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Diurnal Activity patterns and Foraging Habit of White Collared Pigeon (*Columba albitorques*) in Menz-Guassa Community Conservation Area.

A Thesis Submitted to the Department of Zoological Sciences in Partial Fulfillments for the Requirements for the degree of Masters of Science in Zoology (Ecological and Systematic Zoology)

By

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Table of Contents

Contents **Page**

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Acronyms

ANOVA:	Analysis of Variance
GPS:	Geographic Position Satellite
MGCCA:	Menz-Guassa Community Conservation Area
SPSS:	Statistical Package for Social Sciences

List of Tables

List of figures

Abstract

Activity Patterns and Feeding Behavior of White collared pigeon (*Columba albitorques*) in Menz Guassa Community Conservation Area.

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The present study documents, daily activities and foraging behavior of White collared pigeon (Columba albitorques) in Menz Guassa Community Conservation Area (MGCCA). Data were collected during the wet and dry seasons using scan and focal sampling methods. Preliminary surveys were conducted before the data collection. Repeated observations were administered to collect data on activity patterns and foraging behavior of White collared pigeons. Activities patterns including feeding, scanning, flying, preening, resting, and others were observed. Data were analyzed by SPSS Microsoft version 2020. Feeding activity was highest in the early morning (7:00 - 9:00 hours am) during the dry season and mid-day during the wet season. Resting was highest during mid-day hours (12:00 –1:00 pm) during the dry season. During the dry and wet seasons, there was no significant difference in the rates of feeding, flying, resting and preening in the three time slots. However, there was significant difference in the mean rates for scanning ($F_5 = 8.34$, $p < 0.05$) between seasons in three time slots. White collared pigeon feed primarily on grains (90%) and occasionally grasses (10 %) during wet and (grains 96.4%) and grasses 3.6%) during dry seasons. There was significance differences in the type of food items consumed between seasons ($p < 0.05$). The scientific study of activity pattern and feeding behavior of birds has great importance, to understand the relationship of season and time of the day factor on the activity patterns and feeding behaviour of birds. Seasonality, weather condition, food availability, temperature, and time of day were identified as key factors that influence the activity pattern and feeding behaviour of the White collared pigeon. Further study like stomata content and fecal analysis for longer period will be important to get more information about diet composition of white collared pigeon

Key Words: Activity patterns, Feeding ecology, White collared pigeon, MGCCA.

1. Introduction

Birds are well-known bio-indicators and they have a significant role in ecosystem functioning and balancing. Thus, they are agents of nutrient cycles, plant gene flow through pollinations, seed dispersal, and control population size of harmful insects and environmental sanitation through scavenging waste products (Seyoum Kiros *et al*., 2018). Like other organisms birds forage to balance the energy spent in search of food, locomotion, avoiding predators, and handling of food. Bird's diets are varied and often include nectar, fruit, plants, seeds, carrion, grains, and various small animals, including other birds. Various attempts had been made to classify foraging modes of birds depending on the food they feed, such as carnivorous, crustaceovorous, insectivorous, molluscivorous, piscivorous, sanguinivorous, frugivorous, granivorous, nectarivorous, herbivores, omnivores, scavengers, and kleptoparasites (Adalberto *et al*., 2006).

White collared pigeon (*Columba albitorques*) is a species of bird in the family Columbidae and are very common in the highlands, above 1800 meter in Ethiopia, such as in Menz Guassa Community Conservation Area and Eritrea and occur singly, in pairs, and small flocks, at feeding and roosting places (Vivero, 2001; Weldemariam Tesfahunegn, 2016). Despite its abundance in the highlands and villages, where it's the dominant pigeon, little else is known about its life history (Vivero, 2001; Redman *et al*., 2009; Weldemariam Tesfahunegn, 2016).

Menz-Guassa Community Conservation Area (MGCCA) is one of the Ethiopian highland located in Amhara National Regional State, North Shoa Administrative zone and in Menz-Gera MidirWereda (district), about 260 kilometer far from North East of Addis Ababa and it covers 100 kilometer square area. The area is known as a home to important Afro alpine biodiversity including endemics and rare species. Guassa area contains numerous endemic fauna and floras, such as Wattled ibis (*Bostrychia carunculata*), Blue winged goose (*Cyanochen cynaptera*), Ethiopian wolf (*Canis simensis*), Gelada baboon (*Theropithecus gelada*) and Festuca grass land (Guassa grass), Shrubland, Erica moorland (Solomon Tadesse and Teketay Demel, 2017; and Yihenew Aynalem and Bezawork Afework, 2018). This study was carried out to understand the

activity patterns, foraging behavior and to develop a knowledge and understanding habits of White collared pigeon in MGCCA.

1.2. Objective

1.2.1. General objective

The general objective of this research was to study the activity patterns and feeding behavior of White collared pigeon in Menz Guassa Community Conservation Area.

1.2.2. Specific objectives

The specific objectives of this study were:

- To assess the activity patterns of White collared pigeon with respect to the time of the day and seasons.
- To assess the diet composition of White collared pigeon.
- To identify food items consumed by White collared pigeon.

2. Literature review

2.1. Physical characteristics

White collared pigeon has uniform slaty sooty greyish color, with a sharply defined white collar patch on side of neck and white on wings bar in flight and their length is estimated to 32-37 cm long. Crown and hind neck are darker grey in contrast to other body plumage. Folded wings have irregular dark spots and 64-72 cm long. Bill is black with whitish cere (Redman *et al*., 2009). The male and female are alike or similar in appearance as shown on figure below.

