Original Research Article

FIRSTEVER BREEDING RECORD OF PAINTED STORK ALONG WITH GREATER ADJUTANT STORK IN THE FLOOD PLAINS OF KOSI RIVER IN BHAGALPUR, BIHAR, INDIA.

ABSTRACT

Painted stork (*Mycteria leucocephela*) is a large resident wetland bird of stork family- Ciconidae and has been categorized as near threatened. A new nesting colony of wild Painted stork, breeding along with Lesser (*Leptoptilos javanicus*) and Greater Adjutant stork *(Leptoptilos dubius*) have been observed on the same nesting tree (Kadamb- *Anthocephalus cadamba*) at Bagritola village of Kadwa panchayat located on the flood plains of the Kosi river in district of Bhagalpur, Bihar, India. In October, 2015, a single nest and three Painted storks were observed (of which one bird was seen incubating) on a Kadamb tree in the village Bagritola. This breeding site was studied from October, 2015 to March, 2020 to observe the detailed nesting and breeding behaviors. From October, 2015 onwards a significant increase in the number of nests of Painted storks was recorded at the same breeding site and the storks adopted 2-5 separate but closely situated kadamb trees for nesting. In the month of September, 2017, two adjacent Kadamb trees were adopted by the Lesser and Greater Adjutant storks for nesting and they built two nests (one on each) Kadamb tree. In October, 2017, Painted storks also started to build their nest on the same trees which were already occupied by the Adjutant storks. From 2018 onwards, no nests of Lesser adjutant stork were observed and the Painted storks were found to breed along with Greater adjutant storks only, till the end of the study period i.e. March, 2020. Similar to the other two stork species, both the male and female Painted storks were sharing the process of nest building, incubation, nursing and guarding the chicks by rotation. Fragments of old branches of nearby trees as well as from abandoned nests were used for building the nests which were cushioned with the leaves. The Painted storks were successfully breeding along with the Greater adjutant storks on the same nesting trees peacefully without any obvious disturbances. The breeding season of Painted storks was observed to continue between October to March and their incubation period was estimated to range between 27-30 days. The breeding season of Lesser adjutant stork was observed to continue between mid-August to Feb whereas of Greater adjutant stork was observed between September to March with slight variation of 6-10 days in Bihar, India.

Key words: Nesting; breeding; Painted stork; Greater adjutant stork; flood plain; Kosi river; Bihar.

INTRODUCTON

Painted stork (*Mycteria leucocephala*) is a tall, wide spread resident wetland bird of stork family Ciconidae [1]. It is one of the eight species of storks found in India and has been categorized as near threatened [2,3,4]. It is popularly known as Janghil in local language and typically a large stork with a long, heavy slightly curved yellow bill with bare reddish face and pink legs. They are found solitarily or in small groups in open shallow water, marshes, coastal mud flats and open rice fields of Indian subcontinent except for the north east and north western parts [1,5]. It migrates locally for feeding and breeding [6].

It is an obligate piscivore and shows a wide variation in nesting times across its distribution range [7, 4]. The nesting of Painted stork has been reported from different habitats ranging from urban areas, from Delhi Zoo [8,6] from Jakur lake of Bengluru city [4] , villages from Kakare Bellur [9] protected areas from Sultanpur National Park [10] from Keoladeo National Park [11], from Danapur Military Cantonement (IBA), Bihar [12] and mangroves from Bhitarkanika, Odisha [13]. In northern India Painted stork nests from August to March while in Southern India it nests between January to June [7] and in Bihar the nesting season was recorded between October to March [12]. Earlier the Painted storks were found across the country in good numbers, but loss of habitat, lack of suitable nesting trees, human disturbances and use of pesticides collectively made it uncommon in many parts of its wide distribution range [6,12]. Due to the declining trend of this species, Painted stork has been placed in priority schedule under Wildlife Protection Act, 1972 [12].

There are limited reports about the occurrence and breeding of Painted storks in Bihar [12]. Sridhar and Karmarkar [14] reported only six individuals in 1990 and seven in 1991 from Bihar during Asian Midwinter Waterfowl Census (AWC) between 1990 - 1996. Coudhary and Mishra [15] recorded 57 Painted storks along with 52 Greater Adjutant storks (*Leptoptilos dubius*) in Vikramshila Gangetic Dolphin Sanctuary (VGDS) area, Bhagalpur, Bihar in May, 2006. In 2008, a small breeding colony of Painted stork consisting of eight nests was reported for the first time in Bihar from Danapur Military Cantonment area (IBA) near Patna by Choudhary *et al* [12]. Here the birds were breeding along with Asian Openbill storks. Danapur Military Cantonment has been reported as the largest breeding ground for Asian Openbill in Bihar [16].

