanctuary (Figure-2), ii. submerged agricultural land iii. river bank, iv. ponds and v. marshes. They visited foraging areas 10 km away from the sanctuary (Table-1). The main food species of the adult Open – billed stork were *Pila globosa* and *Bellamya bengalensis*. They also took lamelidens and crabs as food. *Bellamya bengalensis* was the main food species of chicks of stork. *Pila globosa* was served to the youngs by the parent as the major food species during their growing stage.

Table-1
Foraging area and distance of foraging area from the nest site of the storks in the breeding season

Serial Number	Foraging area	Distance of foraging area from the nest (m.)
1.	Canals inside the sanctuary	0 -300
2.	Submerged agricultural lands	250-10000
3.	River bank	100-10000
4.	Ponds	300-7000
5.	Marshes	500-6500

In the rainy season particularly in the month of July to September, the surrounding low land areas of the Sanctuary flooded and the molluscs (Pila, Bellamya etc.) reproduced very fast in that submerged areas. The open-billed storks took Pila, Bellamya etc. as their food. The birds required huge amount of food for successful breeding during breeding season. Non breeding birds took low amount of food than the breeding birds.

The densities of *Pila* sp. of almost 11.5±0.160, 17.2±0.237, 8.9±0.100, 11.2±0.107, 26.5 ±0.160 pilas per square meter have been recorded in canals, agricultural lands, river bank, ponds and marshes respectively. *Bellamya* densities of almost 32.3±0.264, 25.9±0.100, 11.2±0.107, 16.9±0.225, 23.9±0.135 bellamyas per square meter have been observed in canals, agricultural lands, river bank, ponds and marshes respectively. The density of lamelidenses, crabs and fishes were given in the Table-2. The percentage of *Bellamya* consumption by the stork was high in the month of July to September of the year (Figure-1).

The Open-billed storks find food from the shallow water or muddy or filled with vegetation. The birds walked slowly in the submerged areas and dipped their bill for searching the food. If a Pila came to contact with the bill of stork, the Pila was taken and removed the operculum part by the bill and consumed it.

Aerial display: Aerial displays of Open-billed stork observed throughout the breeding season in the Raiganj Wildlife Sanctuary from the last week of May to the last week of December of two consecutive years (2007-2008). After coming to the forest of the birds, this displays increased day after day upto the mating period. The number of a group involved for the purpose where maximum at the pre – laying period on the month of June to August of the year when almost birds came to the forest (Figure-4). A group was formed by joining together at number of 10 to 25 birds from 5 to 40 different trees within 2 to 4 minutes. At a time 1 to 4 groups of Open-billed stork flew on separate site in the sky. During aerial display, the storks were flying closely next to each other. Many times the storks tried to fly above other stork at a short distance. These birds fly very fast and they can arrive long height. They can travel long distance. They reached in the sky within 5 to 10 seconds. The birds flew spirally, circle way, up and down and straight way. During aerial display, the birds were visible by nacked eyes up to 27.34±0.098 minutes in 2007 and 30.19±0.088 minutes in 2008 and after that they did not visible by necked eyes up to 9.13± 0.043 minutes and 8.15 ±0.051 minutes in 2007 and 2008 respectively. After vision of eyes they also flew up to 16.44± 0.069 minutes in 2007 and17.48± 0.081 minutes in 2008 observed during study period., All birds of the group did not come back together, rather they came at the number of 2 to 4 birds together after 52.35± 0.099 minutes and 55.59± 0.057 minutes aerial display in 2007 and 2008 respectively (Table-3). Always they did not arrive on the same tree from where they flew.

The birds took rest after aerial display minimum 50 to 60 minutes. After display, the birds that arrived to other's choosen nesting place, they can't settle that place due to their aggressive behaviour. They had to left that place and choose another site around minimum 2 ft distances. During aerial display, the birds choose their mate within 5 to 7 days. After nest formation both did not fly together leaving nest. Male fly in the sky and joined in aerial display and they returned at their nest after taking nesting material or food for his partner by their bill after egg laying on the nest. But female sometimes joined in this work and showed aerial display before pre –laying period. From the laying period female did not perform display in the sky up to the hatchling period. After chick rearing female took initiative flying training for chicks and flew in the sky for aerial display. Male also took part for flying training of chicks and for aerial display. 75 to 90 days aged young chicks performed aerial display with their parent in the same way that was seen at the pre-laying period. In this time hundreds and hundreds bird observed in a group. Because both parent and youngs joined together in aerial display. Sometime two groups of stork were flying in the some direction and closed each – other and finally fused and formed one group of birds. Aerial displays took place at morning to mid day time. It continued from 6.00 hrs to 17.00 hrs. Highest activity was noticed between 8.00 hrs to 13.00 hrs. (Figure-3). After 16.00 hrs no birds flew for aerial display. The birds that came late in the forest also showed aerial display and performed all the activities.

