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BREEDING BIOLOGY OF INDIAN POND HERON *Ardeola grayiis* IN PUNJAB, INDIA

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ABSTRACT

Study on breeding biology of Indian Pond Heron was conducted from February to December, 2017 in village Karamgarh (District Barnala) considered as location I and Punjab Agricultural University Campus, Ludhiana as location II. A total of 23 nests were located having clutch size 2 to 5 at both the locations. The overall maximum mean values of egg length 41.61 ± 0.97 mm and 39.08 ± 0.43 mm, egg width 29.71 ± 0.82 mm and 26.15 ± 0.66 mm, egg volume 16.36 cm^3 and 11.12 cm^3 at location I and II respectively. The average feeding frequency was 1.55 times/hour and 1.63 times/hour at location I and II respectively. Significant positive correlation of egg volume with egg length (r= 0.953) as well as with egg width (r=0.986) at location I was noted; it was not found at location II. There was negative correlation between egg volume and egg shape index (r = -0.259) at location I which was positive (r = 0.144) at location II. Location II which had higher hatching success had attributes like easy food availability due to crop diversity and nesting sites due to presence of indigenous trees.

INTRODUCTION

Herons are wading birds of considerable significance, because they act as indicator species in wetland areas (Abdullah *et al.,* 2017). Indian Pond Heron, *Ardeola grayii* (Order Ciconiiformes) also called paddy bird is a small bird in the family Ardeidae, earthy brown in color during rest with glistening white wsings and tail and rump flashing into prominence during flight. Different studies had mentioned less abundance of Indian pond Heron in and around village ponds and in rice ecosystem of Punjab State (Kler (2002); Kler (2010). Kler and Prashad (2011) had observed a total of 54 bird species in rice and wheat agro-ecosystems and mentioned that Indian Pond Heron had occupied insectivorous/soil invertebrate food guild and ground foraging guild. Joshi and Shrivastava (2012) had mentioned Indian Pond Heron was common in abundance during avian diversity surveyed in Madhya Pradesh State. Different workers had taken observations on the breeding activities of Indian Pond Heron from the Indian sub-continent. Begum (2003) had found it to be colonial breeder in Bangladesh. This species was observed to breed from February to June and preferred indigenous trees for nesting (Jaman *et al*., 2012). Sahi *et al*. (2017) had studied its clutch size and egg characteristics so as to correlate these variables with reproductive success in Jammu region. There has not been detailed study on the breeding activities of this species from Punjab state. Keeping in view low population abundance and lack of information on the breeding biology from Punjab, the present study has been planned to understand its breeding ecology so as to recommend strategies to increase/ conserve its population.

MATERIALS AND METHODS

Study Area

The present study was carried out to study the breeding biology of Indian Pond Heron in village Karamgarh (latitude 30 24 43 N and longitude 75 36 23 E) of district Barnala as location I, and Punjab Agricultural University Campus, Ludhiana (latitude of 30º54'147 N and longitude of 075 47'642 E) as location II. The study was conducted from February to December, 2017. The location I comprising of open-canopy ponds (seven in number) situated selected which was situated within the residential area. The peripheral area of the selected ponds was covered by *Parthenium hysterophorus Cynodon dactylon* and *Trianthema portulacastrum* and was also utilized for dumping animal waste. Location I also comprised of trees species namely *Acacia nilotica*, *Azadirachta indica*, *Ficus religiosa*, *Eucalyptus oblique*, *Ficus benghalensis*, *Melia azedarach, Dalbergia sisso*, *Morus alba* and *Cordia oblique*. Location II was selected in the university campus and it included the road to the College of Fisheries. The selected area had fish rearing ponds. The tree species comprised of *Azadirachta indica*, *Ficus religiosa*, *Eucalyptus oblique*, *Melia azedarach, Dalbergia sisso*, *Mangifera indica, Morus alba, Ficus lacor* and *Callistemon*. The crop diversity surrounding the area was Rice (*Oryza sativa)*, Barseem (*Trifolium alexandrinum*) and Maize (*Zea mays)*.