We conducted our observation on the nesting and breeding of painted stork along with Adjutant storks in between October 2015 to April 2020 in the village Bagritola of Kadwa panchayat situated on the flood plain of river Kosi in the district of Bhagalpur, Bihar.

It is the first report of colonial breeding of Painted stork with Lesser and greater Adjutant stork from the district of Bhagalpur.

STUDY AREA

Bagritola (25^0 5' 42" NL & 87^0 3' 14" EL) is a small village located on the flood plains of river Kosi of Kadwa panchayat under Naugachiya block in the district of Bhagalpur, Bihar. This area is locally known as Kosi - Kadwa flood plain or Kadwa diyara. It is a breeding ground for Lesser and Greater adjutant storks and has been declared as third potential breeding ground for endangered Greater Adjutant storks (Hargila or Bara Garur) in the world after Cambodia and Assam [17].

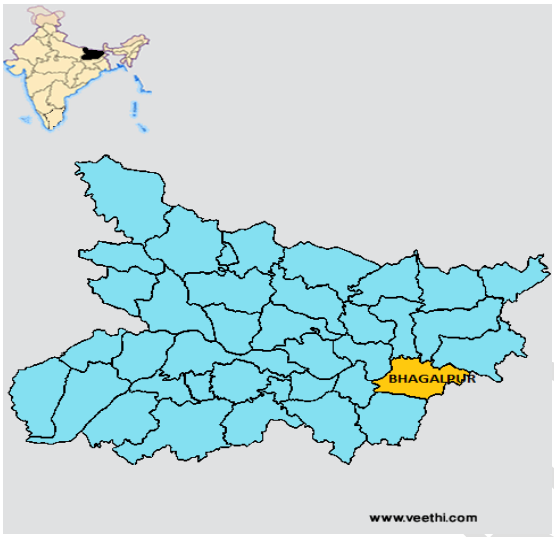
Geographically Bagritola is a flood prone area and is roughly surrounded on three sides by Kosi river and its tributaries. Besides, many wetlands are also present in the adjoining areas, which provide suitable foraging and roosting ground for these storks and other resident and migratory birds too. The river Ganges is flowing at about 15 km south to Bagritola village attracting these nesting birds and their juveniles for foraging. Bagritola is about 35 km north from Bhagalpur district head quarter and is located near Bhagalpur-Madhepura district highway.

Flora mainly consists of larger trees like Peepal (*Ficus religiosa*), Banyan (*Ficus bengalensis*), Semal (*Salmelia malaberica*), Kadamb (*Anthocephalus cadamba*), Gamhar (*Gmelina arborea*), Neem (*Azadirachta indica*), Mango (*Mangifera indica*), Bamboo (*Bambusa tulda*) are in plenty. The major crops of this flood plain are Paddy (*Oryza sativa*), Wheat (*Triticum aestivum*), Maize (*Zea mays*) and Mustard (*Brassica nigra*).

In summer, the temperature varies between 25^0C and 42^0C while in winter temperature ranges between 6^0C and 18^0C. Annual rainfall recorded as 1130 mm.

Due to occurrence and breeding of storks at Kosi-Kadwa flood plain this region has been selected for this study.

Map 1. Showing the Geographical location of Bhagalpur in the state of Bihar.



Map 2. Showing the Geographical location of Bagritola village (red star mark), the breeding site of Painted stork and Greater Adjutant stork in the flood plain of Kosi river (Kosi – Kadwa Diyara) in the district of Bhagalpur, Bihar, India

MATERIALS AND METHODS

The nesting habitat, nesting record and nest building behaviours of Painted stork as well as lesser and greater Adjutant stork was studied at Bagritola village of Kosi-Kadwa flood plain in the district of Bhagalpur, Bihar between October,2015 to April,2020.

Regular surveys were conducted to locate the nesting and breeding sites. The breeding site is located at the middle of the village within the premises of Sri Pintu Mandal and Sri Jai Prakash Mandal. Regular monitoring was done to study the nest building behaviours. Nests were not approached directly and studied from a considerable distance.

Monitoring of breeding of storks in these sites were done by us separately or sometimes together. We are more vigilant during their breeding season from September to April. We visited the site once in a week but during breeding season we spent 7- 8 hrs from morning to evening every 2- 3 days in a week.