Pair formation: Pair formation initiates the first step of breeding success. After coming to the forest, Open-billed storks took shelter on the branches of nesting trees of the sanctuary and assembled from the last week of the month of May of every year. The birds showed aerial display and returned either with mate or without mate on the same branch from where the birds flew off. Sometimes they came back at new nesting site after display. Usually male choose the nesting site. They choose their mate within 5 – 7 days of aerial display. After mate choise they occupied a fixed nesting place and stood side by side and pierced their own body feathers by their bill. Sometimes it was

observed that if the nesting site was not suitable for proper nesting or they defeated by other birds, they leaved that nesting place and selected another branch of tree for nesting but pair remained stable. About 0.8 – 2.0 % of cases pair broken was seen. Early comer birds choose their mate early and selected the best nesting site where human interference was low (Figure-5). A typical paired bird showed up and down standing position and sometimes in opposite direction of standing position also observed. Some birds that came late in the forest did not get any mate and remained unpaired (1.2%) and joined with paired birds. We observed three bills shared one nest and they protected that nest from other bills.

Allopreening: Allopreening was observed amongst Open-billed storks on the selected branch of tree after pair formation. The mated birds touched each – other's bill and pecked their mate's face, head, neck, body and wings feathers also. Often both of them stretched their neck together in the front position. Allopreening was observed on the nest before copulation. Allopreening initiated by male generally (Table-4). It is a mutual phenomenon (after 4.26±0.097 minutes in 2007 and 4.73±0.127 minutes in 2008) for newly paired birds. Allopreening usually noticed during pre-laying period when the male came back to the nest (Figure-7). During egg- laying period, 12 % of the cases allopreening was observed before copulation (Figure-6). Allopreening was also noticed during post-laying period. The birds aged about 75-90 days also showed allopreening for 90-120 seconds.

Copulation: Allopreening preceded copulation in 87 % of the cases. In the present study 250 observations were made regarding the process of copulation and most of the cases took place on the nest. High frequency of copulation (5.5±0.032 times / pair /day) were seen in newly formed pairs and this phenomenon occurred mainly on the selected branches of nesting tree (Table-6). After mate choice, they started nesting and they involved in copulation 3.7±0.029 times / pair /day. 78 % of the observations were made on the nest where as the remaining 22 % occurred on the branches of the nesting tree in 2007 (Figure-9).

During copulation male touched his bill to the females' bill continuously side by side for 35.2±0.206 sec. Then male stood on females back and clattered their bill very fast (Figure-10). The male bird touched his bill on the neck of female and continuously up and down his wing. After that male downed his tail portion towards females cloaca and at that time female relaxed her cloaca simultaneously for successful cloacal contact. During copulation moment, female did not fell down on the nest or fell down from branches of tree bearing the whole body weight of male. After copulation male jumped off and stood both female and male side by side on the branch of tree or on the nest. The female shievered her own body feathers. Then they pierced their own body feather by their bill. Sometimes they pecked each other's head, neck and body. 70 % of the cases of mating were accepted as successful copulation when the cloacal contact was occurred and ejaculation was presumed (Table-5). The duration of copulation process was 9.84±0.197 sec. in 2007 and 9.18±0.194 sec. in 2008. The time was taken for cloacal contact upto 30% of the time engaged in copulation (2.66±0.040 sec. in 2007 and 2.71±0.042 sec. in 2008). The minimum time intervals of two successful copulation attempts was 27.3±0.098 minutes and these were successful. Unsuccessful attempts were also observed during the long observation period. At that time the male just stood on the females back and then jumped off. Copulation attempts were observed amongst Open-billed storks after allopreening from the first week of the month of June to the last week of the month of August of the year. The peak month of copulation period was July of every year. Usually the birds started copulation in the morning at 6.00 hrs and continued up to 17.00 hrs of the day. There is no specific time of copulation during that period. The frequency of the copulatory behaviour was more in the morning (10.00 – 12.00 hr.) than afternoon (14.00 –16.00 hrs) of the day (Figure-8). Copulation (1.8±0.025 times/ pair/ day) is also noticed after 1 to 4 eggs laid. At that time male took part incubation after copulation and female stood on nest for a period of minimum 36.6±0.211 minutes. The copulatory behaviour of Open-billed storks basically ceased after hatching, during chick rearing and fledging period. During copulation, copulated storks were disturbed by the storks of other neighbouring nests. Neighbouring storks bitted the feathers of copulated birds by their bill. In 1 % of cases, the incidence of Extra – pair copulation (Epc) occurred before laying period. During nest building period when the female remained alone on the nest the EPC– behaviour was also noticed in some situations.

