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DIURNAL ACTIVITY PATTERNS AND FEEDING BEHAVIOUR OF AFRICAN JACANA (*ACTOPHILORNIS AFRICANUS* GMELIN) IN LAKE HAWASSA, ETHIOPIA

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ABSTRACT: Birds exhibit great flexibility in adjusting time budget to maintain their daily requirements. A study on the activity pattern and feeding behaviour of African jacana (*Actophilornis africanus* Gmelin) was carried out along the shore of Lake Hawassa, Ethiopia, during the wet (July and August) and dry (January and February) seasons. Scan sampling method was used to study the activity patterns of African jacana. Focal sampling method with 10 minutes observation duration was used to study its feeding behaviour. African jacana were observed engaged in daily activities of feeding, scanning, flying, preening, resting, and showing other antagonistic activities where the feeding activity comprised the highest proportion during both the wet (40.1%) and dry (45.6%) seasons. Time allocated to different activities varied with the different time of the day where African jacanas were predominantly active in the morning and late in the afternoon. There was a statistically significant variation in the type of food consumed by African jacana during the wet season ($F_{1, 39} = 7.86$, $p < 0.05$). They feed primarily on insect (63.7%) followed by worms (16.2), larvae of insects (5.4), snails (5%), seed (3.7%) and other food items (6%). During the dry season, there was also a significant difference in the type of food consumed ($F_{1, 39} = 3.11$, $p < 0.05$). They primarily fed on insects (55.6%) followed by worms (12.2 %), larvae of insects (8.2%), snails (7.1%) seed (6.5%) and others (10.3%). There was no significance difference in the type of food consumed between the wet and dry seasons ($F_{1, 39} = 1.48$, $p > 0.05$). Further ecological studies and impact of human activities on Lake Hawassa should be conducted for the conservation of the bird and other sympatric species.

Key words/ phrases: **Activity patterns; African jacana; Feeding; Lake Hawassa; Scan sampling**

INTRODUCTION

African Jacana (*Actophilornis africanus* Gmelin) is one of the wading bird species with an extremely large range. Of the eight jacana species found worldwide, only African jacana (*A. africanus*) and Lesser jacana (*Microparra capensis* Smith) are found in Africa (BLI, 2016). African jacanas range in length from 23 to 31 cm and its weight is from 137 to 261 g. Jacanas have long and slender necks and toes and claws are extremely long up to 10.2 cm (Redman *et al*., 2009). Their long feet allow them to balance on and move over lily pads and other floating vegetation. The adult has rich chestnut to rufous-cinnamon upper parts, but rump and secondaries are darker and primaries are black. The upper wing is glossy sheen in good lighting. The black hind neck contrasts with the white fore-neck. The tail is short. The under parts are darker maroon-chestnut, except the chin, throat and fore-neck which are white, turning golden yellow on the upper breast. The pale blue bill extends to a large pale blue to grey blue frontal shield. The rest of the crown is black. The sides of the head are white. The eyes are dark brown. They are size dimorphic in which females are about 15 % bigger than males but there is no difference in plumage colouration. The immature African jacanas have blackish washed brown crown and hind neck. They have a white super cilium and the frontal shield is absent or slightly developed. The upper parts are pale brown and the under parts are white, with indistinct yellowish breast band (Redman *et al*., 2009).

Study on the activity of birds is significant in understanding its life history, physical condition, food availability, social structure, environmental condition as well as ecological conditions (Asokans *et al*., 2010; Aissaoui *et al*., 2011). Daily activity is influenced by an individual's need and its interactions with conspecific and other species, environmental factors including ambient temperature, humidity, illumination and precipitation and ecological factors, such as group size, habitat, food availability and predation

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(Lillywhite and Brischoux, 2012). Time budget for-activity patterns are especially suitable for comparative studies among seasons of the year, sexes and different habitats (Sutherland, 2000).