Observational recordings were done using data sheets. All studies were made by visual sightings and by using binocular (a 8x42). Observations were conducted on foot and from the roofs of the nearby houses without disturbing the nesting birds following the method adopted by Choudhary et al [18,19]. Photographic and video records were made by using Camera (Nikon D- 5600 with 70-300mm lens).

The nesting phase were recorded as nest building, incubation, nest with recently hatched chicks and nest with pre fledged young as per the method adopted by Suryavanshi and Sundar [4].

Tables were created following the completion of data collecting, and photographs were arranged to analyze and explain the findings.

RESULTS

During our regular visits we recorded one live nest of Painted stork (*Mycteria leucocephela*) and three adults birds on a Kadamb (*Anthocephallus cadamba*) tree at Bagritola village in the month of October (3rd week), 2015. One bird was incubating the eggs and the nest was located at the height of about 7 - 8 meters from the ground. The nesting tree was located in the midst of the Bagritola village within the premises of Sri Pintu Mandal and Sri Jai prakash Mandal.

Lesser Adjutant stork (LAS) and Greater Adjutant stork (GAS) were already incubating the eggs on another Semal (*Salmelia malaberica*) and Kadamb (*Anthocephalus cadamba*) trees in close proximity of this breeding site of Painted stork. This is the first time when one live nest of Painted stork was recorded in the month of October 2015 at Bagritola village (Graph 2) and this pair successfully raised two chicks at the end of February 2016. A significant increase in the number of nests and juveniles of Painted stork were recorded during our study period in successive years from October, 2016 to March, 2020 at the same breeding site and more than 70% of the canopy area (nest tree cover) was adopted by painted stork. However, few deaths of chicks were also recorded due to falling of chicks from the nests due to unknown reasons (Table 1 and Graph 1).

In the 2nd week of October, 2016 altogether 30 nests of Painted stork were recorded on five separate but adjacent Kadamb trees on the same breeding site. Out of thirty (30), five (05) nests were left abandoned by the Painted storks between 1st and 2nd week of November 2016. However, at the end of February 2017, total fifty six (56) juveniles were counted (excluding 03 chicks died during development) which fledged and vacated the nests before 3rd week of March, 2017. Similarly in March, 2018, total eight (08) nests with nineteen (19) juveniles on two separate Kadamb trees, in 2019, ten (10) nests with twenty five (25) juveniles on two separate Kadamb trees and in March, 2020, in total fifteen (15) nests (of which 02 were abandoned) with thirty three (33) juveniles on three separate Kadamb trees were recorded respectively by us (Table-1 and Graph 1). Thus, maximum five (05) closely adjacent Kadamb trees located within the periphery of 30- 40 meters were adopted by the Painted storks for their nesting and breeding.

Interestingly in the 2nd week of September 2017, two out of these five nesting trees, earlier selected by Painted stork, were adopted by LAS and GAS (other members of the stork family) for nest building purposes. These two species of storks were found busy in nest building activities. Finally, at the end of 3rd week of September, we recorded two (02) nests of each LAS and GAS on two separate Kadamb trees at the same location of Bagritola village (Graph 1 and Graph 2).

In the last week of September 2017, we observed many Painted storks were flying above and around the same nesting trees, two of which were already occupied by LAS and GAS. At the end of the first week of October, we noticed that the same two Kadamb trees were also adopted by Painted storks too and found them busy in nest building activities without any obvious objection by the Adjutant storks. This is the first time (October, 2017) when Painted stork started to breed along with LAS and GAS sharing the same nesting trees and we recorded eight (08) nests of Painted storks (Table 1 and Graph 2). Out of these eight (08) nests, five (05) nests of Painted stork along with one (01) nest of GAS was found on one Kadamb tree whereas three (03) nests of

Painted stork along with one (01) nest of LAS was located on another Kadamb tree respectively. The central part of the nesting tree was occupied by the Lesser and Greater adjutant storks whereas the peripheral parts were selected by Painted storks for the nesting purposes. All the nests were built at a height of about 7- 8 meters from the ground and were very close to each other.

In the next year i.e. in 2018, no nest of LAS was observed. Only two (02) nests of GAS (one on each Kadamb tree) with ten (10) nests of Painted stork were recorded on two separate nesting trees at the same location. Similarly in October, 2018 again no nest of LAS was observed. Only three (03) nesting trees were adopted by both GAS and Painted storks. Each nesting tree was having one nest of GAS with the nests of Painted stork. Total fifteen (15) nests of Painted storks with thirty three (33) juveniles were counted on these three nesting trees along with one nest each of greater Adjutant stork at the end of February 2020 (Table-1 and Graph 1).