Methodology

The study areas were thoroughly scanned to locate the nesting sites of Indian Pond Heron from the month of February onwards. The identified nesting sites were studied using point count method (Verner, 1985). The observations were taken

on weekly basis in the morning from 6 a.m. to 8 a.m. and evening from 4 p.m. to 6 p.m. The observations on clutch size, incubation period and hatching success were recorded. The parameters of the eggs like color, shape, length, width, volume, shape index and specific gravity were also recorded. The weight of eggs was recorded on Electronic pocket scale (d = 0.01g) weighing balance. The dimensions of eggs (length and width) were measured with the aid of Digital Vernier Calliper (resolution 0.01 mm). Egg volume was calculated using an empirical formula calibrated to Northern Lapwing eggs by Galbraith (1988):

Egg volume = $0.457 \times$ (Length)(Breadth)$^2 \times 10^{-3}$ml

According to Stadelman and Cotterill (1995), egg shape index and egg specific gravity were determined using the following equations

$$\text{Egg shape index} = \frac{\text{Egg breadth(mm)} \times 100}{\text{Egg length (mm)}}$$

$$\text{Egg specific gravity(gm/cm}^3) = \frac{\text{Egg weight(gm)}}{\text{Egg volume(cm}^3)}$$

Nest success and the hatching success were determined according to Murray (1999).

$$\text{Nest sucess} = \frac{\text{Number of clutches that produce young} \times 100}{\text{Total number of clutches}}$$

$$\text{Hatching sucess} = \frac{\text{Number of eggs hatched} \times 100}{\text{Total number of eggs laid}}$$

Identification of trees was done according to Sahni (1998). The tree height and the nest height from the ground were recorded with the help of altimeter.

Statistical analysis

Student's t-test was carried out to find out any significant difference between the different egg parameters at both the locations. The correlation between various egg variables were calculated using Pearson's correlation using SPSS software.

RESULTS AND DISCUSSION

Breeding season

In the present study, breeding activities of Indian Pond Heron

Table 1: Tree preference and number of nests of Indian Pond Heron

Nesting site	Name of the trees	No. of trees used for nesting	No. of nests of Indian Pond Heron	Nests of other bird species
Location I				
Nest Site 1	*Acacia nilotica*	1	2	5
Nest Site 2	*Ficus religiosa*	2	3	2
Nest Site 3	*Cordial oblique*	1	1	-
Nest Site 4	*Syzygium cumini*	1	1	-
Nest Site 5	*Melia azedarach*	1	2	-
Nest Site 6	*Dalbergia sissoo*	2	2	-
Nest Site 7	*Ficus benghalensis*	5	7	4
Location II				
Nest Site 8	*Callistemon*	1	2	-
Nest Site 9	*Melia azedarach*	1	3	-

Table 2: Mean tree height and mean tree nest height at location I and location II

	Location I		Location II	
Name of trees	Mean tree height (m)	Mean nest height (m)	Mean tree height (m)	Mean nest height (m)
Acacia nilotica	7	6.7	-	-
Ficus religiosa	19.25	15.8	-	-
Cordial obliqua	9	7	-	-
Syzygium cumini	11	9	-	-
Melia azedarach	8.5	7.2	13	10.3
Dalbergia sissoo	12	8.5	-	
Ficus benghalensis	17.3	13.6	-	
Callistemon	--		9	7.9

Table 3: Clutch size of Indian Pond Heron at location I and location II

	Location I							Location II		
Nest number	1	2	3	4	5	6	7	1	2	3
Nesting trees										
Acacia nilotica	4	3	-	-	-	-	-	-	-	-
Ficus religiosa	3	4	3	-	-	-	-	-	-	-
Cordial oblique	3	-	-	-	-	-	-	-	-	-
Syzygium cumini	3	-	-	-	-	-	-	-	-	-
Melia azedarach	4	4	-	-	-	-	-	3	3	3
Dalbergia sissoo	2	2	-	-	-	-	-	-	-	-
Ficus benghalensis	3	3	2	2	4	3	5	-	-	-
Callistemon	-	-	-	-	-	-	-	3	4	-