Discussion: The Open-billed stork found food from the shallow or muddy or filled with vegetation. They foraged on open natural water bodies such as canals inside the sanctuary, submerged agricultural lands, river bank, ponds and marshes. The densities of Pila per square meter was almost 11.5±0.160, 17.2±0.237, 8.9±0.100, 11.2±0.107, 26.5±0.160 in canals, agricultural lands, river bank, ponds and marshes respectively. The richness of Pila attracted Open-billed storks to forage these areas. Datta[3] observed such type of foraging behaviour of open billed stroks at the Raiganj Wildlife Sanctuary, Raiganj, West Dinajpur, India. The Eurasian Eagle owls are known to nest near their preferred hunting areas[19] and their breeding success depends on the distance between the nest and foraging area. The Indian Eagle Owl builts terrestrial nests on hill slopes, earth cuttings, rocky outcrops and under bushes, where the surrounding areas which are its hunting grounds consisted of agriculture, scrubs, grasslands, waterbodies, hills and rural habitats[20]. The Masked Finfoot was observed foraging in the centre of the shallow pond and along the vegetation-covered edges[21]. During breeding season they also foraged singly around 2 Km. The main food species of Open-billed storks are *Pila globosa* and *Bellamya bengalensis*. They also took lamellidens and crabs as food. The food items of Open-billed stroks reported as *Pila* by Bannerman[22]; fresh water mussel by Root[23]; molluscs by White[24]; Ampullaria (pila) and Unio (mussels) by Jerdon[25];

'chiefly molluscs", *Pila globosa*, also crabs, frogs, other small animals by Ali and Ripley[26]; *Pila*, Leeches (Hirudinea) and earthworms (obligochaeta) by Kahl[27] ; *Pila globosa*, *Bellamya bengalensis*, *Bellamya dissimilis*, *Lymnaea acuminate*, *Lamellidens* sp., and crabs by Datta[3].

Table-2
Abundance of food species in different foraging areas from the nesting zone during breeding season

Serial Number	Foraging area	Number of observations	Number of food species available/square meter area				
			Bellamya	***Pila***	**Lamellidense**	**Crab**	**Fish (Carp)**
1.	Canals inside the sanctuary	50	32.3 ±0.264*	11.5 ±0.160	5.9 ±0.119	3.3± 0.157	36.68 ±0.150
2.	Submerged agricultural lands	50	25.9 ±0.100	17.2 ±0.237	2.7 0±.065	7.28± 0.103	–
3.	River bank	50	11.2 ±0.107	8.9 ±0.100	5.54 ±0.128	6.2 ±0.103	13.6 ±0.146
4.	Ponds	50	16.9 ±0.225	11.2 ±0.107	3.1 ±0.119	7.2 ±0.124	33.16 ±0.205
5.	Marshes	50	23.9 ±0.135	26.5 ±0.160	8.1 ±0.119	11.4 ±0.095	18.68 ±0.129

*****Mean ± S.E.

Table-3
Duration of aerial display of Open-billed storks in the sky

Year	No. of observations	Visible by nacked eyes in the sky (minutes)	Invisible by nacked eyes in the sky (minutes)	Visible by nacked eyes in the sky again (minutes)	Total time spent for aerial display (minutes)
2007	250	27.34±0.098*	9.13± 0.043	16.44± 0.069	52.35 0±.099
2008	250	30.19±0.088	8.15 ±0.051	17.48 0±.081	55.59 0±.057

* Mean ± S.E.

Table-4
Allopreening initiation by male and female Open-billed storks and duration of allopreening behaviour in the year 2007 and 2008

Year	No.of observation	Allopreening initiation by male (%)	Allopreening initiation by female (%)	Duration of allopreening (minutes)
2007	250	181 (72.4)	69 (27.6)	4.26±0.097* (2-7)**
2008	250	178 (71.2)	72 (28.8)	4.73±0.127 (1.5-8)

*Mean ± S.E., **Range

Table-5
Copulation behavior of Open-billed storks studied during the year 2007 and 2008

Year	No.of attempts observed	Copulation failed (%)	Copulation success (%)	Copulation duration (sec.)	Cloacal contact duration (sec.)
2007	250	75 (30)	175 (70)	9.84±0.197*	2.66±0.040
2008	250	62 (24.8)	188 (75.2)	9.18±0.194	2.71±0.042

*Mean ± S.E.

Table-6
Number of copulation attempts between a pair of stork in a day time during their different breeding phases

Breeding phases	No. of observations	Number of copulation attempts/pair/day
After pairing	250	5.5±0.032*
During nesting	250	3.7±0.029
During laying	250	1.8±0.025

*Mean ± S.E.

