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AN ECOLOGICAL STUDY ON HAMERKOPS (*SCOPUS UMBRETTA*) ALONG LAKE HAWASSA, ETHIOPIA

BY

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An Ecological Study on Hamerkops (*Scopus umbretta*) Along Lake Hawassa, Ethiopia

A Thesis Submitted to the Department of Zoological Sciences in Partial Fulfillment of the Requirements for the Degree of Master of Science in Ecological and Systematic Zoology.

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ABSTRACT

An Ecological Study on Hamerkops (*Scopus umbretta*) Along Lake Hawassa, Ethiopia

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A study on population status, foraging nest building and breeding behaviour of hamerkops (*Scopus umbretta*) was carried out along the shore of Lake Hawassa, southern Ethiopia. Data were collected during the wet and dry seasons. Point count method was employed to estimate the population. Direct observation by the help of binoculars and necked eyes was used to record data on foraging, breeding and nest building. Data were analyzed using SPSS version 20 descriptive statistics and paired t test. The mean number of hamerkops in the study area was 168 during the wet season and 314 during the dry season. Hamerkops build huge nest and they spend most of their time in building their nest during the wet season. They breed during the late rain season and early dry season. Cultch size range from minimum three to maximum five. The mean clutch size was 4.3. The mean egg length and width was 45.9 and 34.0 mm, respectively. The mean weight was 27.1 g. Egg laying interval varied between 24 and 48 hours. Incubation started 24 hours after the laying of the first egg. Fledging time depended on the hatching period. Hamerkops feed on different food items at different sites, like fish, fish scraps, frogs and worms. Most of the time they feed on fish scraps during the dry season obtained from the fish market. They frequently feed worms at Fiker Hayiq during the wet season. The feeding pattern significantly differed based sites ($p > 0.05$) in the current study. Further detailed study should be carried out to get more exhaustive information on hamerkops.

Key words: abundance, breeding, egg, foraging, hamerkops, Lake Hawassa, nest building.

1. INTRODUCTION

1.1 Background

Birds are among the most easily defined and readily recognized categories of animals due to their possession of unique feathers. In addition to feathers, the development of forelimbs as wings, mostly used for flight; feathered tail that serves for balancing, steering and lifting; toothless horny beak and hollow skeleton and bipedal locomotion are characteristics of birds (Wallace and Mahan, 1975; Padian and Chiappe, 1998; Tsigereda Dessalegn, 2011).

Most birds have wing shapes that ensure efficient flight. The wings are powered by massive breast muscles, the pectoral and supra-coracoideus, which are responsible for downward and upward strokes, respectively (Newton, 2008). Birds are both visually and acoustically conspicuous organisms of most ecosystems. Because they are comparatively easy to identify, birds have received considerable attention by humans (McLay, 1974; Whelan *et al*., 2008; Tsigereda Dessalegn, 2011).

Birds occupy different habitats and show variations in song, and incredible differences in flight patterns. Birds are often used as a biological model because they are good ecological indicators (Clergeau, *et al*., 2001). Birds can also be used as indicators of sites of high biodiversity (Bibby *et al*., 1992; Hiwot Hibste, 2007). Different birds show adaptations related to their feeding style (Storer, 1971; Tuinen *et al*., 2017).

The hamerkop (*Scopus umbretta*) is a medium-sized wading bird. It is the only living species of the genus *Scopus* of the family Scopidae.

The shape of the head with a long bill and crest at the back is reminiscent of a hammer, which has given this species its name. It ranges in distribution from Africa, Madagascar to Arabia. It occurs in a wide variety of wetland including estuaries, lakesides, fish ponds, river banks and rocky coasts.

The hamerkop is generally considered to be a solitary species, although in good feeding places, such as fish-landing sites, it can be gregarious, with occasionally as many as 50 in one place (https://www.aboutanimals.com, 2015). The hamerkop is one of the iconic species of Africa. It is a genetically distinct bird species (Del Hoyo *et.al.,* 1992). The exact systematic position of its family has long been disputed (Kahl, 1967). There has been no fossil record of the Scopidae (Brodkorb, 1963). The scant fossil evidence suggests the possibility that *Scopus xenopus* may have been better adapted for swimming locomotion and thus may have had different habits from *Scopus umbretta*. If so, *Scopus xenopus* and *Scopus umbretta* may not have had an ancestral-descendent relationship. The tarsometatarsus of *Scopus xenopus* bears a resemblance to that of Pelecaniformes. There are striking similarities between the Shoebill and the Pelecaniformes that are also present genus *Scopus* (Cottam, 1957). The shoebill and hamerkops are two species, which show a blend of morphological characters shared with either waders or non-waders (Sibley and Ahlquist, 1990; Feduccia, 1996; Tunien *et al.,* 2017).

Hamerkops behaviour differs from other birds. One unusual feature of hamerkops is that up to 10 birds join in ceremonies in which they run in circles around each other, all calling loudly, raising their crests and fluttering their wings. They show "false mounting", in which one bird stands on top of another and appears to mount it, but they may not mate and do not copulate. They are considered a species of Least Concern. However, aquatic pollution and habitat destruction could quickly affect their numbers (https://www.aboutanimals.com, 2015).

Hamerkops are widespread and common birds in the Afrotropical region (Wilson *et a l.*, 1987). Hamerkops are medium, dull-brown waterbirds with long crest and flattened bill giving hammer-headed appearance.

They belong to a monotypic family within the Ciconiiformes. Unlike other members of the order, many of them are colonial in their habits. This species is fairly common and is widely distributed in a variety of habitats from sea level to over 3,000 m (Stowell, 1954; Goodfellow, 1958). They are resident though much of Ethiopia and Eritrea and one of the most widespread of all species. It utilizes a wide variety of inland wetland habitats, including freshwater and alkaline lakes, rivers, marshes, streams, muddy pools and sometimes quite small areas or patches of wet ground. They congregate in the presence of a large available food supply, where flocks of 20, 25, 40, 50 and 75 have been observed (Ash and Atkins, 2009). They show buoyant flight, often soaring and may resemble a small eagle (Redman *et al.*, 2009).

Hamerkops fly with a mixture of flapping and gliding, stretching out their legs behind. The neck is drawn back when flapping and extended when gliding (Harrison *et al*., 1993). During normal flapping flight, the head is only partially retracted on the shoulders. When soaring or gliding, a hamerkop usually extends its neck fully and when carrying nesting material in its bill, it fully retracts its head on the shoulders. The flight is buoyant, with about 180-190 flaps per minute. Hamerkops are very agile fliers and are able to maneuver rapidly around trees and other obstacles. The silent maneuverability, coupled with the brown plumage and relatively large, rounded wings, make the bird appear quite owl-like in flight. Occasionally hamerkops are seen soaring on set wings in rising currents of warm air, but this behaviour is less common. Sometimes, when pairs are flying together, the birds communicate with each other by means of a few soft “kek notes”.

In feeding areas or near the nest, hamerkops were seen doing a very rapid, darting, bat-like flight over short distances, during which they sometimes swoop low over the head of another bird (often their mate) standing on the ground. Such erratic flights may serve some display functions. Progress on the ground or in shallow water is by rapid, rather jerky steps, and with each step the head and neck are moved backward and forward. In rapid walking or running, the wings are sometimes held loosely away from the sides or even spread for greater balance (Kahl, 1965). Both the legs and neck are shorter than most wading birds so they feed mainly in shallow water. The beak is deep with a groove along the side. This also helps feeding. This bird consumes frogs and tadpoles are stirred up by shuffling in shallow water (Solomon Mengistu and Afework Bekele, 2015).

Hamerkops build platform nests. They construct an extremely complicated and totally enclosed nests of big size in isolation from its conspecifics (Stowell, 1954; Goodfellow, 1958). The building of such a huge structure by such a small bird will take from four months to six months. Nest construction takes place early in the morning for about 90 minutes. The time of building may differ between individuals. Initially the nest is initiated as a simple cup-shaped structure. The nest cavity consists of a number of room with "a hall, a drawing room and a sleeping apartment." The nest site is usually near the water situated on a rocky cliff, sand bank or on a fork of a tree, sometimes on the ground, often low but it may be up to 150 cm feet above the ground or water (Liversidge, 1963). There is a considerable variation in the size of the nest.