Table 4: Morphometrical characteristics of eggs in different clutches at location I

Nest	Mean length of eggs ± S.E(mm)	Mean width of eggs ± S.E(mm)	Mean Weight of eggs ± S.E (grams)	Egg volume (cm^3)	Egg Shape Index
1	36.68 ± 1.25	25.07 ± 2.00	11.92 ± 0.57	10.54	68.374
2	30.85 ± 1.31	24.23 ± 0.67	11.89 ± 0.50	8.28	78.541
3	36.20 ± 0.61	25.73 ± 0.30	13.20 ± 0.92	10.95	71.077
4	39.82 ± 1.01	29.53 ± 0.77	13.22 ± 0.40	15.87	74.158
5	30.75 ± 0.80	22.71 ± 0.39	10.43 ± 0.47	7.25	73.853
6	31.10 ± 2.38	23.52 ± 0.35	12.13 ± 0.52	7.86	75.627
7	27.61 ± 0.68	23.12 ± 0.39	11.55 ± 0.77	6.74	83.737
8	41.61 ± 0.97	29.33 ± 0.87	13.60 ± 0.26	16.36	70.487
9	40.18 ± 0.36	29.71 ± 0.82	13.68 ± 0.22	16.21	73.942
10	38.18 ± 1.63	29.68 ± 1.10	11.24 ± 2.11	15.37	77.737
11	38.67 ± 1.00	29.10 ± 0.43	13.51 ± 0.06	14.96	75.252
12	33.11 ± 2.77	27.08 ± 1.12	12.27 ± 0.55	11.1	81.787
13	37.05 ± 1.90	28.49 ± 1.08	13.67 ± 0.67	13.74	76.896
14	38.45 ± 1.00	29.00 ± 0.24	13.96 ± 0.31	14.78	75.422
15	39.49 ± 0.84	29.19 ± 0.15	14.65 ± 0.78	15.38	73.917
16	36.74 ± 0.90	27.46 ± 0.77	13.83 ± 0.28	12.66	74.741
17	36.62 ± 1.02	28.41 ± 3.07	14.01 ± 0.84	13.51	77.58
18	34.27 ± 1.14	24.67 ± 0.20	12.85 ± 0.35	9.53	71.987

Table 5: Morphometrical characteristics of eggs in different clutches at location II

Nest	Mean length of eggs ± S.E(mm)	Mean width of eggs ± S.E(mm)	Mean Weight of eggs ± S.E (grams)	Egg volume (cm^3)	Egg Shape Index
1	35.59 ± 0.67	26.15 ± 0.66	12.90 ± 0.33	11.12	73.475
2	36.97 ± 1.16	23.92 ± 0.38	12.86 ± 0.31	9.67	64.701
3	34.53 ± 0.56	23.96 ± 0.24	13.59 ± 0.55	9.06	69.388
4	39.08 ± 0.43	24.61 ± 0.13	13.48 ± 0.09	10.82	62.973
5	35.81 ± 0.26	24.19 ± 0.58	13.60 ± 0.99	9.58	67.55

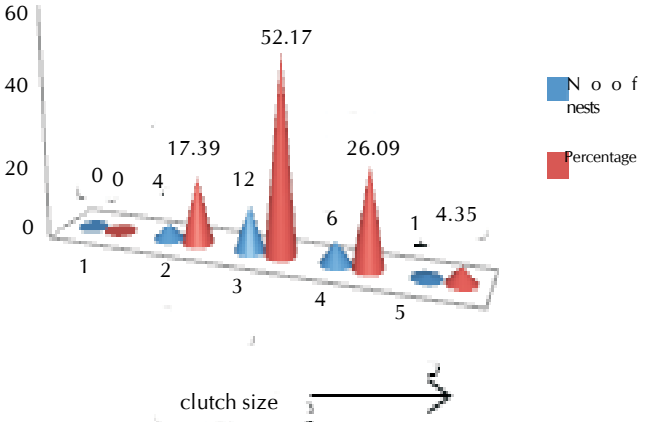

Figure 1: Histogram showing overall percentage of different clutches and number of nests of Indian Pond Heron during the study period