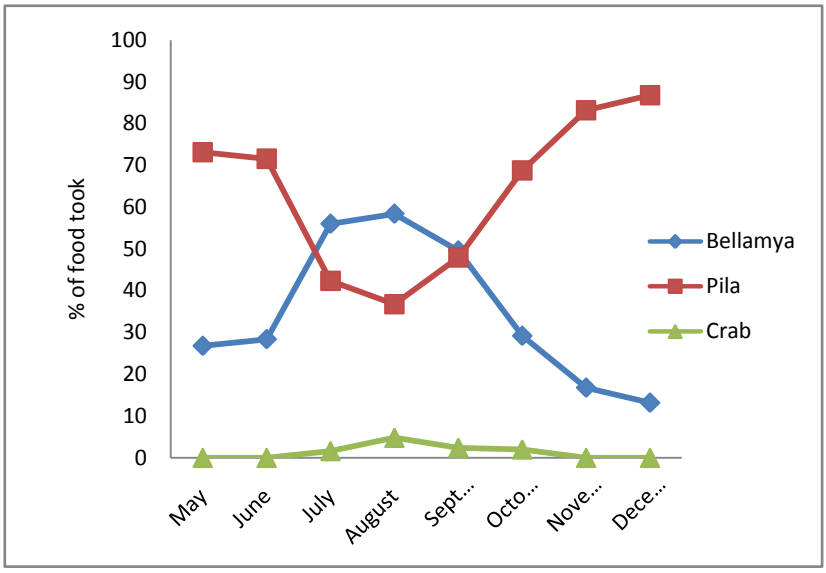

Figure-1
Main food species consumed by the Open-billed stork, *Anastomus oscitans* during the breeding season (n=250)

Figure-2
After arrival the storks searched food in the canal of the sanctuary

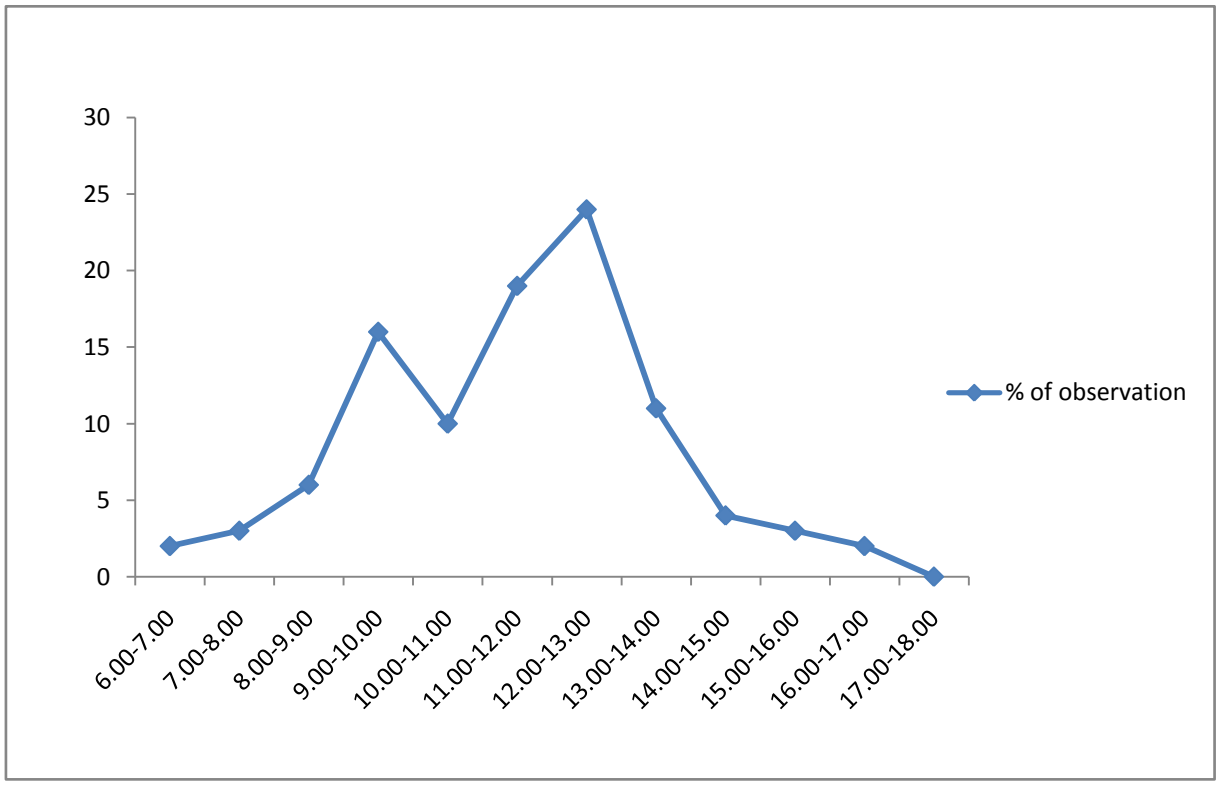

Figure-3
Aerial display behaviour of Open-billed stork at different time periods of the day (n=250)

