

SHORT COMMUNICATION

POPULATION AND FEEDING ECOLOGY OF THE MARABOU STORK (*LEPTOPTILOS CRUMENIFERUS*) AROUND LAKE ZIWAY, ETHIOPIA

Demeke Datiko^{1,*} and Afework Bekele¹

ABSTRACT: A study was carried out around Lake Ziway, covering both dry and wet seasons in 2010, to investigate the population structure, habitat association and feeding ecology of the Marabou stork (*Leptoptilos crumeniferus*). Sample sites were designed based on the vegetation type and area cover. Line transects and point counts counting methods were used on the randomly selected sampling sites. Focal sampling method was also employed for observation of feeding. Face-to-face standard questionnaire interview and direct observation techniques were also conducted. A total of 318 and 594 Marabou storks were counted during dry and wet seasons, respectively. The number of birds during the dry and wet seasons was significantly different ($p < 0.05$). Lake shore was highly preferred for feeding. They were observed to feed on food items such as fish scraps (41%), carrions (23%), frogs (16%), worms (12%) and insects (9%), with variations from season to season. Their breeding nests were mostly in the town and on *Acacia tortilis* and *Acacia nilotica* trees. On average, 2.1 immature/young individuals were observed per nest. Habitat degradation in connection with agricultural activities of floriculture and urban expansion are the main threats to the survival of the Marabou stork and other wetland birds of the present study area.

Key words/phrases: *Acacia*, Marabou stork, Water birds, Ziway.

INTRODUCTION

Ethiopia possesses considerable biodiversity and natural resources, as well as many endemic bird species. According to Shimelis Aynalem and Afework Bekele (2008), out of the 926 bird species listed for the country, 21 are endemic and 19 are globally threatened species. Ethiopia is one of the few countries in the world that possesses a unique and characteristic fauna with a high level of endemism (WCMC, 1992). There are 214 Palearctic migrants recorded from Ethiopia (Pol, 2006). Among these, 45 species have been found to over-summer within the boundaries of the country. Among

¹ Department of Zoological Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia. E-mail: datikodeme@yahoo.com

² Department of Zoological Sciences, Addis Ababa University, P.O. Box 1176, Addis Ababa, Ethiopia. E-mail: afeworkbekele@hotmail.com

* Author to whom all correspondence should be addressed

the birds that occur in the country, Marabou stork is a large bird with grey wings, white below with a white ruff at the base of its flesh-pink neck. Adults develop a large air-filled pink pouch, which hang from the front of the neck. There is a reddish-pink fleshy growth at the back of the neck (Woodcock and Hayman, 1982). The skin of the head and part of the neck is bare, except for a few hair-like feathers. A collar of fluffy white feathers encircles the base of the neck. The skin of the cheeks and crown is reddish and covered with numerous black spots. The eyes are dark brownish or brownish-grey with a dark iris. This species has long neck and legs. The wings are long and broad and the tail is short (Hoyo *et al.*, 1992). Sexes are similar in appearance, though males tend to be noticeably larger than females and have a heavy and long bill. Chicks have pale grey, white down and more feathering on the neck than adults (Hancock *et al.*, 1992).

Marabou storks are resident in tropical Africa from Senegal to Somalia, south to Botswana and few occur in South Africa (Monadjem *et al.*, 2008). The adult Marabous weigh between 5 and 8 kg. They feed on garbage, fish remains, abattoir refuse and vegetable matter (Hancock *et al.*, 1992). Marabous are colonial nesters, building multiple nests in particular tree types. Marabou storks breed throughout the non-forested parts of tropical area, but are most numerous in the areas of moderate rainfall near the equator. Their breeding range is from Swaziland (Monadjem, 2005), north to Ethiopia and Somalia and west to Senegal (Pomeroy, 1978). They are frequent to common in most of their ranges, locally abundant or very abundant forming large colonies. According to Pomeroy (1978), egg laying dates are variable. Marabous take an extremely long period of about 135 days from hatching to fledging, with first flights out of the nest during 110-115 days (Monadjem *et al.*, 2010). Marabous first breed at 6-7 years of age. They can live up to 25 years in captivity (Hancock *et al.*, 1992). Parents commonly bring water, as well as food, to their young in the nests. The biology of the Marabou stork in Ethiopia has not been studied in detail. They occur in some wetland areas of the country. The current population structure, habitat association and feeding ecology and conservation problems of Marabou stork in relation to human impacts are poorly known. The present study attempts to investigate the ecology of this species around Lake Ziway, Ethiopia.

