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Breeding ecology of the Asian pied starling (*Gracupica contra*) at Jahangirnagar University campus, Bangladesh

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Abstract

The breeding ecology of the Asian pied starling (*Gracupica contra*) was studied between 2015 and 2016 at Jahangirnagar University (JU) campus to document the breeding period, nests and nest-site selection, clutch size, egg morphology, hatching and breeding success. Breeding activities of starling in JU campus started in late February and continued to early September. A total of 105 nests were recorded in two breeding seasons. The nests were loosely constructed out of straw into the shape of a dome with an entrance on the side. The average nest depth was 18±4.5 cm (n=21, range =12-29 cm) with a mean entrance diameter of 7.6±1.3 cm (n=21, range= 6-10 cm). Most of the nests (98%) were found in trees (98%), only 2% of them were found on the electric poles (2%). Overall, 17 tree species were utilized by the starlings for nesting and majority of the nests were found in *Albizia procera* (n=25), *Gmelina arborea* (n=17), and *Swietenia mahagoni* (n=13). The Asian pied starling nested between 3 and 18 meters (mean =10.3±3.5m) above the ground. Clutch size varied from 2 to 6 eggs with a mean size of 3.8±1.2 (n=21). Eggs were glossy blue with an average dimension of 26.6±1.6 mm×19.3±0.33 mm (n=35). Both sexes took part in incubation by rotation and fed the young. The average incubation and nestling period were 17.3±3.6 days (n=19, range=14-30) and 23±1.5 days (n=16, range=20-25), respectively. Out of the 80 eggs monitored, 63 eggs successfully hatched and 52 chicks reached their fledgeling stage, resulting in a breeding success of 65%.

Key words: Asian pied starling, *Gracupica contra*, breeding ecology, clutch size, Jahangirnagar University campus.

INTRODUCTION

The Asian pied starling (*Gracupica contra*) is a black and white, medium sized sturnid bird found in the Indian subcontinent and Southeast Asia (IUCN, 2015). In Bangladesh, they are widely distributed throughout the country and commonly found in farmlands, refuse dumps, sewage outlets, towns and villages, and mangroves. They are gregarious bird and usually seen in small family parties. These starlings are omnivorous and feeds on insects, fruits, nectar, dead animals and all sorts of scarps. They usually breed between March and September (Khan, 2008; IUCN, 2015) and use both natural and anthropogenic structure for nesting purposes (Shoma & Begum, 2020).

Breeding is a crucial phase of life history of birds. Studies on breeding biology of birds is imperative to understand the evolutionary pattern of the species and for their better conservation. Comprehensive data on breeding activities provide insights into overall selection pressure confronted by a species and factors leading to variation in breeding

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characters in different species (Dowling, 2003; Bhatt *et al*., 2014). In case of conservation, studies of breeding birds provide essential information about habitat suitability for breeding and factors related to unsuccessful breeding. Moreover, such studies are essential to determine the population status of the species and also to inform the factors influencing their populations (Panyaarj *et al.*, 2017).

Jahangirnagar University (JU) Campus is a semi-natural semi-urban area and renowned for its avian diversity. The Asian pied starling is one of the most abundant and frequent bird species here sharing the same feeding and breeding habitat with three other sturnid species (Shoma & Begum, 2020). Some information about the breeding season, nests and eggs of the Asian pied starling are available (Begum *et al*., 1993; Khan, 2008; Mohsanin & Khan, 2009; Jahan *et al.,* 2018), however, comprehensive published information on reproductive ecology of the species is still scarce in Bangladesh. Therefore, the main goal of this study was to gather detail information on breeding ecology of the Asian pied starling at JU campus specifically on breeding season, nests and nesting sites, eggs, incubation and nestling period, and breeding success.