The nesting of Painted stork along with LAS and GAS was recorded only in October,2017 whereas their breeding with GAS was found to be continued till our entire study period i.e. April, 2020 at the same location of Bagritola (Graph 1).

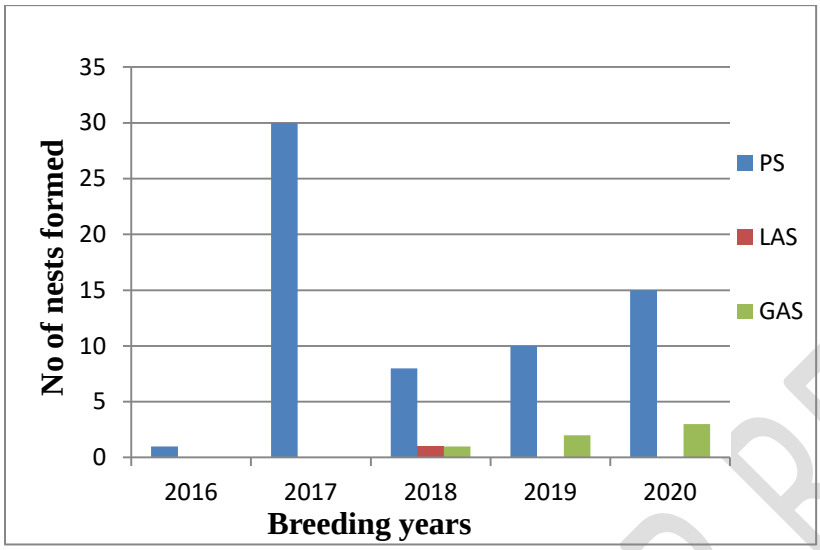
The nests of Painted stork were large platform of twigs and lined with leaves of mainly three plants namely Peepal (*Ficus religiosa*), Neem (*Azadirachta indica*) and Eucalyptus (*Eucalyptus tereticornis*). Both the parent birds alternately shared incubation and protection of chicks after hatching. The nests were repaired regularly with fresh twigs collected from nearby Peepal, Banyan, Gamhar and Eucalyptus trees. They also rearranged the nesting materials, nursed the chicks by preening and shading by spreading their wings above the chicks during rain and sunny days. We also observed an interesting phenomenon that the Painted storks were utilizing the abandoned nests of LAS and greater GAS with certain modifications. It was usual to see one parent bird incubating while the other perching nearby on an exposed branch. The nesting pairs were seen sharing the task of incubation as well as rearing by rotation.

TABLE – 1 : SHOWING BREEDING SUCCESS OF PAINTED STORK WITH ADJUTANT STORKS AT BAGRITOLA VILLAGE IN DISTRICT BHAGALPUR, BIHAR, INDIA .

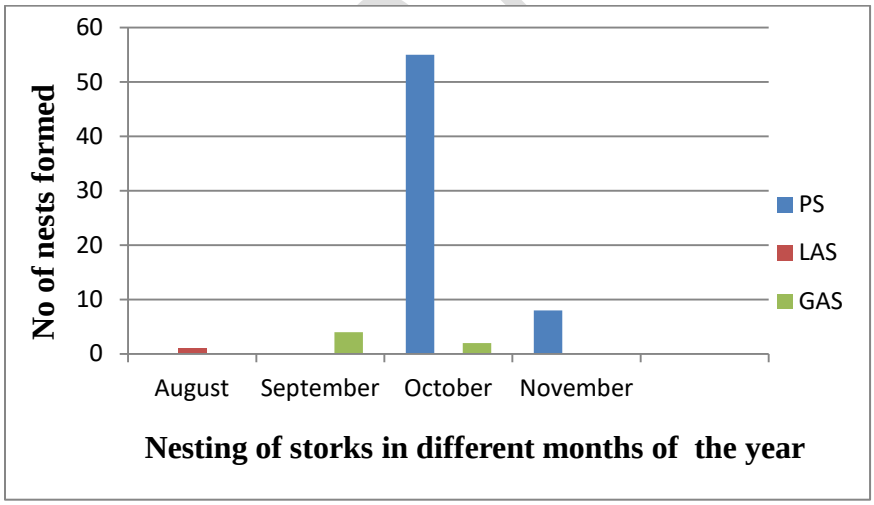
NESTING YEAR	NUMBER OF KADAMB TREES ADOPTED BY THE STORKS	NUMBER OF NEST OF P S OBSERVED	NUMBER OF NEST OF P S ABANDONED	NUMBER OF CHICKS OF P S DIED	TOTAL NUMBER OF CHICKS RAISED BY P S	NUMBR OF NEST OF LAS	TOTAL NUMBER OF CHICKS RAISED BY LAS	NUMBR OF NEST OF GAS	TOTAL NUMBER OF CHICKS RAISED BY GAS
2016	01	01	---	----	02	-----	-----	-----	-----
2017	05	30 (5+9+4+8+4)	05 (1+1+1+2)	03	56	----	----	------	-------
2018	02	08 (3+5)	----	01	19	01	02	01	03
2019	02	10 (5+5)	-----	01	25	----	----	02 (1+1)	06
2020	03	15 (7+5+3)	02	02	33	-----	-----	03 (1+1+1)	08

