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ORIGINAL ARTICLE

An ethogram of Spot-billed Pelican (*Pelecanus philippensis*)

V. GOKULA ✉

Department of Zoology, National College, Tiruchirappalli-620 001, Tamil Nadu, India,

Abstract The Spot-billed Pelican (*Pelecanus philippensis*), a near threatened bird and one of eight pelican species in the world, can be found only in South and Southeast Asia over an area between 129000 and 181000 km^2 with strongholds in India, Sri Lanka, southern Cambodia and coastal areas of Sumatra. In India, it is presently distributed in southern and northeastern India with concentrations in Andhra Pradesh, Tamil Nadu, Karnataka and Assam states. An ethogram of the Spot-billed Pelican was presented and as many as 25 individual behaviors grouped under nine different categories were described: resting, alert, comfort/maintenance, locomotion, foraging, antagonistic, sexual, chick care and foraging, and vocalizations. Descriptions of behaviors of the Spot-billed Pelican in this paper would be immensely useful while preparing conservation and management plan for the species present both in the captive and wild condition.

Keywords ethogram, Spot-billed Pelican (*Pelecanus philippensis*), individual behavior, Tamil Nadu, India

Introduction

Assessing animal behavior is essential to understand animal life. The initial process of studying behavior is to make a catalogue of the discrete, species-typical behavior patterns that form the basic behavioral repertoire of the species, i.e., an ethogram. Making an ethogram from direct observations is fundamental to understanding animal behavior (Martin and Bateson, 2001). Precise descriptions and definitions provided by an ethogram aid the quantitative study of behavior (Lehner, 1996) and allow comparisons of behavior between related species or within the species under different circumstances (Xiao and Wang, 2005). Besides acting as reference sources, ethograms are useful for drawing attention to behavior with unknown functions and suggesting hypotheses for their functions. The Spot-billed Pelican (*Pelecanus philippensis*) (SBP), a near threatened bird and one of eight pelican species in the world, is found only in South and Southeast Asia over an area between 129000 and 181000 km^2 with strongholds in India, Sri Lanka, southern Cambodia and coastal areas of Sumatra. In India, it is presently found in southern and north-eastern India with concentrations in Andhra Pradesh, Tamil Nadu, Karnataka and Assam states (BirdLife International, 2001, 2011). However, no attempt has so far been made to understand the behavior of the SBP in a systematic way. A greater understanding of the interaction of this species with conspecifics, other species, humans and the environment is a necessary first step towards development and implementation of effective conservation practices. Hence, an attempt was made to compile a catalog of behavior of the SBP while studying its ecology between 2007 and 2010 at Karaivetti Bird Sanctuary, Tamil Nadu, India. A description of the behavior of the SBP is presented with the aim of improving the understanding of the species in behavioral studies and providing a valuable basis for further studies both in the wild and under captive conditions. To this end, its behavior is described and compared with that of related species where possible.

Study area

This study was an outcome of an investigation into the ecology of the SBP carried out in Karaivetti Lake, situated between 10°58′01″N and 79°11′07″E, covering an area of about 4.54 km^2, in Ariyalur District, Tamil Nadu, India (Fig. 1). It was designated as a bird sanctuary by the For-

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✉ Author for correspondence (V. Gokula)
E-mail: gokulae@yahoo.com