MATERIALS AND METHODS

Study area: The study was carried out at Jahangirnagar University campus, located 32 km northwest of Dhaka city in Bangladesh. Geographically the campus is located in 23.8824^{o} N latitudes and 90.2671^{o} E longitudes, and is about 700 acres in area. The climate of the campus is hot, humid and rainy in summer, and cool and dry in winter (Nahid *et al*., 2016a). The campus comprises of diverse ecological habitats including grasslands, bushes, woodlands, wetlands, marshy areas, agricultural lands and human settlements. This area once was a vast part of Sal (*Shorea robusta*) forest of Bhawal and Madhupur Tract while the existing plant resource of this area is of secondary in nature (Begum, 2016). A total of 917 species belonging to 534 genera and 145 families of vascular plants are found in the campus (Khan *et al*., 2021). Diverse habitats and vegetation types of the campus shelter many resident and migratory birds providing potential feeding and breeding grounds. According to Begum (2016), the campus is currently harbouring a total of 195 bird species including 78 species of breeding residents.

Nesting data: Nesting data were collected during two successive breeding seasons from February to September between 2015 and 2016. The study area was systematically explored and most of the nests were spotted by following breeding individuals while carrying nest materials or food for the nestlings. Once a nest was discovered, nesting trees, nest position and nest height from the ground level were recorded. Nest dimensions like entrance diameter and depth of the nests were measured with the help of measuring tape and centimeter scale in case of accessible nests. To determine the clutch size, hatching, fledging and breeding success, selected nests were visited at least twice a week. The length and breadth of eggs were measured with digital caliper. Following Hoyt (1979), egg volume was calculated as $V=0.51\times L\times B^2$ where L and B indicates maximum length and breadth, respectively and shape index as $B/L\times 100$.

Breeding success and analysis: The incubation period was defined as the time between the day when the last egg was laid until the first egg hatched. The nestling period was defined as the time lag between the hatching of the first egg and the fledging by the last member of brood (Hoffmann & Rodrigues, 2011). Breeding success was determined as the total number of fledglings in relation to the total number of eggs (Jiang *et al.*, 2017). A nest was considered as successful if at least one young fledged (Brahmia *et al.*, 2015; Chiaradia *et al.*, 2017). At each visit, along with nest contents, any loss of eggs and nests were also recorded. A nest was considered to be predated when all eggs or nestlings disappeared or their remains were found in and around the nests (Wesolowski, 2002; Cockle *et al.*, 2015; Shoma & Begum, 2020).

Plant species were identified with the help of books and by the expert in plant taxonomy. Origin of the plant species (Native or Exotic) was collected from Khan *et al*. (2021). Statistical analyses were done by using Microsoft Excel-Version 16.16.25. Results are shown as mean ± standard deviation (SD).

RESULTS AND DISCUSSION

Breeding season: The breeding activities such as pairing, mating, nest building, egg laying, incubation and rearing chicks of the Asian pied starling were extended from late February to early September. In both years 2015 and 2016, pair formation was commenced in February end and the first active nest was recorded in March. The last nests with eggs or nestlings were recorded in August in both years whereas rearing of nestlings continued till the first week of September in 2016. The maximum number of active nests were found between April and June (75%) with a peak number in May (n= 36) (Fig. 1).

The Asian pied starling is a seasonal breeder (Tyagi & Lamba, 1984). In JU campus, their breeding period was extended over a period of seven months, which is similar to the findings of Mohsanin & Khan (2009). Breeding season observed in different regions in India were also comparable to this study. Tyagi & Lamba (1984) observed a single breeding season from late February to the end of August in Dehra Dun. In Punjab, Kler (2009) reported the breeding period from mid-March to September while Sethi & Kumar (2018) stated the period from February to August. Kumari *et al*. (2018) found the peak breeding period in May and June in Jammu. In the present study, the peak nesting was recorded between summer and monsoon seasons. The most insectivorous birds generally breed during the late dry season and the early wet season due to the abundance of highly protein rich arthropods (Round *et al*., 2014).

