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SHORT COMMUNICATION

POPULATION STRUCTURE, FEEDING HABITS AND ACTIVITY PATTERNS OF THE AFRICAN SACRED IBIS (*THRESKIORNIS AETHIOPICUS*) IN DILLA KERA AREA, SOUTHERN ETHIOPIA

Meseret Chane[1,]* and M. Balakrishnan[1]

ABSTRACT: A study on population structure, feeding habits and activity patterns of the African sacred ibis (*Threskiornis aethiopicus*) was carried out around Dilla Kera area during April–September, 2015. Two 3 km long transects were laid using GPS. Birds were counted within a 50 m belt on either side of the transects twice a day (06:30–10:30 h and 15:30–18:30 h) by walking along the transect lines. Focal animal sampling method was used to study activity patterns. Data were documented twice monthly for six months including dry and wet seasons. Data were analysed using descriptive statistics, independent t-test and chi-square test. Kruskal-Wallis test was performed to compare activities between time blocks. A total of 165 individuals were counted during the dry season and 53 individuals during the wet season. Counts during the dry season were significantly higher than those during the wet season (χ^2=56.8 df=1, p<0.05). The average mean population density of African sacred ibis in the area was estimated to be 20.55±3.28 individuals/km^2. The age ratio of adult to juvenile was 1:0.46 and 1:0.56 during dry and wet seasons, respectively. Feeding on carrions, worms, insects, and other invertebrates was the most important diurnal activity of the African sacred ibis, followed by scanning, flying, preening and resting. African sacred ibis is an opportunistic feeder, which can shift to non-natural food items when the abundance of the prey is less.

Key words/phrases: Activity patterns, African sacred ibis, Dilla Kera area.

INTRODUCTION

Birds select habitats based on vegetation structure, or habitat physiognomy (James, 1971; Svardson, 1993). Avian populations can be influenced by the singular or interactive influences of predation, intra and interspecific resource competition, parasites, diseases, habitat availability and weather (Andrewartha and Birch, 1954; Begon and Mortimer, 1986). The magnitude of the influence of these factors may vary in importance according to geographical area, food habits and migratory status of birds (van Balen, 1980). Activity time budget data are useful in studying the ecological,

[1] Department of Zoological Sciences, College of Natural and Computational Sciences, Addis Ababa University, Addis Ababa, Ethiopia, P.O. Box 1176, Ethiopia. E-mail: meseret.chane2009@gmail.com
* Author to whom all correspondence should be addressed

behavioral and physiological aspects of birds to develop appropriate survey techniques and to manage threatened or endangered species (Hamilton *et al*., 2002; Jonsson and Afton, 2006). Time activity budgets reflect a combination of factors including individual physical condition, social structure and environmental conditions (Paulus, 1988). The African sacred ibis (*Threskiorinis aethiopicus*) is one of the 32 species of the family Threskiornitidea, 11 of which are found in Africa (del Hoyo *et al*., 1992; Hancock *et al*., 1992). It is the most widespread and most common of this family in this continent (Brown *et al*., 1982). Despite its proximity to humans and high abundance in cities, knowledge of the African sacred ibis or any of the other 31 ibis species (Threskiornithinae) that occur around the world is inadequate (Hancock *et al*., 1992). Many species are endangered, critically endangered or have become locally extinct due to habitat destruction and hunting (Hancock *et al*., 1992). Only few studies have been made on the diversity and ecology of aves in Ethiopia (Mengistu Wondafrash, 2003; Shimelis Aynalem Zelelew, 2013). The present study was aimed at investigating the population structure, feeding habits and activity patterns of the African sacred ibis (*Threskiornis aethiopicus*) in Dilla Kera area, southern Ethiopia.