They range in structure from simple depressions on pre-existing sites to completely enclosed and woven nests of very complex architecture. Roofed or enclosed nests are especially characteristic

of small tropical passerines (Collias, 1964). About half of all passerine families contain species which build such nests. Similarly, nests are usually found singly, or with two or three together sometimes in the same tree since a pair often makes more than one nest (Brown et al., 1982; Elliot, 1992). The functions of the nest may be very diverse and many authors have speculated reasons for big sized nests. Protection from predation and solar radiation have been evoked as factors leading to the evolution of different nests (Collias and Collias, 1959). The protection from rainfall and direct temperature is also considered to be the major function of the nest (Conner, 1975; White *et al.,* 1975; Bartholomew *et al*., 1976). Reinforcement of the pair bond is a further possible function (Collias and Collias, 1978). Hamerkops normally feed alone or in pairs, but will also feed in large flocks sometimes. The diet also includes shrimp, insects and rodents. The type of food they take seems to vary by location, with clawed frogs and tadpoles being important parts of the diet. They feed on a wide range of food items and also take very small prey. Resource is plentiful, they feed only part of the day. The usual method of hunting is to walk in shallow water looking for prey. Prey is located differently depending on circumstances if the water is clear, it may hunt by sight but if the water is very muddy, it will probe their open bill into water or mud and close it (Kahl, 1965). So far, studies on the ecology of hamerkops in Lake Hawassa have not been conducted in detail. The present study is an attempt to collect data on nest building, feeding mechanisms and the breeding behaviour of hamerkops.

1.2. Statement of the problem

In the southern region of Ethiopia, along Lake Hawassa, ecological studies of hamerkops such us foraging behaviour and breeding, habitat selection, habitat use, nest building and feeding are poorly known. So, the present study is an attempt to gather information about Hamerkops from the surroundings of Lake Hawassa, Ethiopia.

1.3. Significance of the Study

The findings of this study provide information about hamerkop ecology such as feeding, habitat selection, habitat use, breeding and nest building in Lake Hawassa. These findings will be useful information for any concerned body regarding the general ecology of hamerkops in Lake Hawassa. The findings of this study will also be relevant input for any interested individuals or bodies who would like to conduct further study on this issue.

2. Objectives

2.1. General objective

- To assess the ecology (breeding nest construction and feeding) of hamerkop (*Scopus umbretta)* from the surrounding of Lake Hawassa, southern Ethiopia.

2.2. Specific objectives

- To identify the foraging behaviour of hamerkops.
- To identify habitat association of hamerkops.
- To investigate the nest building, egg laying and hatching processes.
- To study the breeding ecology.

3. Materials and methods

3.1. Description of the Study Area

The present study was conducted along Lake Hawassa, southern Ethiopia. This study area is located 275 km south of Addis Ababa. The town serves as the capital of the Southern Nations, Nationalities, and Peoples' Regional state and located at latitudes of 6° 57' - 7° 9' N and longitude of 38° 24' - 38° 30' E. and at elevation of 1708 m above sea level (Fig. 1). Lake Hawassa lies to the west of Hawassa town. The level of the lake varies considerably from year to year and a dyke has been built to prevent the town from flooding. The surface area ranges between 8,500 and 9,000 ha and the maximum depth is 18-22 m. Hawassa is the smallest of the Rift Valley lakes, but it is highly productive. It has a rich phytoplankton with (over 100 species) and zooplankton that supports large populations of six fish species significant numbers of congregatory water birds occur in the lake, with 20,000 birds counted along less than 25% of the shoreline in January 1999 (https://www.aboutanimals.com, 2015).

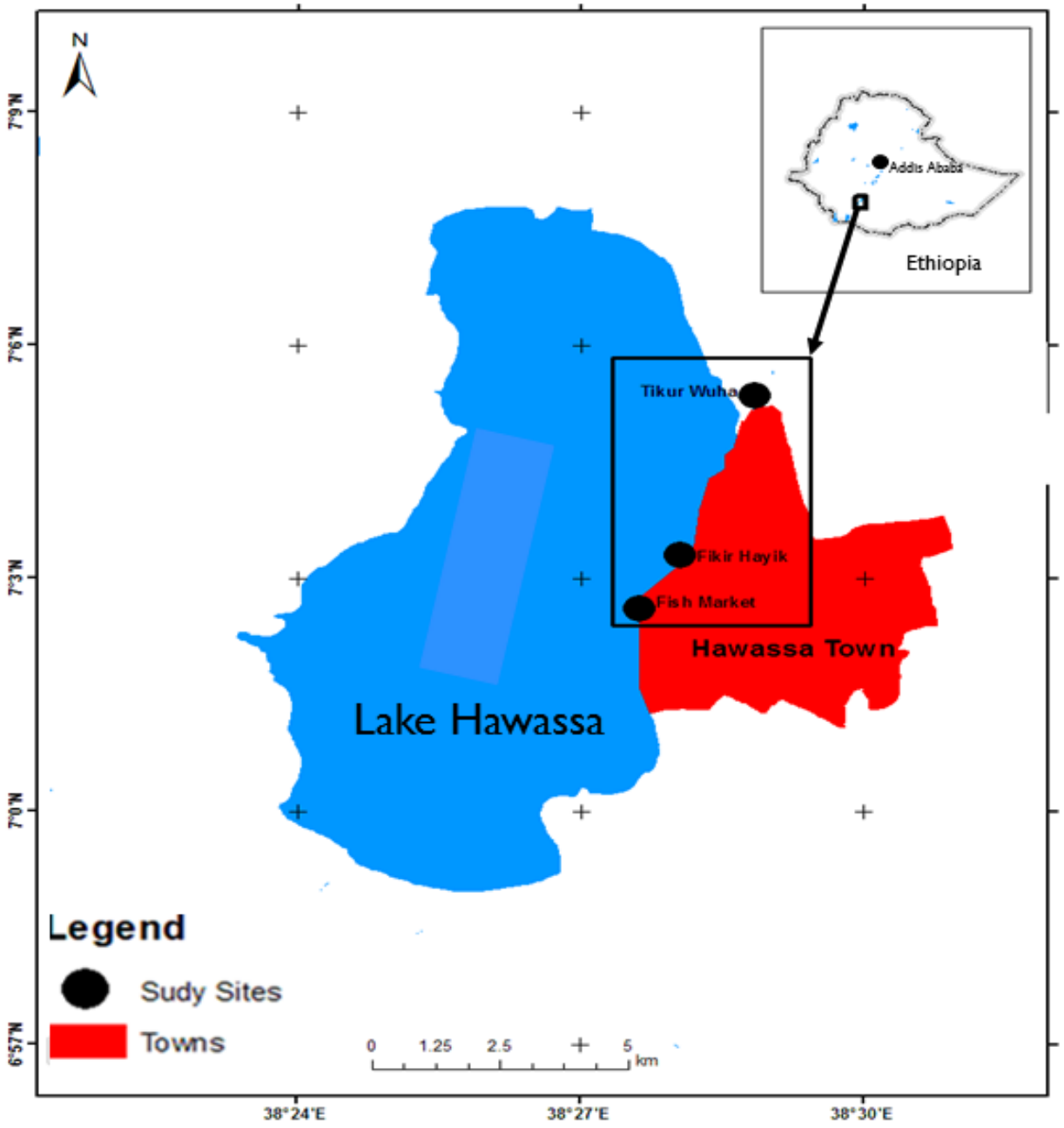

Figure 1. Map of Lake Hawassa and study sites.

3.2. Climate of the Study Area

Lake Hawassa area has a tropical climate with wet season that mainly lasts from July to September and dry season that lasts from January to March with 22.8 C^0 average monthly temperature (Fig. 2) and 63.66 mm of average rainfall (Fig. 3) (2017)

(World weather Online. com).