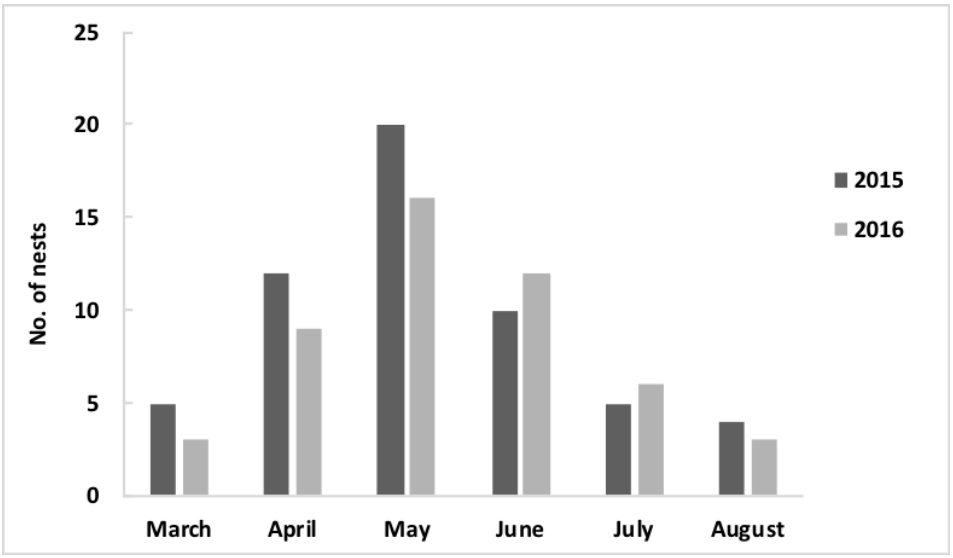

Fig. 1. Nests found in different months in JU campus

Nests and nest-sites: A total of 105 nests of the Asian pied starling were found during two breeding seasons: 56 nests in 2015 and 49 nests in 2016 (Fig.1). The nests were dome shaped but often looked like irregular mass of straw, roots and rags on a foundation of twigs. Dead leaves, ropes, ribbons, pieces of paper and polythene bags, plastics and other miscellaneous rubbish materials were commonly used in outer dome construction. The inside of the dome was constructed with similar but often lined with softer materials like grasses, feathers and cotton. The nests were loosely constructed with an entrance on the side. The nest depth ranged between 12 cm and 29 cm (n=21, 18±4.5 cm) with a mean entrance diameter of 7.6±1.3 cm (n=21, range = 6-10 cm). This favourably compared with other studies from neighbouring countries. Tyagi & Lamba (1984) and Feare & Craig (1998) recorded entrance hole diameter varied from 6 to 8 cm. The average nest depth 14.1 cm with an average entrance diameter 8.17 cm were recorded by Kumari *et al*. (2018).

Out of the total recorded nests, 103 were built in the tree fork and branches, and 2 on electric poles. Nests located in trees were mostly recorded (n= 102) in live trees while only 3 were built in dead trees. The Asian pied starling used 17 different tree species for nesting belonging to 9 families. Thirteen tree species from 8 families were used in 2015 while fifteen species from 8 families were used in 2016. The majority of the nests were found in *Albizia procera* (n=25) followed by *Gmelina arborea* (n=17) and *Swietenia mahagoni* (n=13) (Table 1). However, most of the nests of the Asian pied starling were found in native trees (63%) rather than exotic species (37%). The nests were constructed between 3 and 18 meters (mean=10.3±3.5m) above the ground level. Most of the nests were positioned in the periphery of the trees (66%) rather than the centre (34%). Re-use of the nests was not observed in the second year, 2016 although some pairs used the previous nesting trees.

Table 1. List of nest tree species used by the Asian pied starling in JU campus. E = Exotic species, N = Native species