THE STUDY AREA AND METHODS

The study area

Dilla is located in the Southern Nations, Nationalities and Peoples Regional State of Ethiopia (SNNPRS) in Gedeo Zone, Dilla Zuria Woreda at a distance of 356 km from Addis Ababa, and 86 km from the regional capital, Hawassa. Its geographical location is 6°22′20″– 6°25′30″ N and 38°17′20″–38°20′30″ E. The altitude of Dilla town is 1510 m asl. The mean annual temperature in the area is 27°C and the mean annual rainfall is 1224 mm. Out of the total area of the Zone, 67.53% is sub-humid (“Weynadega”), 32.41% is humid (“Dega”) and the remaining 0.6% is dry (“Kola”). Dilla Kera area is located in Harro Wollabo Sub-city in an area of 7.5 km^2 (Fig. 1).

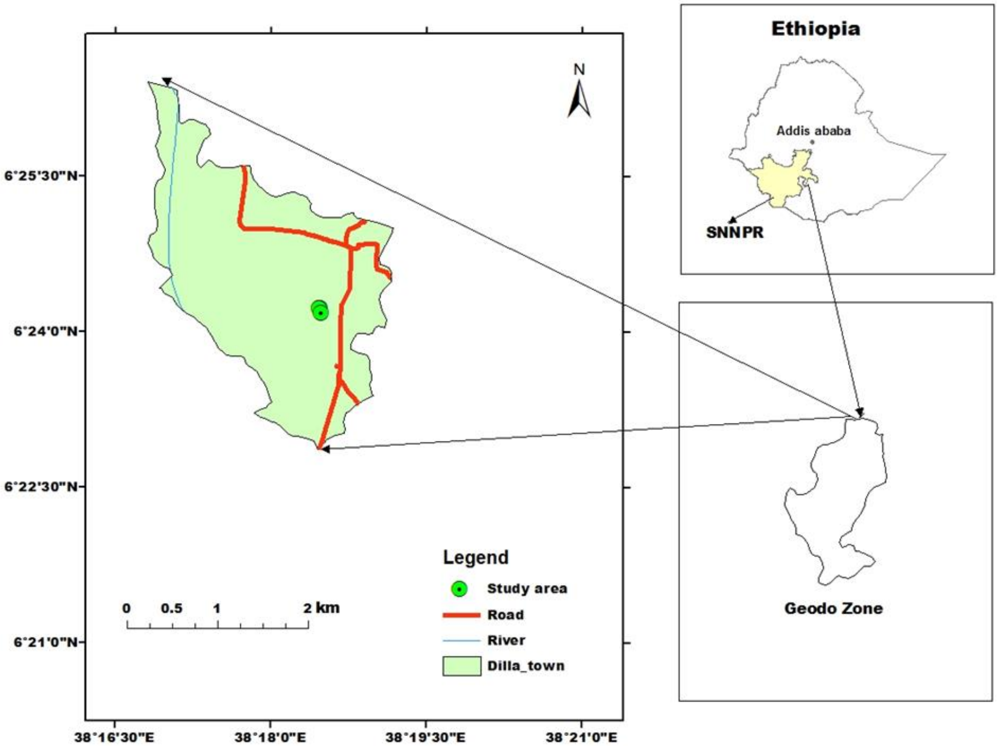

Fig. 1. Map of the study area.

Data collection

Line-transect method described by Gaston (1975) was followed to study the population and density of the African sacred ibis due to the nature of the study area, which is predominantly open with sparse distribution of trees. In the habitat, two 3 km long transects were laid using GPS. Birds were counted within a 50 m belt on either side of transects. Census data were collected twice a day, morning (06:30–10:30 h) and afternoon (15:30–18:30 h) by walking along the transect lines, when most of the avian species were active. Field data sheet was used to record the number and approximate age of the sacred ibis observed. To avoid double counting, routes were spaced out (Niemuth *et al*., 2006). To minimize disturbance during counting, silent movement followed by 5 minutes of waiting period was allowed to settle down from any disturbance (Hosteler and Main, 2001). The data obtained were extrapolated to estimate density as number per square meter using the following formula:

D = Number of birds/2 x L x W

Where L = Length of transect and W = ½ width of transect

Population size of sacred ibis was estimated by multiplying the population density (D) with total extent of habitat, following the method of Buckland *et al*. (1993).

