

Communal nesting ecology of Little Tern (*Sternula albifrons*) and Small Pratincole (*Glareola lactea*) in two seasonally emerged riverine islands in Bangladesh

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Abstract The nesting ecology of two wetland-dependent bird species, the Little Tern (*Sternula albifrons*) and the Small Pratincole (*Glareola lactea*) were studied in two seasonally emerged riverine islands, locally named as charlands in Padma River of Bangladesh. A total of 269 and 299 nests of Little Tern and Small Pratincole were found in the breeding season of 2022. We monitored 70 nests of the two species from two charlands, and the nesting success was 74.28% and 78.57%, respectively. No correlation was found between nesting success of both species in relation to clutch size, nest height, nest depth and presence of vegetation near nest. We found strong positive correlation between nesting success and nest distance to river for Little Tern. Nesting success was higher if the Little Tern's nests were located far from the river channel. However, no such trends were observed for Small Pratincole in the study area. The main factor affecting Little Tern nesting success was nest predation by avian predator ($n = 6$) and tropical storms ($n = 3$). On the contrary, eight Small Pratincole nests were predated by avian predators and four nests were lost due to storm. However, in case of 12 deserted nests (with unhatched eggs) of both species, no apparent reasons were identified. The study suggests that these charlands, if protected from human interferences, can provide great breeding support for colonial ground nesting waterbirds.

Keywords: waterbirds, shorebirds, nesting ecology, colonial breeding, wetlands

Összefoglalás Két, vizes élőhelyekhez kötődő madárfaj, a kis csér (*Sternula albifrons*) és a kis székicsér (*Glareola lactea*) fészkelési ökológiáját vizsgáltuk a bangladesi Padma folyón szezonálisan kialakuló folyóparti szigeteken (Majherchar és Bidirpur), amelyeket helyileg charland-nak neveznek. A 2022-es költési szezonban a kis csérnek 269, míg a kis székicsérnek 299 fészket találtunk meg, amelyek közül mindkét faj esetében hetvenet vizsgáltunk meg részletesen. A költési siker előbbi faj esetében 74.28%, utóbbi esetében 78.57% volt. Nem találtunk összefüggést a két faj költési sikere és a fészkek mérete, a fészkek magassága, a fészkek mélysége és a fészkek közelében lévő növényzet jelenléte között. A kis csér esetében erős pozitív korrelációt találtunk a költési siker és a fészkek folyótól való távolsága között: minél távolabb volt a fészkek a folyótól, annál nagyobb volt a költési siker. A kis székicsérre ez nem volt jellemző. A kis csér költési sikerét leginkább a más madárfaj általi predáció ($n = 6$) és a trópusi viharok ($n = 3$) befolyásolták. A kis székicsér esetében nyolc fészkek madarak, négy fészkek pedig viharok miatt pusztult el. 12, bezáptult tojásokkal rendelkező fészeknél nem találtunk meg a költés sikertelenségének okát. Eredményeink arra mutatnak rá, hogy ezek a szigetek, ha védve vannak az emberi beavatkozástól, kiváló fészkelőhelyet nyújthatnak a telepesen talajon fészkelő vízimadarak számára.

Kulcsszavak: vízimadarak, partimadarak, fészkelési ökológia, telepes fészkelés, vizes élőhelyek

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Introduction

Waterbirds are mostly habitat specific and respond quickly to environmental changes. Such changes can influence behaviour and life history traits of their populations and communities (Ma *et al.* 2010, Tavares *et al.* 2015). Waterbird populations have been experiencing declining trends all over the world, due to various anthropogenic threats like habitat loss and alteration, disturbance, hunting, climate change, along with reproductive failure and invasion of domestic and feral animals (BirdLife International 2017, Ramachandran *et al.* 2017, Keller *et al.* 2020, Datta 2022, Marshall *et al.* 2022). Due to their specialized breeding ecology and habitat requirements, ground nesting waterbirds, such as plovers, lapwings, terns, thickknees, and pratincoles are highly vulnerable to animal predation, habitat loss, hydrologic fluctuations, and disturbance from humans and domestic animals (Sanders & Maloney 2002, Chace & Walsh 2006). Understanding local ecological and environmental changes of waterbird habitats can fill the knowledge gaps regarding understudied species and provide crucial information for their conservation.