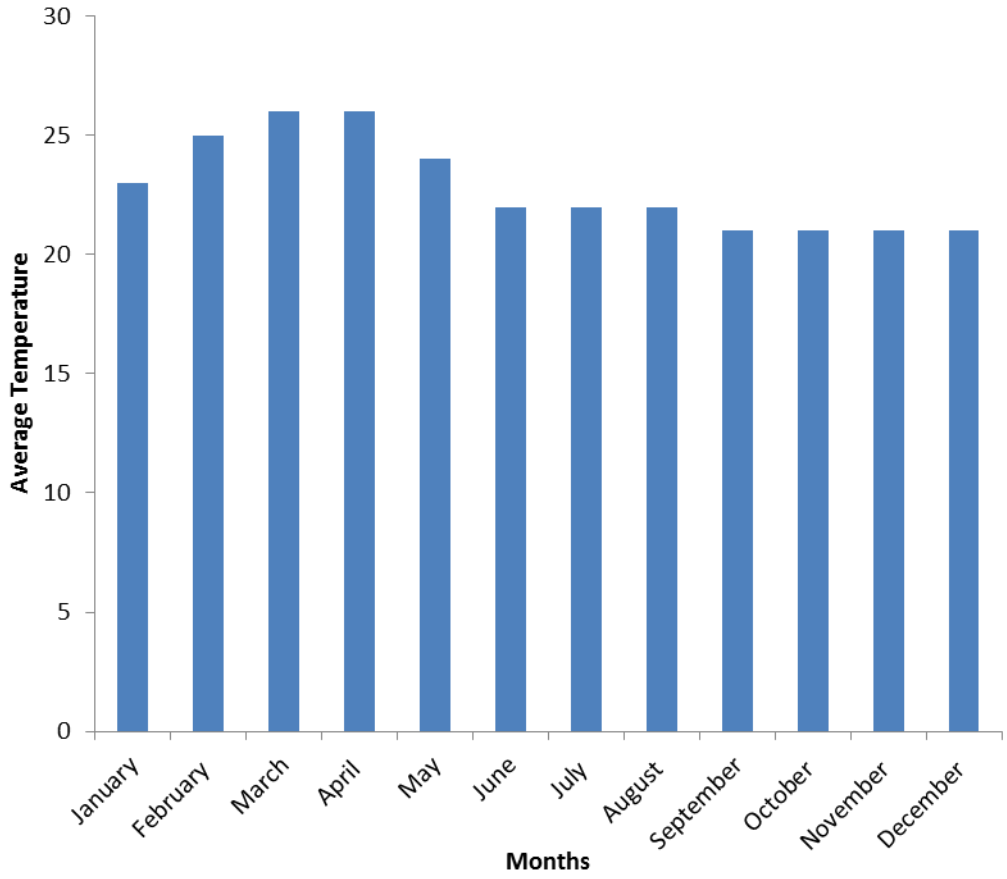

Figure 2. Monthly temperature of Hawassa (World weather Online. Com, 2017).

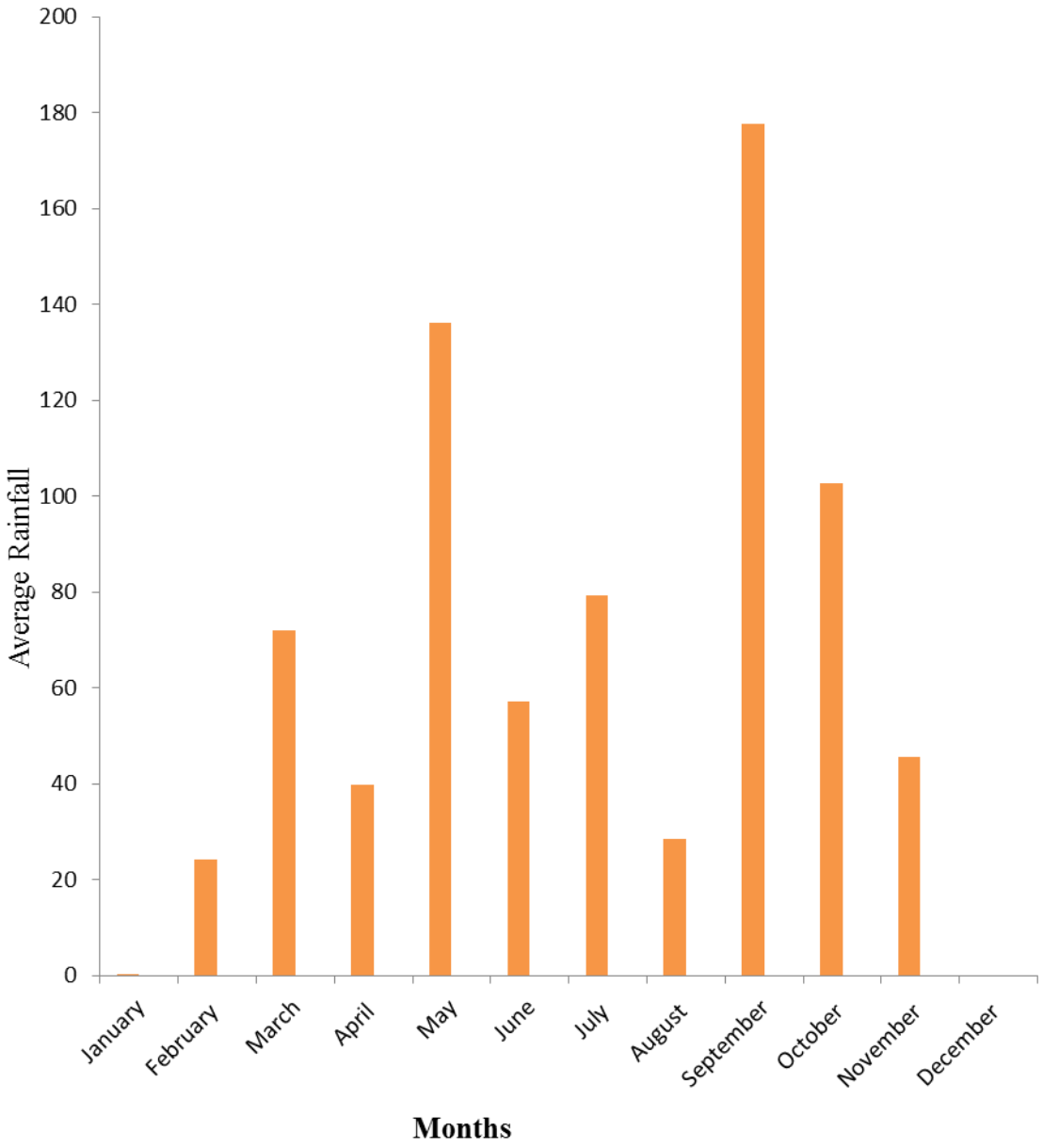

Figure 3. Monthly Ranfall of Hawassa (World weather Online. Com, 2017)

3.3. Materials

Materials used during the data collection period are the following:

- GPS, Digital camera, Field data sheet, Guide books
- Note book, Stopwatch, Pen, Caliper, Binoculars and balance.

3.4. Methods

A preliminary survey was conducted in July, 2017, before the actual data collection, to gather relevant information about the study area and its surroundings. This information helped to identify the specific study area. The actual data collection was carried out from July 2017 to February 2018. The wet season survey was carried out from July to September (2017) and the dry season from December to February (2018). Hamerkop behaviour on nest initiation and associated information was recorded from the beginning to complete the nest building about 11 days during wet season. Weights, length and width of eggs were recorded using scale and caliper (Plate 1).

Plate 1. Measuring egg diameter, length and width during the study period (August, 2017; Photo: Wendsen Endale)

Nests were regularly checked for signs of hatching, fledging and predation starting from the hatching to fledging time about 31 days during the wet season. Timing of breeding in relation to weather conditions was studied as well as the size of eggs and chicks in relation to food quantity and abundance about 5 times during wet season and 5 times during dry season. Hamerkops were

observed within a short distance. Observations were made on the species using binoculars by walking along all parts of the study area, about an hour's where birds were located, 8 days during wet season and 8 days during dry season. The whole area was surveyed thoroughly. Video recordings and photographic pictures were taken for further confirmation. The abundance of hamerkops was studied using a modified point count method following Bibby *et al.* (1992). Census data were collected twice a day, morning (9:30 – 11:30 h) and late afternoon (3:30 - 6:30 h). Nests were visited systematically twice a day from July 2017 to February 2018 during the study period.

Hamerkops also were directly counted as breeding colonies, and at roosts, flocks, or lakes though direct observation by eye contact. The study area can be classified into three suitable sites (Tikurwuha, Fikerhayik and Fish market sites). These site were selected to collect data on relative abundance of hamerkops. The three sites were chosen as they were important feeding and roosting places of hamerkops in the study area. To estimate the population size and detect changes in population size or species diversity, both wet and dry seasons were accommodated

4. Results

4.1. Abundance

Abundance of hamerkops in the study area correlated with season. Individuals of 168 and 314 were counted during the wet (July to September) and dry (December to February) seasons, respectively (Table 1).