N= D x A

Where N= Total population size

D = Population density (individuals per km^2)

A= Total extent of habitat

Repeated observations were made to collect data on feeding habits. Time spent on feeding was recorded using focal sampling, following Pomeroy (1992) and Bhatt and Kumar (2001). Focal sampling consists of watching an individual for 10 minutes. Data on the type of food items consumed and time spent for foraging were recorded. Data on the type of food items consumed were designated as plant, worm, insect, frog, lizard and other invertebrate items. Individual bird was followed at a distance of 10–30 m, based on the behaviour of the individual.

Activity patterns of African sacred ibis were documented twice monthly for six months including dry and wet seasons from 06:30–18:30 h and followed from a near distance range of 5 m to 15 m as conditions favoured. Focal animal sampling method (Altmann, 1974) was used to study time activity patterns. Each observation session started with the choice of a focal individual bird, by selecting the closest readily visible individual. A single bird was observed throughout the day. If that bird was out of sight, another individual closest to the observer was selected (Altmann, 1974). The focal individual was observed with 7x50 field binoculars continuously for 15 minutes, followed by a 5 minutes break. The duration of each behaviour was recorded using a stop watch. In each season, the behavioural data of sacred ibis were collected for 72 hours. Time spent in different activities was calculated, and the percentage time spent for each activity during different times of the day was estimated.

The activities were divided into the following five major categories:

(i) Scanning: perched in an upright position scanning surroundings actively

(ii) Flying: in flight, often in pursuit of prey

(iii) Feeding: capturing prey and swallowing

(iv) Preening: comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, body shaking and tail shaking

(v) Resting: perched sleeping or dozing with head retracted and eyes closed

Data analysis

Data collected were analyzed using SPSS version 20 computer software programme. Chi-square test was used to compare mean seasonal population count and density. Independent t-test was used to compare population count along transects and activity patterns between season. Kruskal-Wallis test was performed to compare activities between time blocks. Significance of all tests were assessed at $\alpha = 0.05$.

RESULTS

Population count

A total of 165 individuals of the African sacred ibis was counted during the dry season and 53 during the wet season. Counts during the dry season were significantly higher than those during the wet season ($\chi 2=56.8$, df=1, $p< 0.05$). The highest and the lowest counts were in June and August, respectively (Fig. 2). There was significant variation ($p<0.05$) on the counts of transects one and two between the two seasons (Table 1).

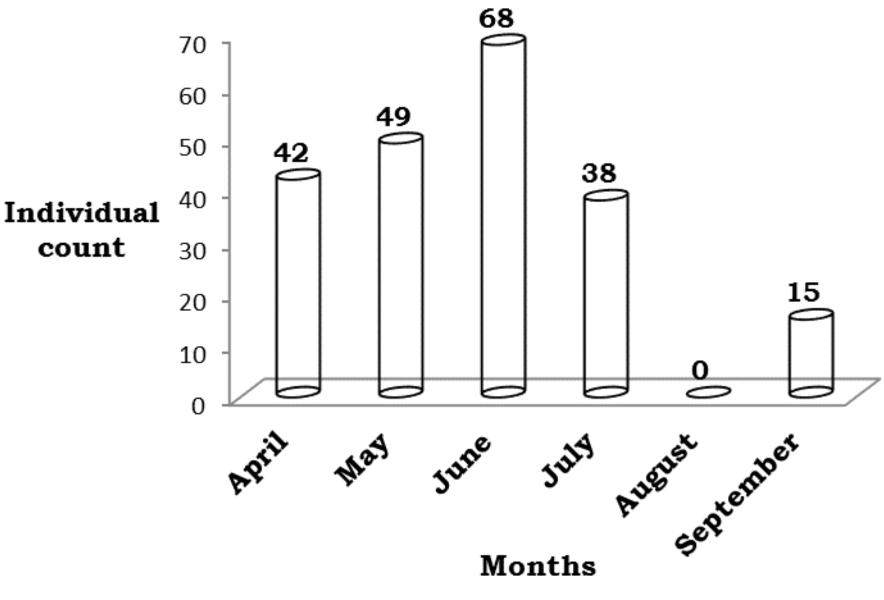

Fig. 2. Monthly counts of African sacred ibis population in the study area.