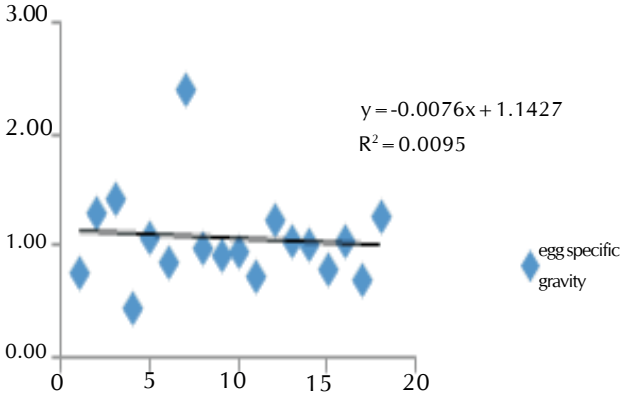

Figure 2: Scattered diagram of egg specific gravity at location I.

were observed from the end of March up to September. Highest numbers of nests were observed in the months of August and September. The breeding pairs acquired maroon hair like plumes on back and long occipital crest in the end March and early April. Previous published work of the author from location I had shown relative abundance of Indian Pond Heron to be 2.90 % among the total bird species (Kaur *et al.*, 2018). Jaman *et al*. (2012) recorded breeding activities to start from February up to June and peak nesting activities were in the month of March. It was further mentioned that this heron species may help to control insects in agricultural fields so as to act as an important biological component to maintain the food chain, ecosystem. Sahi *et al*. (2017) recorded that the breeding season of Indian Pond Heron started from May up to September with peak breeding activities in the months of June and July. But the present study showed August and

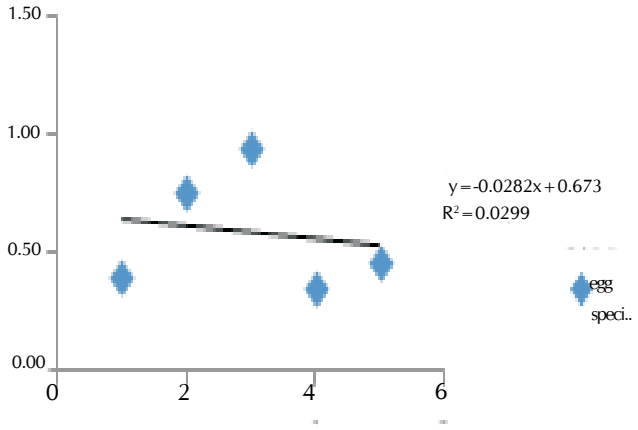

Figure 3: Scattered diagram of egg specific gravity at location II.

September as the peak nesting months. The variation in the breeding season of Indian Pond Heron at different places might be due to variation in the seasons. According to different workers, this time period had been noted to be peak breeding time for almost all the water birds species. Black-winged stilt had been observed to breed from early April till late July (Ashoori, 2011) and Cattle Egret from March to July (Kour and Sahi, 2013).