Table 1. Number of hamerkops counted during the wet and dry seasons.

	Study Sites			
Season	site1	site2	site3	Total
Wet	50	66	52	168
Dry	104	109	101	314
Mean	77	87.5	76.5	241

The result showed that the largest population of hamerkops was recorded during the dry season (6 5.1%) (Fig. 4).

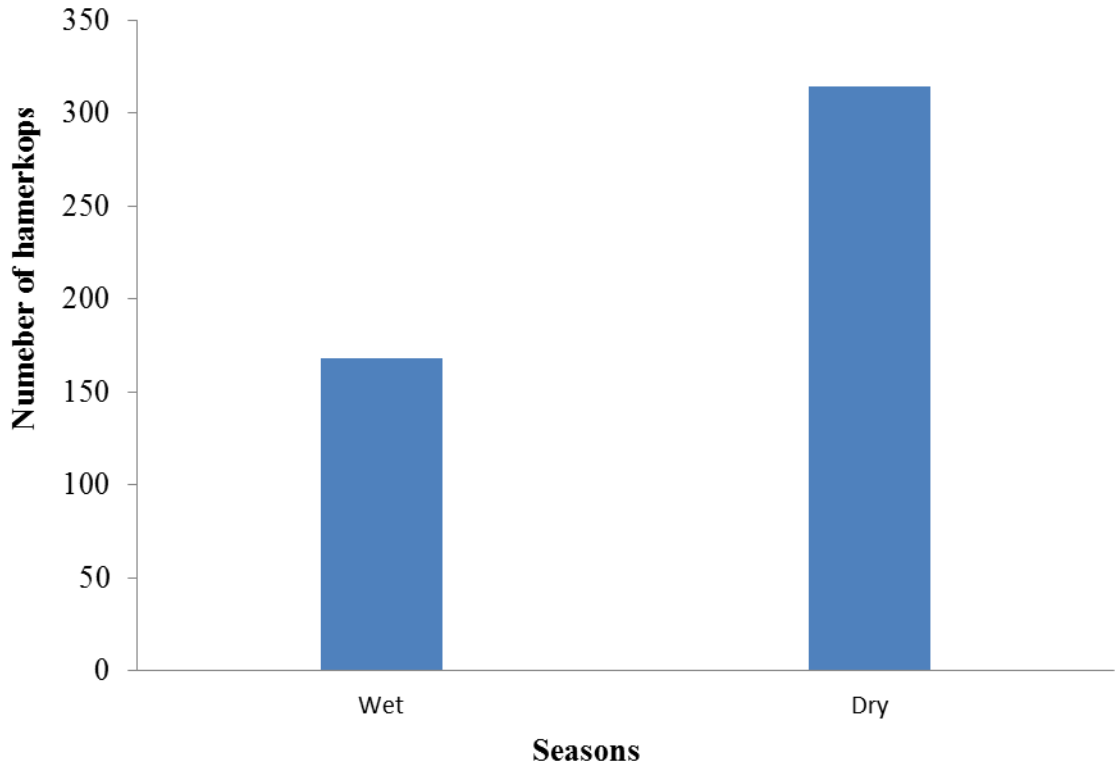

Figure 4. Abundance of hamerkops at wet and dry seasons.

Largest population was recorded at Site followed by Site 2. The least population number was at Site 1. During the wet season, the largest population was at Site 2 followed by Site 3 and the least was from Site 1. The number of hamerkops in Site 3 was the highest, followed by Site 2

and least in Site 1 during dry season. During the wet season Site 2 was the highest, followed by Site 3 and least in Site 1 (Fig. 5).

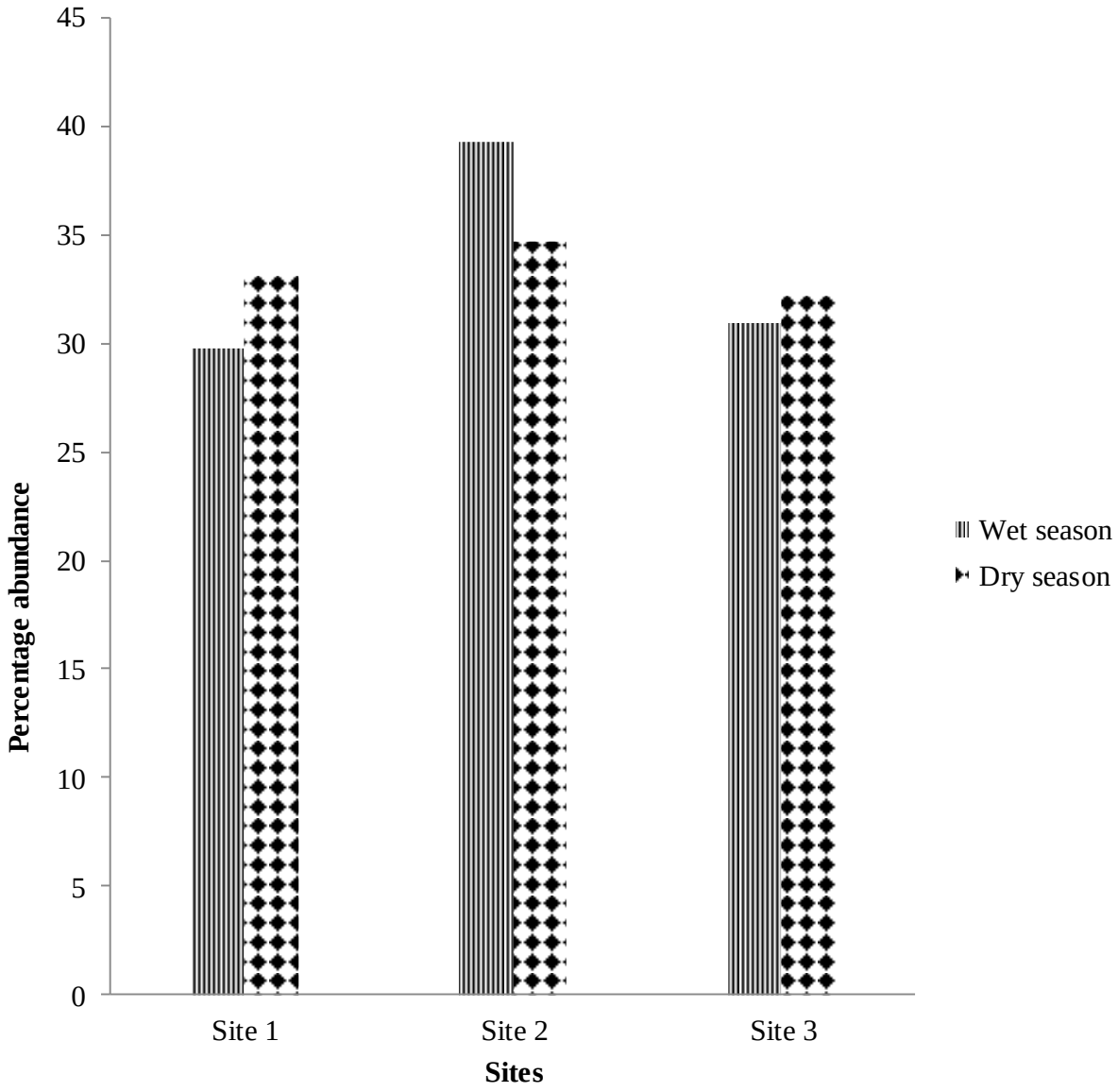

Figure 5. Percentage abundance of hamerkop observed at different sites during wet and dry seasons.

During the wet season, a total of 168 birds were counted in the three study sites. Among the 168 birds, 39 birds were juveniles. There was no juvenile during the dry season (Fig. 6).

