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Nesting behaviour of Indian Pond Heron, *Ardeola grayii* (Sykes, 1832) at Ratanpur, District Bilaspur, Chhattisgarh, India

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Abstract

Nesting parameters *viz.*, nesting trees, nesting period and construction time, nest construction materials, nest morphometry, and visitization rate of Indian pond heron, *Ardeola grayii* from the initiation of the nest construction until completion was studied in Ratanpur for a period of two years (2013-2014). *Dendrocalamus strictus* (Poaceae), *Pithecellobium dulce* (Fabaceae), *Pongamia pinnata* (Fabaceae), *Ficus religiosa* (Moraceae) and *Azadirachta indica* (Meliaceae) were preferred as nesting site with higher frequency of *Azadirachta indica* while *Pithecellobium dulce* was less used. The nest construction period by *Ardeola grayii* was found in summer between late May and starting of June with average nest construction duration of 10 ± 1.63 days. The nest visitation rate by the adult *A. grayii* was higher during initial and middle stage as comparison from late stage. The nests were made of sticks and twigs of *Aegle marmelos, Azadirachta indica, Cassia tora, Dendrocalamus strictus, Ficus religiosa, Mangifera indica, Pongamia pinnata, Tamarindus indica, Vachellia nilotica,* dry leaves of *Dendrocalamus strictus* & *Ficus religiosa* and dry seeds of *Pongamia pinnata*. The weight (197.43 ± 11.48 g), length (30.12 ± 0.78 cm), breath (22.28± 0.76 cm), depth (2.82 ± 0.26 cm) and circumference (83.68 ± 1.62 cm) of the nests revealed that the nest constructed by the species was sufficient to lay 3-5 eggs at a time.

Construction of a nest, incubating and hatching the eggs, feeding and nurturing of the nestlings are all very essential and apprehensive job for the parent birds. The avifauna builds their nests mostly to protect themselves, their eggs and especially their developing young ones from voracious animals and from unfavorable weather conditions during the nesting season. Nest is a container in which eggs and young ones develop safely[9]. The nesting activities of birds are vigorously affected by various extrinsic factors such as quality and quantity of food materials, accessibility of nesting and roosting area, atmospheric conditions, position of the nesting area, inter-specific competition for resources, presence of predators and anthropogenic disturbance[1,14,27-31,32,37]. A wide range of wetland avian fauna breeds during monsoon, when food resources are abundant[3,5]. Pattern of nest construction differs from species to species[16], way of life and their surrounding area[9].

The Indian pond heron, *Ardeola grayii* (Order: Ciconiformes, Family: Ardeidae), commonly called as paddy bird, is old world origin (Europe, Asia and Africa). They are the inhabitant of ponds, pools, rivers, stream, tidal flats, flooded grassland, paddy fields, canals, ditches and breed in marshy wetlands of warm countries such as Southern Iran, India, Myanmar and ShriLanka. Its breeding period varies with latitude. *Ardeola grayii* is a solitary as well as colonial nesting species[6]. Usually, they are less colonial than the cattle and little Egrets[39]. The colonial nesting is supposed to be an adaptation to escape from the predators. They build their nest with other avian fauna such as night herons, egret or other storks, etc. and form a nesting colony[21]. The nesting behaviour of *Ardeola grayii* is relatively less understood excepting for the some discrete information from portions of India and Bangladesh[6,21,26,34,44]. There is no work reported on nesting behavior of Indian pond heron from Chhattisgarh. Therefore, the present study was planned to explore nesting aspects of *Ardeola grayii* a resident species at Ratanpur (85°17'E and 22°3'N; 306 m above sea level) of Bilaspur district of Chhattisgarh, India. The place is historic and famous for Mahamaya Shaktipeeth and other temples, mountainous geography, old forts and over 100 small and large ponds. It attracts a large number of tourists from the distant and wide places of the country. The predominant tree species found in the study area are local species of trees *viz*. Amla (*Phyllanthus emblica*), Amltash (*Cassia fistula*), Bamboo (*Dendrocalamus strictus),* Babool (*Acacia nilotica*), Bel (*Aegle marmelos*), Charoutha *(Cassia tora)* Emili (*Tamarindus indica*) Ganges tamarind (*Pithecellobium dulce*), Guava (*Psidium guajava*), Kachnar (*Bauhinia variegata*), Karanja (*Pongamia pinnata*), Karonda, (*Carissa carandas*), Khair (*Acacia catechu*), Mango (*Mangifera indica*), Neem (*Azadirachta indica*), Peepal (*Ficus religiosa*), Palas (*Butea monosperme*) etc. Consequently, the avi-fauna of this area faces severe anthropogenic pressure and needs conservation. *Ardeola grayii* is an important biotic component of the food chain of the ecosystem and control the insects in agricultural fields.

