

**NESTING PATTERN AND BREEDING BEHAVIOUR OF SPOT-BILLED PELICAN
(*PELECANUS PHILIPPENSIS*) IN KOKKARE BELLUR, MANDYA DISTRICT,
KARNATAKA, INDIA**

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ABSTRACT

In the present study, the nesting pattern and breeding behaviour of the Spot-billed Pelican (*Pelecanus philippensis* listed as endangered) was studied in Kokkare Bellur, Mandya district, Karnataka, the southern India during 2018 to 2020. The study area, Kokkare Bellur which is commonly known as “stork village” situated (12°13'N, 77°0'E) in Maddur taluk, Mandya district in southern part of India in the Karnataka state. Kokkare Bellur is a community biological reserve where there is harmonious relationship between man and birds. Intensive survey was carried-out in different locales of bird habitation at study area. The Spot-billed Pelicans were distributed in selected trees like, Tamarind tree, Banyan tree, Acacia tree, Portia tree respectively. The colonies were in close proximity and vicinity of the human settlements at village and close to roads. Very nearly, 85-90% of the breeding sites of pelicans in the trees, along the side of river Shimsha, dense area of biodiversity regions followed by the private growing near to their village houses or at the backyard, rest of them are in protected areas are observed. The nearest water source to the colony ranged from 1 km to 10 km; while the nearest foraging ground was from 5 km to 50 km. Over all in southern India, almost 75-80% of nests were built on the top canopy of the tree. The Spot-billed Pelican breeds between November and April at the Kokkare Bellur. Soon after few days of arrival, pelicans perform courtship display, form pairs, start nest construction and lay eggs. The courtship display is not as attractive and impressive as in other water birds. The clutch size varies from two to three eggs and the incubation period from 25 to 35 days. The fledgling period varies from a minimum of 90 to a maximum of 105 days. The nest success rate of the Spot-billed Pelican at Kokkare Bellur was 85.56% during the study period. The growth pattern after the birth of spot-billed pelican was constructively analysed by measuring the different parts of body taking 3 days as interval for 90 days in their nestlings. The data of the study was statistically analysed using Correlation coefficient approach. The correlation coefficient can be assessed by characterization, which is theoretically assuming any value in the interval between the range 0 to +1 (or) 0 to -1.

*Correlation is significant at the 0.05 level (2-tailed). Correlation is significant at the 0.01 level (2-tailed). Correlation coefficient (r) in independent value on days of growth vs dependant on Number of nestlings, Weight, Head Length, Bill Length, Bill Depth, Wing Length, Wing Span, Tarsus Length, Tail Length, Pouch, Body Length, Webbed feet. The nestling growth pattern was analysed which shows the number of days it requires to develop the morphological characters. The tall trees of the village (*Ficus religiosa*, *Ficus bengalensis*, *Tamarindus indica*, *Acacia*

nilotica, Thespecia populnea) has provided safe and suitable place for spot-billed pelicans to build their nest to carry out feeding behaviour. In all, the nestling growth pattern help in understanding the morphological characters of Pelicans in the Kokkare Bellur area. The bird community will grow at large by predominantly opting different tree species adjoining the village in two tier format through nesting, breeding and foraging performance thereby; preventing as sort of human activities. In addition, the village community in Kokkare Bellur plays an imperative role in providing suitable habitation for nestling growth pattern and breeding behaviour respectively.

Key Words: Nestling, Breeding pattern, Correlation coefficient, Spot-billed Pelican, Kokkare Bellur

INTRODUCTION

Many bird species cumulated for feeding, roosting and nesting activities, which are prevalent among other category of birds. But, the formation of breeding colonies by animals form is a major unresolved interrogation in the evolutionary biology. The topic continues to stir lively debate (Weins 1992; Danchin & Wagner 1997; Tella *et al.*, 1998) and has been the focus of long term studies (Hoogland 1995; Brown & Brown 1986, 1987, 1988; Danchin *et al.*, 1998). One of the principal issues has been whether colonies form due to limited breeding habitat; with animals forced into nesting aggregations at a net cost, or result from social benefits of clustering (Food finding, reduced predation; Lack 1968; Alexander 1974; Hoogland & Sherman 1976; Wittenberger 1981).

The expressions of nesting and breeding studies were found to be most significant in order to balance the ecology and its ornithological associations. One such area has been focussed exclusively due its superlative historical perspective of eco-ornithological characteristics at the unique habitations i.e., Pelican Reserve area, Kokkare Bellur (PRKB). Since, more than 500 years the village of Kokkare bellur (PRKB) has been shared by birds and human beings living in Symbiosis. The tall trees in village (*Ficus bengalensis*, *Ficus religiosa*, *Tamarindus indica*, *Thespecia populnea*, *Acacia nilotica*) have provided a safe place for spot-billed pelicans to build their nests. In turn, the fish diet of breeding birds has repaid the villagers with a potassium and phosphate rich source of manure for their crops, but now this centuries-old pattern of harmony between avian visitors and their human the hosts are badly shattered and the pelicans' survival is in danger.

About the Spot-billed Pelican

Pelicans are colonial birds. Of the seven species of pelicans in the world, the spot-billed pelican (*Pelecanus philippensis*) and the Pink-backed pelican (*Pelecanus rufescens*) are the tree nesting species, all the other five species are ground nesters (Del Hoyo *et al.*, 1992) among, the seven species, two are found breeding in India. They are the spot-billed pelican and the Great White Pelican (*Pelecanus onocrotalus*). The first is the globally threatened pelican in the world (Ali, 1960). Historically, the spot-billed pelican was common across much of South Asia and has been reported from China, Pakistan, India, Nepal, Bangladesh, Sri Lanka, Myanmar, Vietnam, Laos,

Thailand, Malaysia, Hong Kong and Taiwan. It has undergone a widespread decline in the recent past (Bird Life International, 200& 2001).



Fig. 1 Pelican at Kokkare Bellur Village Fig. 2 Pelican in intermittent approach

In India, the strongholds of the species are in Northeast India (Assam) and southern India (Andhra Pradesh, Karnataka and Tamil Nadu). The breeding of the spot-billed pelican in the Indian Subcontinent was unknown for a very long time (Fig. 1&2). The first record was by Jerdon (1877), in the ‘Carnatic’ in southern India.

The survey was attempted to assess the nesting colonies and studied the nesting practices of spot-billed pelican during the nesting season in southern India. In addition, an intensive study was undertaken at the nesting colonies at Kokkare-Bellur in Karnataka in Mandya district, Karnataka. The study on the vegetation structure and other habitat parameters were associated with the colonies. Besides, the critical analysis was made on whether the nest trees differed from other parameters with respect to their structure and what features of the nesting trees and surrounding environment were important in determining the number of pelicans in the colony.

The nesting patterns and Colonial approach

The nesting patterns in birds ranges from widely spaced solitary nesters to densely packed colonies of hundreds of individuals. Colonial nesting occurs in 29 of the 129 avian families (Lack, 1968). Colonial nesting is an important feature among a majority of the members of the Pelicaniformes and the nesting colonies of these birds species that represent spatial and temporal clumping of nests are popularly referred to as Heronries. Largely, birds that nest and roost colonially are particularly affected by local conditions and by their concentrated numbers, can themselves particularly impact both natural and human environments. At the same time, colonial behaviour permits the construction of common conservation principles and similar best management actions for a group of species. Maintaining populations of colonially-nesting aquatic birds at levels required for their long term conservation therefore; depends on inventory, monitoring, management action, and coordinated planning on a regional, national and international scale (Ali & Ripley 1987; Burger, 1988).

