ACTIVITY BUDGET OF THE BLACK-NECKED STORK *EPHIPPIORHYNCHUS ASIATICUS* DURING NON-BREEDING SEASON IN INDIA

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ABSTRACT

Time-activity budget of the Black-necked Storks was studied from January 1995 till June 1997 in Dudwa National Park, Uttar Pradesh, India. Black-necked Storks spent nearly 46% of their time resting. Except chasing, resting and drinking, no other activity differed significantly among storks in three years. Black-necked Storks spent more time for resting and drinking in summer (April, May and June) and chasing was more in winter (February and March). Time taken for resting varied between habitats among different pairs (N=3). Variations in time budget of Black-necked Storks were correlated with prey availability. Time spent foraging did not vary significantly during the study period and storks had a irregular feeding pattern, greatly influenced by other fish-eating birds. When food availability increased, congregation of other fish-eating birds also increased leading to the conflict with storks. The storks became aggressive when they tried to defend their territory from other fish-eating birds. Most of the aggressive encounters were observed between 0600 and 1000hr.

KEYWORDS

Activities, aggression, Black-necked Stork, *Ephippiorhynchus asiaticus*, India, territory, time budget

The time and amount of energy the bird devotes to different activities must inevitably influence its survival (Orians, 1961). Time-activity budget of birds vary greatly according to the type of habitats they inhabit and food they eat (Paulus, 1984). Cairns (1987) proposed that variations in time budgets of marine birds would correlate with prey availability. Time budgets are especially suitable for comparative studies such as those between sexes, periods of the year, and habitats both within and across species (Holmes *et al.*, 1979).

In Dudwa National Park we studied the activity pattern of Black-necked Stork *Ephippiorhynchus asiaticus* from January 1995 to June 1997. Knowledge about the daily activity pattern of the Black-necked Stork is very essential in order to conserve the species as it declined drastically in the whole of the South-East Asia, and especially in India (Maheswaran *et al.*, 2004). In India, ecological studies on Black-necked Stork have been conducted at Keoladeo National Park in Rajasthan (Ishtiaq, 1998), Dudwa National Park in Uttar Pradesh (Maheswaran, 1998; Maheswaran & Rahmani, 2001, 2002 & 2005) and in Etawa and Mainpuri districts in Uttar Pradesh (Sundar, 2003).

METHODS

Study area

Dudwa National Park is situated on the Indo-Nepal border in Nighasan tehsil of Lakhimpur Kheri district in Uttar Pradesh. The area falls under Terai-bhabar biogeographic subdivision of the upper Gangetic plain (Rodgers & Panwar, 1988). The Park lies between 28°18'-28°42'N & 80°28'-80°57'E. The Himalayan foothills are about 30km north of the Park, and the rivers Suheli and Mohana form the natural boundaries of the Park. After the monsoons, water levels decrease and the prey become concentrated. However, as a management practice, the Forest Department pumps in water to the wetlands to maintain the level for the benefit of Endangered Swamp Deer (*Cervus duvauceli*). This often benefits the Black-necked Storks as they get enough water during peak summer days to maintain their territories. Daily supply of water (10-15 days, 8-10 hours everyday) compensates natural water loss due to evaporation, facilitating birds such as Black-necked Stork, egrets and herons.

Behvaioural observations

To study the activity pattern of the Black-necked Storks, focal animal sampling (Altmann, 1974) was used. Activities of an individual were recorded continuously (from 0600-1800hr) from the watch towers situated in each wetland (Banketal, Badhital and Kakrakatal) at a height of approximately 10-15m. A digital stop watch, a hand-tally counter and an SLR camera were used to record the specific events. One full day was devoted to record the activities of either a male or a female stork in one wetland. The next day another bird was observed continuously so that two days were spent in each of the three wetlands alternatively to study the male and female individuals. Black-necked Storks are highly territorial (Maheswaran, 1998) and can be seen in their respective territories, so finding a particular bird (either a male or a female; distinguished by iris colour) was not difficult. During summer, due to less water level in the wetlands storks disappeared constantly (before forest department started pumping water) from their respective wetlands and this made it difficult for us to locate the focal pair.

As there was a difference in the nature of the wetlands, we decided to analyse data site and pair wise to see the difference in activity, if any. Since, water level fluctuation was more pronounced in three years we analysed the data year wise. Kruskal-Wallis and Mann-Whitney U tests were used to see whether there was any difference in the percentage time spent on different activities by different pairs and between sexes, respectively. We used "t-test" (unpaired) on the arc-sine transformed percentage data to know the difference in particular activity between winter (February and March) and summer

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(April, May and June). All statistical tests were performed using STATA (StataCorp, 1997) statistical package.