In addition, knowledge on foraging ecology of wetland birds has become fundamental in providing an understanding of the ways in which species in a habitat partition their resources (Schulze *et al*., 2000). The foraging behaviour of birds is significantly influenced by the type of feeding habitat they depend on (Mansor and Mohdsah, 2012). A foraging substrate is the micro-habitat from which birds derive their food items. Focusing on foraging habitat explores how birds utilize different food niches to adapt to the habitat since the portioning of food resource is important for the survival of avian species.

African jacana is one of the 24 Palearctic migrants, reported around Lake Hawassa (Pattnaik, 2014). Limited studies have shown that African jacanas prefer lily leaf as a foraging substrate since insect abundance is higher in this micro-habitat (Bonkewitzz, 1997). In addition, they have shown a unique reproductive behaviour where they are mainly polyandrous in which the female may mate with up to seven males (Tarboton, 1992). The sexual roles are partially reversed: females are dominant over males and patrol a super-territory containing the male's sub territories. Incubation and rearing of chicks are performed by males while females spend most of the time foraging and defending their territories (Hockey *et al*., 2005). Little is known about the biology of any of the Jacanidae, a circumtropical family of shorebirds that inhibit freshwater swamps and marshes. Lack of knowledge reflects the limited field research on tropical aquatic birds in general. Hence, this study envisaged to investigate the activity patterns and foraging behavior of African jacana in Lake Hawassa, Ethiopia.

MATERIALS AND METHODS

Description of the study area

Lake Hawassa is located in the Southern Nations Nationalities and Peoples Regional State (SNNPR) about 275 km south of Addis Ababa. The lake lies between 6˚33′-7˚33′ N latitude and 38˚22′-38˚29′ E longitude (Fig. 1). It is the smallest of all the Ethiopian rift valley lakes having a total surface area of 95 km^2 and a total drainage area of 1, 371.6 km^2. Its mean depth is 11 meters while the maximum depth of the lake is 22 m. The lake is found at a surface elevation of 1,686 m asl. It is about 16 km long and 8 km wide and has an estimated volume of 1.3 billion m^3 (Zinabu Gebremariam, 2010). The warmest months of the year are February and April, with an average temperature of 22˚C. The lowest average temperature within the year occurs in December when it is around 18˚C. The heaviest precipitation is during May-July and September-October (www.worldweatheronline.com.).

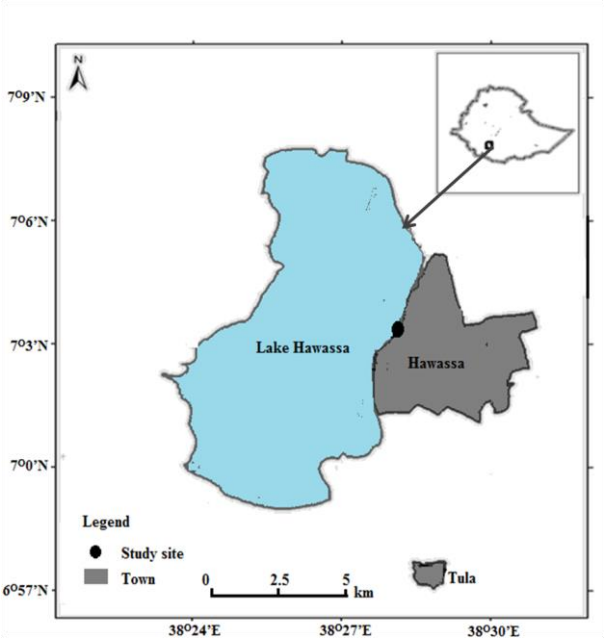

Figure 1. Location map of the study area

Data collection

Ecological studies on the activity patterns and foraging behaviour of African jacana, one of the conspicuous and commonly found birds around Lake Hawassa (locally called "ye fikir hayiq recreation area") was carried out during the wet (July and August) and dry (January and February) seasons in 2017/2018. Data were collected for a total 40 days, 20 days during the wet season and 20 days during the dry season depending on weather conditions when the birds were active.