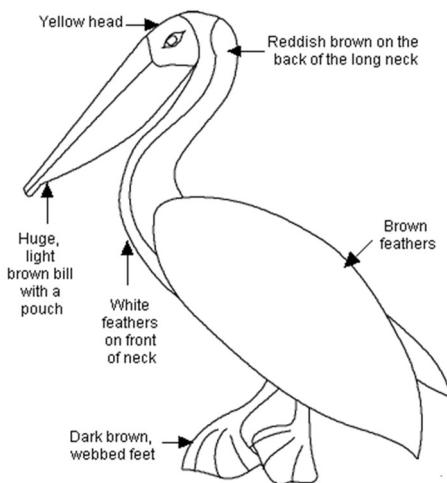


Fig.3 Showing Pelican schematic approach

Colonial nesting is an imperative feature among a majority of the members of Pelicaniformes. The nesting colonies of these birds that represent spatial and sequential clumping of nests are popularly referred to as heronries. One of the prevalent heronries in India is located in the Kokkare Bellur of Karnataka state along the southern regions of India. The brown Pelicans require secure night roosts (place to stay) and loafing (be unoccupied) sites where they can dry and preen their plumage after feeding because their feathers become water-logged (Fig. 3). In Kokkare Bellur, the brown Pelicans gather in roosts on sandy land mass, exposed diversity, and a few artificial structures in the village area encompassed by forest department, Spot-Billed Pelican harbour, and small water streams followed by rock-strewn regions coupled with Shimsha river basin of the total habitation.

Breeding Behaviour

The Spot-billed Pelican breeds usually between November and April. A few days after their arrival in their respective destinies, pelicans perform courtship display, form pairs, start nest construction and lay eggs. Courtship display is not as attractive and impressive as in other water birds. The clutch size varies from two to three eggs and the incubation period from 25 to 36 days. The fledgling period varies from a minimum of 90 to a maximum of 102 days. The nest success rate of the Spot-billed Pelican will be 90.28% during the breeding period. In general, there has been no quantified account of breeding success, a key variable in demographic studies, of Spot-billed Pelican in India.

The Spot-billed Pelican starts nest building largely after courtship. It is initiated by the collection of nest material, mainly small branches. Mating was also noticed during the collection of nest material and in some cases even after nest construction. Both sexes share nest building activities (Fig.4). However, the male largely collects the nest material and the female receives and aligns the material for nesting. Nest construction is undertaken by both members of the pair as reported elsewhere (Nagulu, 1983; Nagulu and Rao, 1990).

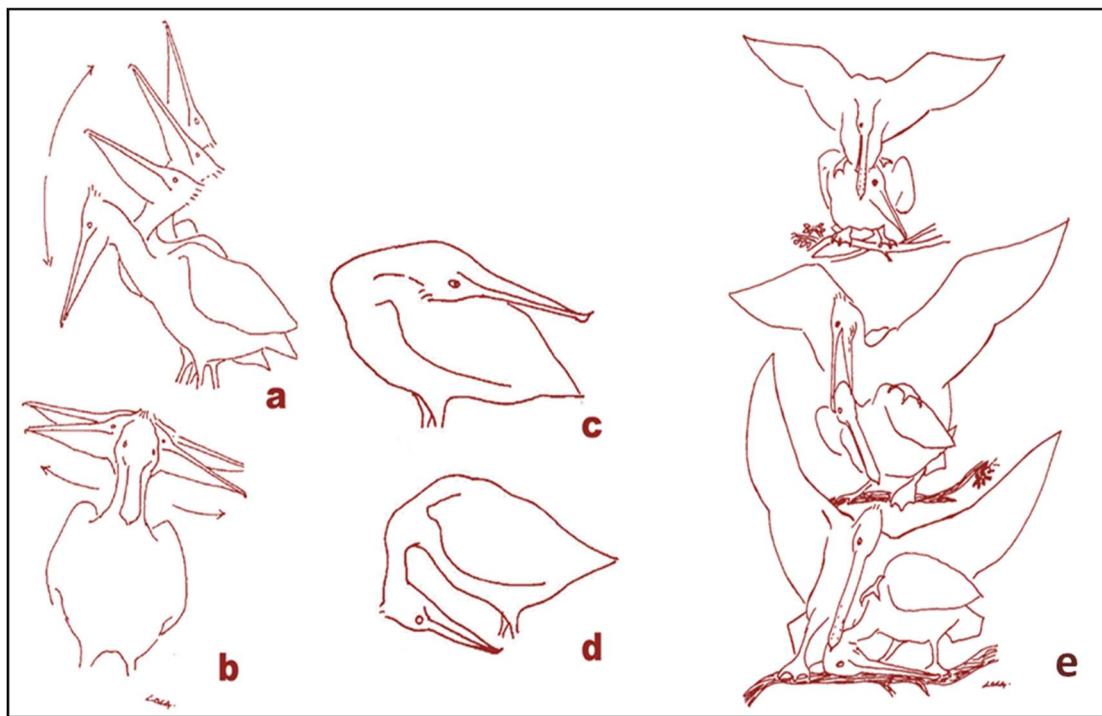


Fig. 4. Display behaviour shown by Spot-billed Pelican.
(a) Head swaying up and down, (b) Head sway-lateral, (c) Head throwing, (d) bowing.
(e) Mating sequences of Spot-billed Pelican

The Spot-billed Pelican lays its first egg 5–10 days after nest construction, with clutch sizes varying from two to three eggs. Further, the Spot-billed Pelican starts incubation as soon as the first egg is laid (Nagulu, 1983). Both sexes share the incubation; however, incubation by females predominates. Both sexes contribute to “domestic duties” during nesting (Lamba, 1963). The incubation period varied from a minimum of 25 days to a maximum of 36 days. Hatching of the first egg starts after an average of 30 days. Newly hatched birds are altricial, *i.e.*, born naked with red flesh. The fledgling period continues from a minimum of 90 days to a maximum of 102 days (Fig. 4).

The young birds start moving, perching and standing only after 30 days (Talukdar, 1995). Typically, the Spot-billed Pelican feeds its young in three ways. After a few days of hatching, the adults give a pre-digested liquid diet to their chicks. Adults drip this pre-digested liquid through the mandibles and right to the mouth of the young. After 7–10 days, the adult, by standing in front of the young, vigorously shakes its neck and regurgitates the food onto the nest. The young pick up this food and eat it bit by bit by seriously tossing or jerking their mandibles. After 30 days, the young are very much capable to draw the food straight from the gullet of the parent by inserting their mandibles up to the neck into the adults’ mouth. Up to 30 days, adults feed their young largely 3–7 times a day and gradually reduce the frequency (Fig. 4).

The Pelicans distributed in southern and north-eastern regions of India with concentrations in Andhra Pradesh, Tamil Nadu, Karnataka and Assam states (Bird Life International, 2001, 2011).

Although observations of a natural history of breeding of the Spot-billed Pelican have been reported from various sites in India, only few specific reports are available on the exploration of breeding biology of this pelican in detail in India (Campbell, 1902; Rhenius, 1907; Neelakandan, 1949; Gee, 1960; Ganguli, 1964; Johnson, 1971; Venkatraman, 1996; Taher, 2007). In addition, there has been no quantified account of breeding success, a key variable in demographic studies, of Spot-billed Pelican in India. Therefore, an attempt was made to document the breeding biology of the Spot-billed Pelican from September 2017 to September 2019 in the PRKB Bird Sanctuary, Karnataka, India.

On the other hand, no proper studies have been reported on their characteristic migration, nesting process and its success degree of the Spot-billed Pelican. However, breeding success will be depending on the proper nesting approach as it is observed that nesting will be constrained largely by river floods, high velocity wind force, cyclones which can lead to felling of nest and nesting trees at Kokkare Bellur, Karnataka, India (Santharam, 1993; Narasimhulu, 1995).

Growth pattern in birds

Growth pattern in birds has recently received considerable attention and the studies of various species exist, and their implications relative to clutch size and growth rate have been thoroughly reviewed by Ricklefs (1968, 1972, 1974). Because of the wealth of weight data available, Ricklefs used weight as the standard for analysis. Le Croy and Le Croy (1974) present a detailed study of four years of growth in common Terns (*Sterna hirundo*) and elucidate the complicated interactions of different growth parameters especially in regarding weight and wing length as means of aging nestlings.

Growth data of nestling seasons of brown Pelicans (*Pelecanus occidentalis*) helps to determine the age and growth of parameters of this species. It assesses to examine weight and other characters such as bill, wing and tarsus lengths as a measure of growth of this species. Growth pattern determines if external measurements demonstrate the physical condition of the individual bird and to use these external measurements as an indication of the age of the nestlings and thus be able to determine the seasonal ability of breeding by sampling once or twice during the season. This is important to since access to breeding colonies is often difficult, either because of time constraints or the inaccessibility of the colony, and because disturbance of the colony causes undue mortality (Schreiber and Risebrough, 1972).