Results

Black-necked Storks in Dudwa spent nearly 46% of their time resting (Table 1). Storks spent more time resting in summer (67.3 ± 2.45) than the winter (49.7 ± 6.58) and this differed significantly (t = -2.514, P<0.01). Storks have been observed resting by sitting on their tarsus in an open grass-covered ground little away from the main water body. The distance from the main water body to their resting sites ranged from 3 to 80m.

Black-necked Storks are highly territorial and spent 18% of their time for foraging and 17% for chasing (Table 1). Aggressive behaviour (towards intra- and inter-species) was more during winter (percent time ± SE) (2.25 ± 0.68) than summer (0.62 ± 0.21) (t = 2.277, P<0.01). Our earlier (see Maheswaran, 1998) observations indicate that the storks' territoriality increased as food resources became depleted. Most (>50%) of the aggressive encounters were observed between 0600 and 1000hr. Totally, 17 species (including the Black-necked Storks) were observed interacting with storks; Spoonbills (*Platalea leucorodia*) had interacted often (67.4%) followed by the White-necked Storks *Ciconia episcopus* (16.6%).

Except chasing, resting and drinking, no other activity differed significantly among Black-necked Storks in three years (Table 2). Interaction rates were also increased immediately after the monsoon when water started receding. Number of Spoonbills that interacted with storks varied from one to 43. Often Spoonbills were seen in flocks and their tendency to forage almost throughout the day compelled them to be there in the wetlands the whole day. White-necked Storks were also frequently chased by the Black-necked Storks (16%, n = 274). In 1995, of the 19 encounters observed with different species, six (31.5%) were with intra-species followed by Spoonbills.

Activities of Black-necked Storks in 1995

There were no major differences in activities of Black-necked Stork between winter and summer, except for drinking and resting. Storks were observed drinking more during summer (0.08 ± 0.06) (t = -2.3017, P<0.01) when the temperature had reached 42°C. In summer immediately after each foraging bout, storks drank water by bending down and placing their open bills in water pointing upward by scooping and raising the bills to swallow the water. Similarly, resting was significantly higher (t = -2.514, P<0.01) in summer. Resting activity also differed significantly; storks spent more time resting in summer (69.4 ± 3.49) than winter (44.2 ± 10.3) (t = -2.3026, P<0.01).

Activities of Black-necked Storks in 1996 & 1997

In 1996, storks spent equal amount of time for all activities. However, we could not find any explanation for this behaviour. Whereas in 1997, chasing activity differed statistically, where storks spent more time chasing in winter (2.98 ± 0.66) than summer (0.68 ± 0.46) (t = 2.8380, P<0.01). Rest of the activities did not differ statistically between the two seasons.

Table 1. Per cent time spent on different activities by Black-necked Stork in three years

Year	Sex	Preening	Chasing	Foraging	Resting	Flying	Miscell.*
1995	Male	6.32	0.3	24.8	57.2	5.16	6.22
	Female	4.7	1.68	12.5	72.6	3.23	5.29
	Combined	5.67	0.82	20.7	62.6	4.37	5.84
	N	**413 h**					
1996	Male	7.25	1.1	15.2	70.4	1.1	4.95
	Female	8.73	1.8	20.5	63.4	0.87	4.7
	Combined	7.8	1.4	17.5	67.4	0.75	5.15
	N	**543 h**					
1997	Male	5.46	1.88	29.1	58.2	0.64	4.72
	Female	9.4	1.75	15.4	67.4	0.37	5.68
	Combined	7.17	2.08	24.1	63.2	0.54	2.91
	N	**617 h**					
Overall		6.85	17.3	17.76	45.7	4.17	8.22

* - Miscellaneous activities include Walking, Flying, Drinking, Yawning, Wing stretching, Bill clattering, Bathing and Feeding the chicks.