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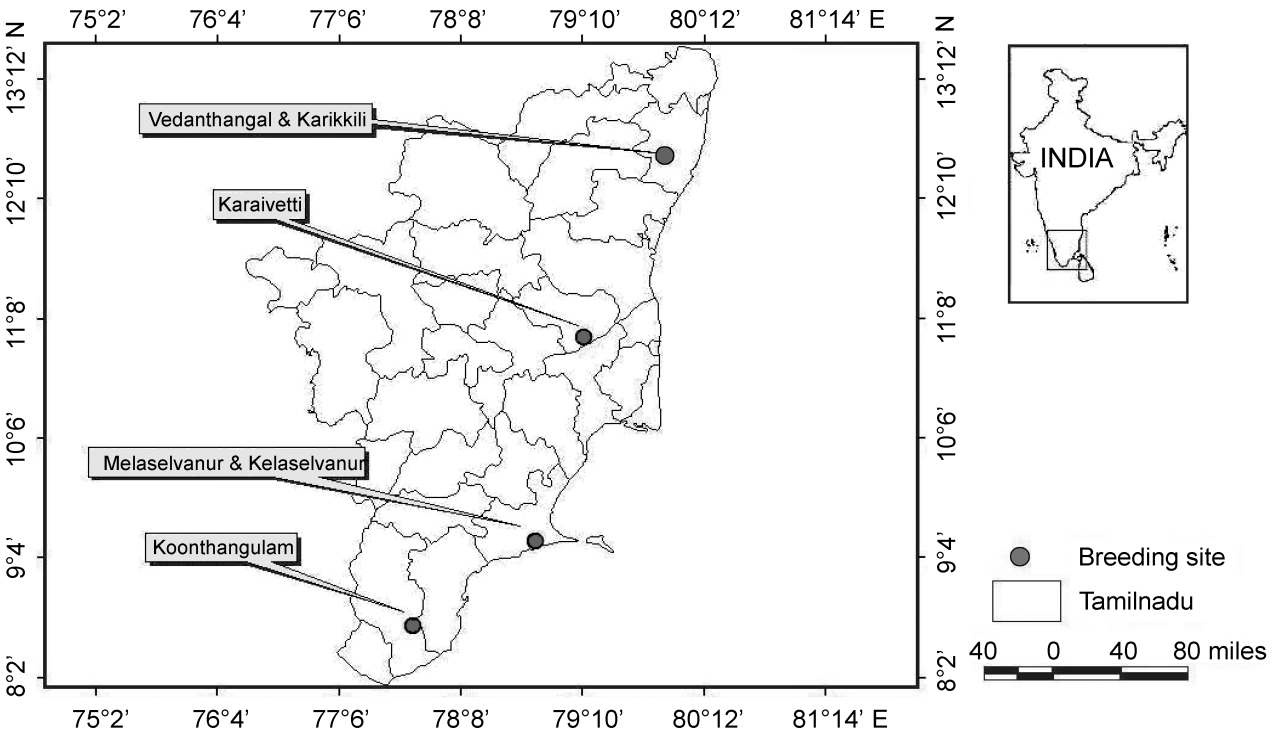

Fig. 1 Map of the study area

est Department in 1997. Rainfall ranges between 800–2000 mm and the temperature varies from 14°C to 33°C. This freshwater lake is fed by the Pullambadi and Kattalai canals. It is the largest waterbody in the district, attracting large numbers of birds every year. The natural and planted vegetation present inside and at the edges of the lake consist of *Acacia nilotica*, *Prosopis chilensis*, *Azadirachta indica* and *Tamarindus indica.* The *Acacia nilotica* plantation is a major nesting site for the birds. Recently, the lake has also been identified as one of the Important Bird Areas (IBA site code: IN-TN-13) in India by the Indian Bird Conservation Network (Islam and Rahmani, 2004). Since 1998, the SBP has been breeding at this lake. Although a maximum of 56 pairs were only found breeding in the lake (18 pairs in 2007-08, 50 pairs in 2008-09, and 56 pairs in 2009-10), a considerable number of individual SBPs migrates from unknown sites during late May of the past three years (2007, 2008, 2009). Since most of the lakes in Tamil Nadu go dry in the summer, it is presumed that the SBP move from places which lack adequate amounts of water to places with adequate water. In general, the numerical status of the population of this pelican has been increasing for the past five years in Karaivetti. However, studies of this wetland or its dependant avifaunal species are very scanty.

Methods

The behavior reported during the three years was based on the behavioral study carried out on the SBP at Karaivetti Lake, Tamil Nadu, from September 2007 to September 2010. Besides, observations were also made at other breeding sites of the SBP in Tamil Nadu, i.e., in Vedanthangal, Karikilli, Melaselvanur and Kelaselvanur and Koonthangulam (Fig. 1). Pelicans were observed by recording their activity patterns from 06:00 to 19:00 hours during the breeding season (November to May). Pelicans were continuously observed from elevated places throughout the daylight period. Observations began with randomly of a focal individual by selecting a random number (1–25) and counting that number of individuals from the left to the right edge of the observation area (i.e., field of view including all birds for which activity could be reliably determined). Once selected, the focal individual was observed for 5 min, its behavior during this interval was recorded with descriptions and field sketches. At the end of the 5-min observation period, another bird was chosen by selecting the fifth bird to the right of the previous focal bird. Once the entire observation area had been completed, observations were repeated with the random selection of another bird, as described. As the repertoire will vary

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from species to species as well as between individuals, depending on sex, age and experience, the behavior by adult males, adult females, chicks and sub-adults of unknown sex were recorded for the present study. All the measurable behavior traits were categorized comprehensively and unambiguously defined for this study. Behavior is defined in terms of consequences. The consequences are the effect of the behavior of the subject on the environment, on other individuals, or on itself. Information from the literature was also used to supplement descriptions. Behavior is grouped into a number of categories: alert, resting, comfort/maintenance, locomotion, foraging, antagonistic, sexual, chick care and feeding and vocalization. However, this catalog was restricted to the behavior of the SBP during the breeding season (November to May).