Abbreviations : P S - Painted stork, LAS – Lesser Adjutant stork, GAS – Greater Adjutant stork, Data within bracket indicate the number of nests on each tree. Year 2016 means October, 2015 to Feb, 2016 i.e. the breeding season of PS , rest years are in the same manner.

Graph 1. Graphical representation showing relationship between number of nests of Painted storks (PS), Lesser adjutant stork (LAS) and Greater adjutant stork (GAS) and breeding years from 2016 to 2020 (Year 2016 indicates Oct,2015 to Feb,2016, the breeding season of PS, rest years are in the same manner).



Graph 2. Graphical representation showing relationship between number of nests of Painted stork (PS), Lesser adjutant stork (LAS) and Greater adjutant stork (GAS) built in different months of the breeding year.



Parents fed their young ones more actively during the middle of the day, they collect the food materials mainly fishes, crabs, and frogs from the nearby wetlands, from the river Kosi and the Ganges. They are usually seen foraging and collecting food materials within 40-50 square km as recorded by us. Perhaps this is the home range of Painted stork particularly during their breeding season. They have been observed to regurgitate the entire food items on the nest floor. The juveniles were seen begging for food by moving their heads up and down as the parents approach them. Initially during the 3rd week of February, the fledglings were seen practicing to fly by repeatedly flapping their wings and leaping up briefly in the air from the nest floor. Sometimes the fledglings also took short flights from branch to branch or from tree to tree or in the air and returned to the nest. Fledglings of Painted stork fledged successfully from the nest between 2nd and 3rd week of March. By the end of March almost all the nests were vacated and the full-fledged chicks were seen perching on the host tree or on the nearby trees with the adult birds. In few cases, fledglings were seen up to the end of March also. We noticed that Painted stork started to assemble at the breeding site mostly between the last weeks of September to 2nd week of October and started nesting activity. Thus, it was estimated that the breeding season of painted stork in Bihar might be between October to March and the incubation period was about 28 – 30 days as recorded by us.

Nest diameter of LAS and GAS were larger than that of Painted storks. The breeding season of LAS was estimated between mid-August to February whereas of GAS it was a little larger i.e. September to March with a variation of 6-10 days.

Descriptions of Photographs (Left to right)

Photo 1 & 2 : Painted stork on the host tree at Bagritola village, Bhagalpur, Bihar.


Photo 3 &4 : Nest building by Painted stork along with Greater adjutant stork on the Same host tree.


Photo 5 & 6 : Painted storks are shading their hatchlings on the nest.


Photo 7 & 8 : Painted stork and Greater Adjutant stork with their nestlings on the same host tree.


DISCUSSION

Painted storks (PS) also preferred Bagritola village for their breeding and preferred trees which are inside the village where there is human habitation. Regarding the site selection, Painted storks are known to have strong loyalty to their breeding sites and were found to prefer places among human habitation irrespective of noise pollution and other anthropogenic disturbances [20, 21]. Few reports are available on the breeding colonies of Painted stork located on large trees growing on islands, in the villages and agricultural fields [22,21]. Selection of only one species of plant i.e. Kadamb (*Anthocephalus cadamba*) as a nesting tree in the midst of the village was again very specific and interesting may be due to sufficient space or platform present among the upper radiating branches of Kadamb tree.