Activity patterns

Activities were recorded using scan sampling method throughout the study period (Altiman, 1974). During the observation period, a group or an individual bird were followed at a time at a

distance of 5-10 m, depending on their presence. Five minutes scan samples were taken at interval of 10 minutes. The observations were made from early morning to late evening dividing the day into three time slots; morning 6:00–9:00 hrs, mid-day 12:00-13:00 hrs, and late afternoon from 16:00-18:00 hrs. The activities were divided into five major categories following Asokan *et al.* (2010) as (i) Feeding: capturing prey and swallowing into the buccal chamber, (ii) Scanning: actively looking the surroundings, (iii) Flying: moving in the air, (iv) Preening: comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, and body and tail shaking, (v) Resting: dozing with head retracted and eyes closed, (vi) Others: activities such as calling and showing agonistic activity.

Foraging behaviour

To collect data about feeding habits of African jacana, repeated observations were carried out during the wet and dry seasons. Observation was made with the aid of binoculars and naked eye. Time spent on foraging was recorded using focal sampling methods following Sutherland *et al*. (2005). Individual bird was followed from a distance of 5–10 m. Observation was made when the weather condition is not drizzling and raining (Schulze *et al*., 2000). Data were collected early in the morning from 06:00–10:00 hrs and late in the afternoon from 14:00–18:00 hrs, when most of the avian species were engaged in feeding activities (Sutherland, 2000). To find the focal bird, the observer walked approximately 4km/h across the study area and every bird that was actively feeding identified as the focal bird. The bird was first observed for 10 seconds without recording any data. This time period minimized the likelihood of recording only the conspicuous behaviour, and also ensured that the bird resumed normal activity patterns in the presence of the observer (Sutherland, 2000).

Observation of the focal bird while feeding was made for 10 minutes. Time data on foraging behaviour (per minute) was collected. A stop-watch was used to record the start, stop and duration of activity. Observation began as soon as the focal bird began foraging. When the focal individual stopped foraging or was lost from sight before 30 seconds (of the one minute observation) elapsed, these data were not considered for analysis. When the focal bird stopped foraging or lost from sight, another individual bird within the flock was selected as the focal bird in order to complete the observation period (De Melo and Guiherme, 2016). Data were obtained on food capture and handling technique such as (i) picking;- when birds walk on the ground and pick prey along the route; (ii) run-picking;- when picking of insect prey preceded by a short sprint. Food handling, food type and type of foraging substrate selected for food capture were recorded. Each distinct peck at the foraging substrate was considered as a feeding attempt hence number of pecks per minute accurately represented feeding rates (Davis, 1997). The records were treated as independent in the analysis (Fitzpatrick and Bouchez, 1998). To avoid re-sampling the same bird, the observer moved 150 m from the location before sampling of the next bird began (Munoz and Colorado, 2012).

Data analysis

Data were analyzed by using SPSS version 20 computer software program (SPSS inc, IL, USA) and Microsoft Excel. Wet and dry season activity patterns, differences in time budget were compared using two ways ANOVA. Food habits and food handling techniques were compared using one way ANOVA.

RESULTS

Activity Patterns

African jacanas were observed engaged in daily activities of feeding, scanning, flying, preening, resting, and showing other activities. Feeding activity comprised highest (40.1%) followed by scanning (19.6%), flying (16.5%), resting (11.6%), preening (9.7%) and other (2.5%) during the wet season. Similarly, during the dry season, feeding activity was the highest (45.6%) followed by scanning (19.7%), flying (15.2%), resting (9.2%), preening (7.9%) and other activities (2.3%) (Fig. 2). The proportion of time spent for different activity categories by the African jacana varied with season for feeding and flying ($p < 0.05$).

The mean proportion of time spent to different activities varied with the time of the day during the wet and dry seasons (Fig. 3). During the wet season, African jacanas showed higher rates of feeding in the morning and late afternoon hours than the mid-day ($F_{2, 118} = 11.07$, $p < 0.05$). Scanning

rate was highest in the morning than the mid-day and late afternoon ($F_{2, 118}$=5.77, $p < 0.05$). However, time spent for resting was highest during mid-day hours ($F_{2, 118}$= 6.38, $p < 0.05$). There was no statistically significant difference in time spent for preening and other activities in the three time slots ($F_{2, 118}$= 6.64, $p > 0.05$; $F_{2, 118}$= 0.89, $p > 0.05$, respectively).