Results

Twenty types of behavior were grouped into nine categories: alert, resting, comfort/maintenance, locomotion, foraging, antagonistic, sexual, chick care and feeding and vocalizations.

Alert

The SBP, in the alert mode, remains motionless, with its eyes open and with the neck fully extended in a posture of sitting or standing on the ground/nest (Fig. 2). A few individual birds even raise one foot slightly off the ground. Pelicans in this posture appear to focus on threat or the direction of the threat. Alert behavior is often elicited by activities such as any unusual sudden noise or an intrusion by man or birds of prey. The alert behavior is very quickly adapted by the rest of the members in the colony of incubating pelicans or in a congregated colony of pelicans near a water body. This alert behavior also occurs in loafing congregations and in an individual while foraging.

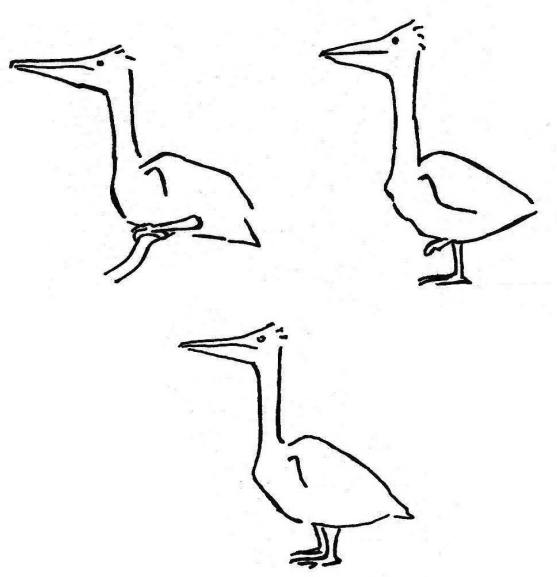

Fig. 2 Alert

Resting

While resting, the SBP remains motionless with its eyes closed (different from alert) either in a position of sitting or standing on the ground/nest (Fig. 3). It is done largely after an extensive foraging activity in water. The resting first starts as a standing posture and moves to a sitting posture only when resting in the standing posture is completed without any disturbance. The SBP sits by resting its entire belly on the tarsi and the entire bill on the breast. It is frequently exhibited by members in a pelican colony but occasionally exhibited when a pelican is alone.

Comfort/maintenance behavior

Comfort/maintenance involves all the actions concerned with maintaining the body surface.

Stretching: Stretching occurs after birds have been resting for an extended period or after prolonged incubation. A SBP may stretch its leg, wings or body. Stretching is performed in two ways (Fig. 4): in one, one wing and leg on the same side are extended downward, with the feathers spread on the extended wing and the tail (wing and leg stretching) and in the other way, the SBP raises to a certain extent its wings and extend the neck horizontally (body

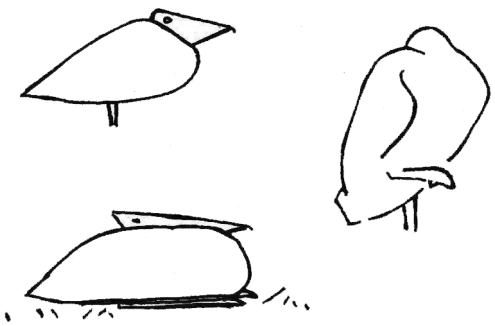

Fig. 3 Resting

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stretching).

Scratching: To scratch its body, the SBP shifts its weight onto one leg and scratches the surface of the body by the other leg. During this process, the parts to be scratched are often drawn towards the scratching leg. Largely, neck, head and pouch are most often scratched (Fig. 5).