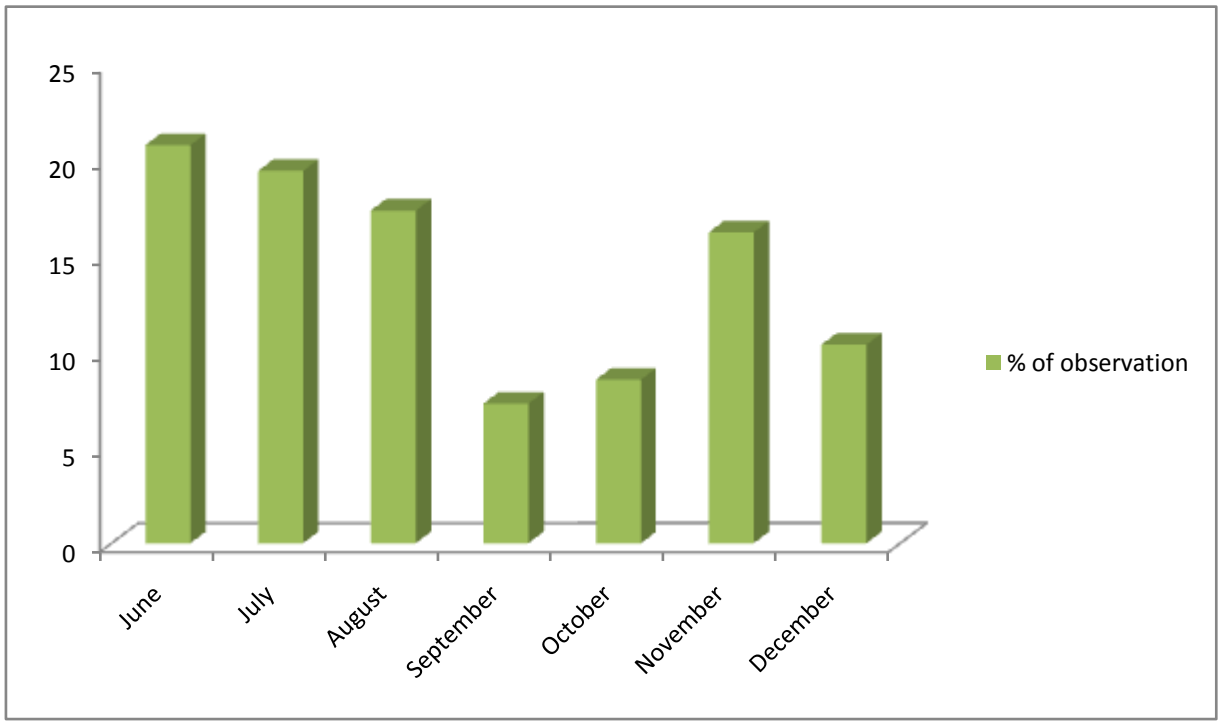

Figure-4
Aerial display behaviour of Open-billed stork at different months of the year (n=517)

