Introduction
Asian openbill storks *Anastomus oscitans* (AOS) are the smallest among the nine stork species found in India. They are pale grey storks with black scapulars and remiges, black tail, short reddish legs and a swollen looking bill with a narrow gap between mandibles. Adult birds have a prominent gap between down–curved upper and recurved lower mandible as an adaptation for grasping snails which is their main prey. However young birds are born without gap in the bill. They are widely distributed in the plains and the peninsula of the Indian subcontinent. Although mostly resident within their ranges, these birds cover long distances in response to weather suitability and food availability for overwintering and breeding. They breed during the monsoon between July and September. Previous observations have also reported their congregation in nesting colonies with the onset of south–west monsoon from mid June to January. Colonial nesting site of AOS at Nandankanan Wildlife Sanctuary (NWS) is considered as second largest heronry of the state Odisha, eastern India with nesting report since 1999. But, information and published literatures on the nesting habits, population trend and habitat preference of AOS at NWS are inadequate and inconsistent. The present communication intended to report the details of colonial nesting habits of these storks at NWS.

Materials and method
The study was carried out between June, 2015 and December, 2018 at Nandankanan Wildlife Sanctuary (20°23'08" to 20°24'10"N and 85°48'09" to 85°48'13" E) in the state Odisha, eastern India (Figure 1). The sanctuary spreads over an area of 4.37 sq. km. and has wetland areas more than 1.01 sq. km, which provides a suitable feeding and breeding habitat for many migratory and resident birds including AOS. The sanctuary enjoys a moderately hot humid climate around 30ºC with annual average rainfall of 1350mm. The vegetation is of moist mixed deciduous type. The natural forest areas of Nandankanan is home to a rich assemblage of free–living wild animals including 13 species of mammals, 15 species of reptiles, 123 species of birds, 20 species of amphibians, 85 species of butterflies and 51 species of spiders. The documented bird species of the sanctuary includes two species of storks, namely painted stork and Asian openbill stork.

Abstract
A field study on nesting habits of Asian openbill stork (*Anastomus oscitans*) was conducted during breeding seasons of 2015 and 2018 at Nandankanan Wildlife Sanctuary, Odisha, India. Observations revealed the stocks arrived for nesting in July and most left December. The details of nest and nesting habits were reported.
Field observations on nesting colonies carried out ad libitum from June to December every year. Colony is defined as a group of storks nesting on a contiguous canopy that may have had more than one tree. Observations were made with the naked eye or with 10 x binoculars during day time only. A detailed census of nesting colonies were carried out during first week of October every year. Nesting trees were identified following Panda and Panda. Occupied nests were determined by presence of adult storks and/or their egg or chicks. Information like number of nests on each tree, species of nesting tree and number of storks present on the nests was collected during first week of October every year with minimal disturbances to the nesting storks. To gather information regarding nest characteristic including size, depth and height from the ground we measured 50 apparently intact abandoned nests (after fledglings are fledged out of the nests) during 3rd week of December, 2018.

**Observations**

The species usually form monospecific colonies with an affinity to nest on the upper and upper middle canopy. The colonial nesting recorded in 20 species of trees with maximum number of nests with *Pterospermium hyaeneanum* tree (Table 1). Other important nesting tree species are *Ficus bengalensis*, *Strychnos asper*, *Aegle marmelus*, *Syzygium cumini*, *Putranjiva rosburghii*, *Pterostrongyx sturtii*, *Cassia fistula* etc. Nests are constructed at 4.57m–10.67m high from ground. The diameter of the nest varies from 30–61cm and with 20–36cm high nesting materials. The nests are shallow and have a depth of 3.5cm–6cm. The birds start arriving in the month of July and begin to occupy the earlier vacated nests, if available, or make new nests. Around third week of July, most of the trees in the nesting areas are occupied and the storks those arrive late had no option other than to choose a preoccupied nesting trees for nesting, which often resulted in intraspecific fighting. Collection of nesting material continues from July till November. The nesting materials include twigs, leaves and grasses. The number of chicks in the AOS nests varies from 1–3 (Figure 2). We observed chick in some AOS nests around mid August, and the young storks feeding on snail (weaning) was sighted in first week of October (Figure 2). During this four–year study period, we observed increasing trend in the number of occupied nests (Figure 3). AOS nests were recorded in 212.75±16.32 trees on which 2117.75±415.89 nests and 8477.5±1658.76 number of storks was observed during study period (Table 1). The highest number of trees with nests are of *P. hyaeneanum* (33.01%) followed by *S. noxvomica* (12.81%), *A. indica* (8.58%) and *G. maulata* (8.11%) (Figure 4). The highest number of nests are recorded in *Pterospermium hyaeneanum* (38%), followed by *S. noxvomica* (14%), *F. bengalensis* (11%) and *A. indica* (7%) (Figure 5). Nesting of AOS occurred 73m to 89m away from the roads. Most of the stork leave the nesting site by December except few those stay as resident birds.