Two globally widespread, least concern waterbird species, the Little Tern (*Sternula albifrons*) and Small Pratincole (*Glareola lacteal*) inhabit inland wetlands, shallow coastal, marine intertidal and artificial (marine and freshwater) systems (del Hoyo *et al.* 1996, BirdLife International 2016, 2019). The Little Tern has a wide distribution range across the East Asian-Australasian Flyway (EAAF) and the East Atlantic Flyway (EAF) (Jang *et al.* 2015). The species breeds throughout most of Europe, as well as in some locations on the coast and inland in parts of Africa, western, central and eastern Asia, and also in northern Australasia (Oro *et al.* 2004, BirdLife International 2019). It has a declining population trend (BirdLife International 2019). Its habitat specific colonial breeding aspects and nesting ecology is well studied in Europe, where the terns mostly use coastal mudflats, salt marsh, and artificial habitats as breeding sites (Goutner 1990, Catry *et al.* 2004, Medeiros *et al.* 2007, Scarton 2008, Eason *et al.* 2012, Medeiros *et al.* 2012, Ramos *et al.* 2013, Pakanen *et al.* 2014). However, we still do not fully understand the nesting site strategies of Little Tern in seasonally emerged sandy islands and influence of associated local ecological and environmental factors in Bangladesh.

The Small Pratincole occurs in Afghanistan and Pakistan, through India to south China, south and south-east to Southeast Asia, where it is uncommon to locally common resident in Myanmar, Thailand, Cambodia and Lao PDR (Maclean & Kirwan 2020). The species prefers inland wetlands such as rivers, streams, creeks, lakes, estuaries, and marine intertidal habitats such as salt marshes with emergent grasses (del Hoyo *et al.* 1996, Grimmett *et al.* 2016). Current population trend is unknown according to Wetlands International (BirdLife International 2016). Small Pratincoles usually breed on gravel or sandy banks near rivers and lakes. However, detailed breeding ecology of the Small Pratincole such as how they share their breeding sites with other ground nesting species in a seasonally emerged island is under-studied.

In this study, our objectives were to investigate nesting ecology of the two species in two seasonally accreted riverine islands and to examine the influences of other ecological and environmental factors on their nesting success.

Materials and Methods

Study area

Fieldwork was carried out during the breeding season of 2022 (March–June) in several riverine islands (locally called “chars”) of Padma River, the distributary of Ganges under Rajshahi Division in Bangladesh. Although we found several chars as breeding ground for our targeted species, we concentrated on two riverine islands namely Majherchar and Bidirpur char, due to huge crowd of breeding pairs and nests, respectively. Padma riverine islands are nationally and globally important habitat for migratory waterfowl and waders including Painted Stork (*Mycteria leucocephala*), Black Stork (*Ciconia nigra*), Asian Openbill (*Anastomus oscitans*), Asian Woollyneck Stork (*Ciconia episcopus*) and Indian Skimmer (*Rynchops albicollis*) (Thompson 2021).

The Majherchar breeding colony had a comparatively large mass of land and covering an area of 135 ha (Figure 1). This is a seasonally emerged char where vegetation is dominated mostly by grass species. The site is totally devoid of human interferences and the nearest human habitation is situated about 0.45 km apart in Bangladeshi part and 5 km apart from India. No cattle grazing or agricultural activities were observed in this char, however, fishermen sometimes anchored their boats nearby and use the area for resting and pastime activities.