Nesting trees				Number of nests		
Common name	Scientific name	Family	Origin	2015	2016	Total
Jackfruit	*Artocarpus heterophyllus*	Moraceae	E	2	2	4
Areca palm	*Areca catechu*	Arecaceae	E	1	2	3
Mahogany	*Swietenia mahagoni*	Meliaceae	E	8	5	13
White siris	*Albizia procera*	Mimosaceae	N	15	10	25
North Indian rosewood	*Dalbergia sissoo*	Fabaceae	N	2	2	4
Teak	*Tectona grandis*	Lamiaceae	N	7	4	11
Earleaf acacia	*Acacia auriculiformis*	Mimosaceae	E	4	3	7
Pride of India	*Lagerstroemia indica*	Lythraceae	N	1	2	3
Ipil-ipil	*Leucaena leucocephala*	Mimosaceae	E	2	2	4
Gmelina	*Gmelina arborea*	Lamiaceae	N	10	7	17
Mango	*Mangifera indica*	Anacardiaceae	E	1	2	3
Jujube	*Sarcomphalus mauritianus*	Rhamnaceae	N	1	–	1
Neem	*Azadirachta indica*	Meliaceae	N	–	2	2
Rain tree	*Albizia saman*	Mimosaceae	E	–	1	1
Royal poinciana	*Delonix regia*	Caesalpiniaceae	E	–	2	2
False ashoka	*Polyalthia longifolia*	Annonaceae	E	–	1	1
Banyan	*Ficus benghalensis*	Moraceae	N	1	–	1

The Asian pied starling preferred to nest in proximity of human habitations. The nests were solitary while many were close vicinity to each other. The present findings on preference of nesting site as tress was similar to Begum *et al*. (1993), Jahan *et al*. (2018) and Kumari *et al*. (2018). In contrast, Sethi & Kumar (2018) found that most preferred nesting site of the Asian pied starling was anthropogenic structure like electric poles. However, the selection of nest sites by birds often influenced by different factors like protection from predators, convenience to foraging, availability of nesting materials and competition (Liebezeit & George, 2002; Marshall & Cooper, 2004; Archawaranon, 2006; Ali & Santhanakrishnan, 2015; Nyirenda *et al*., 2016). High intraspecific and interspecific competition for nesting sites due to lack of sufficient natural structures used in nesting may force the species to choose mam-made structures. JU campus is a semi urban area but still provides a good number of large trees as nesting site. The pied starling used different number of tree species for nesting which are relatively large and commonly found on campus. Although they used diverse species of exotic trees, however, they mostly preferred native trees as their nesting site. During this study, they nested between 3-18 m height which is greatly higher than 3-5.5 m recorded by Begum *et al*. (1993). This may be in favour of avoiding growing human interference in campus. Kumari *et al*. (2018) reported a range of 1.54 -11.68 m nest height with a lower nesting success in nest placed in lower height. Sethi & Kumar (2018) recorded a maximum height of nest was 21m on the high voltage power transmission.

Clutch size and egg characteristics: Clutch size varied from 2 to 6 eggs with a mean size of 3.8±1.2 (n=21). Most of the clutches contained 4 eggs (n=7, 33%) while the least was clutches of 5 eggs (n=2, 10%). Clutches of 3 eggs (n=6, 29%) were twice as many as clutches of 2 and 6 eggs (n=3, 14%). There were no significant differences in clutch size from year to year (χ^2 = 1.06, p = 0.89). The mean clutch size varied between 3.9±1.2 (n=12) in 2015 and 3.7±1.3 (n=9) in 2016. No evidence of second clutch in the same year was recorded in the present study. The average clutch size found in the current study fell within the range reported in comparable studies. Begum *et al*. (1993) reported the clutch size of 3-6 eggs and Jahan (2010) mentioned the clutches of 4 eggs in JU campus. Sethi & Kumar (2018) found that clutch size of the Asian pied starling varied from 4-5 eggs in India.

Eggs of the Asian pied starling were glossy, unmarked, blue in colour and oval shaped with an average dimension of 26.6±1.6 mm × 19.3±0.33 mm (n=35). The length of eggs varied from 23.47 mm to 29.24 mm and the breadth of eggs ranged between 18.47 mm and 19.85 mm. The mean egg volume and shape index were calculated as 50.82±3.9 and 72.79±4.2 respectively (Table 2). The egg morphometry of the Asian-pied starling reported in other studies are also similar to the findings in the study area. Average egg size reported in Dehra Dun was 27.41 × 20.32mm (Tyagi & Lamba, 1984). Kler (2009) recorded the average egg size of 27.50 × 20.10 mm while Sethi & Kumar (2018) reported the eggs with mean dimensions of 26.36 ×19.55 mm in Punjab, India.