Table 2. Activities of the Black-necked Stork recorded during winter and summer of 1995-97 at Dudwa National Park. All values are expressed as percentage of time spent engaged in that activity. Percentage values were Arc-sin transformed for statistical analyses. n.s. = non-significant

Activities	Winter February, March mean ± SE	Summer April, May, June mean ± SE	t	Probability
Foraging	20.5 ± 4.88	17.2 ± 2.47	0.596	n.s.
Preening	5.96 ± 1.14	6.03 ± 0.96	- 0.045	n.s.
Chasing	2.25 ± 0.68	0.62 ± 0.21	2.277	0.03
Resting	49.7 ± 6.58	67.3 ± 2.45	-2.514	0.01
Walking	3.03 ± 0.67	4.80 ± 0.74	-1.761	n.s.
Flying	2.80 ± 1.07	2.40 ± 1.43	0.256	n.s.
Drinking	0.10 ± 0.05	0.45 ± 0.17	-1.925	n.s.
Yawning	0.53 ± 0.26	0.30 ± 0.09	0.771	n.s.
Wing stretching	0.35 ± 0.11	0.20 ± 0.05	0.873	n.s.
Bill clattering	0.15 ± 0.04	0.1 ± 0.55	-0.113	n.s.
Bathing	0.66 ± 0.15	0.1 ± 0.16	2.261	n.s.
Feeding the chicks	0.56 ± 0.16	0.3 ± 0.16	1.073	n.s.

Activities of male and female Black-necked Storks

When data of male storks for three years were pooled together to look for any difference among activities between winter and summer, no such differences emerged. However, the female spent significantly more time resting in summer (73.3 ± 2.00) than the winter (47.5 ± 11.2) (t = -2.2628, P<0.01).

Similarly, when data of three years were pooled together and analysed, we found that there was no significant difference in the activities of male and the female storks irrespective of months and habitats except for wing-stretching. In 1996, none of the activity differed significantly between sexes. Whereas, in 1997, males (5.5 ± 2.80) spent less time preening than the females (9.35 ± 0.91) (Z = 2.607, P<0.01).

Habitat-wise differences in the activities of storks

When data of all three years were pooled and analysed, all pairs (Banketal, Kakrakatal and Badhital) spent almost equal amount of time performing various activities except Banketal pair that spent more time resting (χ^2= 6.003, d.f. = 2, P<0.01). No significant difference among activities was observed in the

years 1995 and 1996, however, in 1997 foraging (χ^2 = 7.403, d.f. = 2, P<0.01) and resting (χ^2 = 6.382, d.f. = 2, P<0.01), differed significantly among Black-necked Storks between wetlands. Badhital pair spent less time foraging because fishes here were bigger than those of Banketal and Kakrakatal, thus more prey profitability.

When months were pooled, time spent resting (χ^2 = 6.700, d.f. = 2, P<0.05) differed significantly among Black-necked Storks of different wetlands. In 1996, none of the activity differed significantly either between sex or between habitats. However, in 1997 resting activity differed significantly (χ^2 = 6.525, d.f. = 2, P<0.05) between different wetlands.

Discussion

Storks may often be seen resting on their tarsi. Though this behaviour was common among juveniles and nestlings, the posture curtailed the birds from taking off quickly in emergency. The reason for the stork's prolonged resting period during summer was its high foraging success. It is reckoned that food availability is the most important limiting factor for storks in almost all aspects of their ecology, including distribution, longevity, breeding success and population numbers (del Hayo *et al*., 1992). In Dudwa, foraging bouts of the Black-necked Storks were greatly affected by the presence of other fish-eating birds (Maheswaran & Rahmani, 2001). Prey abundance in most of the wetlands attracted other fish-eating birds. Several studies have demonstrated a link between avian activity pattern and prey abundance (Burger & Piatt, 1970; Monaghan *et al*., 1994). In Dudwa, during summer, due to evaporation, fishes were concentrated in the drying pools which attracted fish-eating birds, resulting in increase in the number of inter-specific conflicts.

Though studies on tropical species show that birds tend to feed mostly in the first and last hours of day light and often spend most of the day loafing, we observed a different trend among the Black-necked Storks. They had an irregular feeding pattern, greatly influenced by changes in water level and presence of other fish-eating birds.

We witnessed an enhanced foraging success among storks and a reduction in the corresponding time taken for foraging especially in Bhadital pair. This was mainly because of the different types of foraging techniques the pair adopted, when compared with others (Maheswaran, 1998). It has been observed that when the prey species are smaller in size, Black-necked Storks used tactile technique for foraging. In Badhital, prey size was comparatively big and this enabled the foraging storks to detect their prey visually.

The Black-necked Storks are very aggressive while defending their territories. Storks showed aggressiveness when intruders decided to feed on fish from the wetlands where the storks reside. The reason why Spoonbills were chased or interacted more with storks might be due to their presence in almost all the wetlands. Similar kind of interaction was observed in Lewis Woodpeckers and Red-headed Woodpeckers in southern Colorado (Bock *et al*., 1971).