Preening: Preening involves the contact between the bill and the feathers. The SBP uses its bill to straighten the feathers on its breast, neck, tail, legs or wings (Fig. 6). There are three types in the preening movement: the closed bill moves down through the feathers as if combing, vibrates when downing through the feathers, where the bill is moved slowly through the feathers with short, rapid biting movements. Besides arranging the feathers, dirt and parasites are also removed by the bill. The pelican performs this behavior while sitting, standing or swimming. They predominantly preen on the wings, back, sides and chest. Feathers are arranged by nibbling, pulling and shifting with the tip of the bill.

Body fluffing: The feathers on the neck, wings and back are erected and then smoothed down (Fig. 7)

Dust bathing: The SBP lies flat and rubs its belly, head, neck and wings on the ground (Fig. 8). Dust bathing helps keep plumage clean.

Sun bathing: In this behavior, the SBP spread its wings and stands for awhile in the sunlight (Fig. 9).

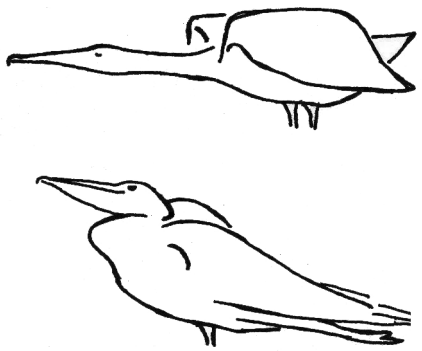

Fig. 4 Stretching

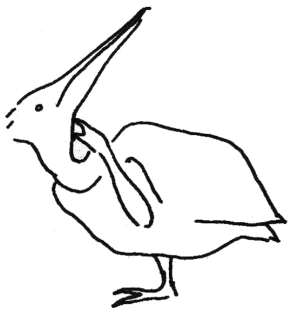

Fig. 5 Scratching

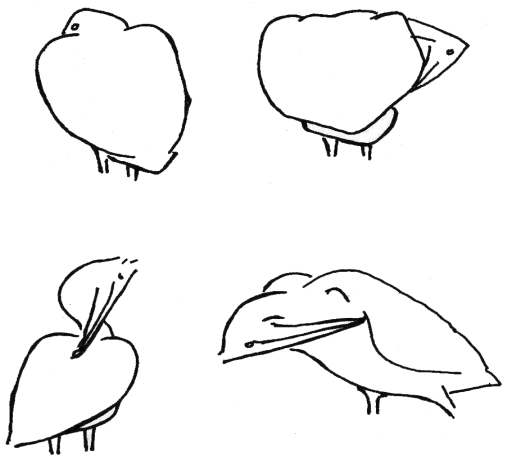

Fig. 6 Preening

Fig. 7 Body fluffing

Fig. 8 Dust bathing

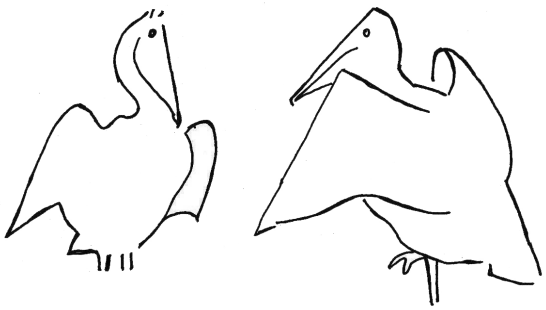

Fig. 9 Sun bathing

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Bill gaping: The mouth is briefly opened wide and the pouch is extended as if the bird is yawning (Fig. 10). It is done largely after stretching.

Pouch shaking and spreading: The SBP flutters its pouch after preening, feeding the young and soon after foraging. After fluttering, the SPB spreads and retracts the pouch for some time. Both may be an act of dislodging some objects from other objects.

Locomotion

The Spot-billed Pelican moves around in the following ways:

Walking: The SBP moves about at an easy pace while walking (Fig. 11). Walking is very clumsy and performed largely while gathering near water bodies after foraging. It shifts its weight from side to side while walking. Wings are often folded and some times slightly opened when speed increases. It walks on land or in shallow water.

Running: The SPB moves at a speed faster than walking with its head held high and extended. It is performed for a very short distance during fighting or take-off. Wings are largely opened while running. It is performed rather less frequently.

Flying: The SBP frequently flies after swimming (Fig. 12). Soaring in circles with other members of the same species, or with Painted Storks (*Mycteria leucocephala*) and Open-billed Storks (*Anastomus oscitans*), are the predominant style of flying in the Spot-Billed Pelican.