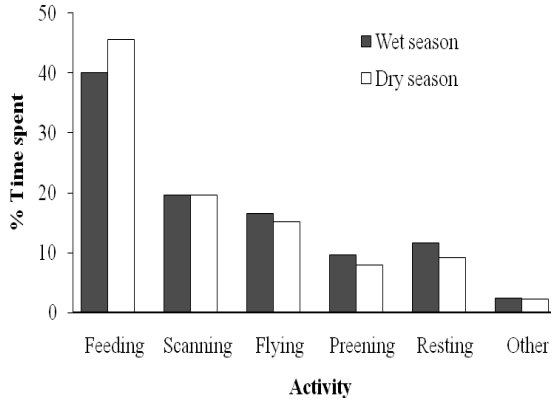

Figure 2. Percentage time spent for different activities in African jacana during wet and dry seasons.

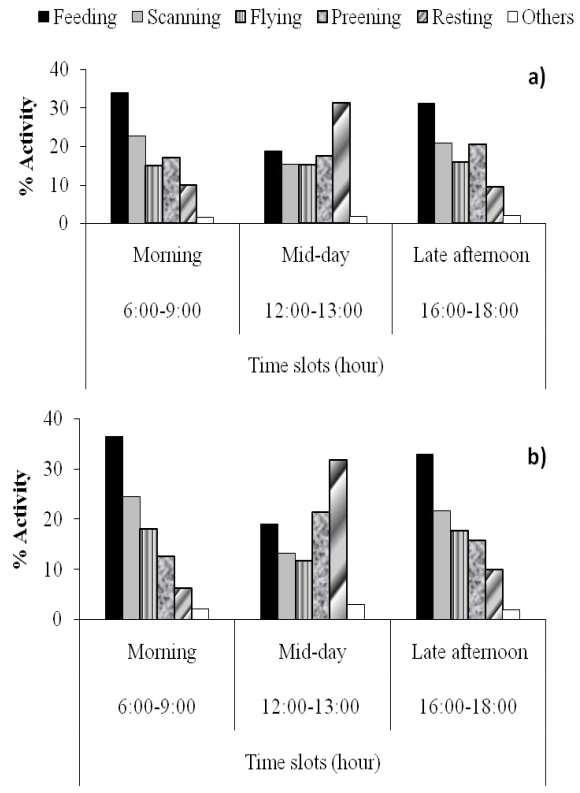

Figure 3. Activity patterns of African jacana in three time slots during a) wet and b) dry seasons.

During the dry season, highest rates of feeding was observed in the morning than mid-day and in the late afternoon hours ($F_{2,118}$ =15.24, $p < 0.05$). A statistically significant difference in the mean rates for scanning ($F_{2, 118}$= 6.9, $p < 0.05$), flying ($F_{2, 118}$= 5.03, $p < 0.05$) and resting ($F_{2, 118}$=4.33, $p < 0.05$) was also observed in the three time slots where scanning and flying were pronounced during morning hours and resting during mid-day hours. However, mean rates of preening and other activities showed no statistically significant difference in the three time slots ($F_{2, 118}$ = 1.13, $p > 0.05$, $F_{2, 118}$ = 0.12, $p > 0.05$, respectively).

Foraging microhabitats

African jacanas used different microhabitats to forage. They were observed collecting insects and seed from the lily leaf, worms and snails from shore line mud flats and occasionally feeding from substrata collecting insects, seed and other invertebrates. During the wet season, 51% of African jacana foraged from lily leaf, 25% from Kissimmee grass (*Paspalidium germinatum)*, 18 % in mud flats and 6% from substrata. During the dry season, they use lily leaf (56%) and *Paspalidium germinatum* (3%) as the main foraging microhabitat and occasionally they were observed searching for food in shoreline mud flats and substrata (Fig. 4).