METHODS

Description of the study area

The study was carried out around Lake Ziway in the main Ethiopian Rift Valley Lakes about 160 km south of Addis Ababa (Fig. 1). It lies at an altitude between 1,650 to 1,850 m asl. The Ziway watershed falls between 7°15' N-8°30' N latitude and 38°E-39°30' E longitude, covering a total area of about 7300 km². The lake has a surface area of 442 km², a maximum depth of 8.9 m and an average depth of 2.5 m. The catchments of Lake Ziway contain a number of habitat types (riverine, woodland, grassland) along the rivers Ketar and Meki, and agricultural lands. Lake Ziway is well-known for its aquatic animals and plants. It is a fresh water lake, which is fed by the two incoming rivers, Ketar and Meki. Both these rivers are perennial (Tenalem Ayenew, 2004). Adjacent to Lake Ziway, the economy of the town is based on fishing, floriculture and agriculture. The area has a semi-arid to sub-humid type of climate with a mean annual precipitation and annual temperature of 650 mm and 25°C, respectively (Degefu Workineh, 1987).

Population structure and habitat association

The actual data collection was conducted during the dry and wet seasons in 2010. The study area was stratified according to habitat types based on the methods of Jones (1998) and Shimelis Aynalem and Afework Bekele (2008). Line transects and point counts were used as appropriate on the randomly selected sampling grids. The length and width of transect lines were determined based on the size of the sample block or grid (Shimelis Aynalem and Afework Bekele, 2008). Observations were also made using binoculars and/or naked eyes by walking along all parts of the study area. To avoid repeated counting of birds, areas were divided, based on their distribution and habitat types. The whole area was surveyed thoroughly, supported by video recordings and photographic pictures. Data were collected twice a day in the morning (06:30-10:00 h) and late afternoon (16:30 to 18:00 h). This was the period when most of the avian species were active (Shimelis Aynalem and Afework Bekele, 2008). Immature and mature individuals were recorded to determine the proportions. The general activity pattern of foraging, roosting and flying were observed following the methods of Hertel (1994).

In addition, observations on the breeding biology of Marabou storks was also carried out based on Pomeroy (1977). The total height of the nesting tree, nest location and nearest tree (potential non-nesting tree) from the floor

was estimated. The total height of the nesting tree from the floor was measured in metres using a marked rope method as in Pettingill (1985). The number of chicks were counted with the aid of a binocular, and rarely by climbing in a hide nearby and looking inside the nest from a height.