Swimming: The SBP swims by alternately paddling its feet. The SBP neither submerges completely nor swims below the surface.

Foraging behavior

The SBP, being a piscivore, feeds mostly on freshwater and occasionally backwater species of fishes. It fishes preferentially in the morning and late in the afternoon. It forages in two ways: communal and individual foraging.

Individual foraging: The common fishing behavior of the SBP is to swim in either an upright position or head rested in the back position (Fig. 13a, b). It plunges its head straight or slightly angled into the water to catch fish in the surface position. The SBP normally feeds by moving on the water surface and dipping its bill down into the water column. When the prey is captured, the forager raises its head well above the water surface to swallow. When a prey item is within reach, the bird snaps it with its bill.

Communal foraging: Members of a SBP flock alone or along with members of a Little Cormorant (*Phalacrocorax niger*) flock engage in communal foraging (Fig. 13c). The flock of SBP follows the flock of the cormorants. The frequent diving of cormorants disturbs schools of fish in deep water and forces the fish to scatter in all directions. Fishes coming to the surface by the conduct of the cormorants are caught by the pelicans. During this act, all pelicans keep their wings halfway raised and folded while following the cormorants. It also helps to drives the disturbed fishes into one place where they can be easily caught. Besides, the SBP also occasionally performs skimming to catch the fish swimming near the upper layer of the lake

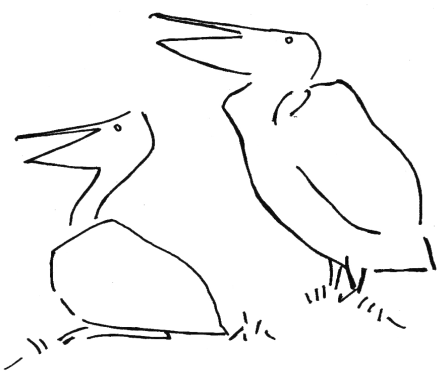

Fig. 10 Bill gapping

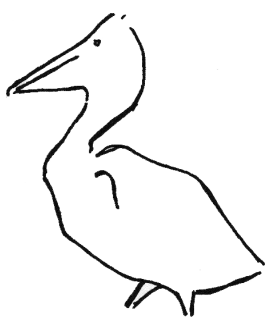

Fig. 11 Walking

Fig. 12 Flying

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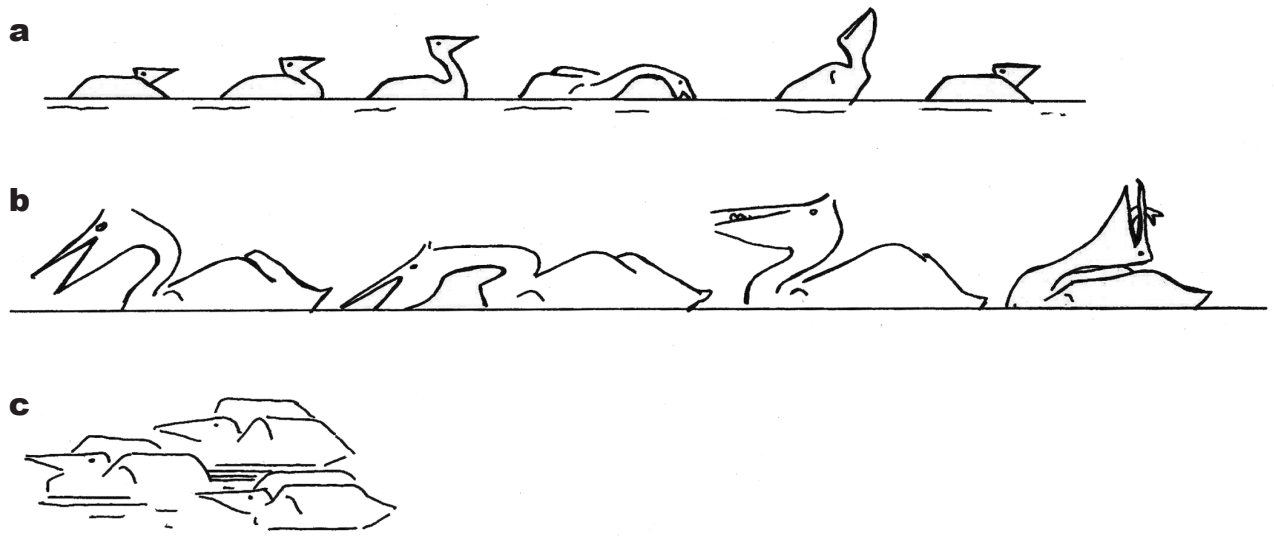

Fig. 13 Foraging. (**a**) foraging sequences A (individual); (**b**) foraging sequences B (individual); (**c**) communal foraging.