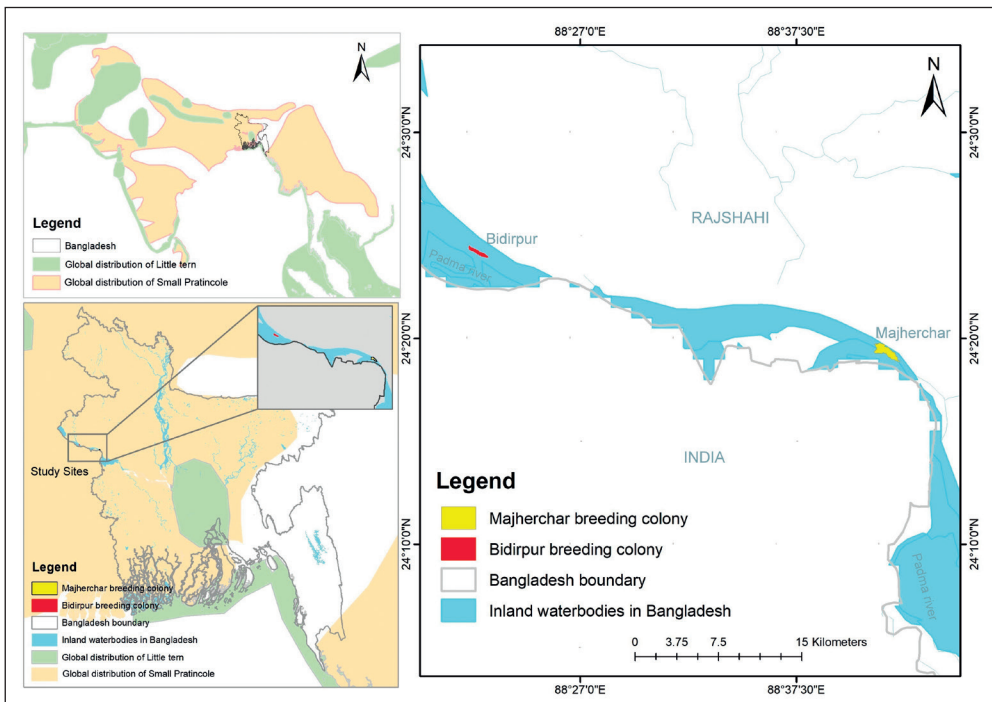


Figure 1. Breeding sites of Little Tern and Small Pratincole in Rajshahi, Bangladesh

1. ábra A kis csér és a kis székicsér fészkelési helyei a vizsgálati területeken Bangladesben

About 33 km upstream is located Char Bidirpur, which is comparatively a small char of about 55 ha area (*Figure 1*). This site is also free from anthropogenic activities and nearest human habitation is situated about 1.1 km apart in Bangladeshi part and 4.65 km apart from Indian part. No significant plant species were observed other than some scattered grassy vegetation. The study sites were sandy and barren, with sporadic patches of Madras carpet (*Grangea maderaspatana*), Bermuda grass (*Cynodon* sp.), cocklebur (*Xanthium strumarium*), wild sugarcane (*Saccharum spontaneum*), common purslane (*Portulaca oleracea*) and white water fire (*Bergia capensis*).

Data collection and analysis

We surveyed both chars through systematic searches along their perimeters and interior along transects spread out 5 m apart and parallel to one another. When a nest was encountered, we marked the nests using small and individually numbered bamboo sticks placed close to the nest. Most of the nests were monitored from the laying of the first egg to the hatching of the last egg by regular visits, on average every four days. For each nest, we measured nest placement (distance between nest and nest distance to shoreline) and nest diameters. We also recorded clutch size and determined laying date (Mayfield 1975). A nest was considered successful if at least one egg hatched, otherwise the nest was considered to have failed. When the same number of eggs remained in a nest after the expected date of hatching it was considered deserted (Bensaci 2014). The length and width of each egg was measured to the nearest 0.05 mm using callipers. Nest fates were determined by observations of chicks, nest age, parental behaviour, and signs of predator (Feral Dog *Canis lupus familiaris*, Golden Jackal *Canis aureus*, Feral Cat *Felis catus*, crow species *Corvus* spp.) and presence of eggshell fragments (Mabee 1997).

Factors affecting nesting success of Little Tern and Small Pratincole were measured by binomial general linear models. All other relevant descriptive statistical analyses and figures were computed in R version 4.2.1 (R Core Team 2022). A critical $p < 0.05$ was used and results are reported as mean $\pm$ standard deviation (SD), unless otherwise specified. A breeding colony map was prepared in ArcMap (version 10.3).

Results

Distribution and abundance of Little Tern nests

A total of 269 nests of Little Tern were recorded from both study sites and 70 nests were monitored till fledging of chicks (*Table 1*). Nests were constructed as shallow depressions in the sand with diameters of 7.5–13 cm (9.8 ± 1.3 , $n = 70$) and depths of 1.5–3 cm (2.02 ± 0.4 , $n = 70$). Nests were located 8–25 m (15.64 ± 4.25 , $n=70$) from water. The average distance to the nearest active nest was 5.26 ± 0.46 m ($n = 70$).