Nesting ecology

A total of 23 nests of Indian Pond Heron were studied out of which 18 nests were recorded at location I and 5 nests at location II. The nest number observed on tree species like *Ficus benghalensis, Ficus religiosa, Acacia nilotica, Melia azedarach, Dalbergia sissoo, Syzygium cumini* and *Cordial oblique* were 7, 3, 2, 2, 2, 1 and 1 respectively at location I. At location II, nests were spotted on *Melia azedarach* and *Callistemon* (Table 1). The trees having Indian Pond Heron nests were in the immediate vicinity of village ponds and fish rearing ponds at location I and II respectively. The most preferred tree for nesting was observed to be *Ficus benghalensis, Ficus religiosa* and *Melia azedarach*. The nest type was observed to be an open untidy flat platform of loosely arranged twigs. Similar kind of nest was observed by Henry (1971), Ali (2003), Seedikkoya *et al*. (2008) and Jaman *et al*. (2012). Yesmin *et al*. (2001) said that the nesting materials were arranged in a criss-cross fashion, resulting in a circular platform with a cup in the center. The present study showed maximum tree height of *Ficus religiosa* (19.25 m) and minimum tree height of *Acacia nilotica* (7 m) at location I. Except one all the nesting trees were above the height of 9 m. At location II, the maximum average tree height was of *Melia azedarach* (13 m) and minimum of *Callistemon* (9 m). The maximum average nesting height recorded was 15.8 m and 10.3 m while the minimum average height of nest recorded was 6.7 m and 7.9 m at location I and location II respectively (Table 2). Begum (2003) recorded Indian Pond Heron to use eight different tree species for nest building and nest height to vary between 9 and 10 m of height. In the present study, all the tree species preferred for Indian Pond Heron nesting except *Syzygium cumini* were different from the study conducted by Begum (2003). Different tree diversity in different geographical regions might be the region for tree specific preferences for nest sites in both the studies. An interesting observation in the present study was about solitary nesting of Indian Pond Heron on *Syzygium cumini* as compared to colonial nesting on the same tree species observed by Begum (2003). According to her, mango tree was the most preferred for nest building. Jaman *et al*. (2012) found both bamboo and mango as preferred trees for nest building and average nest height was 7.82 m from the ground. But the present study showed *Ficus benghalensis, Ficus religiosa* and *Melia azedarach* as the most preferred trees for nest building which showed difference in tree preference from the above mentioned authors. The nesting on *Ficus religiosa* was also observed by Porte and Gupta (2017) during a study conducted in Chhattisgarh. The nest height recorded was 2 to 10 m above the ground by Ali and Ripley (2001). In the present study, range of tree height varied from 7 m to 19.25 m and nest height varied from 6.7 m to 15.8 m which is different from nest height and tree height as mentioned by Begum (2003), Jaman *et al*. (2012) and Yesmin *et al*. (2001). Similar trees species like *Acacia nilotica* and *Mangifera indica* were also preferred by Cattle Egret (Kour and Sahi, 2013).

During the present study, Indian Pond Heron was observed both as solitary and colonial breeder. Mixed colonial nesting of Cattle Egret, House Crow and Indian Pond Heron were observed at nest site 1, nest site 2 and nest site 7 of location I. Many authors have recorded colonial nesting of Indian Pond Heron which might be to protect the nests from predators. Seedikkoya *et al*. (2008) found both solitary as well as colonial nests and mentioned that Indian Pond Heron might be less colonial than the Little Egret and Cattle Egret. The present findings about colonial as well as solitary behavior of Indian Pond Heron are in consonance with Seedikkoya *et al*. (2008). Mixed colonies were also recorded in the Malagasy Pond Herons particularly with Squacco Herons (Sam and Bamford, 2017). Heronries are considered as the sources of breeding population of herons, egrets and other associate water birds and play vital role in the conservation of these birds (Li *et al*., 2016).

Egg characteristics

The eggs observed were oval, sea green in color and were without spots. Similar observations were recorded by Yesmin *et al*. (2001), Ali and Ripley (2001), Fazili (2014) and Sahi *et al*. (2017). Egg laying in Indian Pond Heron was not continuous at both the locations. Seedikkoya *et al*. (2008), Fazili (2014) and Sahi *et al*. (2017) also recorded similar findings about the egg laying behavior of Indian Pond Heron. During the present study, maximum clutch size observed was five and minimum clutch size was two at location I. At location II, maximum clutch size was four and the minimum clutch size was three. Clutch size of three was most common; clutch size of five was very rare and recorded only in one nest at location I (Table 3). The present findings are in consonance with that reported by Yesmin *et al*. (2001), Fazili (2014) and Sahi *et al*. (2017). Ali and Ripley (2001) recorded clutch size of 3 to 5. Fazilli (2014) observed clutch size of Indian Pond Heron to vary from 2 to 6 while Sahi *et al*. (2017) recorded clutch size of 1 to 5. Sam and Bamford (2017) recorded similar average clutch size in

Malagasy Pond Heron *i.e.* three.