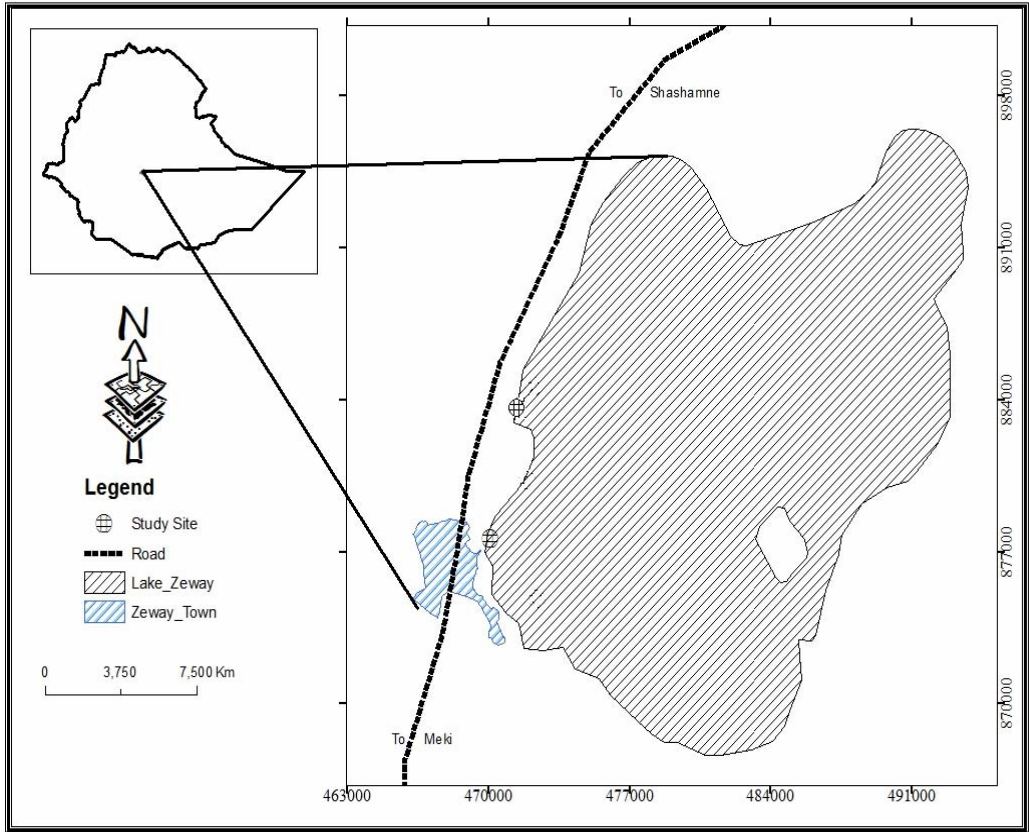


Fig. 1. Map of the study area with location of the main foraging sites.

Feeding ecology

To collect data on foraging behaviour of the Marabou stork, repeated observations were carried out. Individual birds were followed at a distance of 4-15 m. Time spent on foraging was recorded using focal sampling as in Hertel (1994). Focal sampling included watching an individual for 10 minutes. Using this method, data on the type of food items consumed, time spent for foraging, activities during foraging and the duration of perching were collected.

Data analysis

Using SPSS version 16, chi-square test, one-way ANOVA, and descriptive statistics were used to compute the variation in relative abundance, population size, age groups between seasons and habitats.

RESULTS

A total of 318 and 594 Marabou storks were counted during dry and wet seasons, respectively. They showed significant difference in distribution from site to site ($\chi^2 = 44.10$, $df=2$, $p<0.05$). Lake shore was the preferred site. Most birds were counted from Korokonch (Lakeshore) (47%) followed by Batu (Lakeshore) (31%) and (22%) in Ziway town during their feeding time (Table 1). However, most birds (86%) roosted openly on trees in the town and only 16% had their roost outside the town. They used nests only for breeding.

Table 1. Number, distribution and relative abundance of Marabou stork in the three study sites.

Study site	Altitude (m)	Seasons		Average	Relative abundance (%)
		Dry	Wet		
Korokonch	1649	141 (44%)	287 (48 %)	214	47
Batu	1647	94 (30%)	191 (32%)	142.5	31
Ziway town	1643-1654	83 (26%)	116 (20%)	99.5	22
Total		318 (100%)	594 (100 %)	456	100

Age groups (adult and juveniles) were represented in the population count during both dry and wet seasons. A total of 318 (276 adults) and 594 (568 adults) Marabou storks were counted during dry and wet seasons, respectively (Table 2). They showed significant variation ($\chi^2 = 101.02$, $df=1$, $p<0.05$) between seasons. Out of 318 counted during the dry season, 42 (13%) were juveniles and 276 (87%) were adults. All of the immature individuals were counted inside the nest. In contrast, out of the 26 (4%) young Marabou storks counted during the wet season, only 6 were inside the nest and the rest were observed outside the nest. Moreover, the number of immature/young decreased by almost half from 42 to 26 during the wet season. The relative abundance of Marabou storks increased by 86.8% during the wet season. They also showed significant variation ($\chi^2 = 3.76$, $df=1$, $p<0.05$) in the number of young between seasons.

Table 2. Composition and relative abundance of different age groups of Marabou stork during both dry and wet seasons.

Seasons	Adult	Immature/chicks		Total count	Relative abundance (%)
		In the nest	Outside		
Dry	276	42	-	318	35
Wet	568	6	20	594	65
Mean	422	24	10	456	

During both dry and wet seasons, they were restricted in the town and around the lake shore on the side of the town. They were not observed on the other side of the lake and on the islands. They were highly abundant only where the leftover of fish and waste dumping site occurred. They preferred *Acacia* tree (91.4%) to other trees (8.6%) in the study area for resting and breeding. There was a significant difference ($\chi^2 = 68.56$, $df = 1$, $p < 0.05$) in the selection of trees for nesting and resting. Breeding/nesting and resting were mostly in the town than in other places. Taller *Acacia* trees were preferred outside the town (Table 3). Large number of nests were recorded on *Acacia* trees in the town. On an average two chick individuals were recorded per nest. The number of individuals in a colony was also high on *Acacia* trees among non-breeding individuals.

Table 3. Nesting site, types of tree, average number of nests, young observed and average number of individuals in a colony observed (n=29 *Acacia*, n=3 other trees).