Nestling growth variability has largely been studied looking at effects on individual fitness of offspring and parents (e.g., Murphy 1983, Magrath 1991, Halupka 1998). Differences between populations can manifest as morphological differences or differential timing in the growth and maturation of certain body components (Murphy 1983, Burns 1993). However, the growth rate of a single species throughout its entire range can sometimes vary little (King and Hubbard 1981, Murphy 1983, Pereyra and Morton 2001) In nestling growth patterns, each body component can begin growth at a different point in time relative to other components, resulting in a staggered growth pattern. Specific patterns in this type of growth are generally adaptations for nest survival. Growth pattern helps to understand the different morphological characters that develop within them.

THE STUDY AREA

Kokkare Bellur commonly known as “stork village” situated ($12^{\circ}13'N$, $77^{\circ}0'E$) in Maddur taluk, Mandya district in southern part of India in the Karnataka state. The study area is a dry area with cultivated agricultural fields, with different kinds of trees in and around the surrounding regions of the village. The annual rainfall is 525 mm with an average altitude of about 850msl (Fig. 5).

Kokkare Bellur is not a reserve forest sanctuary but it is declared Community Reserve by Wild life range, Melukote, Mysore wild life division as the community plays an very significant role in conserving the threatened species Spot-Billed Pelican as well as Painted stork. In this way several efforts taken by the community to conserve these species has been considered as role model for replication at other places.

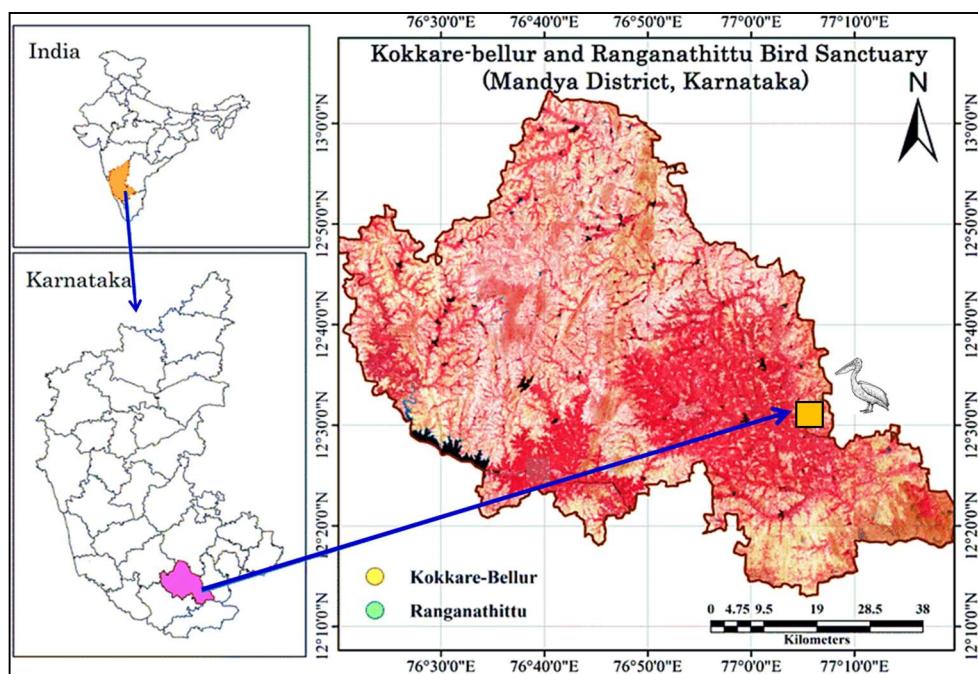


Fig.5 Geographical location of Study area: Kokkare-Belluru, Karnataka, India

Kokkare Bellur is typically combination of drylands and wetlands with the perennial river Shimsha flowing towards the south. However from November to July; the village transforms into a spectacle as they prepare for the arrival of rare migratory birds, specifically Spot-billed Pelicans and Painted Stork who set up their nests on the backyard trees of the village homes. Other local birds include cormorants, egrets, black ibis, white ibis and pond heron. This is rare, unusual and mysterious phenomena which have been occurring for several hundred years. Hence Kokkare Bellur is a community biological reserve where there is harmonious relationship between man and birds. Many conservation activities have been initiated by NGO's and government organization. In this regard, Forest department has declared 772 hectare as community reserve hence human activities like deforestation are prohibited in this area in order protect the biodiversity in the given study

area.

METHODOLOGY

The base line survey was comprehensively conducted at different locations of Pelicans Reserve area Kokkare Bellur (PRKB) from 2017 to 2019. During the survey, the technique was used explicitly to evaluate the tree dimensions and the nearest nest-tree distances which were almost same as in the complete study. The regular visits were made to all the Pelicanries (minimum two times) with respect to nestling area of PRKB respectively. The critical analysis was done by taking into two consecutive breeding seasons. Besides, survey of nesting colonies, the nest placement in the upper, middle or lower canopy were recorded respectively (Manakadan, R. and V. Kannan, 2003; Kannan, 2004). The colony surveys were mainly based on the earlier reports and literature surveys. In addition to the surveys, information about new locations of Spot-billed Pelicans was also gathered to know the species colony extension.

At each colony, the nest trees were identified and counted the number of nests in each tree. The tree dimensions were measured including height of the tree from the ground, diameter at breast height (DBH) and canopy area. Height of the tree and height of the nest were estimated visually by comparing known tree height. Canopy spread was determined by measuring the spread from the base of the tree trunk in four directions at right angles to each other. The mean canopy spread was taken as the average of the four radii. The trees containing pelican nests were measured and the dominant vegetation around each nesting tree was also noticed. The distances of other habitat parameters such as nearest house, nearest forest, nearest road, nearest water source and nearest foraging ground from the nest tree were also estimated.

Furthermore, the statistical analysis was executed using T- Tests to assess the significance of differences between nest trees, height of the tree, DBH and canopy area. The data were pooled to find the difference in dimensions of tree and nesting vegetation. The mean height of nests in each tree was divided by the tree height to obtain the nest position by using non-parametric Kruskal-Wallis test to know the relative nest height differed between the colonies (Singha *et al*, 2002). A t-test was used to compare the structure of trees with more (5 nests) or fewer nests (< 5 nests).

Moreover, the assemblage of Spot-billed Pelican nests were noticed on trees in the total habitation of the area and the behaviour of the Spot-billed Pelican from a distance with binoculars and a spotting scope, permitting detailed observations without interrupting the clusters of pelicans. In its entirety, 620 hours were paid out for reviewing the pelicans with respect to nesting and breeding. Methodically, the visible nests along with their contents (eggs/chicks), built in the outermost trees in clusters found in the PRKB total area, were subjected for a systematic study of the breeding biology of the Spot-billed Pelican during the study period.

The eggs lay, hatched and those unsuccessful to hatch were documented in order to calculate rate of nesting success. Generally, gestation can start as soon as the first egg is laid, in which case eggs will hatch asynchronously (one or two days apart); when the clutch is completed, eggs hatch synchronously, or at some point in between. When it comes to the pelican, the incubation starts when the first egg is laid. The fledgling period is typically the time spent in the nest for altricial

species, while birds may be dependent on their parents for a much longer period out of the nest (in some cases several weeks). In the proposed study, the fledgling period of the Spot-billed Pelican was considered the time between the hatching of eggs and the independence of the chicks (leave the parents). Altogether, 112 nests were monitored in the current study: 34 nests in September 2017-June 2018, 52 nests in September 2018-June 19 and 26 nests in September 2019-June 2020. Further, the growth pattern in spot-billed pelican was analyzed by measuring the different parts of body like body weight, head length, bill length, bill depth, wing length, wing span, tarsus length, tail length, pouch, body length, webbed feet taking 3 days as interval for 90 days in their nestlings. The increase in the size as well as length of the body was calculated. The raw data collected was then sent for Harman Institute of Science Education and Research for further statistical analysis. Data were statistically analysis on Correlation coefficient (r) using SPSS ver.20.