Antagonistic behavior

The SBP very rarely expresses antagonistic behavior. During any such infrequent antagonistic encounter, a pelican performs initially either a slight jerk of the head in the direction of the other animal or claps the bill rapidly (Fig. 14). Very rarely do pelicans engage in an aggressive fight. Initially, the pelican faces the offender with its head raised and a horizontal bill, without an extended pouch. This is followed by rapid clapping of the bill. Once determined to fight, both jab once and close their bill with a snap, followed by repeated hard jabs directed usually at the head of the other bird. Both often hold the neck of each other during such an act (Fig. 15). In the case of inter-specific response, no particular behavior is evident except fleeing. On one occasion, a male was found lunging its bill towards a Painted Stork in such a way that its distended gular pouch remained taut.

Fig. 14 Bill clapping

Fig. 15 Fighting

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Sexual behavior

Courtship: In the SBP, bill and gular pouch are the prominent display parts. The male initially distends his reddish bright gular pouch and wobbles vigorously. After a few seconds, the male swings his head up and down and side ways (Fig. 16a). During this display, the pelican also throws his bill over the back down to the tail a few times (Fig. 16b). After a few seconds, the pelican claps his bill loudly while his head sways up and down. However, not all these displays are performed exclusively to attract the opposite sex. Head sways and bill claps are often performed when any intruder nears a pelican or even some times in a disturbed state. Hence, head sways and bill claps are signals of threat to other males from predators, besides acting as courtship signals to an eventual partner. Moreover, all the activities are more vigorous in courtship display than in other acts. After head sways and bill claps, both sexes bow each other (Fig. 16c) as an act of acknowledgement. After this event, some males take flight and do some circling in the air above the nest for a few seconds. The partner at the nest performs again head sway, bill clap and bow activities when the male returns to the nest from its flight.

Copulation: Mating occurs at the nest just after the courtship displays. The male holds the neck of his partner between his mandibles and mount on her back. The male keeps his wings spread and outstretched while mating (Fig. 17). Once the mating is over, the male release the neck of the female from his mandibles and dismounts.

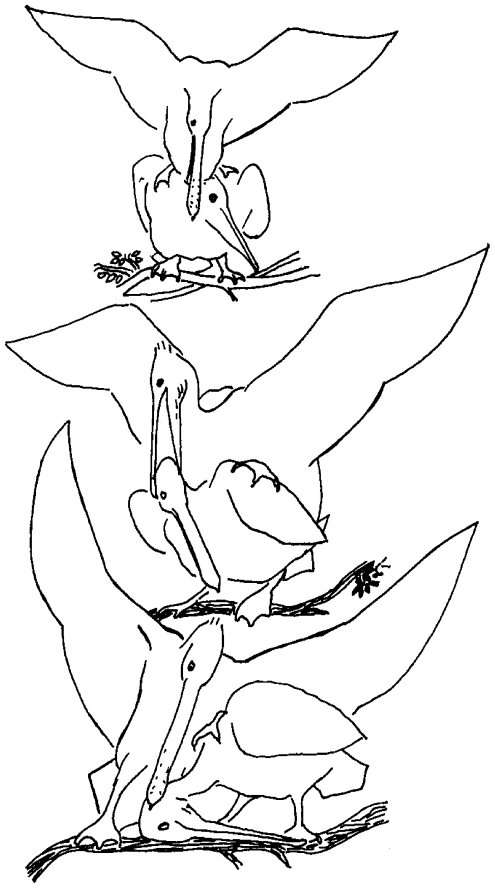

Fig. 17 Mating

Nest building: The SBP starts nest building largely after courtship. Both sexes share in nest building activities. However, the male largely collects the nest material and the female receives and aligns the materials to build the nest. Nest material is largely collected from the ground and occasionally from plants and other old nests. The nest material is transported with the mandibles (Fig. 18). In nest building, the SBP performs five different activities: searching for nest material, collection of nest material, carrying the nest material, depositing the material and arranging the material. Of the five activities, the male largely does all of the first four activities while the female does the arranging of the nest material in the nest.