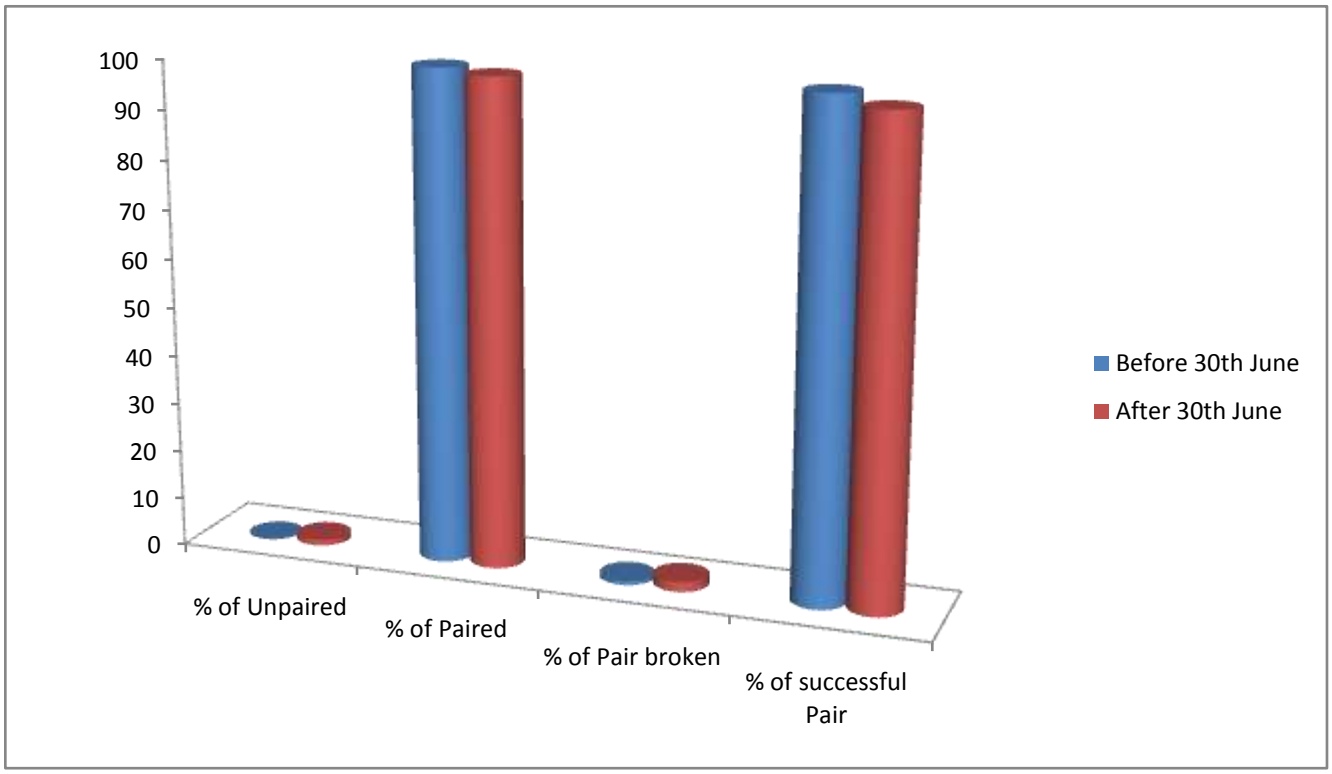

Figure-5
Percentage of successful pair formation of Open-billed storks according to their arrival time in the sanctuary (n=250)

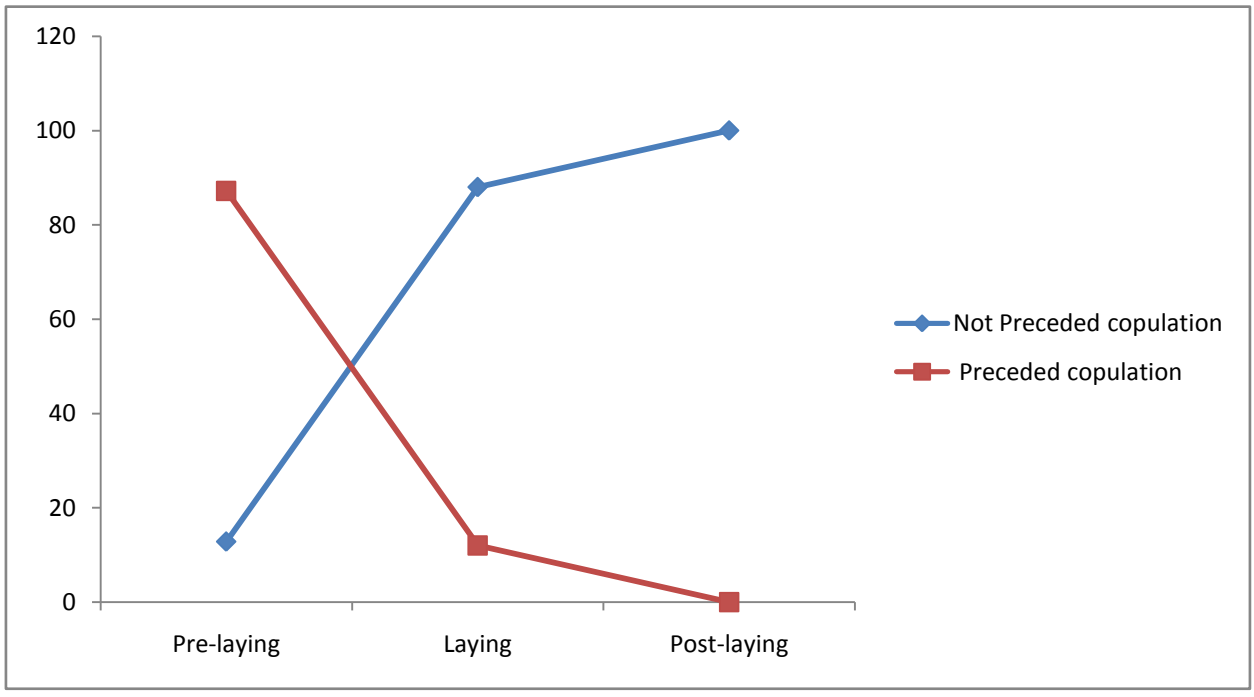

Figure-6
Percentage of successful allopreening of Open-billed storks according to their breeding phase (n=250)

Figure-7
The paired Open-billed stork performed allopreening behaviour on the branch of nesting tree