RESULTS AND DISCUSSION

The compilation of result data generated through extensive baseline survey conducted at different colonies in Pelican reserve, Kokkare Bellur (PRKB), Mandya district, Karnataka, India. The data was represented in tables, graphs and photographs accomplished during regular surveys. The colonies were distributed in almost all directions of north, east, west and south locales of PRKB respectively. The colonies were intensively located in the close vicinity of village called Kokkare Bellur. The arrival of Spot billed Pelican in PRKB area was timed and the breeding season indicated invariably, they were timed to arrive in October/November and to halt until April/May.

Construction of Nest

Pelican starts constructing nests only after courtship or even after a couple of mating. The vegetation serving for nest material was dry, hard and thorny twigs from the scrub and projections from the nesting trees. The nests were lined with diversified tree vegetation such. In addition, all the colonies were close proximity and vicinity of the human settlements and close to roads (**Table 1**). Almost 33.3 % of the breeding sites of pelicans the trees were belong to the private growing near to their house or at the backyard rest were protected. Around five of the nine colonies were noticed in water tanks and the rest were in the villages. The nearest water source to the colony ranged from 1 km to 20 km; while the nearest foraging ground was from 10 km to 100 km (**Table 1&2**). In PRKB, the distance from a nest tree to the next nearest nest tree was 10 m. The distance from a nest tree to the next nearest nest tree was 5 m and 1.5 m (Kannan and Manakadan, 2005). Interestingly, atypical assertiveness was noticed that, after the chicks are grown to fledgling stage due to their bigger size and non-availability of space to accommodate parent bird and young, the adult birds were using the nearest non-nesting trees for their resting and settling at tree stratum. It was also observed that, the nests of Spot-billed Pelican in seven species of trees, among which the *Barringtonia acutangula* (36%) and *Acacia nilotica* (45%) were most frequently accomplished (**Table 3**). The height of the nests between different colonies was a maximum of 8.6 m and a minimum of 6.2 m was observed in PRKB. Besides, during the study period, (2017-2019), the numbers of nests were recorded at all the different diversity locations of PRKB.

Breeding period and movement

The reasonable part of the Spot-billed Pelican colony arrives at the PRKB area in late November while a considerable number of pelican will arrive in late December. After a few days from their arrival, the pelican starts breeding activities when there are necessary topographical and favorable climatic conditions poised with plentiful water bodies in the study area. On the whole, the breeding season of the Spot-billed Pelican starts in September and ends in May, sometimes, the season may also extend up to June when the arrival of the pelicans is delayed (**Table 4**).

Interestingly, the breeding of the Spot-billed Pelican is reliant on the monsoon time of year and not on the volume of the rainfall. It must be distinguished that the onset of the monsoon mainly determines the arrival of pelicans in PRKB area. The similar trend of breeding attitude in pelicans PRKB was also approached by the previous studies (Kannan, 2007), Talukdar (1994; 1995a; 1995b).

Habitually, the Spot-billed Pelican is a companionable bird, roosting and nesting on trees in great numbers at the breeding sites. On the other hand, among the 220 species of total bird's species anchorages at the PRKB area, fascinatingly, the Spot-billed Pelicans are the prominent arrivals and thus are forced to occupy the remaining tree strata and different vegetative diversity locations reinforced with river Shimsha basin for nesting, settling followed by breeding actions in the PRKB area. Largely thin-canopied trees, present at the periphery of clusters of trees (*Acacia nilotica*) present in the habitation, are often ignored by other bird species and therefore these trees are only occupied by pelicans adjacent to the village population. Sometimes, in a year, the PRKB also harbors both non-breeding (not mature enough to breed) and breeding Spot-billed Pelicans. Although pelicans arrive in large numbers, only a small part of pelicans actually breed (of the 114 individual birds, only 36 bred in 2017–2018, 100 of 265 in 2018–2019 and 112 of 295 in 2019–2020) since pelicans reach maturity only after three years (Sharma and Raghavaiah, 2002).

Sexual dimorphism

Generally, the male pelican grow with a bright yellow skin around its pinkish red eyes. The breeding adults are intensely white with darker grey primaries. Both sexes develop a grey and white mixed crest during the initial period of breeding, which gradually is shed as the breeding advances. The bill of both sexes becomes brilliant yellow and with perceptible dark brownish spots during the breeding season (Fig. 8).

Courtship display and Copulation

After the arrival of Spot-billed Pelican, the colony pay out four to six days to settle down and the birds will realize their nesting trees for breeding activities in the course of these days. Later, Pelican combines to pair after exhibiting few display events in many nesting trees in PRKB area. But, their display is not found to be as striking and exciting compared to other water birds. Pelicans perform their courtship activities only at the top of trees and not in midcourse of air or in water, in contrast to other pelican species. There are some reports on group display of courtship in Great White Pelicans (*P. onocrotalus*) and American White Pelicans (*P. erythrorhynchos*) in comparative analysis (Brown and Urban, 1969; Schaller, 1964). In contrast to this, Spot-billed Pelican have no such displays observed in the PRKB area; as the bill and gular pouch are the prominent display in

the Spot-billed Pelican. Initially, the male pelican swell up its reddish bright gular pouch and wobbles vigorously. After a few seconds, the male swings his head up and down and sideways (Fig. 4a, 4b). In the course of this display, the pelican also throws his bill a few times over the back down to the tail (Fig. 4c). Subsequently, the bird claps his bill loudly in a few seconds by way of swaying the head up and down (Schreiber, 1977). The above typical expressions were not neither displayed nor performed exclusively to attract the opposite sex.

However, the head sways and bill claps are often performed when any intruder nears the pelican or even when in a disturbed state. Further, the head sways and bill claps are the indications of threat to other males or predators besides acting as courtship signals to attract decisive partners. Later, the two opposite sexes of pelicans bow to each other when head sways and bill claps, which indicate as an act of acknowledgement (Fig. 4d). Thereafter, a few males take flight and do some revolving in the air above the nest for a few seconds. The, the partner at the nest performs the head sways, bill claps and bow activities when the male returns to the nest from its rotational flight thereby, the mating occur at the nest just after the courtship displays. On the spur of the moment, the male clamp the neck of his partner between its mandibles mounts her back and keeps his wings spread and outstretched while mating. In a while, the male releases the neck of the female from his mandibles and dismounts, when the mating process is concluded.

Construction of Nest

In the main, after successful accomplishment of courtship processes, the Spot-billed Pelican starts constructing nest essentially. Customarily, both male and female together will take part in nest building activities where it is initiated by the collection of nesting materials like, small twigs, micro branches, leaves and fibre like natural resources. The nests are positioned in a very close vicinity to the adjacent one in such a way that an out-stretched wing can touch the nest of a nearby pelican. The nests are constructed on the top and outer canopy and a minimum of 5 to a maximum of 7 nests are found in a single nest plant (Table 4). Obviously, the mating was also observed in pelican's couple in the course of the gathering of nesting material and intermittently, the courtship has also been noticed even after nest construction. In the nesting processes, the male essentially collects all the nest materials and meanwhile, the female receives the materials and systematically arranges the material for nesting courses (Nagulu, 1983; Nagulu and Rao, 1990). In the procedural way, the nest building is primarily done during the morning hours (07:00–10:00 hours, $n = 68$). The nest material is mainly collected from the ground and alternately from plants and also from older nests (Fig. 6&8).

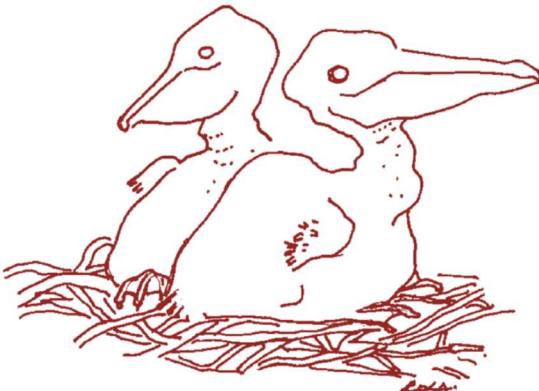


Fig. 6 Chicks of Spot-billed Pelican at Nest

The nesting will always be in inner canopy of the tree to facilitate pelicans for free landing and take-off in order to self-monitoring of their size. During observations, nearly 10–15 nests were recorded in a single tree at PRKB area (Talukdar, 1995a Subramanya and Manu, 1996). The process of nest construction generally ceases in early December; however a few pelicans group also take part in nesting during February 2018 due to their late arrival. Initially, the nests look arranged with a loose knot, later it becomes strong enough to hold two adult birds by supplementing with a lining of fresh vegetation in the nest.