Table 1. Breeding and nesting sites information on Little Tern and Small Pratincole
1. táblázat Adatok a kis csér és a kis székicsér költéséről a vizsgálati területeken

Name of the breeding colony	Species	Area size	Distance (km)			Total nest found	Nests Monitored	Nest fate		Nesting Success (%)
			River Bank	Human habitation				Predated	Deserted	
				Bangladesh	India					
Majherchar	Little Tern	135 ha	0.33	0.45	5	144	45	4	8	73.33
Bidirpur		55 ha	0.97	1.10	4.65	125	25	2	4	76
Majherchar	Small Pratincole	135 ha	0.33	0.45	5	178	40	5	4	77.5
Bidirpur		55 ha	0.97	1.10	4.65	121	30	3	3	80

Clutch size and egg dimensions of Little Tern

Clutch size varied from one to three eggs (2.77 ± 0.48 eggs, $n = 194$). 56 clutches had three eggs, 12 clutches had two eggs, two clutches had only one egg. Egg length and breadth varied between 27.62–40.92 mm (30.88 ± 2.67 , $n = 194$) and 20.86–24.46 mm (22.78 ± 0.85 , $n = 194$), respectively.

Breeding phenology of Little Tern

The first nests were found on 11 March 2022 in the Majherchar and on 14 March 2022 in the Bidirpur char. Egg-laying was observed from 17 March to 16 May (61 days) in Majherchar, and from 18 March – 19 May (63 days) in Bidirpur (Figure 2). Hatching was observed

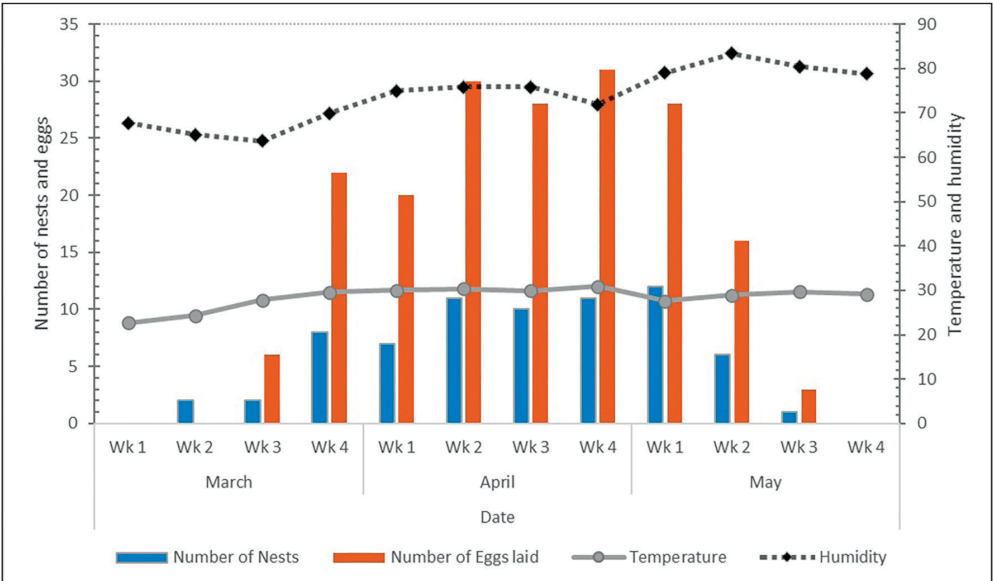


Figure 2. Nesting and egg laying phenology of Little Tern in relation to temperature and humidity in study areas

2. ábra A kis csér fészkelésének és tojásrakásának időzítése a vizsgálati területeken a hőmérséklet és a páratartalom függvényében

from 31 March – 22 May (53 days) in Majherchar and from 1 April – 21 May (51 days) in Bidirpur site. Incubation periods ranged from 15–17 days (16.07 ± 0.8 days). During the breeding season, the mean atmospheric temperature and relative humidity varied from 21.5–30.9 °C (28.5 ± 1.9 °C) and 57–95% ($73.9 \pm 6.5\%$), respectively. *Table 1* and *Figure 2* outlined detailed breeding information on Little Tern from the two study sites.