Nesting sites	Types of trees	Height estimated (m)	No. of nests per tree	No. of chick per nest	Individuals in a colony (Mean)
In the town	<i>Acacia</i>	10-20	1-6	1-3	14.7
	Others	>17	1-2	1-3	4.9
	<i>Acacia</i>	15-20	1-3	1-3	10.5
Outside the town/lake shore/	Others	>17	1-2	1-3	4.2

Five major food items were observed to be selected by Marabou storks (Table 4). Fish scraps and carcasses were frequently consumed. Out of a total of 110 feeding observations, the highest percentage frequency (41%) was on fish and 23% on carcasses (Fig. 2). There was a significant difference in frequency of taking foods items ($\chi^2 = 30.55$, $df = 4$, $p < 0.05$).

Table 4. Food items preferred by Marabou stork in the study area.

Feeding site	Season	Food items observed (alive/dead)				
		Fish scraps	Frogs	Worms	Insects	Carcasses
Lake shore	Dry	***	*	*	**	***
	Wet	***	**	**	*	***
In the town	Dry	*	-	*	*	***
	Wet	*	*	*	*	***

- = absent, * = rare, ** = frequent, *** = very frequent

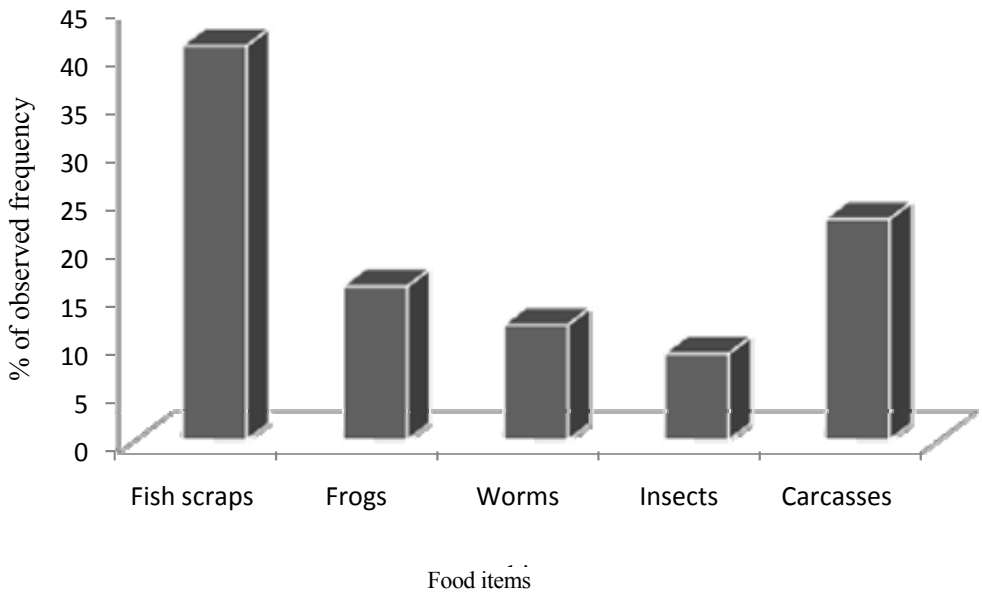


Fig. 2. Observed foraging frequency of Marabou stork on different food items.

DISCUSSION

Variations were observed in the number of Marabou storks recorded during dry and wet seasons. The number of birds were found to be more during the wet season. This might be related to habitat suitability for foraging, other environmental factors and migration. Richardson (1978) had noted that migration greatly alters the bird population by changing both the number and composition. Most of these variations were observed in July during the rainy period. The high difference in habitat composition of the area during the dry and wet seasons could contribute to the effects of seasons on bird abundance. During the dry season, some species might abandon the area, decreasing the number of individuals in unhealthy habitats (Jokimäki *et al.*, 1996). Lee and Rotenberry (2005) stressed that modification of the natural environment affects the relative abundance of species. Moreover, as noted by Monadjem *et al.* (2008), Marabou storks are known to move large distances. Similarly, large movements in other large colonial-breeding scavenging birds have been recorded in Namibia (Bamford *et al.*, 2007). Similar situations might also contribute to variations in the abundance of the birds in the present study area.

According to Hoyo *et al.* (1992), the habitat of the Marabou stork includes wetland and arid areas of Africa. Most of their activities are in open dry savannas. They are also found near swamps, river banks and lake shores (especially during searching food for the young), fishing villages and rubbish dumps. In eastern and southern Africa, they are commonly found around carcasses, in association with other scavengers (Hoyo *et al.*, 1992). They were observed around lake shore and in Ziway town, concentrated around human inhabiting areas. Hancock *et al.* (1992) also indicated that Marabou storks respond to increasing urbanization by adopting a scavenging life style and cosmopolitan diet in urban areas. This preference might be related to their feeding habit or availability of food such as fish scraps around the lake shore and carcasses at waste dumping areas near the town. The other reason might be to avoid predators that prey on their eggs and young in the nest in the wild.