The interesting fact, that, the individual birds have a tendency to nest in the same place in the tree canopy each year, even though the new locations within the canopy and new trees are chosen occasionally (Subramanya and Manu, 1996). Although nests are found in the same place every year, it is difficult to identify that if the same individual birds are involved or not, but nest site fidelity may not be governed. In PRKB area, it was also noticed that, the Spot-billed Pelican often nest beside the Painted Stork (*Mycteria leucocephala*) (Abraham, 1973; Talukdar, 1995b) or the Lesser Adjutant (*Leptoptilos javanicus*). In some similar area, the colonies are again mixed with adjutants and other storks followed by the Painted Stork and Asian Openbill-stork (*Anastomus oscitans*) shared the nest trees with the Spot-billed Pelican. (Parr *et al.*, 1996).

Egg laying process in Pelicans

Normally, the Spot-billed Pelican lays its first egg 6 to 12 days after nest construction, with clutch sizes varying from two to three eggs (Table 4). In the PRKB area, the clutch invariably contained four-five eggs in about seven days, although there was presumably some undetected variation (Rao, 1986; del Hoyo *et al.*, 1992). The eggs are laid at a minimum of two- to three- day intervals (mean = 2.04, SD = 0.4) at the PRKB regions. The pelicans are not precisely aggressive against predators and thus they do leave the nest when any bird of prey approaches their nests (Fig. 8).

Incubation period

The incubation period will start when the first egg is laid and both male and female share the responsibility of incubation processes but, it will be predominated by female (Nagulu, 1983). The incubation period varied from a minimum of 26 days to a maximum of 38 days (Table 2). The

adult bird puffs its wings to fully cover the entire nest and performs no activities in incubation. In some cases, analogous incubation periods (30–36 days) have also been reported (Nagulu, 1983; Rao, 1986; del Hoyo *et al.*, 1992).

Fledgling period in pelicans

The hatching process can be seen after an average of 35 days and the newly hatched bird young ones are altricial and appear as naked with red flesh (Fig. 4). However, the fledgling period carry on from a minimum of 90 days to a maximum of 102 days (Table 4). Further, the young birds start moving, perching and standing only after 30 days. Unfortunately, no adults will show any interest to rescue the chicks in the act of frequent fall from the nest. As a result of this nonsignificant event, few young birds are able to regain the nest and die in the ground or water. Therefore, during the study period, 11 chicks were lost their life due to such occurrences (4 in 2017–2018, 3 in 2018–2019 and 4 in 2019–2020) respectively.

The adult pelican basically try to escape when any intruder nears the nest rather than showing any aggression. Adults remain in the nest up to a maximum of 15 days after hatching; after that, they remain outside the nest to safeguard the young for about a further maximum of 19 days. Thus, the adults are rarely seen in the nest after 30 days of hatching and adults visit explicitly to the nest only during delivery of food to the young bird. When the young are 30–36 days old, they do not remain in the nest and dismantle it by pulling out the sticks from the nest. The young remain perching on the branches till they finally take off. At the end of the breeding season, it is very difficult to locate even the rudiments of nests on the tree and one finds on the ground, under the nesting tree, heaps of fallen white sticks Nagulu (1983), del Hoyo *et al.* (1992) and Talukdar (1995).

Feeding the young Pelican bird

Typically, the adult Pelican feeds its young one in three ways, after a few days of hatching, the adults will give a pre-digested liquid diet to their chicks. Then, the adults drip this predigested liquid through the mandibles and right to the mouth of the young. The adult, by standing in front of the young birds after 6–12 days and dynamically shakes its neck and bring up the food on the nest. The young pick up this food and eat it bit by bit by seriously tossing or jerking their mandibles. Further, the young are very much capable after 30 days, to draw the food straight from the gullet of the parent by inserting their mandibles up to the neck into the adults' mouth (Fig. 7). The feeding habit of Pelicans to their young birds *i.e.*, 3–7 times a day and gradually, the frequency of feeding will be reduced after 30 days.

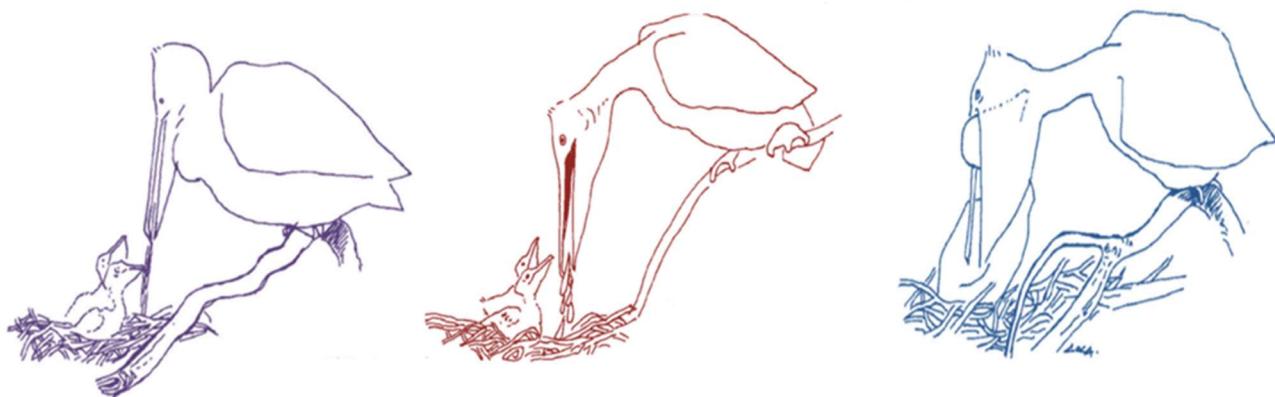


Fig. 7 Different approach of feeding the chicks by Spot-billed Pelican at PRKB, Karnataka
a). Feeding pre-digested liquid diet, **b).** Bring up small fingerlings at Nest, **c).** Young bird picks up food from adult Pelican.

Success rate of Nesting

There are no specific reports available on the Success rate of Nesting of Spot-billed Pelicans. But, the considerable reports are accessible on breeding success that are constrained largely by floods, cyclones and felling of nesting trees (Nagulu, 1983; Santharam, 1993; Narasimhulu, 1995; Talukdar, 1995b). At Kokkare Bellur, India, an average of 1.6 nestlings fledged per nest was observed as compared with the data of other similar studies (Nagulu and Rao, 1990). In the present study, the density status of Pelicans was judged that, the pelicans nesting at PRKB area had a breeding success of 78.5%. During 2019-2020, of the 71 nests studied, the Spot-billed Pelican had a nest success of 89.40% at PRKB was noticed (**Table 4**).

Nesting growth pattern

Further, the nesting growth pattern in spot-billed pelican is analyzed by taking 3 days as interval for period of 90 days. The growth pattern is analyzed by counting total number of nests followed by initial weight of young ones in terms of grams using weighing machine. The key features selected for estimating growth pattern like headlength, bill length, bill depth, wing length, wing span, tarsus length, tail length, pouch, body length as well as webbed feet is measured by using measuring tape in terms of centimeters (Table 5). The difference in rate of growth is also calculated. Some of the important characters are described below:

Body weight: It is the weight of the body of the nestling just after the nestlings taking three days as the interval which was recorded to calculate the rate of growth while being weighed in a polythene bag.

Head Length: It is to measure the distance between the back of the head and to the tip of the bill is termed as the head length.

Bill Length: It is the distance measured from the tip of the lower mandible to the end of the culmen on the forehead is the bill length. It is used to measure the total length of the bill.

Bill Depth: Bill depth is the measure of height of the beak to calculate the distance between the two consecutive beaks *i.e* upper and the lower bill.

Wing Length: Wing length is usually measured from the bend of the wing to tip of the longest feathers.

Wing Span: It is the measure of the distance between one end of the wing tip to the other end of outstretched wing is termed as wing span.

Tarsus Length: Tarsus length is the measure taken from the point of the joint between tibia and metatarsus to the point of joint at the base *i.e* the length of the longest toe to the tip of the claw.

Tail Length: The distance from the tip of the longest portion of tail to the point between the middle part where they emerge from the skin measured is the tail length.