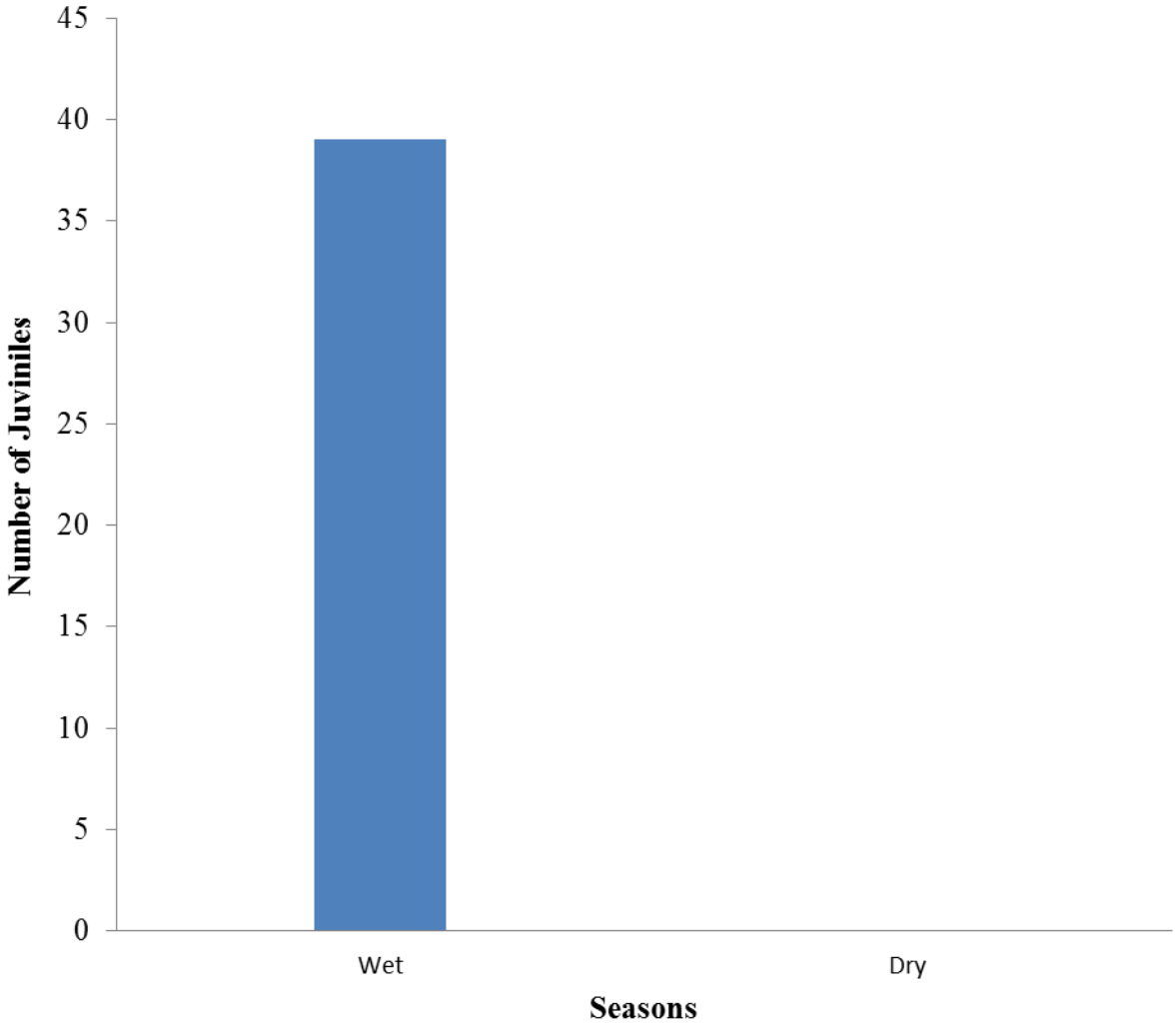

Figure 6. Number of juvenile's during wet and dry seasons.

4.2. Breeding behaviour

4. 2. 1 Nest construction

Hamerkops are generally found in pairs during breeding seasons and though out their life. This suggests that they mate for life and stay together throughout the year. A permanent pair-bond is advantageous in a species that constructs such an elaborate nest. It was not determined whether they use the nest in successive seasons. Construction of the nest at Lake Hawassa was conducted during July to September. Both females and males actively build their nests for about two hours each morning and two hours each afternoon. It took them approximately six weeks for the nest to be completed. Males continue building the nest even if they start breeding. The nest begins as a pile of sticks on the bifurcated branching of the tree (Plate 2).

Plate 2. Nest initiations as a pile of sticks on the branch of a tree (Photo by Zebib 2017).

This pile build up into a large inverted pyramid with a concave platform on top. Then the different sides are built up forming a deep cup with a V-shaped notch in front, which will ultimately become the entrance tunnel. Different sides increase in height and are eventually arched over and joined forming a roof over the hollow interior. use any mass of sticks, grass, mud, plastics, cloth, even money and other material are placed on the top, making the roof thicker and essentially waterproof to protect even the heaviest rain. When completed, the outside dimensions of the nest may be as long as 2 m. and 1-2 m. high (Plate 3). They build their nest at the tip of tree branch and the mean height of the tree was about 10 m from the ground to conceal from predators (Table 2).

Table 2. Type and height of tree during nest building of hamerkops.

Nests	Type of tree	Tree height in meter
Nest 1	*Acacia*	11
Nest 2	*Acacia*	7.0
Nest 3	*Ficus*	12
Mean		10

Plate 3. Huge nests of hamerkops and height of the tree (Photo by Zebib 2017).

The interior of the nest is lined with sticks, grass and mud which is carefully woven. This woven part helps them during breeding period keeping the egg from damage and providing heat for the chicks. Few sharp ends project into the chamber (Plate 4). Access to the nest chamber is through a narrow tunnel near the bottom of one side where predators cannot easily reach (Plate 5).

Plate 4. The interior of hamerkop nest (Photo by Zebib 2017).

Plate 5. A narrow tunnel along the huge nest of hamerkops (Photo by Zebib 2017)

4. 2. 2 Clutch size

A total of 8 nests were built in the study period but only three nest were used for breeding. Hamerkos lay white eggs and the clutch size 3 to 5 (Plate 6). A total of 13 eggs were laid the study period.

Mean clutch size was 4.3± 0.94. Clutch size did not change significantly with time, although the number of eggs per clutch was larger during the late rain season and in the early dry season (Fig. 7).

Plate 6. Clutch size per nest (Photo by Zebib 2017).

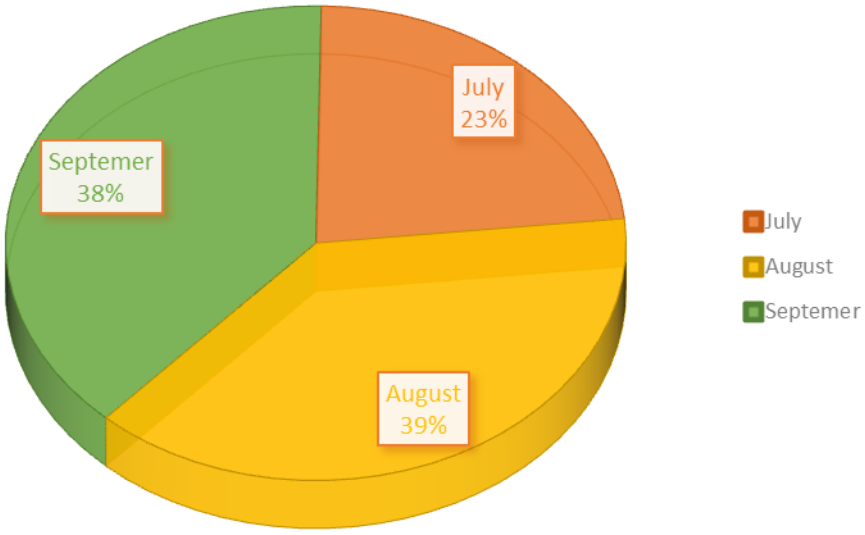

Figure 7. Percentage of eggs per clutch laid during different months**.**

4. 2 .3 Egg dimensions

A total of 13 eggs were counted and measured with a mean length of 45.9 mm (range 44.2-46). Mean breadth was 34 mm (range 33.8-34.2). Eggs laid in July and August were broadest and greatest in volume while those laid in September were smaller in size. Eggs laid by different females also differed significantly in all dimensions (Table 3). Mean weight of 13 laid eggs was 27.1±0.08 g. (27-27.2).