Several field surveys were carried out for identifying nesting trees of *Ardeola grayii* within the human settlement area. Five nests of *A. grayii* were randomly collected during the non-breeding period. Morphometry, like weight, length, breadth, depth and circumference of every nest was measured. The composition of nest was studied manually. The nests were weighed and their components were measured using an electronic precision balance (Sartorius, ELT602, 400×0.01 g).

The nest constructions and nest visitation study was done repeatedly for two years (2013 and 2014) during the months of nest construction period. The nesting progress was observed in the morning incessantly for three hours with the aid of video camera (Sony HXR-MC1500P). The nest visitation rate of breeding birds during nest building was also noted for the phase of three hours each day between 07:00 and 10:00 for 12 days. Video clippings were replayed in slow motion for a total period of 36 h (3 h/ day). Nest visitation rate was observed from the video replay for three different stages (*i.e.* initial stage, mid stage and final stage) of nest building. Data was collected in the form of a database in the

MS Excel worksheet on which descriptive statistical analyses were performed and the ANOVA and Duncan's multiple range tests were employed to compare means among groups with the help of SPSS (Version 10).

Nesting Trees:

Ardeola grayii builds nest on isolated large trees or clumps. They used various types of tree species for nest construction often growing in the middle of noisy town and are not necessarily close to water. In Ratanpur during the beginning of breeding season (between May to June), *Ardeola grayii* prominently used the *Dendrocalamus strictus* (Bamboo) Femily- Poaceae, *Pithecellobium dulce* (Ganges tamarind) Femily-Fabaceae, *Pongamia pinnata* (Karanja) Femily-Fabaceae, *Ficus religiosa* (Peepal)-Family-Moraceae and *Azadirachta indica* (Neem) Femily- Meliaceae as shelter trees among the other present there. (Figures 1a-e). Result clearly indicate that at Ratanpur *A. grayii* used *Azadirachta indica* (33.33%) more frequently as nesting tree while *Pithecellobium dulce* was used least (11.49%) for nest construction (Table 1).