The choice of sites for breeding colonies seems to be determined primarily by the availability of food. This might be the reason for observing Marabou storks breeding and living in the town and near the lake shore where food was available. It is also advantageous to breed as close as possible to the food source. According to Pomeroy (1978), the main breeding population of the Marabou stork is centred in northeast Africa (Ethiopia-Somalia) between October-November. The present investigation also revealed that more breeding sites were observed during this period in the study area. The study further showed that the specific time of breeding in Ethiopia was during the dry season extending up to January. Moreover, the main breeding population of the Marabou stork is centred in northeast Africa (Mlingwa, 2002), and in south-central Africa (Tarboton, 2001). In southern Africa, small breeding populations are even further dispersed in Zimbabwe and Swaziland (Monadjem, 2005). The present study also revealed nesting on *Acacia* trees which is very similar to the situation described by Monadjem (2005) in Swaziland. All nests were situated on the canopy of these flat-topped trees, with estimated mean height of 16.8 m above ground, ranging from 9-20 m. These birds select nesting sites and tree types significantly at this breeding site.

The number of adults increased during the wet season. However, 46 juveniles were observed during the dry season and only 26 young individuals were observed during the wet season. This showed that half of the young might have died or migrated away from the area. According to Pomeroy (1977), in most colonies Marabou storks leave the area as soon as the young have fledged and are rarely seen until the next breeding season

(Monadjem *et al.*, 2008). This might be also another reason for the decline in the number of young in the present study area during the wet season. During the wet season, only few (6) juvenile individuals were observed inside the nest. This observation confirms that the reproductive time of Marabou stork is mostly during the dry season in the study area. This is in line with the findings of Pomeroy (1978) on Marabou storks in East Africa during the dry season. However, only a small percentage of the population appeared to breed during the study period. This showed that the rate of productivity is low. Kahl (2010) also made a similar observation. Population size might be controlled by food availability influencing reproductive success.

Even if these birds breed in the town, they prefer tree types and height for nesting and resting. The present study revealed the preference for *Acacia* trees to others in the study area. They also preferred tall and large *Acacia* trees for nesting outside the town than in the town. This might be related to the suitability of the branches of trees to build nests. They may also prefer to minimize the falling down of the young from the nest during the early stage of flying. The reason for selection of nesting in the town was probably to minimize the effects of predation on eggs and young as well as availability of food/proximity to a reliable food source in the town/human habitats. Pomeroy (1977) also noted that the choice of sites for breeding colonies seemed to be determined primarily by availability of food. They construct nests only during the breeding season. A maximum of six nests were counted per *Acacia* tree and less on other trees. This might be related to the suitability of *Acacia* trees for nesting. Only 1-3 immature individuals were counted per nest. This might indicate that Marabou storks lay between 1-3 eggs during breeding/season.

As noted by Campbell (1974), the present study revealed that Marabou stork is a scavenger. It primarily relies on the carcasses of dead animals as a source of food. However, they also consume live preys, such as fish, frogs, worms and locusts. Marabou is a common scavenger in regions where game is common (Kahl, 2010). The feeding site of Marabou storks is usually around lake shore where fishermen remove fish scraps and dump waste around the town. The consumption of worms and frogs were common during the wet season and that of insects/grasshoppers during the dry season. Fish and dead animal matter were commonly consumed around the lake shore and in the town during both seasons. This implies that season has a significant impact on food availability and preference by the birds. This foraging habit might be the main reason for the observation of these birds

around the lake and towns. Generally, the consumption of small-sized food items by the bird was not frequent even if they were available in their foraging area. This might be related with the energy economy, and the structure of their beak to collect/capture the food items. MacArthur and Pianka (1966) also noted that a predator should rank prey types according to their energy value per handling time. This might be the main probable factor for the preference of food items by the birds.

CONCLUSION

This study addressed the population status and feeding ecology of Marabou stork (*Leptoptilos crumeniferus*) in the study area. The lake shore provides a suitable habitat for water birds to get food and water resources. These factors attract large number of bird species including Marabou stork. However, as observed during the study period, large parts of the natural vegetation around the lake have already been degraded. As a result, the threats to birds in the study area are also highly associated with the fragmentation and habitat loss due to anthropogenic factor. As the birds are very important for various purposes, further research is important to understand the biological interaction of urban as well as wetland birds in the area.

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