Table 3. Length and width (mm) and weight (g) of eggs in hamerkops

Nest	Cluch Size (mm)	Length (mm)	Weight (gm)	Width (mm)
N 1	5.0	46.0	27.1	34.0
N 2	3.0	46.2	27.2	34.2
N 3	5.0	45.4	27.0	33.8
Mean	4.3	45.9	27.1	34.0

4. 2. 4. Laying interval and incubation period

There were two laying intervals of eggs, 24 hours and 48 hours. The incubation period varied between 28 and 32 days. Most of the incubation during day time is by the female and the male spent their time by nest building and food gathering. Incubation appeared to start about 24 hours after laying of the first egg as hatching is asynchronous.

4. 2. 5. Hatching success

From those incubated nests 10 (77%) of the eggs were hatched and 3 (23%) of the eggs did not hatch. Three were crushed, two were late embryo deaths and one of the eggs failed to hatch for an unknown reason. The highest mortality risk was met after the first three days of hatching because they were altricial and without down feathers during the hatching period (Plate 7). In a brood, earlier-hatched young survived better than later-hatched ones.

Plate 7. Chicks of hamerkops (Photo by Zebib 2017)

4. 2. 6. Fledging success

During the study period three nest were used for breeding and in the three nest 13 egg were laid from the egg only tens are hatched. The mean number of young fledged from successful nests was 3.3. Only 61.5% of young were fledged from completed clutch sizes and 38.5% did not succeed. Mean age at fledging was 47 days.

There were no significant differences in the age at fledging and month of hatching, but young hatched later in the sequence left the nest at significantly younger ages than those hatched earlier in the sequence (Plate 8).

Plate 8. Differences at age at fledging in different hatching periods (Photo by Zebib, 2017)

4. 3. Foraging

Hamerkops are carnivorous, most of the time and foraged on frogs, fish, worms and fish scraps in the three different sites in Lake Hawassa during the study period (Table 4).

Table 4. Number of hamerkops feeding on different food items at different site during the wet season.

	Food Items			
Sites	Fish	Frog	Worm	Scraps
FikirHayik	4	3	27	7
FishMarket	2	0	2	25
TikurWuha	2	1	10	21
Total	8	4	39	53

They fed largely on fish scraps and worms. Occasionally, they consumed small fish and other aquatic animals at different sites depending on the availability of food at different seasons. More number of hamerkops was observed in the vicinity of Site 2 than other Sites along Lake Hawassa during the wet season because of the presence of wetland near to the lake with different worms and frogs in the wetland. They fed frequently at this wetland more than others (Fig. 8).

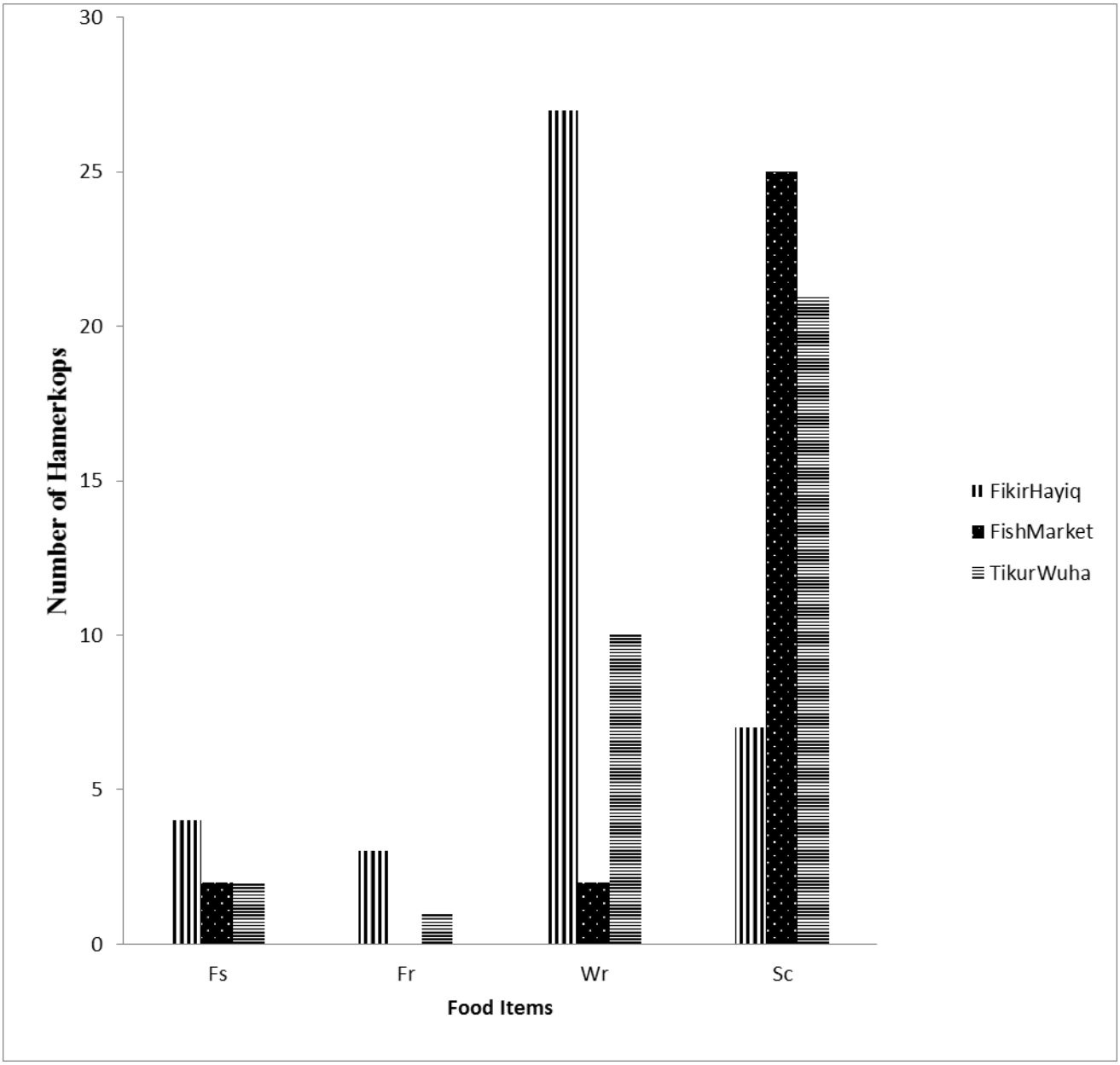

Figure 8. Number of hamerkops feeding on different food items at different sites during the wet season (Fs = Fishs, Fr = Frogs, Wr = Worms, Sc = Scraps).

Hamerkops were frequently observed searching for their prey at Site 2 at different periods (Plate 9).

Plate 9. Hamerkops searching prey at Site 2 (Photo by Zebib, 2017).

However, they were more hamerkops observed searching at Site 3 than other Site due to excess fish scraps at this Site during the dry season (Fig. 9).