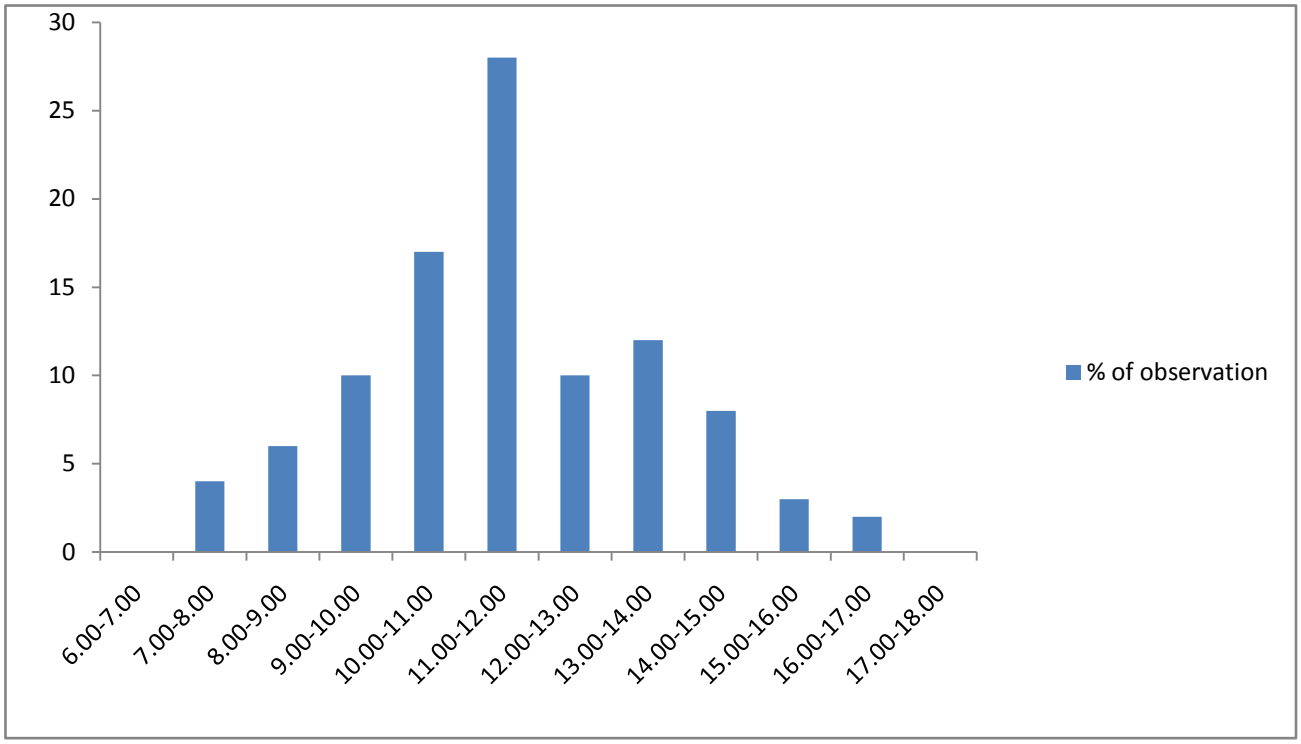

Figure-8
Copulation attempts of Open-billed stork at different times of the day. (n=250)

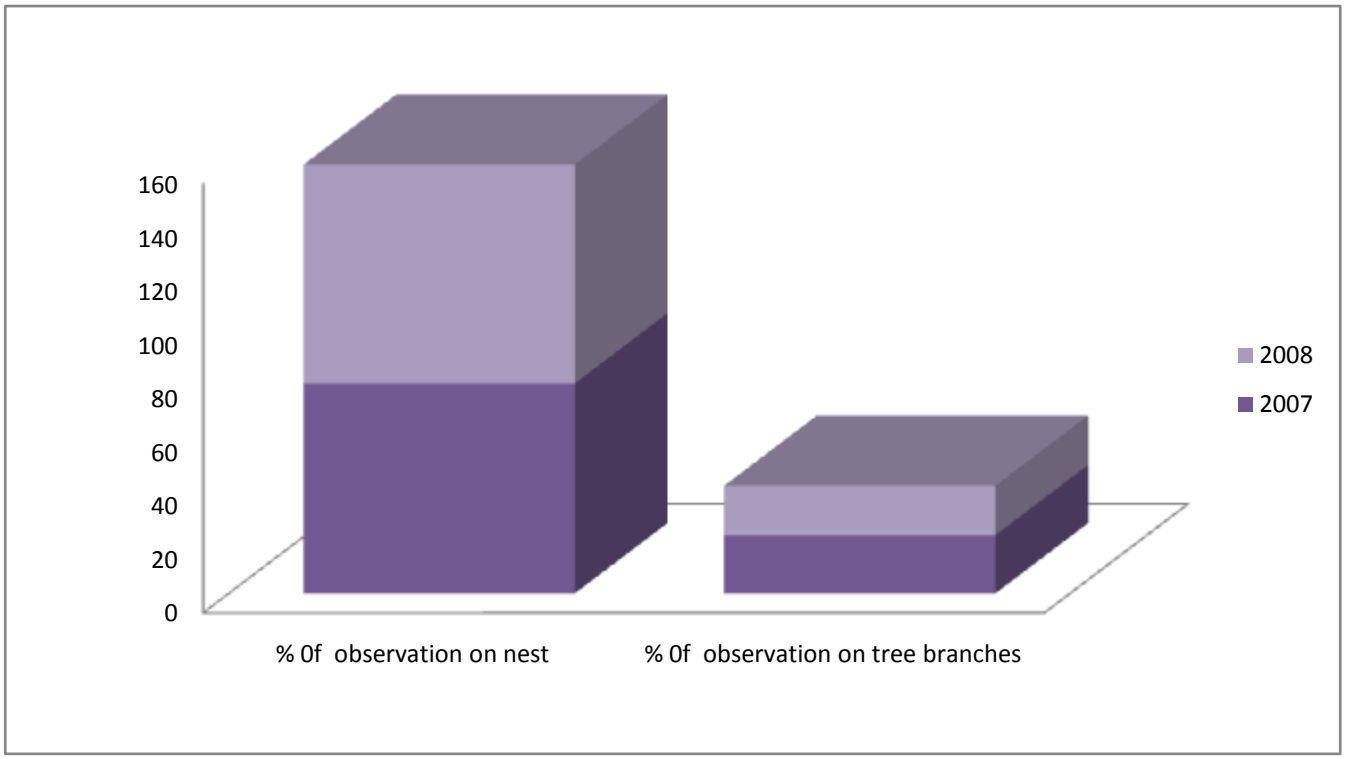

Figure-9
Copulation place of Open-billed stork at the day time in the sanctuary (n=250)