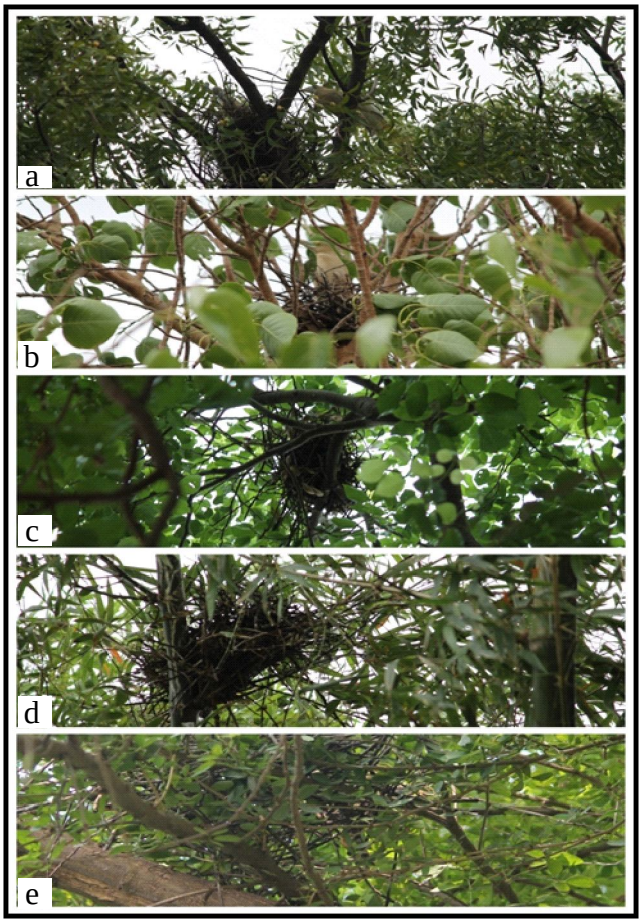

Figure1(a-e). Different nesting trees of Indian Pond Heron, *Ardeola grayii*; a. Neem (*Azadirachta indica*), Peepal (*Ficus religiosa*), c. Karanja (*Pongamia pinnata*), d. Bamboo (*Dendrocalamus strictus*) and e. Ganges tamarind (*Pithecellobium dulce*).

Table-1. The nesting trees of Indian Pond Heron, *Ardeola grayii*, located in study sites (Ratanpur) during 2013 and 2014.

Nesting tree species	No. of nesting tree	No. of nest/year		Average	%
		2013	2014		
Azadirachta indica	14	28	30	29	33.33
Dendrocalamus strictus	11	9	15	12	13.79
Ficus religiosa	12	24	20	22	25.28
Pithecellobium dulce	7	11	9	10	11.49
Pongamia pinnata	8	16	12	14	16.09
Total	52	88	86	87	

Nest construction period:

Nest-construction time was observed for two consecutive years, *viz.*, 2013 (28 May – 08 June) and 2014 (26 May – 02 June), from the beginning of the nest construction until completion of nest (Figures 2a & b). The average duration for nest construction by these birds was 10 ± 1.63 days (Table 2). The nest construction period was found to be between late May and starting of June.

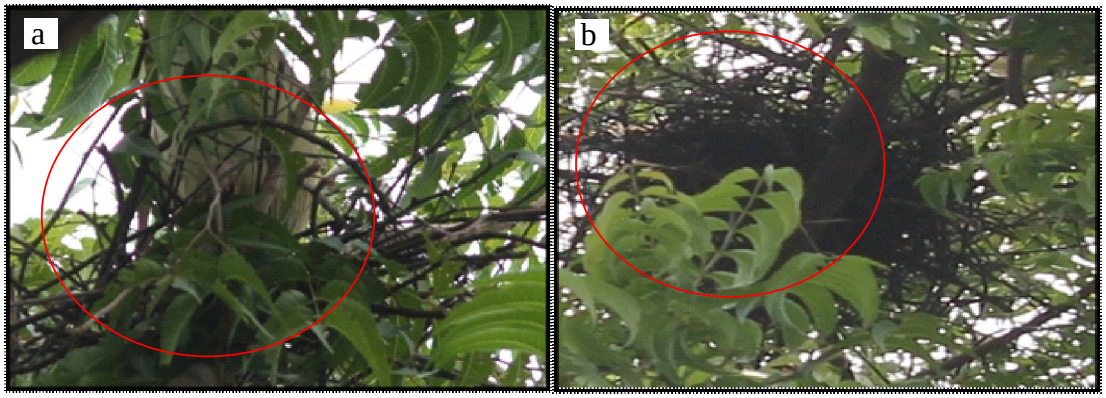

Figure 2a & b. Nest construction period: the first day (commencement) (a) and the last day (cessation) (b) of nest construction.

Table-2. Nest construction period of Indian Pond Heron, *Ardeola grayii* during two different years.