Incubation: The SBP starts the incubation as soon as the first egg is laid (Fig. 19). While both sexes share in the incubation, the female predominantly incubates. During

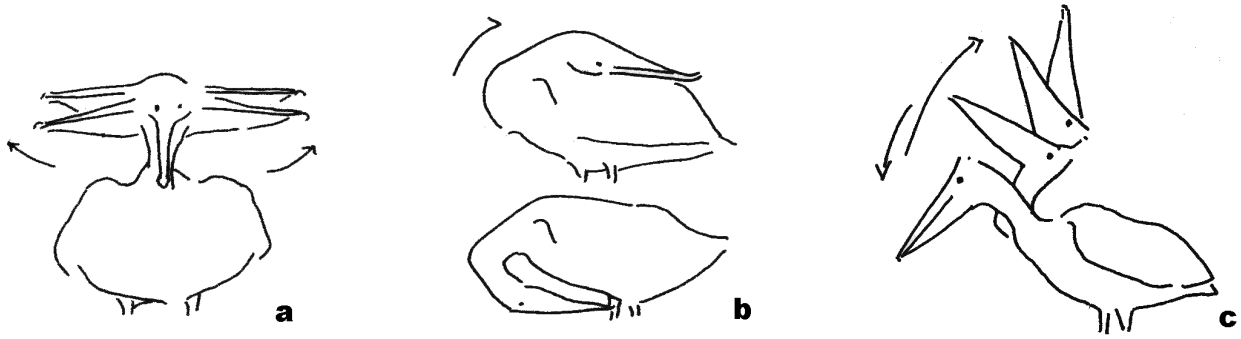

Fig. 16 Courtship. (**a**) head swaying; (**b**) bill throwing; (**c**) bowing.

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Fig. 18 Nest building

Fig. 19 Incubating

incubation, the adult puffs its wings to fully cover the entire nest and performs no activities. It insures warmth and controls the humidity of the eggs. In the absence of brood patches, the SBP transfers heat from its highly vascularised totipalmate feet.

Nest relief: Since both sexes share the incubation, nest relief has become an important behavior in the life of a SBP. While relieving one member from the nest, both members bow to each other several times. On certain occasions, head swaying is also exhibited by this pelican.

Chick care and feeding

Feeding the young: The SBP feeds its young in three ways. After a few days of hatching, the adults give pre-digested liquid diet to the helpless chicks. Adult drips predigested liquid through their mandibles and right to the mouth of the helpless young (Fig. 20a). After 7–10 days, the adults, by standing in front of the young, vigorously shake their neck and regurgitate the food onto the nest (Fig. 20b). The helpless young picks up the food and eat bit by bit by serious tossing or jerking their mandibles. After 30 days, the young are very much capable to draw the food straight from the gullet of the parents by inserting their mandibles up to neck into the mouth of the adults (Fig. 20c).

Begging behavior: Days old chicks often beg vigorously for food by sitting upright in front of their parent with neck stretched and beating their wings (Fig. 21). This continues until it gets food from the parents or any other response from the parents.

Vocalization

The SBP is generally silent, though adult grunts and chicks often croak and hiss to attract the attention of their parents. Adults emit grunts or croaks during antagonistic behavior, nest relief, courtship and copulation. It also occasionally screams before fleeing when any potential predator intrudes the nest (Fig. 22).

Discussion

An ethogram is a set of comprehensive descriptions of characteristic behavior patterns of a species (Brown, 1975). It is the result of refining the catalog of behavior after many hours of observations and description and should be the starting point for any ethological research, especially species oriented research. Based on field observations of a SBP colony, consisting of adult males, adult females, chicks and sub-adults of unknown sex over a period of 236 hours, a total of nine different categories, comprising 25 different activities, were recorded. The resulting ethogram