All the three storks (PS, LAS and GAS) selected their nesting and breeding site among the human habitation in the midst of Bagritola village irrespective of anthropogenic disturbances may be due to protection provided by the villagers from the poachers [19,21] or from predatory animals [7]. As per reports available the primary cause of nest failure in Sultanpur Natioal Park and in many other parts of the country was attributed to predation by House crow, Marsh Harrier and Greater spotted Eagle though other factors may be important driving nesting success [7,4]. The other important factor affecting the nest site selection was availability of food.

Selection of nest site is often considered as an important determinant of reproductive success in bird species and the major selective factors fevouring colonial nesting in birds chiefly enhancing avoidance of predators and enhancing more efficient exploitation of food resources [23 , 21]. The presence of the Kosi river, its tributaries and other smaller and larger wetlands in the vicinity of Bagritola village (breeding site) could be crucial for the selection of this site. It is well known that the foraging ground is also an important factor in colony site selection [3].

Painted storks are obligate piscivore hence dependent on the availability of fishes. This has led to the amplizit assumption that their nesting should be highly associated with the fish availability [4]. In many of the breeding sites Painted stork showed diversity in the selection of nesting trees such as Ashok (*Saraca longifolia*), Babool (*Accacia negav*), Sammi (*Prosopis juliforea*), Peepal (*FIcus religiosa*), Tamarind (*Tamarindus indicus*), Neem (*Azadirachta indica*), Ber (*Zizipus jujube*), Teek (*Tectona grandis*) and some other plants also [12, 20, 21].

Painted storks are colonial breeders and they have been found nesting communally with other species such as Grey Heron [24, 25] with Cormorants, Night Herons, Egrets and Ibises

[6, 3], with Asian Openbill [12] but here in Bagritola village in district of Bhagalpur, Bihar, Painted storks shared the trees with lesser and greater Adjutant storks (one of the world's most endangered species of bird). Nesting with both the species of storks were found very close to each other even though no case of chasing among them was observed during the study period. The painted storks built their nests along with GAS, the largest and rarest stork of the world probably due to getting more protection from other predatory birds like House crow, Eagles, Kites and Harriers [7, 4]. Reports are available when smaller birds were found to build their nests near the nests of other larger birds on the same or adjacent trees for getting security such as Green Pigeons, Mynas, Doves, Magpie Robins, Red vented Bulbuls used to build their nest along with the nests of House Crow and Black drongo [26].

In 2017, the number of nests of Painted stork were found comparatively less (08) in comparison to 2016 where the number of nests were thirty (30). It may be due to less rainfall in this area as recorded by us. Less rainfall results in lack of sufficient water in the nearby water bodies and tributaries which ultimately lead to less availability of fishes as their main food.

The nests of all the three storks (PS, LAS and GAS) were large platform of twigs and lined with leaves of mainly three plants i.e. Peepal (*Ficus religiosa*), Neem (*Azadirachta indica*) and Eucalyptus (*Eucalyptus tereticornes*). The storks were using these green leaves for cushioning the nests [27, 19]. As the leaves of Neem and Eucalyptus have insect repellant properties may be the another reason [21].

In the recent past Painted storks were seldom reported to be breeding in Danapur Military Cantonment (IBA) near Patna, which is the largest breeding ground for Asian Openbill in Bihar [16,12]. But there is no documentary evidence of nesting of this species from the district of Bhagalpur. Colonial nesting of all the three species of storks (PS, LAS and GAS) are still continued signifying that these birds might have selected Bagritola village as a permanent breeding ground. However, Painted stork may select other adjacent villages too for their nesting and breeding in coming future similar to LAS and GAS as their numbers are increasing every year in this area.

We are vigilant and may add some more information about the breeding ecology and other activities of these storks in near future.

CONCLUSION

The above investigation clearly revealed that the Painted storks are colonial breeders and they are very perfect in their site selection. They mostly preferred those places for their nesting and breeding which are located near the water resources like rivers and wetlands. Clutch size was mostly 2-3 chicks per breed and four chicks are rare. Similar to other adjutant storks, Painted storks also use green and soft leaves for cushioning the nest. Breeding season of Painted storks in Bihar was estimated between October to March and incubation period ranges between 27-30 days. They were found very active and sincere in nursing and guarding their chicks after hatching.

Our study also revealed that the Painted storks are local migrant and they migrate locally for feeding and breeding. They again appeared in their old breeding sites in the next breeding season. Comparatively the nest diameter, incubation phase as well as breeding season of Lesser and Greater adjutant storks was of larger duration than Painted stork.

DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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