Year	Number of nest observed (n)	Month		Number of Days	Average nest construction Commencement Cessation period (d)
		Commencement	Cessation		
2013	5	28 May	08 June	12	10 ± 1.63
2014	3	26 May	02 June	08	

Nest visitation rate:

Result of one-way ANOVA showed that an insignificant difference was validated in the adult's visitation rate to the nest at different stages (i.e. initial, middle and final) during the nest construction tenure ($F_{2, 11}$ = 0.53, $p > 0.05$). However, the adult's visitation rate in the nest was insignificantly higher during initial stage (3.96 ± 0.45 visits/ h), middle (4.04 ± 0.68 visits/ h) and final stage (3.00 ± 1.09 visits/ h) (Figures 3 & 4).The day wise activity during the nest construction period clearly indicated that nest visitation rate/ hour were progressively higher on 2nd, 4th and 5th day of nest construction period. Thereafter, the nest visitation rate by the adult bird were little slower upto 9th day but later they again established their maximum participation on 10th day in respect to complete the nest for egg laying.

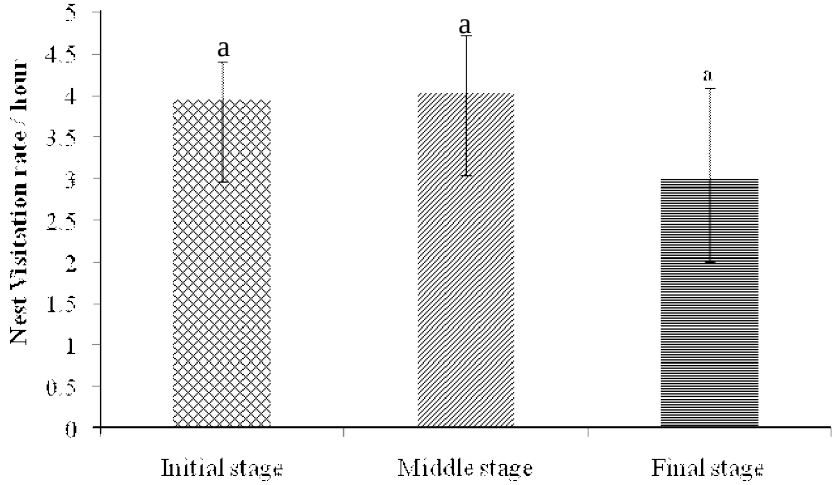

Figure 3. Nest visitation rate (visits/h) of adults during nest construction period (initial, middle and final stages). ANOVA summary: $F_{2, 11}$ = 0.53, $p > 0.05$. Means bearing the same letter are not significantly different from each other at $p < 0.05$ (based on Duncan's multiple-range test).

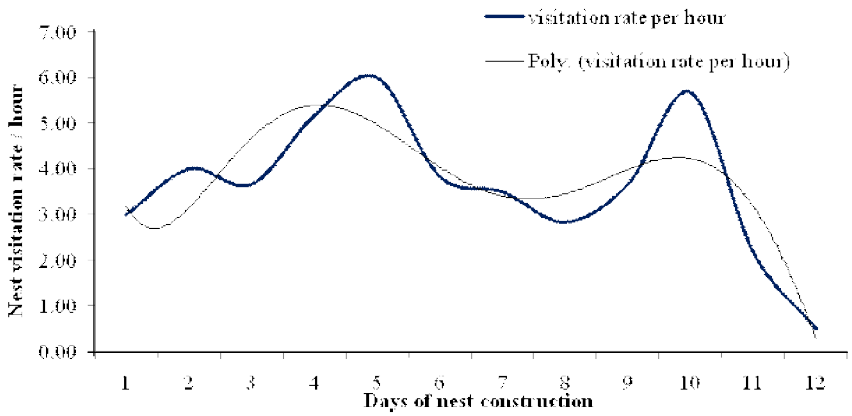

Figure 4. Nest visitation rate (visits/h) of adults during nest construction days at Ratanpur, Chhattisgarh.