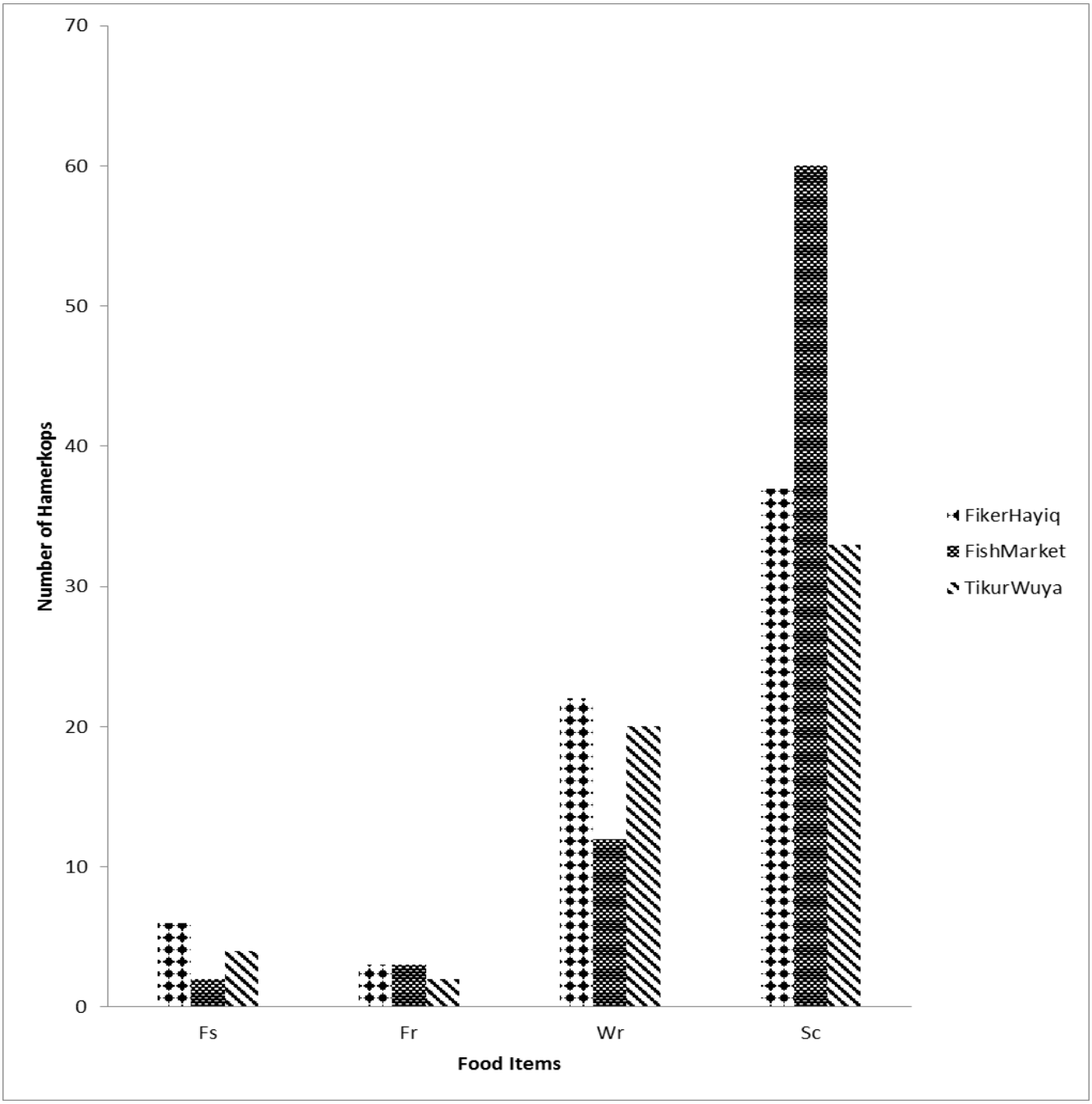

Figure 9. Number of hamerkops feeding on different food items at different sites during the dry season (Fs = Fishes, Fr = Frogs, Wr = Worms, Sc = Scraps).

Generally, hamerkops feed their chicks in the nest for a month. During the period of feeding, they feed them different food items like fish scraps, whole fish and different aquatic animals (Plate 10)

Plate 10. Whole fishes in the nest of hamerkops (Photo by Zebib)

Hamerkops were frequently observed waiting for fish scraps to be thrown and then act immediately (Plate 11)

Plate 11. Hamerkops feeding on fish scraps at Site 3 (Photo by Zebib, 2017).

During foraging, the bird usually walks with rather quick steps along the edge of the lake. Hamerkops feed on different food items during wet and dry seasons in all the sites. However it was not statistically significant ($p > 0.05$).

5. Discussion

The number of birds counted varied among the sites. Willard (1977) suggested that the distribution of wading birds in an area is determined by the prey abundance and the ability of the birds to exploit these preys. In the present study, the greater number of hamerkops were recorded in Site 3 during the dry season and Site 2 during the wet season. Birds selected those sites due to the high availability of fish scraps and worms. Kahl (1967) states that, the favourite food of hamerkops under natural conditions are frogs and tadpoles. The shortage of frogs and tadpoles in the study area has made hamerkops to feed on fish scraps, whole fish and worms. The availability of wetland near to the lake with different worms has helped the hamerkops to have worms in their menu and through time this has become a preferred food for them. They are very adaptive in their feeding depending on the availability of food types. For instance, they were observed feeding on fish scraps during the dry season at Site 3. The availability of food has also affected their seasonal abundance. At Site 1, few hamerkops were observed. This is due to unavailability of fish scraps and different worms unlike that of Sites 2 and 3. The distribution of hamerkops in different sites and seasons were due to the availability of resources. Food resources are the most important attractant feature for the birds. Abundance are influenced by local resource availability and vegetation composition, in addition to the size of habitat patches. It is probable that continuous nest building is in some way related to the maintenance or strengthening of the pair-bond. However, well-defined territories, for breeding or feeding, were not maintained in this study although birds did have a home range area. No details of territory were recorded by Cowles (1930) but he considered that there was a maximum of four pairs on 40 km^2. In contrast to this extended range, five nests on 1 ha, all occupied by different pairs and all of which reared young, have been recorded elsewhere in South Africa by Van Ee (1977). Van Ee

(1963) earlier noted three pairs in close proximity, and concluded that there was no territorial competition in the hamerkop.

The reason for construction of big hamerkop nest has generated some discussion amongst African ornithologists. Protection of eggs and young by concealment is certainly not a relevant argument in this case. Collias and Collias (1971) argue that, the entry of potential predators is prevented neither by the position nor by mode of construction as is the case for some Ploceidae; a view accepted by Brosset (1974) to be applicable for many other African species. Pitman (1958) mentions monitor lizards to be among the most common reptilian predators on bird eggs. In this regard, as they are establishing nests near monitor lizard territories (shore lines), the different chambers in their nest might be used to minimize predator attack.

The daily activity pattern established during the present study agrees with the observations of Liversidge (1963), who noted that most construction took place at early morning and late afternoon. It is probable that continuous nest building is in some ways related to the maintenance or strengthening of the pair-bond.

The scattered literature relating to the breeding season is conflicting with Pitman (1959). considered that hamerkops breed as a result of an indeterminate rhythmic response independent of the rains while Brown *et al*. (1982) were of the opinion that most breeding occurs during the dry season and that since the main food is amphibian, food supply could not be the proximate factor in its induction. The significant differences in the times at which clutches were laid observed in the present study might indicate that these birds breed at the end of wet and early dry season. Larger and bigger clutch sizes at the end of the rains and in the early dry season could be

related to the food supply. Mean clutch size in the present study was 4.3± 0.94 which compares with that of 4.38 ± 1.04, Dean (1971). Hamerkops which lay eggs and hatch and rear young during the rains and post-rains periods are more successful than those which attempt to breed in the dry. It is probable that this success is directly related to the food supply but that the stressful effects of high temperatures also contribute to the poorer performance of birds breeding in the dry season Wilson *et.al.,* (1987). Variations in clutch and egg size in the current study are possibly related to an optimal time of breeding related to the food supply at the end of the rains. A mean length of 45.9 mm mean breadth was 34 mm compared with that of a mean length of 44.5 mm and mean breadth 33.9 mm which was identified by Wilson *et.al.,* (1986). Variations in egg mean length and mean breadth in the current study area are possibly related to the seasons. The differences in size of eggs laid by individual females are presumably genetic. Lack (1956) considered that clutch size was related to the maximum number of young that could be reared and that current clutch size is a result of natural selection.

There was a 48 hour interval between eggs laid except between the second and third, where there was only a 24 hour interval. Though the young frequently leave the nest the same day there is often a difference in size. The greatest discrepancy in size between young is mentioned by Liversidge (1963). In terms of number of young fledged per egg, hamerkops have a high wastage rate compared to most other birds that build enclosed nests. The mean number of young fledged from successful nests was 3.3. Only 61.5% young were fledged from completed clutches. Mean age at fledging was 47 days observed in the present study. This compares with the study of Lack (1956).

There were no significant differences in age at fledging time. But young hatched at a later stage in the sequence left the nest at significantly younger ages than those hatched earlier in the

sequence. This compares with Wilson *et al*., (1987a). The differences in growth between birds in different seasons show clearly more rapid growth in birds born in July to December. It seems evident that there are considerable advantages accruing to birds which breed in this period, first and second hatched birds had a slight advantage during early growth.