| Sl. No. | Name of the tree used for nesting | No. of trees | No. of nests | No. of Open bill storks |
|---------|----------------------------------|-------------|-------------|-----------------------|
| 1       | *Pterospermium hyaeneanum*       | 55          | 54          | 69                    |
| 2       | *Strychnos noxvomica*           | 18          | 25          | 31                    |
| 3       | *Azadirachta indica*            | 25          | 17          | 11                    |
| 4       | *Ehretia laevis*                | 8           | 8           | 7                     |
| 5       | *Strybus asper*                 | 15          | 18          | 6                     |
| 6       | *Putranjiva rosburghii*         | 0           | 0           | 5                     |
| 7       | *Diospyros melanoxylon*         | 0           | 0           | 0                     |
| 8       | *Pongamia pinnata*              | 0           | 0           | 3                     |
| 9       | *Terminalia arjuna*             | 0           | 0           | 3                     |
| 10      | *Ficus bengalensis*             | 15          | 17          | 7                     |
| 11      | *Adina cordifolia*              | 7           | 8           | 7                     |
| 12      | *Aegle marmelus*                | 7           | 6           | 2                     |
| 13      | *Melia azadirach*               | 0           | 0           | 0                     |
| 14      | *Glyricidia maculate*           | 25          | 29          | 15                    |
| 15      | *Stereospermum colais*          | 0           | 0           | 1                     |
| 16      | *Alangium lamarkii*             | 8           | 9           | 4                     |
| 17      | *Mimusops elengi*               | 0           | 0           | 5                     |
| 18      | *Cassia siamia*                 | 15          | 17          | 5                     |
| 19      | *Syzygium cumini*               | 15          | 12          | 0                     |
| 20      | *Diospyros ovatafolia*          | 9           | 8           | 0                     |

**Table 1** Year wise nesting details of openbill storks at Nandankanan Wildlife Sanctuary, Odisha, India

Citation: Mohapatra RK, Panda BP, Panda MK, et al. Colonial nesting of Asian openbill storks (*Anastomus oscitans*) in Nandankanan Wildlife Sanctuary, Odisha. *Int J Avian & Wildlife Biol*. 2019;4(1):14–17. DOI: 10.15406/ija wb.2019.04.00145
Colonial nesting of Asian openbill storks (Anastomus oscitans) in Nandankanan Wildlife Sanctuary, Odisha

Discussion

The wetlands of NWS provide good food resources with minimal disturbances for the storks. Availability of water body in vicinity is instrumental in determining the vegetation pattern which in turn warrants adequate nest–site availability with sustainable food and nest–construction material for birds.\textsuperscript{14,15} We also believe the availability of resources and conducive environment at NWS may be the reason for nesting of AOS every year. Abundance of food resources in and around the heronry and the minimal disturbance due to the remoteness of the area are speculated to be the principal factors for this large congregation of breeding birds.\textsuperscript{8,16} Nesting in mixed colonies during monsoon was reported.\textsuperscript{1} But in the present case mono–specific nesting was observed. At Bhitarkanika National Park, Odisha, nesting of AOS was reports exclusively on \textit{E. agallocha} trees and most of these trees are located in the centre of the heronry.\textsuperscript{16} Though AOS preferred \textit{P. hyaenaea} for nesting at the study site, it does not exclusively nest on this species. A total of 20 different nesting tree species recorded in the present study. They also reported that AOS showed affinity to nest in the top canopy and their mean nest height was 14 ft (4.26m).\textsuperscript{16} We also observed similar affinity of AOS to nest on top canopy but the nesting height varies from 4.57m–10.67m (15–35 feet).

Nests are semi–circular to circular in shape and measured 30.21±0.12cm in radius and with a depth of 6.9±0.02cm approximately.\textsuperscript{17} The present study found similar shape of nests as described by Kanaujia et al.\textsuperscript{17} with 22–35cm radius and 3–5cm of depth. The nesting materials include twigs, leaves and grasses. Collection of nesting material continues from July till November. Both the sexes help to brood and feed the chicks.\textsuperscript{3} Movement of the chicks in the nest reported at the age of 4–5 weeks onwards, whereas young birds observed flying to short distances from the nest at about 60 days.\textsuperscript{6} Asian Openbill mainly feeds on the molluscs of \textit{Pila sp.} by inserting the tip of the mandible and dislodging the molluscan body from the shell apart from the regular notion that the gap in the bill is used like a nutcracker to crack the molluscan shell.\textsuperscript{3} The gap in the bill is absent in the juveniles. The juveniles feed on regurgitated feed on the nest.\textsuperscript{3,17} We observed chick in the nest around mid August. While in the nest the chicks were fed with regurgitated feed from parent storks. During first week of October the young storks feeding on snail

Figure 2 Nesting of openbill stork at Nandankanan Wildlife Sanctuary, India. 1) Colonial nests of AOS, 2) roosting openbill storks, 3) nest with two surviving hatchlings, 4) nest with 3 surviving hatchlings, 5) AOS fledgling fallen on ground, 6) fledgling feeding on feeding on snail.