Figure-10
Male and female Open-billed stork both clattered their bill during copulation

Aerial display of Open-billed storks were noticed during foraging period. They started from the morning continued upto the afternoon when most of the birds returned nearer to the nest site of the sanctuary. Xirouchakis and Mylonas[17] observed aerial display in the Griffon vulture *Gyps fulvous* on the island of Create (Greece). The Open-billed stork performed this behavior in a group with more than hundred birds. At a time 1- 4 groups were observed on separate sites in the sky during breeding season. During flight, the storks were flying closely next to each other and sometimes tried to fly above other storks at a short distance. This flight behavior can be exhibited for about 45-60 min. In griffon vultures, this time was about 5-20 minutes[28]. The stork can fly very fast and they reached in the sky within 5-10 seconds. They usually occupied the top position and lasts on average 7-10 minutes. During flight, the storks were visible by nacked eyes upto 30 minutes and after that they did not visible when they reached the top level of the sky. After aerial display, all birds of the group did not return at the same time as well as on the same position of the selected tree before pair formation. Usually they came back at the number of 2 to 4 birds together. They could act as a mechanism for assessing the birds quality and might be related to mate choice[5]. The flight occurred throughout the breeding season and they were located nearer to the nesting zone and foraging areas. The highest activity was observed before egg laying period between 8.00 hrs to 13.00 hrs of the day. Immature storks were also involved in flight movement in the sky. This may represent signs of hierarchical status and the social structure of the group or they may constitute a means of communication[29].

Pair formation behavior leads to activate the stork for breeding and forms the colony. The Open-billed storks choose their mate within 5 to 7 days of aerial display. After mate choise, they occupied a fixed nesting place and stood side by side. A typical paired birds showed up and down standing position[3] and sometimes in opposite direction. The percentage of successful pair was higher before 30th June than after 30th June of the year. Pair broken may be caused due to improper choice of nesting place and nesting tree and attacks of unpaired storks.

Allopereening was a behavioural characteristic frequent among Open-billed storks and usually occurred either on the nest or on the selected branch of nesting trees before copulation. This type of allopreening behaviour before copulation was observed by Xirouchakis and Mylonas[17] in the Griffon vulture *Gyps fulvus* on the island of Creat (Greece). Allopreening usually preceded copulation[30].

The frequency of the stork's copulatory behaviour was more in the morning (10.00 – 12.00 hrs) than afternoon (14.00 – 16.00 hrs) of the day. The diurnal pattern of copulations detected in Griffon vulture by Xirouchakis and Mylonas[17]. High frequency of copulation (5.5±0.032 times/ pair /day) occurred in newly formed pairs in the present study. Copulation was also noticed after 1 to 4 eggs lay. The duration of actual cloacal juxtaposition took up 30% of the time involved (2.66±0.040 sec in 2007 and 2.71±0.042 sec in 2008). 70% of the cases of mating were accepted as successful copulation when the cloacal attachment was occurred and ejaculation was presumed. The copulatory behaviour of storks basically ceased after hatching that is during chick rearing and fledging period. The higher copulation frequency observed in African griffons may be explained by their higher breeding density[31]. The high copulation rates are not a rule for colonial species, as was initially expected[32], it might have resulted from a low risk of extra- pair paternity. Frequent within pair copulations are expected to occur as a strategy of paternity assurance[33] in species. In the present study, within pair capulations were regarded as frequent when they were performed more than 2 times / pair /day.

Conclusion

The behaviour of the Asian Open-billed stork in the Raiganj Wildlife Sanctuary would greatly benefit in understanding the breeding biology of this particular bird species and this would be helpful for better management because conservation efforts need to focus on protection of different breeding stages, not only in Open-billed stork but in other bird species present in the sanctuary.

Acknowledgement

Authors are grateful to the Department of Zoology, University of Kalyani, West Bengal, India, for permitting us to carry out our research work in this Department. Authors are very grateful to the Chief Conservator of Forests, Wildlife (Head quarters) and Chief Wildlife Warden, Government of West Bengal, India; Conservator of Forests, North-West circle, West Bengal; Divisional Forest Officer, Raiganj Division, West Bengal and Forest Ranger Mr. Anil Roy, Raiganj Division, West Bengal for issuing permission to carry out the present research work within the Raiganj Wildlife Sanctuary.

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