Table 1. Comparison of transect counts between dry and wet seasons using t-test.

Transect	t-value	p-value
T1	4.4	0.00*
T2	4.7	0.001*

*Comparison is significant at 0.05 levels (2-tailed)

Population size and density

The mean population density of African sacred ibis was 9.82±3.41/km^2 during the wet season and 31.28±3.16/km^2 during the dry season (Fig. 3), with an average of 20.55±3.28 individuals/km^2. Mean population density during the dry season was significantly higher than during the wet season ($p<0.05$). The population sizes of sacred ibis were estimated to be 235 and 71 individuals during dry and wet seasons, respectively, with 95% confidence interval of 180–289 and 15–133 at 17 degree of freedom. The total population size estimated from the mean population density estimate (D = 20.55±3.28) was 155 individuals with 95% confidence interval 100–209 at 1 degree of freedom.

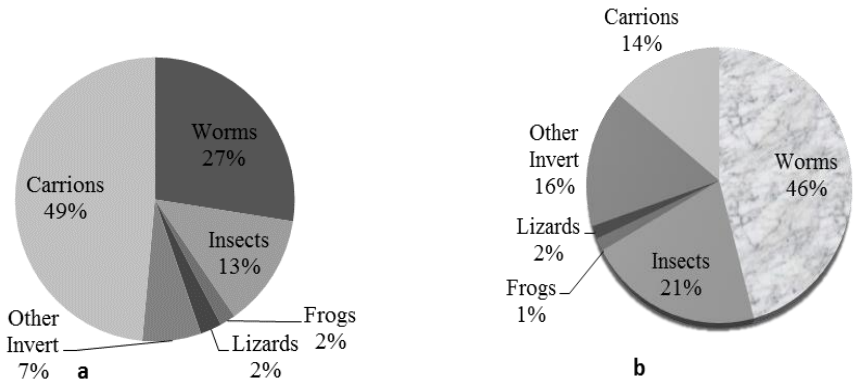

Fig. 3. Diet of African sacred ibis during the dry season (a) and (b) wet season.

Age structure

Out of the total number of 218 individuals counted during the present study period, 137 (62.8%) were adults and 71 (36.2%) were juveniles. The age ratio of adult to juvenile was 1:0.46 and 1:0.56 during the dry and wet seasons, respectively (Table 2). There was no significant difference in the age ratio observed during wet and dry seasons ($p>0.05$).

Table 2. Percentage of time spent (mean ± SE) on different activities by African sacred ibis in relation to the time of the day (H = K-W value; P = p-value).

Activities	**Time of the day, h**					
	12:30–09:30	**09:30–12:30**	**12:30–15:30**	**15:3-18:30**	**H**	**P**
Feeding	50.1±3.29	30.9 ±3.94	26.5 ±3.54	48.9±3.00	22.88	0.000*
Flying	14.2±1.93	10.1±1.39	7.0 ±1.16	20.4±2.34	20.88	0.000*
Scanning	26.1±2.38	39.2±2.61	43.1±2.32	22.9±2.04	26.78	0.000*
Resting	4.7±1.08	9.1 ±2.38	11.1±1.97	3.3±0.75	13.05	0.005*
Preening	4.9±1.01	10.7 ±2.04	12.3 ±1.71	3.5 ±1.71	14.65	0.002*

*Differ significantly (Kruskal–Wallis test, $p<0.05$) between time blocks

Feeding habits

Out of the total of 12 focal observations of foraging sacred ibis (six observations per season), 415 feeding records were made with a mean number of 34.6 feeding records per observation. From the total feeding observations, 280 (67.5%) were during the dry and 135 (32.5%) were during the wet season. Feeding observations during the dry season were significantly higher than during the wet season ($p<0.5$).