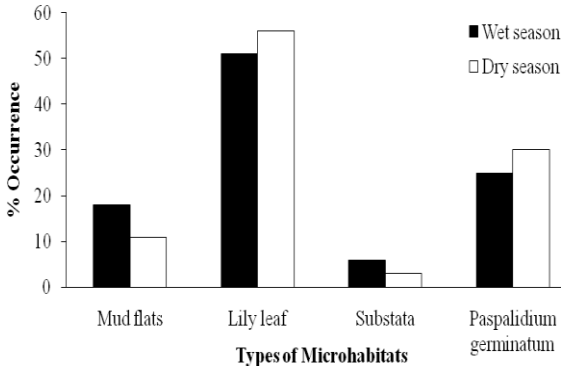

Figure 4. Foraging habitat preference of African jacana during the wet and dry seasons

Food habits

African jacanas were frequently observed foraging on insect (63.7%), worms (16.2%), larvae of insects (5.4%), snails (5%), seed (3.7%) and other food items (6%) during the wet season. During the dry season, 55.6% of their diet constituted insects, 12.2% worms, 8.2% larvae of insects, 7.2% snails,

6.5% seed and 10.3% other food items (Fig. 5). There was a statistically significant difference in the frequency of the type of food consumed by African jacana during both wet and dry seasons ($F_{5,11}$= 5.05, P< 0.05). However, season effect was not statistically significant different in food preference between seasons ($F_{1, 11}$ = 6.06, p > 0.05).

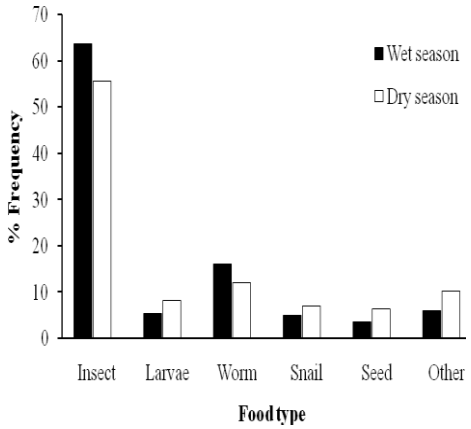

Figure 5. Diet of African jacana during the wet and dry seasons

Food capturing and handling

Two food capturing techniques were observed by African jacanas. These were picking and picking while walking on the ground (98.1%) and run-picking, picking of food preceded by a short sprint (1.9%). The two food handling techniques observed in the African jacana were tearing and gulping (cutting of food into smaller pieces followed by swallowing) and gulping (swallowing upon capture without manipulation other than food being held briefly using the bill). During the wet season, gulping was employed to handle food in 90.2% of the feeding bouts observed while tearing and gulping accounted for 9.8% of the feeding bouts. During the dry season, gulping was employed for 71.6% of the feeding bouts compared to tearing and gulping which accounted for 28.4%. Gulping predominates as a major food handling technique in both seasons (p < 0.05).

DISCUSSION

Birds exhibit great flexibility in adjusting time budget to maintain their daily requirements (Das *et al*., 2011). Daily activity patterns of birds are influenced by several factors including weather, season and habitat (Bull, 1997), even though, activity patterns are likely to differ among species (Blake, 1992). African jacana exhibits variety of activities during morning, mid-day and late afternoon periods within a day. Feeding was the most frequently observed activity of African jacana in during both wet and dry seasons as energy requirements are the driving factor in the time allocation of animals. African jacana exhibited a typical biomodal feeding pattern: one peak during the morning and another peak during late in the afternoon. Many species of birds are known to exhibit maximal feeding early in the morning and late afternoon (Natarajan, 1991; Evers, 1994; Ramachandran, 1998; Rodway, 1998; Sivakumaran and Thiyagesan, 2003; Ali *et al*., 2010, Asokan *et al*., 2010; Aissauoi *et al*., 2011). Higher feeding rate at the beginning of the day may be due to the start of their day-to-day activities, which demands high energy requirements. The feeding peak at the end of the day may reflect the overnight energy requirement of the birds (Kelly, 1998). The differences recorded in seasonal feeding activity indicate that birds spend more time feeding during the dry season compared to the wet season. This may be due to scarcity of food items during the dry season that requires the birds to spend more time forging to fulfill their energy requirements. In addition, a dry season provide favourable weather condition to forage uninterrupted, giving more time for birds to forage.