Distribution and abundance of Small Pratincole nests

A total of 299 nests of Small Pratincole were recorded from both study sites and 70 nests were monitored till fledging (*Table 1*). Nests were found in shallow depressions in the sand with diameters of 6.5–11.5 cm (9.02 ± 1.2 , $n = 70$) and depths of 1–3 cm (1.5 ± 0.97 , $n = 70$). Small Pratincole nests were located 7–26 m (14.45 ± 4.27 , $n = 70$) from water. The average distance to the nearest active nest was 6.14 ± 0.65 m ($n = 70$).

Clutch size and egg dimensions of Small Pratincole

Clutch size varied from one to three eggs (2.77 ± 0.48 eggs, $n = 146$). 14 clutches had three eggs, 48 clutches had two eggs, eight clutches had only one egg. Egg length and breadth varied between 25.16–28.27 mm (26.54 ± 0.82 , $n = 146$) and 19.56–23.45 mm (21.65 ± 0.76 , $n = 146$), respectively.

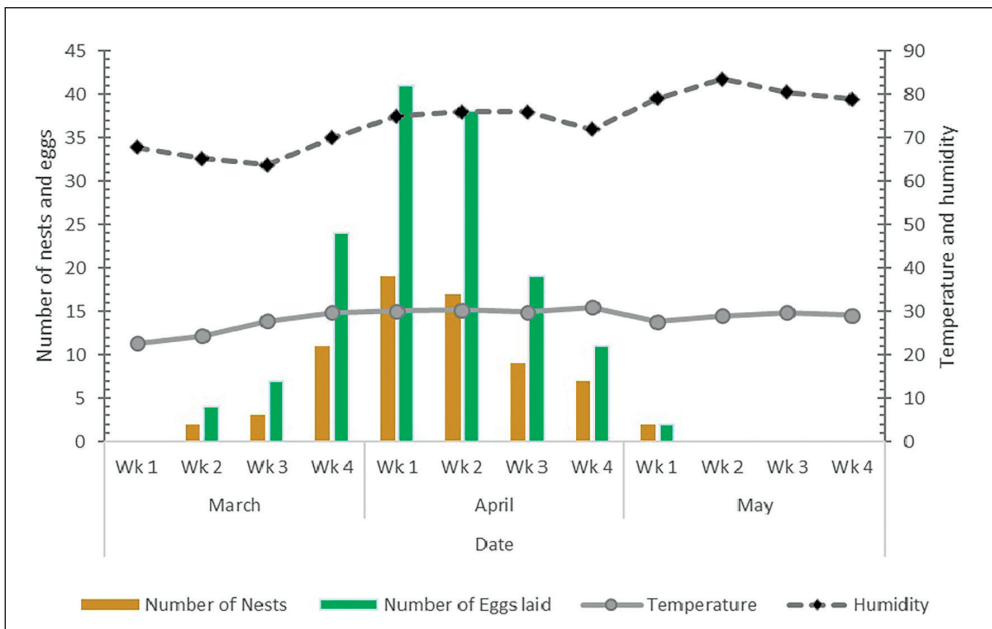


Figure 3. Nesting and egg laying phenology of Small Pratincole in relation to temperature and humidity in study areas

3. ábra A kis székicsér fészkelésének és tojásrakásának időzítése a vizsgálati területeken a hőmérséklet és a páratartalom függvényében

Breeding phenology of Small Pratincole

The first breeding pair of Small Pratincole was seen on 4 March 2022 in Majherchar and on 5 March 2022 in Bidirpur. The first nests were found on 11 March and 14 March, respectively. Egg-laying was observed from 11 March to 4 May 2022 (55 days) in Majherchar, and from 14 March to 3 May 2022 (51 days) in Bidirpur (Figure 3). Hatching was observed from 24 March to 17 May (55 days) in Majherchar and from 26 March to 15 May (51 days) in Bidirpur. Incubation periods ranged from 13–15 days (13.64 ± 2.75). Table 1 and Figure 3 outlined detailed breeding information on Small Pratincole from the two study sites.