According to McNeil & Rompre (1995), among Willets and Whimbrels, during daytime, the higher an intruder pressure, the longer the time devoted to territorial defence and the duration of time spent by Willets on their territories was directly proportional to the number of chases and parallel walks. Even though there was no direct physical interaction between intruders and storks, the latter showed aggressive threat display (bill clattering).

In 1997, the study pairs were seen with a minimum of one to a maximum of three young in their feeding grounds. All young birds were totally dependent on their respective parents for food. This compelled the parents to forage for more time. Apart from this, fish of 4, 5 and 6cm were more available to the foraging storks in Dudwa in 1996 and 1997 (Maheswaran, 1998). The reason behind the availability of this size category fish might be due to the presence of Indian Cat Fish (*Heteropnestus fossilis*) in large numbers in almost all the wetlands. The overall prey profitability derived from fish of 5cm and 6cm was 0.63 and 1.1g/sec, respectively (Maheswaran, 1998; Maheswaran & Rahmani, 2002). To a big bird, this profitability may not be sufficient to meet its own energy metabolism, and has to forage often especially before the breeding season begins. These factors forced the storks to chase the competitors more often in the early breeding season. However, this factor considerably decreased their time spent foraging.

It was the male that fed the juveniles after their departure from the nest around the second week of January 1997. Females were rarely seen feeding the young and even if so with less food. However, during winter, females (while on nest during breeding season) showed increased aggressiveness towards other intruders, giving more time and opportunity to her mate to concentrate more on foraging activity. In summer, the females were seen resting more than the males. The present study is important in the sense, being a bird of freshwater wetlands and waterbodies (except Gujarat where there are reports of the species feeding on fishes along coasts) and the threat these wetlands are facing nowadays in India, understanding the behaviour of a species will help the managers to device strategies in order to manage such wetlands in an effective manner.

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CASE REPORT **ZOOS' PRINT JOURNAL 22(11): 2878-2880**

PSEUDODIAPTOMUS ANNANDALEI (COPEPODA: PSEUDODIAPTOMIDAE) FROM COASTAL WATERS OF SRI LANKA

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ABSTRACT

The demersal copepod, *Pseudodiaptomus annandalei* Sewell, 1919 is reported for the first time from the plankton samples collected from coastal waters of southern Sri Lanka during August 2004 to January 2005. These new data together with existing data on distribution of the *P. annandalei* indicate that it has the largest geographical ranges for Indo-Pacific pseudodiaptomids.

KEYWORDS

Calanoid copepod, illustrations, new record, *Pseudodiaptomus annandalei*, Sri Lanka

ABBREVIATIONS

P5 - fifth swimming leg; Pr - prosome; Ur - urosome; Ur1-5 - urosome segments 1-5; MS1-5 - mesosome segment 1-5; CR - caudal ramus.

The demersal copepods of the genus *Pseudodiaptomus* Herrick (1884) for *P. pelagicus* from specimens collected near the mouth of the Mississippi river are circumglobal in tropical and temperate regions, mostly in estuaries and near shore environments. Typically, pseudodiaptomids are found in shallow coastal waters (0.5-15m) over sand or grass flats, coral reefs and rubble, and mud bottoms of river mouths. Unlike other planktonic copepods, the shallow-water demersal nature of *Pseudodiaptomus* has rather restricted distribution of species and has conducive to geographical isolation of species that makes the genus as an ideal group for a zoogeographic study (Walter, 1987; Mulyadi, 2001). With the intension to confirm the occurrence of demersal *Pseudodiaptomus* species, the authors examined more than 20 samples from five sites (Fig. 1) along the southern coastal waters of Sri Lanka. The present paper deals with the occurrence of *P. annandalei* Sewell, 1919 from coastal waters of Sri Lanka.

MATERIALS AND METHODS

The material was sorted from plankton samples collected from five sites, i.e., Galle, Weligama, Matara, Tangalle and Hambantota, along the southern coastal belt of Sri Lanka from surface and subsurface layers, using hand-towed conical plankton net (aperture diameter 30cm, mesh size 300µm) during the August 2004 to January 2005. All samples were preserved immediately in buffered 4% formaldehyde before transfer to 70% ethanol. Two or more males and females of *P. annandalei* were dissected in pure dehydrated glycerin medium under stereomicroscope (Wild 3MB) and mounted in glycerin medium as temporary slide preparation. Measurements were made with an ocular micrometer and drawings were made with the aid of camera lucida (Olympus 1.25x) on an Olympus CH2 microscope (10x, 40x or 100x objective lens, 10x ocular lens). Total lengths were taken dorsally from anterior margin of head to distal end of CR (excluding caudal setae). Length of the prosome and urosome were taken dorsally from the anterior

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