Pouch: It is measure of the distance of fluffy region from tip of beak of one end to the other end.

Body Length: It is the measurement from the tip of the bill to the tip of the longest portion of the body is the body length.

Webbed Feet: It is the measure of distance of fused fingers that is present in both the toes is termed as the webbed feet.

A.



G.Pelican-45 days





H. Pelican- 2.5 Months
1 Year



I. Pelican-3 Months



J. Pelican-



K. Adult Male Pelican
Year Adult



L. Adult Female Pelican



M. Pelican -3

Fig. 8. Nestling and Growth pattern in Spot-billed pelican

Table 1. Number of Nests and Nesting Tree of Spot billed Pelican at PRKB area, Karnataka, India

State	Pelican area	Trees (nos.)	Nests (nos.)	Height of Tree (m±SD)	Height of Nest (m±SD)	DBH (m)	PRKB Canopy area
Karnataka	PRKB (Kokkare Bellur)	11	256	7.8±0.4	6.6±0.5	4.2	18.4 ² ±8.7

Table 2. Showing Characteristic features of Spot billed Pelican at PRKB area, Karnataka, India

State	Pelican area	Nearest House (m±SD)	Nearest Road (m±SD)	Nearest Forest (m±SD)	Nearest Water (km)	Nearest Foraging Area (km)
Karnataka	PRKB (Kokkare Bellur)	28.4±0.6	256	7.8±0.4	15-20	75-100km radius

Table 3. Dimensions of Nest tree species opted by Spot billed Pelican at PRKB area, Karnataka, India

Trees @ PRKB area							
Parameter s (m±SD)	Barringtonia acutangula	Azardictia indica	Ficus bengalensis	Ficus religiosa	Propolis chilensis	Acacia nilotica	Tamarindus indica
Height	--	5.7±0.3	7.2±0.2	8.6±2.3	--	5.2±0.1	7.4±0.2
DBH	--	3.8±15.2	6.2±26.3	2.3±66.5	--	2.4±18.2	3.2±26.5
Canopy area	--	7.8±0.5	32±0.3	9.8±2.6	--	5.7±0.3	15±0.0

Table 4. Showing Breeding success in Spot billed Pelican at PRKB area, Karnataka, India (2017-2020)

Parameters (m±SD)	2017-2018	2018-2019	2019-2020	Overall
Clutch Size				
Mean	2.64	3.2	3.3	3.04
Mode	4	3	4	3.6
Range	3-4	3-4	3-4	3-4
Incubation Period				
Mean	34.4	32.6	34.5	33.83
Range	25-35	28-33	30-34	27-34
SD & SE	2.02, 0.28	1.06, 0.12	0.92, 0.08	1.33, 0.16
Fledging Period				
Mean	96.6	95.2	93.88	95.22
Range	92-99	91-102	92-103	92-101
SD & SE	2.32, 0.45	2.56, 0.62	2.62, 0.49	2.5, 0.52

Survival Rate				
% of Successful Nest ^a	100	100	100	100
% of Eggs hatched	86.66	93.54	100	93.4
Nesting Success				
Rate (%) ^b	83.44	90.66	96.26	90.12
Fledgling/Total Nests	1.6	2.1	2.4	2.03

^a-Nest that hatched at least One young; ^b-total fledglings/total eggs

Table 5. Nesting growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare Bellur

S L N o	Gro wth Days	No of nestli ngs	Wei ght (g)	Hea d Len gth (cm)	Bill Len gth (cm)	Bill Dep th (cm)	Win g Len gth (cm)	Win g Spa n (cm)	Tars us leng th (cm)	Tail leng th (cm)	Pou ch (cm)	Bod y leng th (cm)	Web bed feet (cm)	Gro wth rate (gm s)
1	1	143	200	2	1	2	6	1.9	2.5	2	1.5	10	1.5	200
2	3	143	300	3	1.2	2.2 5	12	2	4	2.8	2.4	15	2.25	100
3	6	143	375	4	1.4	2.5	20	2.4	5	4	3	20	2.5	175
4	9	143	480	5	1.8	3	32	3	5.5	6	3.7	25	2.5	105
5	12	143	590	6	2	3.5	43	3.5	6	8	4.8	32	2.8	110
6	15	143	695	7	2.3	4	55	3.5	7	8.5	5.5	38	3.5	105
7	18	143	805	8	3.5	4.5	68	4	8	9	6.7	45	3.8	110
8	21	143	950	10	5	5	80	4.5	10	10	7.5	50	4.3	145
9	24	143	1050	11	6.5	6	95	5	12.5	11	8	55	5	100
10	27	143	1200	12	8	7	108	5.8	12	12	8.7	62	5.8	150
11	30	143	1400	13	9	8	115	7	13	14	9.3	68	6	200
12	33	143	1750	14	10	9	128	7.5	14	15	10	74	6.5	350
13	36	143	1900	15	11	10	140	8	15	17	10.5	80	7	150
14	39	143	2170	16	12	11	150	8.5	17	19	11	86	7.5	170
15	42	143	2400	18	13	12	162	8	18	20	11.5	90	8.5	230

1 6	45	143	2700	20	14	14	170	9.5	20	22	12	95	9	300
1 7	48	143	2950	22	15.5	15	178	10	21	24	13	100	10	250
1 8	51	143	3250	24	16.5	17	180	11	22	26	13.8	105	10.5	300
1 9	54	143	3500	26	18	18	188	12	23	28	14.4	111	11	250
2 0	57	143	3700	28	19	20	198	14	24	29	15.5	115	12	200
2 1	60	143	3850	30	20	21. 5	205	15	25	30	16.2	120	13	150
2 2	63	143	4010	33	22	24	212	18	26.5	32	17	125	13.5	160
2 3	66	143	4200	34	24	25	220	21	28	34	17.5	133	14	190
2 4	69	143	4350	40	26	27	225	24	29	36	18	138	14.5	150
2 5	72	143	4600	45	28	30	232	26	30	38	18.5	147	15	250
2 6	75	143	5000	48	30	32	240	28	31	40	19	155	16	400
2 7	78	143	5250	50	32	33	245	30	32	41	19.8	162	17	250
2 8	84	143	5530	55	33	34	250	32	33	42	20.5	168	18	280
2 9	87	143	5800	58	34	36	255	34	34	43	21	175	18.5	170
3 0	90	143	6000	60	35	38	260	38	36	44	22	180	20	200

On the **1st day**, weight was **200 g**, head length 2 cm, bill length 1 cm, bill depth 2 cm, wing length 6 cm, wing span 1.9 cm, tarsus length 2.5 cm, tail length 2 cm, pouch 1.5 cm, body length 10 cm, webbed feet 1.5 cm and **growth rate** was found to be **200 gms**. On the **3rd day**, weight was **300 g**, head length 3 cm, bill length 1.2 cm, bill depth 2.25 cm, wing length 12 cm, wing span 2 cm, tarsus length 4 cm, tail length 2.8 cm, pouch 2.4 cm, body length 15 cm, webbed feet 2.25 cm and **growth rate** was found to be **100 gms**. On the **6th day**, weight was **375 g**, head length 4 cm, bill length 1.4 cm, bill depth 2.5 cm, wing length 20 cm, wing span 2.4 cm, tarsus length 5 cm, tail length 4 cm, pouch 3 cm, body length 20 cm, webbed feet 2.5 cm and **growth rate** was found to

be 175 gms. On the 12th day, weight was 590g, head length 6 cm, bill length 2cm, bill depth 3.5 cm, wing length 43 cm, wing span 7.5 cm tarsus length 6 cm, tail length 8 cm, pouch 4.8 cm, body length 32 cm, webbed feet 2.8 cm and **growth rate** was found to be 110 gms. On the 18th day, weight was 805 g, head length 8 cm, bill length 3.5 cm, bill depth 4.5 cm, wing length 68 cm, wing span 4 cm, tarsus length 8 cm, tail length 9 cm, pouch 6.7 cm, body length 45 cm, webbed feet 3.8 cm and **growth rate** was found to be 110 gms. On the 24th day, weight was 1050 g, head length 11 cm, bill length 6.5 cm, bill depth 6 cm, wing length 95 cm, wing span 5 cm, tarsus length 12.5 cm, tail length 11 cm, pouch 8 cm, body length 55 cm, webbed feet 5 cm and growth rate was found to be 100 gms. On the 30th day, weight was 1400 g, head length 13 cm, bill length 9 cm, bill depth 8 cm, wing length 115 cm, wing span 7 cm, tarsus length 13 cm, tail length 14 cm, pouch 9.3 cm, body length 68 cm, webbed feet 6 cm and **growth rate** was found to be 200 gms (Table 5).