Direct observations have revealed that sacred ibis was carnivorous. They mainly feed on carrions during the dry season (49%) and worms during the wet season (46%) (Fig. 4). From the identified food items, consumption of carrions was significantly higher during the dry season than the wet season ($\chi 2=88.3$, $p<0.05$), whereas other food items did not show significant variations between the two seasons.

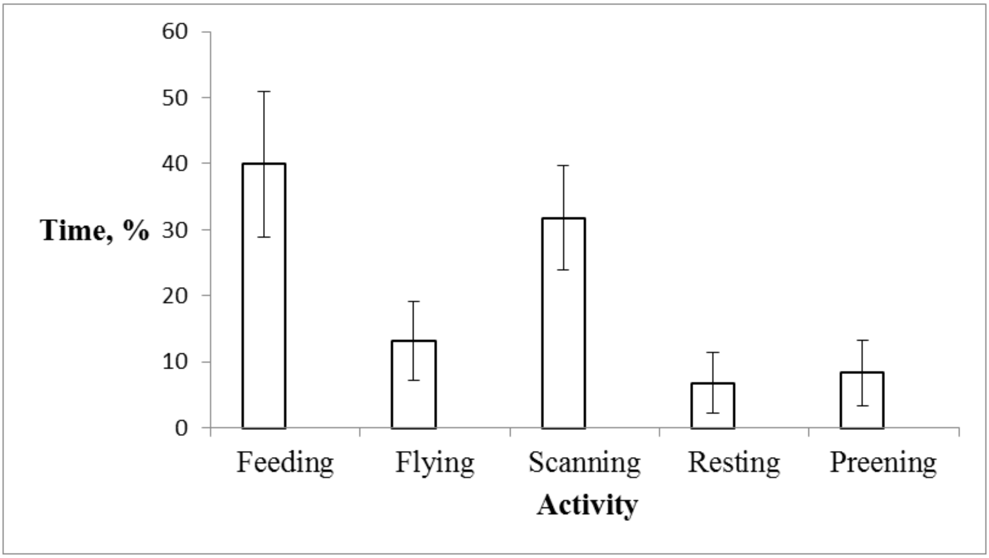

Fig. 4. Diurnal activities (mean + SD) of the sacred ibis.

Diurnal activity patterns

Feeding was the most important diurnal activity (39.9±11.1), followed by scanning (31.8±7.9) (Fig. 4). There was a strong relationship between time allocated to each activity and time of the day (Table 3). Feeding activity varied among daylight hours and was higher in the morning (50.1±3.29%) and evening (48.9±3.00%) hours than during mid-day (26.5±3.54). The peaks in flying were similar to the peaks in feeding in all the time blocks of a day, whereas scanning, preening and resting were higher during the mid-day (Table 3). Percent of time spent feeding, scanning and preening differed significantly during the dry and wet seasons (Table 3). The African sacred ibis fed least during the wet season (31.5±1.78) and more during the dry season (48.2±2.38). Scanning was the most prevalent activity during the wet season (36.3±2.79) and was the second most prevalent activity (27.3±2.69) during the dry season. Preening and resting activities during the wet season exceeded those during the dry season, while flying was more during the dry season.

Table 3. Percentage of time spent (mean ± SE) on different activities by African sacred ibis during the dry and wet seasons.

Activities	**Seasons**			
	Dry	**Wet**	**t-value**	**p-value**
Feeding	48.2 ± 2.38	31.5 ± 1.78	3.96	0.003*
Flying	15.3 ± 2.69	11.3 ± 1.93	1.22	0.250
Scanning	27.3 ± 2.69	36.3 ± 2.79	-2.316	0.043*
Resting	4.6 ± 2.24	9.1 ± 1.37	-1.695	0.121
Preening	4.7 ± 0.83	12.1 ± 1.17	-5.234	0.000*

*The difference is significant at 0.05 levels (2-tailed)

DISCUSSION

Seasonal difference in population count and density of sacred ibis was recorded in the study area. These were significantly higher during the dry season than during the wet season. It was not associated with the availability of food items. Instead, sacred ibis is a wetland and migratory bird. It had not been seen during the second week of July and arrived during the last week of September in the study area. This was the period when rainfall decrease and insects and worm populations increase. Migration greatly alters the bird population by changing both the number and density. This is related to the findings of Pulliam (1988), who recorded that migratory status is among various factors, which may be cited for the variation in bird density and counts. Jokimakia *et al*. (2002) have shown that different habitat features affect the habitat selection of wintering birds.