Nest morphometry:

Figure 5a depicts the box plot of the weight of the nest. For the weight of the nest, the 25th and 75th percentiles were 180.32 and 205.85 (g), respectively. The median value and H-spread (75th-25th percentile) were 186.95 and 25.53g, respectively. Figure 5b shows the box plot of the length, breadth, depth and circumference of the nests. For the length of the nest, the 25th and 75th percentiles were 29.7 and 30.6 (cm), respectively. The median value and H-spread for the length were 30.5 and 0.9 (cm), respectively. The 25th and 75th percentiles for the breadth were 21.5 and 23.3 (cm), respectively. The median value and H-spread for the breadth were 22.6 and 1.7 (cm), respectively. The 25th and 75th percentiles for the depth were 2.5 and 3.4 (cm), respectively. The median value and H-spread for the depth were 2.5 and 0.9 (cm), respectively. For the circumference of the nest, the 25th and 75th percentiles were 4.4 and 4.8 (cm), respectively. The median value and H-spread were 4.5 and 0.4 (cm), respectively. The lower and upper whiskers indicated the minimum and the maximum value of the data, respectively (Figure 5a-b). The weight of the nests (n=05) was recorded to be in the range of 175.54 – 238.51 g (197.43 ± 11.48), length was 27.5 – 32.3 cm (30.12 ± 0.78), breadth was 19.8 – 24.3 cm (22.28± 0.76), depth was 2.2 – 3.5 cm (2.82 ± 0.26) and circumference was 78.4 – 87 cm (83.68 ± 1.62) (Table 3).

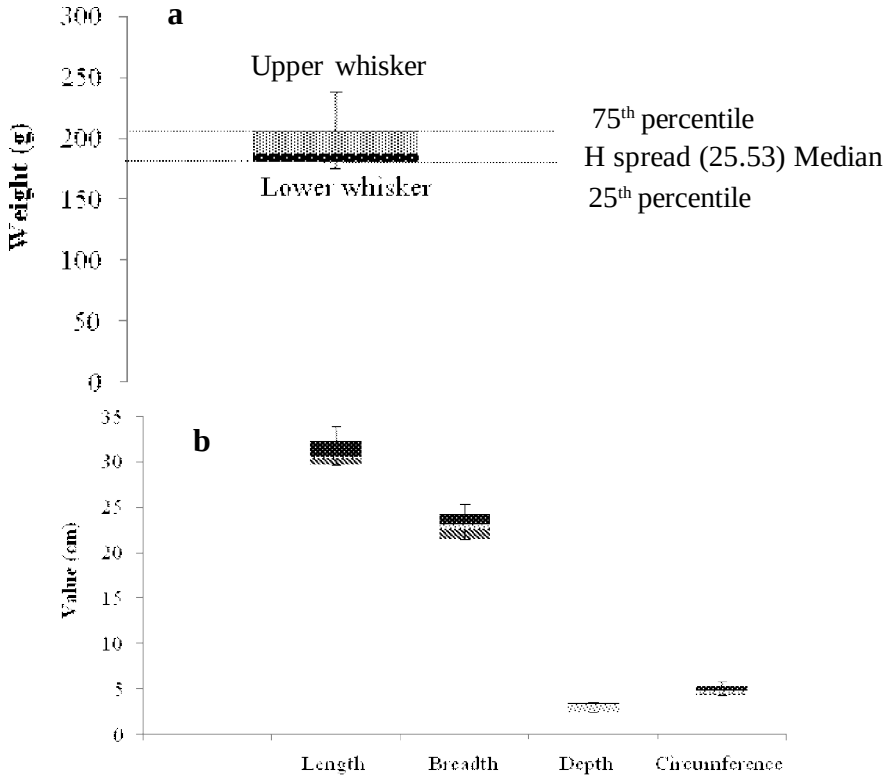

Figure 5. (a) Weight; (b) length, breadth, depth & circumference of the nest.

Table-3. Descriptive statistics for morphometric measurements of the nests (n= 05) of Indian Pond Heron, *Ardeola grayii* at Ratanpur, Chhattisgarh.