On the 36th day, weight was 1900 g, head length 15 cm, bill length 11 cm, bill depth 10 cm, wing length 140 cm, wing span 8 cm, tarsus length 15 cm, tail length 17 cm, pouch 10.5 cm, body length 80 cm, webbed feet 7 cm and **growth rate** was found to be 150 gms. On the 42th day, weight was 2400 g, head length 18 cm, bill length 13 cm, bill depth 12 cm, wing length 162 cm, wing span 8 cm, tarsus length 18 cm, tail length 20 cm, pouch 11.5 cm, body length 90 cm, webbed feet 8.5 cm and **growth rate** was found to be 230 gms. On the 48th day, weight was 2950 g, head length 22 cm, bill length 15.5 cm, bill depth 15 cm, wing length 178 cm, wing span 10 cm, tarsus length 21 cm, tail length 24 cm, pouch 13 cm, body length 100 cm, webbed feet 10 cm and **growth rate** was found to be 250 gms. On the 54th day, weight was 3500 g, head length 26 cm, bill length 18 cm, bill depth 18 cm, wing length 188 cm, wing span 12 cm, tarsus length 23 cm, tail length 28 cm, pouch 14.4 cm, body length 111 cm, webbed feet 11 cm and **growth rate** was found to be 250 gms. On the 60th day, weight was 3850 g, head length 30 cm, bill length 20 cm, bill depth 21.5 cm, wing length 205 cm, wing span 15 cm, tarsus length 25 cm, tail length 30 cm, pouch 16.2 cm, body length 120 cm, webbed feet 13 cm and **growth rate** was found to be 150 gms (Table 5).

On the 66th day, weight was 4200 g, head length 34 cm, bill length 24 cm, bill depth 25 cm, wing length 220 cm, wing span 21 cm, tarsus length 28 cm, tail length 34 cm, pouch 17.5 cm, body length 133 cm, webbed feet 14 cm and **growth rate** was found to be 190 gms. On the 72nd day, weight was 4600 g, head length 45 cm, bill length 28 cm, bill depth 30 cm, wing length 232 cm, wing span 26 cm, tarsus length 30 cm, tail length 38 cm, pouch 18.5 cm, body length 147 cm, webbed feet 15 cm and **growth rate** was found to be 250 gms. On the 78th day, weight was 5250 g, head length 50 cm, bill length 32 cm, bill depth 33 cm, wing length 245 cm, wing span 30 cm, tarsus length 32 cm, tail length 41 cm, pouch 19.8 cm, body length 162 cm, webbed feet 17 cm and **growth rate** was found to be 250 gms. On the 84th day, weight was 5530 g, head length 55 cm, bill length 33 cm, bill depth 34 cm, wing length 250 cm, wing span 32 cm, tarsus length 33 cm, tail length 42 cm, pouch 20.5 cm, body length 168 cm, webbed feet 18 cm and **growth rate** was found to be 280 gms. On the 90th day, weight was 6000 g, head length 60 cm, bill length 35 cm, bill depth 38 cm, wing length 260 cm, wing span 38 cm, tarsus length 36 cm, tail length 44

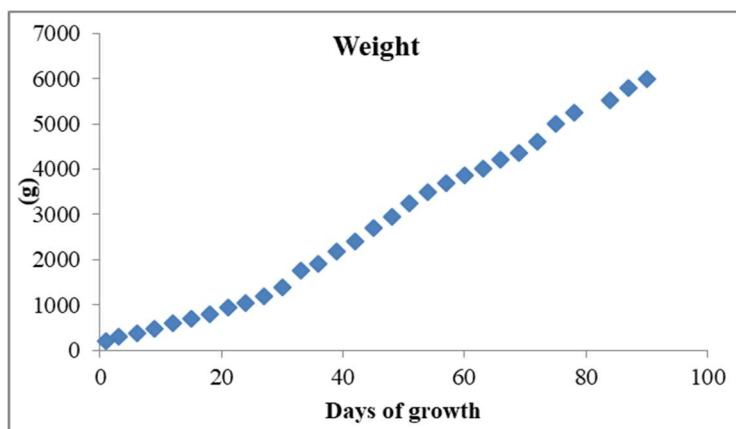
cm, pouch 22 cm, body length 180 cm, webbed feet 20 cm and **growth rate** was found to be **200 gm** (Table 5).

Table 6. Growth pattern correlation matrix (N = 30)

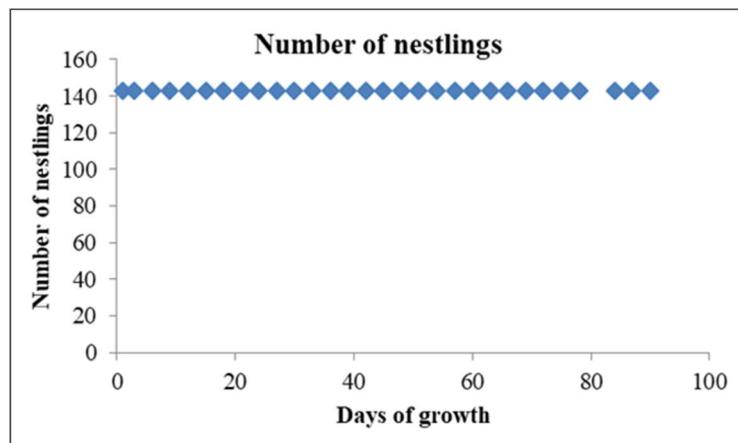
	Days of growth	Weight	Head Length	Bill Length	Bill Depth	Wing Length	Wing Span	Tarsus Length	Tail Length	Pouch	Body Length	Webbed feet	Growth rate
Days of growth	1												
Weight	0.994 **	1											
Head Length	0.973 **	0.982 *	1										
Bill Length	0.990 **	0.994 *	0.991 **	1									
Bill Depth	0.982 **	0.992 *	0.994 **	0.996 *	1								
Wing Length	0.987 **	0.970 *	0.927 *	0.962 *	0.943 *	1							
Wing Span	0.945 **	0.958 *	0.992 **	0.974 *	0.983 *	0.886 *	1						
Tarsus Length	0.998 **	0.993 *	0.968 **	0.989 *	0.980 *	0.988 *	0.939 *	1					
Tail Length	0.996 **	0.996 *	0.977 **	0.993 *	0.989 *	0.978 *	0.952 *	0.996 **	1				
Pouch	0.997 **	0.986 *	0.960 **	0.982 *	0.971 *	0.992 *	0.930 **	0.996 ***	0.992 *	1			
Body Length	0.999 **	0.992 *	0.974 **	0.991 *	0.981 *	0.987 *	0.947 **	0.996 ***	0.995 *	0.996 *	1		
Webbed	0.995 **	0.997 *	0.985 **	0.996 *	0.993 *	0.969 *	0.965 **	0.993 ***	0.995 *	0.988 *	0.993 *	1	

feet													
Growth rate	0.484 **	0.487* *	0.441 *	0.486* *	0.457* *	0.519* *	0.400 *	0.490 **	0.486* *	0.475* *	0.495* *	0.464* *	1

Data were statistically analyzed on the Correlation coefficient (r) using SPSS ver.20. Data was statistically significant at 0.05 for two tails. The ‘correlation coefficient’ was coined by Karl Pearson in 1896. Accordingly, the correlation coefficient, denoted by r , is a measure of the strength of the straight-line or linear relationship between two variables (Table 6). The correlation coefficient can by definition, that is, theoretically assume any value in the interval between the range 0 to +1 (or) 0 to -1. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed). In this data analysis on correlation coefficient (r) in independent value on days of growth vs dependent on Number of nestlings, Weight, Head Length, Bill Length, Bill Depth, Wing Length, Wing Span, Tarsus Length, Tail Length, Pouch, Body Length, Webbed feet and Growth rate reported on table correlation matrix (r).