Maximum and minimum mean length of the eggs was 41.61 ± 0.97 mm 27.61 ± 0.68 mm respectively at location I. Maximum and minimum mean width of the eggs was 29.71 ± 0.82 mm and 22.71 ± 0.39 mm respectively at location I. Maximum mean weight of eggs recorded was 14.86 ± 0.33 g and minimum mean egg weight was 10.43 ± 0.47 g at location I. Egg volume of the eggs varied from 6.74 cm^3 to 16.36 cm^3 at location I (Table 4). At location II, maximum mean egg length and width was 39.08 ± 0.43 mm and 26.15 ± 0.66 mm respectively. Maximum mean egg weight was 13.60 ± 0.99 g at location II. Maximum egg volume recorded at location II was 11.12 cm^3 (Table 5). Yesmin *et al*. (2001) recorded egg length of 30-44 mm and egg width of 25-37 mm which is greater than the egg length and egg width recorded in the present study. As compared to present study, Sahi *et al*. (2017) recorded egg length (3.90 ± 0.16 cm) and egg breadth (2.78 ± 0.19 cm) which showed reduction in egg size as compared to present study. Yesmin *et al*. (2001) and Sahi *et al*. (2017) had recorded egg weight to be 19.27 g and 17.93 g respectively which was higher as compared to the egg weight noted in the present study. The present study showed higher egg volume at location I and lesser at location II as compared to the egg volume (15.57 cm^3) recorded by Sahi *et al*. (2017). Nedjah *et al*. (2014) recorded 57.0 ± 5.1 g, 60.9 ± 2.2 mm, 42.2 ± 1.1 mm and 55.3 ± 4.7 cm^3 of mean egg weight, egg length, egg breadth and egg volume at Lake Fetzara of Grey Heron, respectively. In the present study the eggs of Indian Pond Heron were lighter and smaller as compared to the eggs of Grey Heron given by Nedjah *et al*. (2014).

Maximum percentage of nests was 52.17 %, 26.09% and 4.35 % with clutch size 3, 4 and 5 respectively at both the locations (Fig 1). As compared to the present study, Sahi *et al*. (2017) recorded higher percentage of nests (49.09%) with clutch size 4 whereas Seedikkoya *et al*. (2008) recorded higher percentage (87%) with clutch size 3. The specific gravity ranged from 0.46 g/cm^3 to 2.43 g/cm^3 at location I (Fig 2) whereas it ranged from 0.41 g/cm^3 to 0.46 g/cm^3 at location II (Fig 3). Statistical analysis showed significant difference between widths of eggs at both the locations (Student's t-test, $t = 2.09$, $p = 0.04$). Student's t-test showed no significant difference between the egg length ($t = 0.23$, $p = 0.81$), egg volume ($t = 1.63$, $p = 0.11$) and egg weight ($t = 0.56$, $p = 0.57$) at both the locations.

Correlation between various egg variables

A statistically significant and strong positive correlation was recorded between egg length and egg volume ($r = 0.953$, $á = 0.01$) as well as egg width and egg volume ($r = 0.986$, $á = 0.01$) at location I. The egg weight also had positive and significant correlation with egg length ($r = 0.688$, $á = 0.01$) and egg width ($r = 0.682$, $á = 0.01$) at location I. A negative significant correlation was found between egg length and egg shape index ($r = -0.534$, $á = 0.05$) where as a negative insignificant correlation was found between egg width and egg shape index ($r = -0.114$) at location I. However, a negative insignificant correlation of egg weight was recorded with egg length ($r = -0.063$) and egg width ($r = -0.454$) at location II. The correlation between egg shape index and egg length was negative insignificant ($r = -0.777$) whereas a positive correlation was found between egg shape index and egg width ($r = 0.651$) at location II. A positive correlation was observed between egg volume and egg shape index ($r = 0.144$) at location II whereas at location I, the correlation was negative ($r = -0.259$).

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