Variable	Mean ± SE	Median	Mode	Mini.	Maxi.	Range
Weight (g)	197.43 ± 11.48	186.95	-	175.54	238.51	62.97
Length (cm)	30.12 ± 0.78	30.5	-	27.5	32.3	4.8
Breadth (cm)	22.28± 0.76	22.6	-	19.8	24.3	4.5
Depth (cm)	2.82 ± 0.26	2.5	2.5	2.2	3.5	1.3
Circumferenc (cm)	83.68 ± 1.62	84	87	78.4	87	8.6

Nest composition:

The nests were simple and untidy receptacle of different parts of plants present in the vicinity of nesting site. The nests were made up of dry sticks and twigs of *Aegle marmelos* (Bael) Femily- Rutaceae, *Ficus religiosa* (Peepal) Femily- Moraceae, *Mangifera indica* (Mango) Femily-Adiaceae, *Pongamia pinnata* (Karanj) Femily-Fabaceae, *Tamarindus indica* (Emli) Femily-Fabaceae, *Acacia nilotica* (Babool) Femily- Fabaceae and *Cassia tora* (Charoutha) Femily-Fabaceae, dry leaves of *Dendrocalamus strictus* (Bamboo) Femily- Poaceae and *Ficus religiosa* (Peepal) Femily- Moraceae and dry Seeds of *Pongamia pinnata* (Karanj) Femily-Fabaceae.

The percentage contribution of various plant components of the nests were 2.90 % *Aegle marmelos;* 17.57% *Azadirachta indica; 3.11% Dendrocalamus strictus; 19.26% Ficus religiosa; 9.31% Mangifera indica; 6.1% Pongamia pinnata; 12.15% Tamarindus indica;* 19.03% *Vachellia nilotica sticks*; 1.77% *Cassia tora* twigs; 1.40% dry leaves of *Dendrocalamus strictus*; 2.93% dry leaves of *Ficus religiosa*; and 4.35% dry Seeds of *Pongamia pinnata*. 89.54% parts of nest were formed by dry sticks, 1.77% of dry twig, 4.33% of dry leaves and 4.35% of dry seeds of plants. *Ficus religiosa and Acacia nilotica* stick had 100 percent occurrence and found in all observed nest. This is followed by sticks of *Azadirachta indica, Tamarindus indica* (Table 4).

Table-4. Details of nesting materials used in the nests (n = 05) of Indian Pond Heron, *Ardeola grayii* at Ratanpur, Chhattisgarh.

S. No.	Name	Plant parts	Weight of nesting materials in each nest					Total weight	% Contri-bution	% Occur-rence
			1	2	3	4	5			
1.	*Aegle marmelos*	Sticks	28.72	-	-	-	-	28.72	2.90	20
2.	*Azadirachta indica*	Sticks	-	29.19	52.81	47.29	44.17	173.46	17.57	80
3.	*Cassia tora*	twig	-	-	-	17.48	-	17.48	1.77	20
4.	*Dendrocalamus strictus*	Sticks		30.78				30.78	3.11	20
		leaves	-	-	-	-	13.88	13.88	1.40	20
5.	*Ficus religiosa*	Sticks	31.52	41.55	20.93	20.93	27.85	190.19	19.26	100
		leaves	-	-	28.95	-	-	28.95	2.93	20
6.	*Mangifera indica*	Sticks	-	-	-	31.12	60.82	91.94	9.31	40
7.	*Pongamia pinnata*	Sticks	32.64	27.38	-	-	-	60.02	6.1	40
		Seeds	29.55	13.42	-	-	-	42.97	4.35	40
8.	*Tamarindus indica*	Sticks	30.98	-	31.32	25.77	32.87	120.94	12.15	80
9.	*Acacia nilotica*	Sticks	26.91	33.22	24.43	44.36	58.92	187.84	19.03	100
		Total	180.32	175.54	205.85	186.95	238.51	987.17		