In the study area, insect preys were abundant during the wet season compared to dry season. This may also have contributed to the relatively shorter foraging duration by African jacana during the wet season as insects fulfill their protein requirements (Asokan *et al*., 2003). Time spent for scanning was the second major diurnal activity for African jacana as it was higher during the dry season than the wet season. This difference may be due to the inundation of the area following rainfall which can reduce the insect prey visibility, abundance and distribution. African jacana also spent considerable time scanning during the dry season that may be associated with the relatively lower abundance of prey items including insects that might have forced them to devote more time scanning compared to the wet season. The amount of time spent to scanning in different habitats may be inversely related to the availability of insects. When insects are abundant, the birds spend less time on scanning (Ali *et al*., 2010). Resting was highly pronounced during the mid-day hours

mainly on Kissimmee grass *(Paspalidium germinatum)* that may be attributed to the mid-day heat during this time slot. An increase in resting during midday helps birds minimize heat load during high environmental temperatures (Tewodros Kumsa and Afework Bekele, 2013). Previous studies on the activity patterns of the birds (Abrham Megaze and Afework Bekele, 2013; Wlodarczyk, 2017) have revealed similar patterns of resting during the mid-day. Preening occupied a small portion of the time budget that was usually performed in the early morning and late evening as a means of feather maintenance. It was highly pronounced during the wet season, as they need to preen their feather after a heavy shower. Similar finding was also observed in bronze-winged jacana (Akhatar *et al*., 2009).

Foraging behaviour of African jacana showed that they utilize different microhabitats for searching their food and forage. Among these, the preferred habitat of African jacana was water body covered with lily leaf followed by *Paspalidium geminatum* grass during both wet and dry seasons. This may be due to the greater food abundance compared to other micro-habitats and also better cover while foraging minimizing predation risk as reported by Bonkewitzz (1997). In this study, African jacanas were observed feeding on a variety of food item although insects constituted the highest proportion during both wet and dry seasons. High feeding frequency on insect could be due to the growth of different vegetation that support insects during the rainy season and also the emergence of variety of insects immediately following the rainfall during the dry season ensuring insect abundance. Tewodros Kumsa and Afework Bekele (2013) noted that animals become vulnerable to nutritional deficiencies when they are extremely selective in their diet and are easily affected to the slightest disturbances in their habitat. Hence, generalist species benefit a lot as they can exploit a wider range of food resources, adjusting their diet preferences. The insect groups consumed by African jacana included Diptera, Hymenoptera, Trichoptera, Lepidoptera, Odonata, Coleoptera (Bonkewitzz, 1997). Feeding activity on lily leaf in the present study may provide wide spectrum of insect prey. An insect diet has nutritional value and digestibility of fat and proteins (Okolie *et al*., 2015) and constitutes elements essential for growth and hence most birds depend on insects.

African jacanas were observed picking and gulping food items, only occasionally tearing before gulping. Such food capturing and handling technique may have an advantage in maximizing energy input with less energy expenditure in food handling and also as a means of efficient time budgeting of foraging activity in habitats such as Lake Hawassa where human disturbance is common. Habitat destruction and human disturbance due to recreational activities are major threats to African jacana and other birds in Lake Hawassa that require immediate conservation measures.

CONCLUSION

Wetlands support a wide variety of bird species that depend on the habitat for foraging and other biological activities. The degradation of such habitats and anthropogenic disturbances has an adverse effect on water birds such as waders. In Lake Hawassa, African jacana is one of the waders commonly observed along the shoreline. They are predominantly active foraging early mornings and late afternoon hours with peak resting during mid day hours. Lily leaf is the major microhabitat they use as a foraging substrate consuming a wide variety of insects as a major diet. Arican jacanas were frequently observed foraging with frequent scanning of their habitat. The shoreline of Lake Hawassa is frequently visited by people that use the different recreation centers causing disturbances to African jacana and affecting their normal behavioural activities. Conservation of Lake Hawassa and protection of its shoreline habitats with minimal disturbance on wader birds is important for human-wildlife coexistence.

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