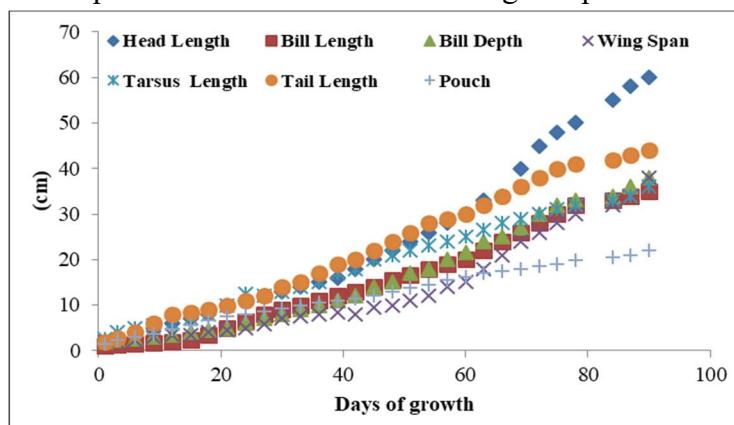


Graph 1. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare bellur. The graph-1, represents the total weight gained in total number of days. The total weight in the spot-billed pelican is 6000 g attained in 90 days. As the days progress the weight increases in its size due to the parental care and food that is fed to the young ones for developing these morphological features.

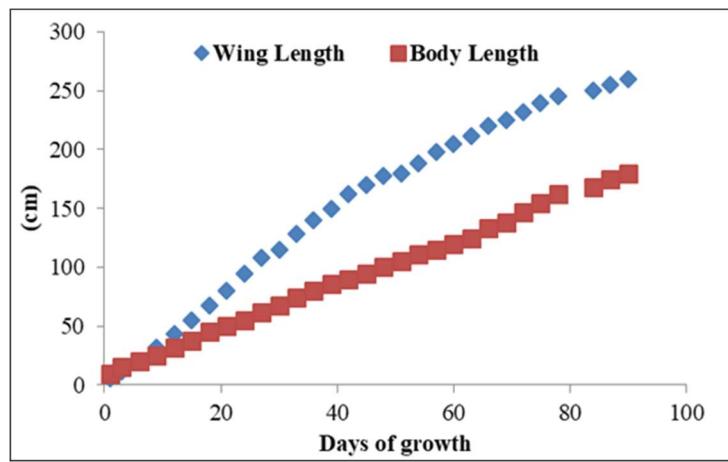


Graph 2. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare Bellur

In the graph-2, it is observed that total number of nestlings in Kokkare Bellur was estimated about 143. These nestlings show the growth pattern in about 90 days. These nestling was found in the different tree species particular big banyan tree where more number of nest habitat was located in colonies in the canopy of the tree species as discussed in the nesting tree preference.

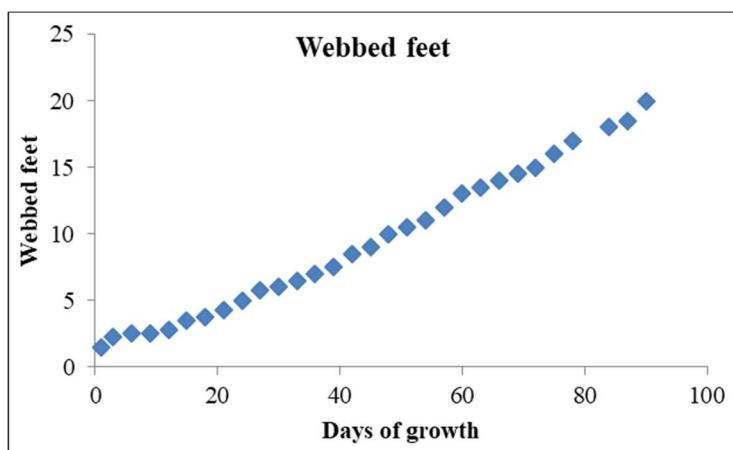


Graph 3. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare Bellur
Graph-3 illustrates different morphological features like head length, bill length, bill depth, wing span, tarsus length, tail length as well as pouch. All these features are well developed due to parental care, favorable environmental conditions, good feed habitat nurtured by the parental pelicans. All these factors have played an important role in developing the morphological features in the spot-billed pelican.

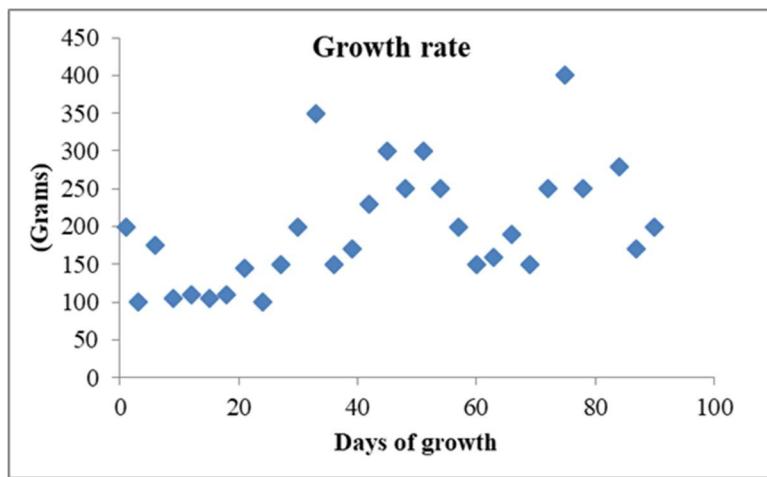


Graph 4. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare Bellur

The morphological features like wing length as well as body length have shown considerable increase in their growth (Graph-4). This can be clearly understood in the rate of growth observed in each day.



Graph 5. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare bellur
Finally the webbed feet which are one of the distinct features in the spot-billed pelicans have shown considerable increase in their growth (Graph-5). Webbed feet help in capturing the prey and play an important role in kleptoparasitism. Kleptoparasitism is the process, where the prey in the form of fish is captured from the other pelican during the period of flight. Webbed feet also help in flying high in the air.



Graph 6. Nestling growth pattern of Spot-billed pelican (*Pelecanus philippensis*) in Kokkare bellur All the morphological features developed show the rate of growth (Graph-6). The total weight gained in terms of grams at the interval of 3 days is taken into consideration in around 90 days to attain the stage of maturity.

CONCLUSION

The nestling growth pattern was analysed which shows the number of days it requires to develop the morphological characters. The tall trees of the village (*Ficus religiosa*, *Ficus bengalensis*, *Tamarindus indica*, *Acacia nilotica*, *Thespesia populnea*) has provided safe and suitable place for spot-billed pelicans to build their nest to carry out feeding behaviour. The community in Kokkare Bellur plays an important role in providing suitable place for nestling growth pattern and breeding behaviour. They feel that arrival of pelicans is good sign of prosperity that bring welfare to the entire village. The spotting of Pelicans and other species highlights the importance of Kokkare Bellur Sanctuary as a significant region for bird habitat in Karnataka. This will help in increasing the population size of spot billed pelican which is considered as threatened species thereby help in balancing the biological diversity. Nestling growth pattern help in understanding the morphological characters thereby community in the Kokkare Bellur will grow large tree species for nesting, breeding and foraging behaviour thereby preventing as sort of human activities.

In all, the Spot-billed Pelican breeds successfully during November and April at the PRKB area. The availability of suitable nesting trees, nest material, colonies surrounded by Shimsha river basin for safety reasons was found to be most significant factors. The provision of good food supplies within the habitation and at nearby lakes, considerably fewer human disturbances and poaching activities could be the strategic reasons for the successful nesting activities of the Spot-billed Pelican in recent years at the PRKB area.

ACKNOWLEDGEMENTS

This work was facilitated by 'Hamsa Research Foundation', Mysuru for their valuable directions, suggestions offered over the years, for which I am grateful. The Researcher expressed sincere thanks to Dr. G. Panduranga Murthy for his esteemed support in the preparation of this manuscript.

We also thank the local residents for their support in field works and for assisting during data collection. I would also thank **Mr. B. Linge Gowda (Head of Hejjarale Balaga)** and my **Research Assistant Ramesha K.R.** for assisting during period of my study. I express heartfelt gratitude to the Authorities of **Bharathidasan University, Tiruchirappalli (Tamilnadu)** for their support and encouragement during the study.

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