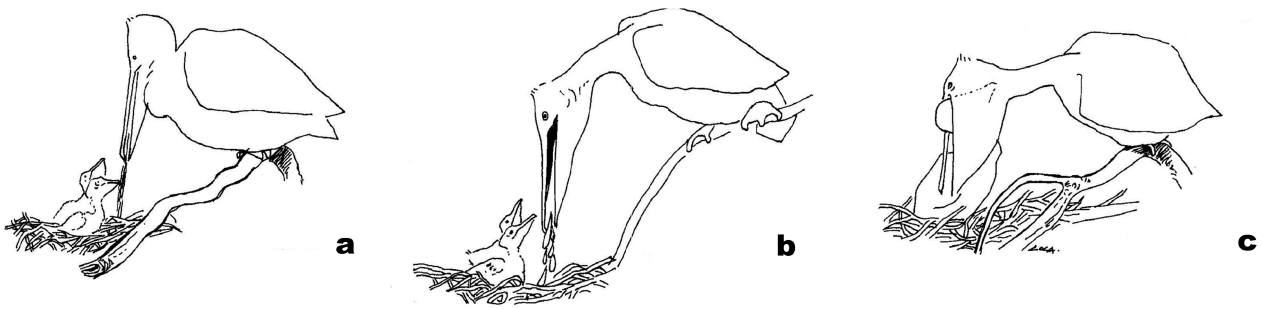

Fig. 20 Feeding the chicks

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Fig. 21 Begging

Fig. 22 Screaming

constructed for the SBP is important for the understanding of the behavior that has a function in the maintenance and ecological significance of species in the evolution of our ecosystems. Since no ethograms have ever been produced for the SBP before, the Karaivetti, Koonthangulam and Vedanthangal bird sanctuaries offer great opportunities to study the behavior and other ecological parameters of pelicans in the wild. Periodic and generally leisurely types of egocentric behavior (comfort and maintenance behavior) are fundamental to all birds and do not tend to differ greatly among rather distantly related groups, at least beyond the constraints set by anatomy and proportions. Hence, except bill gaping and pouch shaking and spreading, other behavior recorded in comfort and maintenance behavior may be similar to that of other birds. Many of the types of behavior (courtship, copulation, nest building, incubation, nest relief, comfort/maintenance behavior, antagonistic behavior and Chick care and Feeding) described here are also reported for the White Pelican (*Pelecanus erythrorhynchos*) by Schaller (1964). However, the Spot-billed Pelican differs from other species of pelicans in certain behavioral aspects. Brown and Urban (1969) reported group displays in White or Great White Pelicans (*Pelecanus onocrotalus*), while Schaller (1964) reported strut walking in the American White Pelican. However, no such displays were observed in the SBP during courtship. Schaller (1964) reported that the American White Pelican, as a ground nester, never carries sticks or other matter to the nest. Moreover, unlike the White or Great White Pelicans, the Pink-backed Pelican *(P. rufescens*) (Mackworth-Praed and Grant, 1952) and the Brown pelican (*P. occidentalis*) (Chapman, 1908), known to nest both on the ground and in trees, the SBP nests only in trees. The Spot-billed Pelican is not as aggressive to other members of the same species and other species as the White Pelican (*Pelecanus erythrorhynchos*), as reported by Schaller (1964). The types of behavior listed here are the most commonly exhibited by the SBP in the wild. Additional observations by other researchers, including detailed studies of sex specific (if any) and age specific (if any) behavior during the breeding and non-breeding season are needed. Gaining a better understanding of the SBP behavior, both in the wild and in captivity, is a necessary first step towards improving the husbandry and management of captive Spot-billed Pelicans and designing future conservation efforts that take into account all aspects of life history and behavior of the wild Spot-billed Pelican.

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斑嘴鹈鹕（*Pelecanus philippensis*）行为谱

V.Gokula

(Department of Zoology, National College, Tiruchirappalli-620 001, Tamil Nadu, India)

摘要：斑嘴鹈鹕（*Pelecanus philippensis*）是一种近危鸟类，为世界上鹈鹕属 8 种鸟之一，仅见于南亚及东南亚，分布面积为 129000 至 181000 km^2，主要分布于印度、斯里兰卡、柬埔寨南部及苏门答腊岛沿海地区。在印度境内，在南部及东北部均有分布，主要集中于安德拉邦、泰米尔纳德邦、卡纳塔克邦及阿萨姆邦。本文提供了斑嘴鹈鹕的行为谱，描述了栖息、警戒、扶养 , 运动、觅食、对抗、性行为、育雏、发声等 9 大类 25 种个体行为。对斑嘴鹈鹕行为的描述，非常有助于规划该物种笼养和野外种群的保护与管理。

关键词：行为谱，斑嘴鹈鹕（*Pelecanus philippensis*），个体行为，泰米尔纳德邦，印度

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