A typical nest of the Indian Pond Heron, *Ardeola grayii*, was studied to be simple, single as well as less colonial and untidy platform of loosely packed twigs, sticks, dry leaves and dry seeds of the number of plants that are present in the vicinity of the study site at Ratanpur, Chhattisgarh. Its nest looks like in appearance with the nest of Dove[4] or the Crow[40]. The Indian pond heron built their nest in the trees where little egret (*Egretta garzetta*) and little cormorants (*Phalacrocorax niger*) built their nest[38]. Colonial nesting is an advantageous against predation[6] and act as an information centre[43]. It is also advantageous in selection of suitable partners by increasing the choice available in species, which probably take new partner every year[19]. The avian nest shows great diversity in their shape, size, structure, nesting materials, nest planning, nesting site and even nesting tree, etc.[36]. Nest formation and placement are associated with the reproductive season, appropriate nesting sites, accessibility of nesting materials, availability of foodstuff and interaction of predators[11,25,33]. For reproductive success, it is essential to choose the safe nesting site that reduces the predation pressure. In this context the height of the nesting site from the ground also influence the predation rate[27]. Many ornithologists[2,7,8] suggested that the nest site selection and nest characteristics are influence the reproductive success of the wild bird. Ajitha and Jose[1] reported that the nesting tree, nesting tree features such as size, height, canopy, number of branches along with availability of nesting materials and food materials are the major factors that attract the bird to the nesting site. The result of present study revealed that this avian fauna have chosen the top branches of the large trees. Commonly tree-forks were the desired sites for the construction of nest. The nest height is found to vary widely between 2 and 10 meter above the land surface on isolated trees[4,15] or between 9 to 10 meters above the ground[6]. Yesmin *et al*.[44] reported that the height of nesting trees was considerably less when birds are in captivity. In the present study *Dendrocalamus strictus, Pithecellobium dulce, Pongamia pinnata, Ficus religiosa* and *Azadirachta indica* were preferred for nesting with higher frequency of *Azadirachta indica* (33.33%) while *Pithecellobium dulce* (11.49%) was less used. Maximum use of *Azadirachta indica* may be due to its microbicidal activity and suitability for this type of nest construction. Seedikkoya *et al*.[40] reported that the *Bambusa longispiculata* and *Mangifera indica* were the main nesting trees in Kerala. The purpose of bamboo (*Dendrocalamus strictus*) not only for nesting but also as food resources or accessibility of invertibrates and escape cover[41]. A variety of local trees consisting of *Azadirachta indica, Ficus religiosa, Pongamia pinnata, Pithecellobium dulce,* etc. were also occupied by several heronary birds during breeding season. Hilaluddin *et al*.[18], Raval[36], Das *et al*.[10] and Joshi[22] reported similar results.

In the present study the nests were made up of sticks and twigs of plants viz., *Azadirachta indica, Vachellia nilotica, Aegle marmelos, Tamarindus indica, Pongamia pinnata, Ficus religiosa, Mangifera indica, Cassia tora* and dry leaves of *Dendrocalamus strictus* and *Ficus religiosa* and dry seeds of *Pongamia pinnata.* The bird used maximally the dry sticks of *Ficus religiosa, Acacia*

nilotica, Azadirachta indica, Tamarindus indica, Mangifera indica, Pongamia pinnata, Dendrocalamus strictus, Aegle marmelos and minimally *Cassia tora* twig, dry leaves of *Dendrocalamus strictus* and *Ficus religiosa* and dry seeds of *Pongamia pinnata*. The use of similar nesting materials were reported by number of investigators[12,21,39,40]. Seedikkoya *et al*.[40] reported that the nesting materials chiefly were small sticks of *Mangifera indica* , *Tamarindus indica*, *Aegle marmelos* and leaves of *Bambusa longispiculata*. The use of completely dried plant part in the construction of nest is an advantageous act that may protect the nest from the pathogens or microorganisms. Most of the nesting materials were presents near the nesting site and the daytime roosting site. It elucidate that the Indian Pond Heron, Ardeola grayii, has developed a great capability to use local resources in nest constructions. Therefore, wide feeding ground is essential for breeding success of members of Ciconiiforms[24].