Conclusion and Recommendations

Lake Hawassa is one of Ethiopian Rift Valley lakes located along the western edge of Hawassa town. It is known to support a diverse bird community. The lake has a number of attractant features. Natural habitats within the study area included wetlands, water body and trees. Human induced attractants are roofs of buildings, fishermen, cafeterias and other areas with significant human activities. The area possesses favourable places for birds to nest, rest and a good access to food as well as water resources. These features attract the birds to visit the area at different situations. Hawassa Lake is a dominant feature of the area. Wetland and other areas were also found to be attractant as water and food resource. Food wastes around different parts of the study sites also play a great role in attracting birds. Tree features attract birds to use the area as their roosting and nest building sites. There was significant difference in bird abundance between the wet and dry seasons as well as among the months of the study period. The activity pattern of birds showed that, they use the study area as their foraging, roosting, breeding and nesting sites. The breeding season of hamerkops is associated with both seasons and food availability. They breed during the wet season when there is enough supply of food at Lake Hawassa.

On the basis of the results of the study, the following recommendations are suggested:

- Ensure the sanitation and prevent Lake Hawassa and its surrounding from infestation of weeds.
- Protect the wetland and trees near to the lake at Fiker Hayik that attract a number of hamerkops as source food as well as roosting habitat.
- Introduce environmentally friendly fishing approaches for fishermen, as the non-selective fishing practice might hamper the live fishes available for hamerkops.

- Generally, habitat management is necessary at and around Lake Hawassa to provide the lake environment that birds use for nesting, foraging, resting and breeding.

Lists of Plates

Plate 12. Hamerkops searching prey in groups (February, 2018; Photo: Zebib Asrat)

Plate 13. Water body and grass along the shore of the Lake (August, 2017; Photo: Zebib Asrat)

Plate 14. Hamerkops waiting for scraps at Site 3 (July, 2017; Photo: Zebib Asrat)

Plate 15. Data collector during study period (July, 2017; Photo: Zebib Asrat).

References

Ash, J. and Atkins, J. (2009). *Birds of Ethiopia and Eritrea: An atlas of Distribution*, Christopher Helm, London, pp. 109-110.

Bibby, C. J., Burgess, N. D. and David, H. (1992). *Bird Census Techniques*, Academic Press, London. pp. 65-67.

Brodkorb, P. (1963). Catalogue of Fossil Birds (*Archaeopterygiformes* through *Ardeiformes*). *J. Biol. Sci*. **7**: 179-293.

Brows, L. H., Urban, E. K. and Newman, K. (1982). *The Birds of Africa*, Academic Press, London. pp. 32-34.

Clergeau, P., Mennechez, G., Lemoine, A and Sauvage, A. (2001). Human perception and appreciation of birds: A motivation for wildlife conservation in urban environments of France. **In**: *Avian Ecology in an Urbanizing World* (Marzluff, J. M.; Brwman, R. and Donnelly, R., eds.) Kuwer Academic Publishers, Norwell, pp. 69-88.

Collias, E. C. and Collias, N. E. (1978). Nest building and nesting behavior of the Sociable Weaver *Philetairus socius. Ibis* **120**: 1-15.

Collias, N. E. (1964). The evolution of nests and nest building in birds. *Amer. Zool*. **4**: 175-180.

Cottam, P. (1957). The Pelecaniforms characters of the skeleton of the Shoe-bill Stork *Balaenicepsrex. J. Zool*., London **5**: 51-71.

Cowles, R. B. (1930). The life history of *Scopus umbretta*. *Auk.* **2**:159-176.

Dean, W. R. J. (1971). Breeding data for the birds of Natal and Zululand. Durban Mus. *Novitates* **9**: 61 -91.

Del Hoyo J, Elliott, A and Sargatal, J. (1992). Handbook of the birds of the world. *Ostrich* **1**: 14 16.

Elliot, A. (1992). Family Scopidae (Hamerkop) **In**: *Handbook of the Birds of the World*, (Del Hoyo J, Elliott, A and Sargatal, J., eds.). Barcelona: Lynx, pp. 109-110.

Feduccia, A. (1996). *The Origin and Evolution of Birds*. Yale University Press, New Haven P.76-79.

Fekade Daniel (2012) *Lake Hawassa*, Suns Tours in Bird site, Lalibela.

Goodfellow, C. F. (1958). Display in the Hammerkop (*Scopus umbretta*) *Ostrich* **29**: 1-4.

Harrison, C. and Greensmith, A. (1993) *Birds of the World*. Dorling Kindersley, London. pp. 44-47.

Hiwot Hibste (2007) *Species composition, Abundance and Activity Pattern of Birds of Addis Ababa Abattoirs Enterprise*, MSc. Thesis, Addis Ababa University, Addis Ababa.

https://www.aboutanimals.com (2015). Behavior and ecology of Hamerkop, From Wikipedia, the Free Encyclopedia, accessed on 6/6/2017.

Kahl, M. P. (1965). Observations on the Behaviour of the Hamerkop *Scopus umbretta* in Uganda. *Ibis*. 109: 26–28.

Kahl, M. P. (1967). Observations on the behaviour of the Hamerkop *Scopus umbretta* in Uganda. *Ibis*. 109: 25–32.

Lack, D. (1956). Variations in the reproductive rates of birds. *J. Rol. S oc*. **145**: 329-333.

Liversidge, R. (1963). The nesting of the Hamerkop (*Scopus umbretta)*. *Journal of Ornithology*. **34**:55-57.

McLay, C. L. (1974). The species diversity of New Zealand forest birds. In: some possible consequences of the modification of beech forests, *New Zeal. J. Zool*. **2**: 179-196.

Newton, I. (2008). *The Migration Ecology of Birds*, Acadamic Press, Oxford. pp. 34-36.

Padian, K. and Chiappe, L. M. (1998). The origin and early evolution of birds. *Biol. Rev*. **73**: 1- 42.

Pitman, C.R.S. (1959). Breeding biology and physiology. *Ibis* **101**: 501-503.

Plowes, D. C. H. (1945). Data of Birds eggs collected. *Ostrich* **16**: 116-118.

Redman, N., Stevenson, T. and Fanshawe, J. (2009). *Birds of the Horn of Africa*, Christopher Helm, London, pp. 23.38.

Sibley, C. G. and Ahlquist, J. E. (1990). *Phylogeny and Classification of Birds: In Study in Molecular Evolution*, Yale University Press, New Haven. pp. 12-14.

Snow, D. W. (1978). The nest as a factor determining clutch size. *Journal of Ornithology*. **119**: 227-230.

Solomon Mengistu and Afework Bekele (2015). Population status and activity patterns of hamerkop (*Scopus umbretta*) in Lake Hora-Arsedi, Bishoftu, Ethiopia. *Ethiop. J. Biol. Sci*. **14**:185-200.

Storer, R. W. (1971) Adaptive radiation in birds. **In**: *Avian Biology* (Farner, D.S and King, J. R.,eds) New York. pp. 149-188.

Stowell, R. F. (1954). A note on the behaviour of *Scopus umbretta*. *Ibis* **96**: 150-151.

Tsigerega Dessalegn (2011). *Species Diversity and Abundance of Birds of Addis Ababa Bole International Airport*, MSc. Thesis, Addis Ababa University, Addis Ababa.

Tuinen, M. V., Butuil, D., Kirsch, J. A. W. and Hedges, S. B. (2017). Convergence and divergence in the evolution of aquatic birds, *J. Biol. Sci*. **268**: 1345-1350.

Van Ee, C. A. (1963). Hamerkop nesting together. *Ostrich* **34**: 252- 253.

Van Ee, C. A. (1977). Hamerkop. *Bokmakierie* **29**: 51-52.

Wallace, G. J. and Mahan, H. D. (1975). An Introduction to Ornithology, Macmillan Publishing Co. Inc., New York. pp. 27-30.

Whelan, C. J., Wenny, D. G. and Marquis, R. J. (2008) Ecosystem services provided by birds. *Ann. N.Y. Acad. Sci*. **1134**: 25–60.

Willard, D. E. (1977). The feeding ecology and behavior of five species of herons in southeastern New Jersey. *Condor* **79**: 462-470.

Wilson, R. T., Wilson, P. M and Durkin, W. J (1987b). Growth of nestling Hamerkops (*Scopus umbretta*) in central Mali. International Livestock Centre for Africa. pp. 1-6.

Wilson, R.T., Wilson, M.P. and Durkin, J.W. (1986). Incubation patterns of the Hamerkop (*Scopus unmbretta*) in central Mali. *Ibis* **129**: 382-388.

Wilson, R.T., Wilson, M.P. and Durkin, J.W. (1987a). Aspects of the reproductive ecology of the hamerkop in central Mali. (*Scopus umbretta*) *Ibis* **129:** 382-388.