Nest survival for Little Tern and Small Pratincole

Among the 70 monitored nests of Little Tern in two riverine chars, at least one chick from 52 nests successfully hatched, yielding a nesting success of 74.28%. Both the sites showed almost similar trends in terms of nest survival (Table 1). The main factors affecting nesting success were nest predation by avian predators (Figure 5c) ($n = 6$) (House Crow *Corvus splendens*, Black Kite *Milvus migrans*, and *Circus* sp.) and storms ($n = 3$). In case of nine deserted nests (with unhatched eggs), no apparent reasons were identified. No correlation was found for nesting success of Little Tern regarding clutch size, nest height, nest depth and presence of vegetation near nests (Table 2). Although, strong positive correlation was found between nesting success and nest distance to river for Little Tern (Figure 4).

Overall breeding success of Small Pratincole was 78.57%. No significant differences were observed in terms of nesting success in two distant islands (Table 1). Eight Pratincole nests were predated by avian predators and four nests were lost due to storm. However, in case of three deserted nests (with unhatched eggs) we failed to find any cues. No influence of clutch size, nest height, nest depth, nest proximity to water and presence of vegetation near nests were found in favor of Small Pratincole's nesting success (Table 2).

Table 2. Binomial general linear models showing parameters affecting nesting success of Little Tern and Small Pratincole in the study area

2. táblázat A kis csér és a kis székicsér költési sikerét befolyásoló tényezők a binomiális általános lineáris modellekkel végzett számítások alapján

Model parameters	Coefficients		Z value	Pr(> z)
	Estimated	Standard Error		
Nesting success of Little Tern				
Distance to river	0.160	0.080	1.995	0.040
Nest height	0.193	0.906	-0.213	0.831
Clutch size	-0.220	0.673	-0.328	0.743
Nesting success of Small Pratincole				
Distance to river	-0.073	0.080	-0.914	0.361
Nest height	-0.066	0.350	-0.190	0.850
Clutch size	0.335	0.623	0.538	0.591
Presence of vegetation near nest	0.422	1.878	0.225	0.151

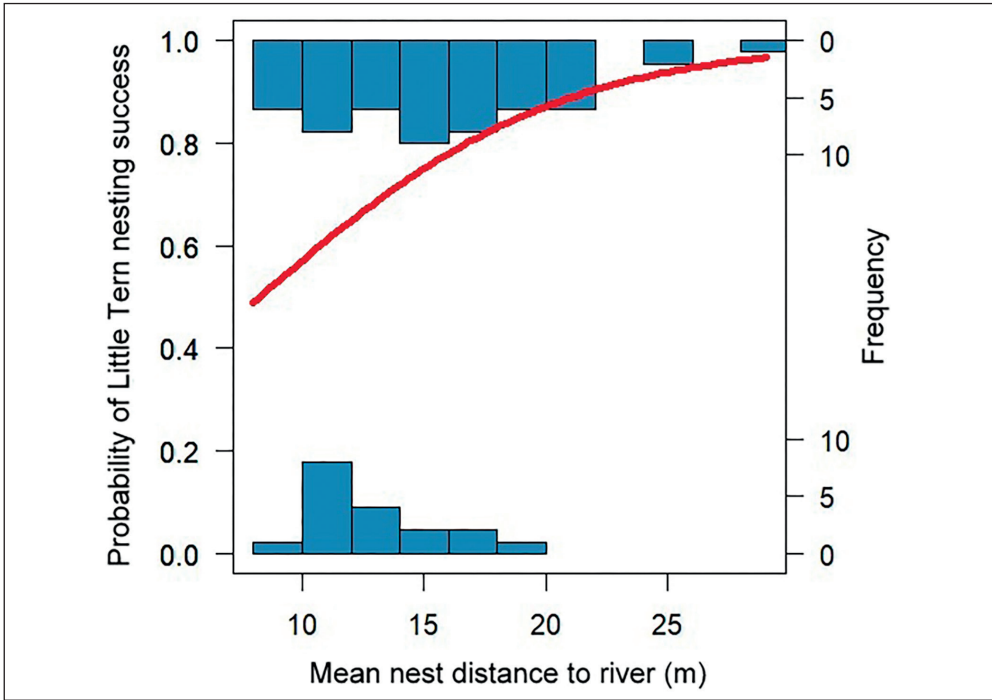


Figure 4. Predicted probability of Little Tern nesting success in relation to nest distance to river

4. ábra A kis csér költési sikerének feltételezett valószínűsége a folyótól való távolság függvényében