Table 2. Egg dimensions of the Asian pied starling

Egg parameter	Minimum value	Maximum value	Mean ± SD	Coefficient of variation (%)
Length *L*, mm	23.47	29.24	26.64±1.6	6
Breadth *B*, mm	18.47	19.85	19.33±0.33	1.7
Volume V, cm^3	44.26	57.93	50.82±3.9	7.7
Shape Index	63.81	81.93	72.79±4.2	5.8

Incubation and nestling period: The incubation period of the Asian pied starling varied from 14 to 30 days (n=19, 17.3±3.6 days). Both male and female took part in incubation, although for the most part was done by females. During this time, the birds relieved each other for short feeding trips. When one bird was in the nest, the other mostly remained in the vicinity of the nest. Incubation period reported by Feare & Craig (1998) and Kler (2009) were 14 -15 days and 14 days, respectively, which is little shorter than the average period (17.3 days) found in the present study. However, incubation period of birds is likely to be influenced by environmental factors, clutch size and parental traits such as body size (Jiang *et al.*, 2017; Higgott *et al*., 2020).

Overall, the nestling period varied from 20-25 days (n= 16, 23±1.5 days). The newly hatched chicks were almost naked, with fleshy pink bodies and closed eyes. Both male and female fed the nestlings and the diet mostly included animal food like grubs, insects and earthworms. Youngs remained dependent on parents for provisioning and safety at

least for twenty days. Thereafter, they started to leave the nests to search for food. Similar type of findings was also reported by other authors, e.g. Craig & Faere (1998) reported that nestling period varied from 21-25 days whilst Kler (2009) mentioned as 25 days.

Breeding success: To determine the fate of the nests, a total of 21 nests were observed between 2015 and 2016 and it was found that 76.2% (16 out of 21) of the nests had at least one fledgling. The mean number of fledglings per successful nests was 3.25±0.7 (n=16, range=2-4). Nesting success did not significantly vary by year ($\chi^2 = 3$, $p = 0.56$). Out of 80 eggs, 63 eggs hatched and 52 chicks reached their fledgling stage, resulting in a breeding success of 65%. The breeding success varied between 63.8% in 2015 and 66.6% in 2016. The highest breeding success was observed in the clutch size of 3 (83.3%) (Table 3).

Table 3. Breeding success in different clutch sizes of the Asian pied starling

Clutch size	Frequency (nest number)	Eggs hatched (n)	Eggs reached fledgling stage (n)
2	14.3 % (3)	66.6% (4)	66.6% (4)
3	28.6 % (6)	83.3% (15)	83.3% (15)
4	33.3% (7)	82.1 % (23)	64.3% (18)
5	9.5% (2)	70% (7)	30% (3)
6	14.3% (3)	77.7% (14)	66.6% (12)
Total	100 (21)	78.6% (63)	65% (52)

The loss of nests and nest contents was greater before the hatching period than during the nestling period. Of the 5 unsuccessful nests, three (60%) contained eggs and two (40%) were in the nestling stage when they failed. Most of the nest failures were probably due to predation (three with eggs and one with nestlings) while one nest lost its nestlings due to parasitism by insects (unidentified).

An earlier study found that breeding success of the pied starling was 60% and it was affected by eggs fertility and predation (Begum *et al*., 1993). High nest predation in other bird species has been reported in JU campus (Nahid *et al*., 2016a; Nahid *et al*., 2016b). Although no direct events of predation were observed in the field, human interference was common in low height nests since the nests of the Asian pied starling were massive and conspicuous. Children often tend to tamper the nests and collect eggs and nestlings for their fun and enjoyment. Jahan *et al*. (2018) stated that nests at lower height (1-5 m) are more prone to predation as well as human disturbances.

Conclusion: My study suggests that the Asian pied starling has an extended single breeding season in JU campus. For their nesting sites, they preferred trees to man-made structures which eventually indicates the suitability of JU campus with lots of natural nesting sites and plentiful resources. However, construction of new roads and buildings on campus and human disturbances including growing visitor pressure would be a matter

of concern. Future plantation should consider the preference of native and large nesting trees which is important for successful breeding of the Asian pied starling in JU campus.

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