Seedikkoya *et al*.[40] reported that the Indian Pond Heron breeds from April to September depending on the monsoon and if summer rain begins earlier, they started reproduction before time. In the present study, the nests were constructed in the month of late May to early June. The average period used for the complete construction of nest in the present study 10 ± 1.63days. Similar finding of the 7-14 days construction periods were reported by Jaman *et al*.[21]. However, Seedikkoya *et al*.[39] and Fazili[13] reported that the nest was constructed within a week (5-7 days). The weight of the nests (n=05) was recorded to be in the range of 175.54 – 238.51 g (197.43 ± 11.48), length was 27.5 – 32.3 cm (30.12 ± 0.78), breadth was 19.8 – 24.3 cm (22.28± 0.76), depth was 2.2 – 3.5 cm (2.82 ± 0.26) and circumference was 78.4 – 87 cm (83.68 ± 1.62) (Table 3). Seedikkoya *et al*.[39] reported the quite higher mean value of length, breadth, depth and weight which were 33.58 cm, 7.94 cm, 2.82 cm and 247 g respectively.

In *Ardeola grayii*, both the sexes shared and worked hard in building their nest but the female pond heron was more active than the male[20]. In this study, the adult's visitation rate in the nest was higher during initial stage (3.96 ± 0.45 visits/h), middle (4.04 ± 0.68 visits/h) and lower in final stage (3.00 ± 1.09 visits/h). No data on visitation rate at the time of nest building are available for Indian Pond Heron, *Ardeola grayii*, for comparison. However, Kankariya,[23] studied on nesting behaviour of house swift, *Apus affinis* and found that a significant difference was validated in the adult's visitation rate to the nest at different stages (*i.e.* initial, middle and final) during the nest construction.

The, *Ardeola grayii* preferred various types of dry sticks and twigs as nesting material, which are available on their surrounding area. The nests of Indian Pond Herons were small and made up of loosely set dry soft twigs and its appearance like that of a crow. Ali and Ripley[4] illustrated the nest of Pond Heron as a messy arrangement of twigs to some extent considerable than a dove's nest. Indian Pond Heron's nest reported as quite flat with devoid of middle lining[17]. Taylor[42] explored the nest of Chinese Pond Heron as a scanty structure of small branches in tops of elevated trees. Yesmin *et al*.[44] studied the nesting activity of Pond Heron in

captivity and found that the birds used dry small branches and petiole of leaves of diverse number of trees for the preparation of nest.

This wading bird prefers the nesting area adjacent to the human settlements, close to the pond and other water resources for finding foodstuff without any difficulties. They have chosen the top branches of the large trees. Commonly tree-forks were the desired sites for the construction of nest. Nesting materials were mainly small sticks of *Mangifera indica*, *Tamarindus indica*, *Aegle marmelos* and dry leaves of *Dendrocalamus strictus*. Most of the nesting materials were from the surrounding area of the nesting sites[21]. This study clear indicated that *Ardeola grayii* mostly prefer the trees for nesting purposes which are present along the road side as compared to the trees surrounded between the community area.

This heron species is an important biological component to maintain the food chain, ecosystem and can help to control the insect in the agricultural fields. The time required for nest building was 10 days. The nest visitation for the constructions of nest could be on explain that the breeding period of the Indian Pond Heron, *Ardeola grayii*, was about to happen. *Ardeola grayii*, builds their nest with the height of the tree or they shows colonial nesting form with same as well as alike to the other species which deals the social behaviour, surviving and defensive ideas among various situations. They mainly make their nests near daytime roosting areas and near human settlement in rural areas. But unfortunately the human activities are the main threat, such as cutting of roosting and nesting trees, destroying the nest and egg, catching young animals, illegal hunting as game bird and industrialization. In Ratanpur area these avian species are illegal catching by hunters for flesh and shelling purposes, especially during the monsoon which is the breeding season of this bird leads the dangerous situation for the existence of this avian species. Therefore, the study of nesting behavior has vital for the protection and management of the Indian Pond Heron, *Ardeola grayii* at Ratanpur area which harbors various avian fauna along with their suitable habitat or ecological conditions. Consequently, additional inclusive exploration on these aspects is advantageous.

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