Figure 3 Number of nest and number of AOS during study period (2015–18).

Figure 4 Trees used for nesting by AOS and its species composition.

Figure 5 Percentage of nests in each tree species used for nesting of AOS
was sighted as a sign of weaning. The area adjacent to visitor path was left up to 73m to 89m without nesting by the storks though similar vegetation available in those areas. Besides they are known be least affected anthropogenic activity with a sound breeding record in the human disturbed areas.\textsuperscript{1,18}

The dependence of storks on the particular nesting site makes the protection and scientific management crucial for their conservation. The present study described some major aspects of nest and nesting habits of AOS. The identification of tree species used as nesting material, behaviour of the storks during nest building, incubation and local migration to be studied further.

Acknowledgments
The authors are thankful to Prof. Sudarsan Maharana for his valuable suggestions in improvement of the manuscript.

Conflicts of interest
Author declares no conflicts of interest.

References
1. Rasmussen PC, Anderton JC. Birds of South Asia. The Ripley Guide. Second edn, National Museum of Natural History– Smithsonian Institution, Michigan State University and Lynx Edicions, Washington, DC: Michigan and Barcelona; 2012. p.1–378, 1–683.
2. Anam J, Ahmed M, Saikia MK, et al. Food and feeding behaviour of Openbill stork (Anastomus oscitans) in Assam. India J Glob Biosci. 2016;5(6):4188–4196.
3. Kahl MP. Food and feeding behaviour of the Openbill storks. Journal of Ornithology. 1971;112:21–35.
4. Grimmett R, Inskipp C, Inskipp T. Helm field guides Birds of the Indian subcontinent. Second edn. Delhi: Oxford University Press; 2011. p.1–528.
5. Ali S. The Book of Indian Birds. 13th edn. BNHS: Oxford University Press; 2002. p. 1–326.
6. Pramanik AK, Santra KB, Manna CK. Nest–building behaviour of the Asian open billed stork Anastomus oscitans, in the Kulik bird sanctuary, Raiganj, India. Our Nature. 2010;7(1):39–47.
7. Kumar A, Kanaujia A. A flourishing breeding colony of Asian openbill stork (Anastomus oscitans) in Nawabgunj bird sanctuary, Uttar Pradesh. International Journal of Extension Research. 2016;10:1–4.
8. Gopi GV, Pandav B. Observations on breeding biology of three stork species in Bhitarkanika mangroves, India. Indian Birds. 2007;3(2):45–50.
9. Panda P, Panda S. Floral Diversity of Nandankanan Wildlife Sanctuary, Odisha: Nandankanan Biological Park, Forest and Environment Department, Government of Odisha; 2012. p. 378.
10. Kamal S, Indresh GN, Mishra AK, Vertebrate faunal diversity of Kanjia Lake, Nandankanan. e–planet. 2009;7(2):29–33.
11. Panda S, Mishra S, Mishra AK, et al. Nandankanan Faunal Diversity. Odisha: Nandankanan Biological Park, Forest and Environment Department, Government of Odisha; 2010. p. 152.
12. Mohapatra RK, Panda S, Purohit KL. Wintering avian population of Nandankanan wildlife sanctuary, Odisha. Tigerpaper. 2013;1(2):31–34.
13. Mohapatra RK. Sighting of Indian grey hornbill and Rufous woodpecker at Nandankanan Wildlife Sanctuary, Odisha, India. Int J Avian & Wildlife Biol. 2018; 3(4):307–308.
14. Raulings EJ, Morris K, Roache MC, et al. The Importance of Water regimes operating at small spatial scales for the diversity and structure of wetland vegetation. Freshwater Biol. 2010;55:701–715.
15. Garg A. Nest–plant correlation and predator preclusion in Asian openbill storks (Anastomus oscitans): a case study from Nawabgunj bird sanctuary, India. Indian Forester. 2016;142(2):179–186.
16. Gopi GV, Pandav B. Nest Space Partitioning among Colonial Nesting Waterbirds at Bhitarkanika Mangroves, India. World Journal of Zoology. 2011;6(1):61–72.
17. Kanaujia A, Kumar M, Kumar A, et al. Asian openbill: a colonial breeder. Green. 2014;8(3):1–9.
18. Datta T, Pal BC. The effect of human interference on the nesting of Openbill stork Anastomus oscitans at the Raiganj Wildlife Sanctuary, India. Biological Conservation. 1993;64:149–154.