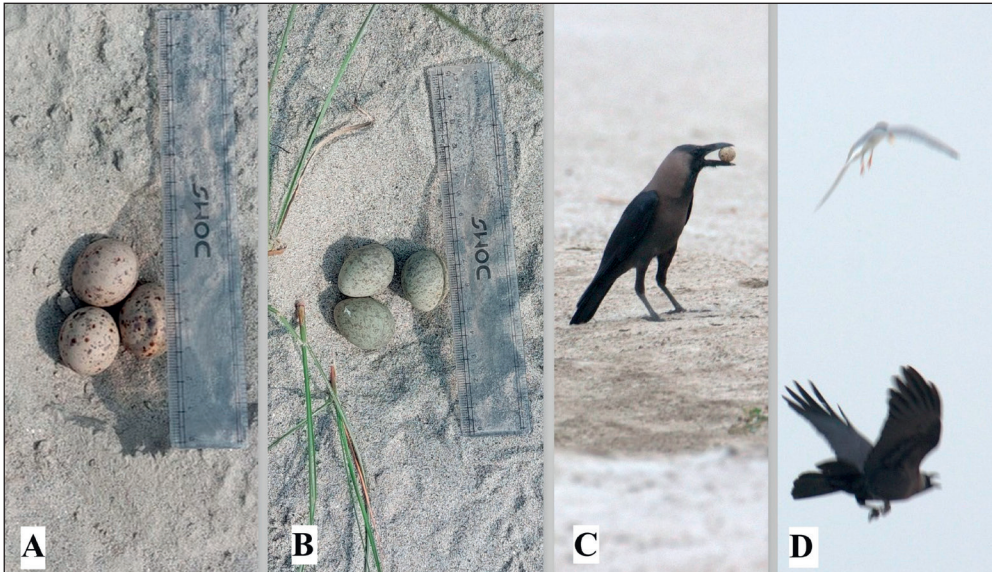


Figure 5. (a) Eggs of Little Tern (b) eggs of Small Pratincole (c) Little Tern egg predation by House Crow and (d) nest defense by Little Tern

5. ábra (a) kis csér tojásai (b) kis székicsér tojásai (c) indiai varjú kis csér tojásával a szájában (d) fész-
két védőmező kis csér

Discussion

Colonial nesting of Little Tern and Small Pratincole with other Charadriiforms (including Collared Pratincole *Glareola pratincola*) is common and observed in many other countries (Fasola & Canova 1992, Fernandes & Besten 2013, Kiss *et al.* 2018). In this study, we confirm it for the Ganges-Padma River floodplain in Rajshahi district, Bangladesh. Nest building, egg laying and hatching of Little Tern and Small Pratincole occurred from March to May in both study sites with a peak during April. Both study species completed the breeding activities concurrently and no inter specific aggression behaviour was observed. On the contrary, both species defend their nests from avian predators.

Little Tern and Small Pratincole collective nesting success was similar (74.28% and 78.57%) in the study sites. We did not find any mammalian predator, cattle and feral dogs or cats, which probably increase the breeding success of the two studied species. Medeiros *et al.* (2007) found that predation and anthropogenic disturbance play a vital role in limiting breeding success. In case of Little Tern, nests near water have less probability to success as nests located close proximity to water channel had a higher chance of flooding (Claassen *et al.* 2018). We suspected that about 10 nests of both species were abandoned due to heavy rain and storms. Similar nest flooding was observed as an important limiting factor for nesting success in Little Tern and Small Pratincole (Goutner 1990, Pakanen 2014, Debata 2019).

The study sites are only two of the many riverine islands in the Ganges-Padma River floodplain, which are periodically transformed in shape by silt deposition and erosion. These islands become completely submerged during monsoon. Previous studies found many nationally and globally threatened bird species from these areas (Chowdhury *et al.* 2014, Thompson 2021). However, cattle grazing, sand extraction, hunting during winter season, extensive fishing, conversion of grassland into croplands are some prevailing threats (Chowdhury *et al.* 2014, Datta 2022, Jahan *et al.* 2022), which must be managed for better protection of waterbird and grassland bird species. We further recommend conducting additional in-depth surveys to learn more about the diversity of fish and other waterbird prey species, as well as their influence on breeding biology.

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