Sex and age structure of a population at any given point of time is also an indicator of the status of the population (Woolf and Harder, 1979). The fluctuations in the number of adults and juveniles of sacred ibis were indicative to show that some of the birds were either new visitors or may use other feeding sites. The proportion of adult to juvenile was greater during the wet season than during the dry season. This goes in line with the findings of Hancock *et al*. (1992); where the wet season is associated with breeding season of sacred ibis.

Studies on food and feeding behaviour are crucial to study the ecology of a bird species (Wiens, 1992). In the present study, sacred ibises were observed to feed during the day in flocks. They were observed feeding primarily on worms, insects, carrions and other invertebrates. They consume frogs and lizards occasionally. The food of African sacred ibis includes natural prey items such as fish, frogs and terrestrial and marine invertebrates (Carrick, 1959; Marchant and Higgins, 1990), and non-natural food items such as human food waste and carrion (Marchant and Higgins, 1990). Studies on the diet of other urban-exploiting species have reported that non-natural food items are a primary food source for some species, yet comprise an unimportant food source for others (Marzluff *et al*., 2001; Pierotti and Annett, 2001).

The difference in feeding carrion during the dry season than during the wet season might be due to scarcity of other food items. Wiens (1992) reported that the diet of birds showed variations temporally and spatially in response to the availability of preferred food items.

Time budget is a quantitative expression of how animals apportion their time for diverse activities (Ramachandran, 1998). In this study, feeding was the most important diurnal activity of African sacred ibis. Birds are known to exhibit more feeding early in the morning and late in the evening hours (Sivakumaran and Thiyagesan, 2003; Rodway, 1998). More feeding activity of sacred ibis in the morning is to compensate the loss of energy for metabolic activities during the whole night and late evening may reflect need to obtain energy for overnight energetic requirements. Seasonal feeding activity showed that they feed less during the summer and more during the winter. This might be due to their frequent visit to these feeding sites, when scarcities of food occur in their breeding sites.

The peaks in flying were associated with peaks in feeding. This is because birds prefer to rest than fly during the cold season as reported by Eshetu Moges and Balakrishnan (2014) on movement patterns of African spoonbills.

In this study, scanning was the second time-consuming activity of sacred ibis. They spent much of their time searching for prey and other non-natural food items. Previously, many investigators have reported that scanning is a major diurnal activity in predatory birds (Ettinger and King, 1980; Mahabal, 1991; Sivakumaran and Thiyagesan, 2003). Scanning activity was high during the wet season and low during the dry season. The reason for high percentage of time spent during the wet season was due to heavy rainfall. Birds devote more time for scanning in the heavy rainfall season with cold temperature, while the reverse is true during the summer (Asokan and Mohamed, 2010). High and low amount of time spent in scanning within the time blocks was directly related to the availability of food items.

Resting showed significant difference among the time of the day, and peaked during the mid-day. Tamisier (1976) suggested that an increase in resting during mid-day is a mechanism to minimize the heat load on a bird at higher environmental temperatures. Sleeping mostly on dense trees and rocks was the major diurnal resting activity.

Breast, wings and back were body parts most often preened by African sacred ibis, followed by the tail, neck, rump and feet. The most frequent comfort activities were bill scratching, feather shaking and wing flapping. Spending time for this kind of body maintenance activities was common in several bird species (Khera and Kalsi, 1986; Muzaffar, 2004).

African sacred ibis is intra-African migrant and its migration influences the population number and density. Seasonal fluctuations of foraging behaviour of African sacred ibis were related to the abundance of prey and availability of non-natural food items in the study area. Feeding was the most important diurnal activity because the study area was primarily used for the purpose of feeding.

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