Figure 1. White collared pigeon physical character (source: Birds Life, 2012).

2.2. Taxonomy

White collared pigeon is the species of birds in the family Columbidae. Scientific classification of White collared pigeon is: Kingdom Animalia, Phylum Chordata, Class Aves, Order Columbiformes, Family Columbidae, Genus Columba and species *Columba albitorques* (Baptista *et al*., 1992, 2009). Pigeons and doves are much related species. Both doves and pigeon refers to the species of birds from the Columbidea family and order Columbiformes. They live in all terrestrial habitats from desert to large urban areas. Pigeon and doves can be solitary to very social and can be found in flocks of hundred and primarily grainivors and occasional fruit eaters. They display variety of songs and calls when they use to find mates, signal dangers, and defend

territories. Males have special vocalization that is only used in courtship and advertising either on the ground or in the air. On the ground males lift their tail, lower their head, twitch their wings, and scratch the ground with their feet while calling. There is no difference between a pigeon and doves in a scientific nomenclature. The only differences between of them are linguistic; colors and body size depend on dietary they preferred. Doves that preferred small fruit have small size and bill and that preferred large fruit have large bill (Baptista *et al*., 1992, 2009; Gibbs *et al*., 2001; Macdonald, 2008).

2.3. Distribution

Pigeons are one of the most successful bird groups occupying a variety of habitats especially in tropical and temperate zones including some of the harshest on earth (Baptista *et al*., 1997). Among pigeons White collared pigeons are very common in the areas, above 1800 m. a. s. l. in Ethiopia, and Eritrea. They mainly occurs in rugged areas, cliffs, escarpments, and also common in many plateau villages, and other large buildings. Especially in Ethiopia they are found in Addis Ababa, Sululta, Ankober, Debre Zeit, Lalibela, Shashemene, Gosh Meda, Bale mountain National Park, Simien Mountain National Park, Choke Mountain, Entoto Natural Park, Jimma, Lake Ashenge, Debre Birhan, North Omo, and Guassa Community Conservation Area **(**Vivero, 2001; Weldemariam Tesfahunegn, 2016).

2.4. Feeding habit

White collar pigeon occur singly, in pairs, and flocks, during feeding, resting, roosting and occasionally forms large mixed flocks with speckled pigeon (*Columba guinea*) during feeds. Regularly they move from their roosting sites to feeding areas like agriculture areas, and moorland below on the lower level of the cliffs they roosted. When disturbed from roosting site to feeding areas, flocks circling (rotating) to a considerable height before descending (divided in different direction), much as pigeons do. In late afternoon they either remain inland, and roost in trees or they return to the cliffs where they hurtle themselves over the edge and passing within a few meters of the cliff face fly at very high speeds their roosting sites hundreds of feet's below (Weldemariam Tesfahunegn, 2016). The altitudinal ranges they live are between 1800-4100 meters and every morning they spiral up to the top of the cliffs. Often they fly very vast and close to the cliff face in a total vertical descent when return to their roosting sites and they feed different grains such as, wheat, barley, maize, pea, bean, wild weeds, lentil, and occasionally

they feed grasses. They prefer solitary tree or cliff to alight in before descending to feed or drink (Vivero, 2001; Redman, 2009; Weldemeriam Tesfahunegn, 2016).

2.5. Reproductive behavior

Most pigeons are solitary nester, monogamous including White collared pigeon. Monogamy allows for both parental care; especially important for protecting their chicks from other predators, used during incubation period and when females require male assistance for successful brood rearing and nest buildings (Vivero, 2001). During nest building either sex, more often the male, may walk around the ground picking up suitable nesting materials; these can be little sticks, grass stalks or feathers. He takes them up with his bill and shakes them to check if useful or else will be discarded. The sticks are carried, a single stick at a time to the nest site and placed near the partner. The female builds the nest with materials brought in by the male. However, a reversal of the roles occurs to some extent. Their nest is mainly on sheltered ledges of buildings, cliffs, bridges, and also inside buildings and dark natural rock crevices and caves (Vivero, 2001; Weldemeriam Tesfahunegn, 2016).

Pigeons are not a singing birds but they call during courtship, protect their territory, and predation (aggression). Their call is divided into three main categories. These are standard coo, courtship coo, and nesting coos. The three coos are almost the same; with only a difference in tempo and volume (Baptista *et al*., 1992).

The standard coo sound can be described as a long cooc-r-r-r-r-oooo. The average duration of a coo is three seconds. The standard coo is mainly a sign for congeners/rivals to show their presence. The standard call is repeated several times with short intervals and is never obviously directed at any particular birds in sight.

There is also a courtship coos which is made often by sexes together. It's the same with standard coo, but it's repeated quicker, with short intervals. After cooing are repeated several times, and if the female is permissible to that, she sits in pairing position. She squats, lowers her head, and raises her shoulders which will support the feet of the male. When the female is in a sex-crouch, the male will not hesitate for long to mount her, bending his tail under hers for copulation. He maintains his balance by fluttering his wings. The pairs take about 5 to 10 seconds, for completion. After mating, most of the time they preen each other's to tightness the bond between

the partners. The psychological effect is more important, so that the act may be somewhat ritualized and the preening movement is often more cursory than a real preening.

Nesting coo is softer, less forceful, and more intermittent. It's always accompanied by wing flipping. Both pigeons are cooing, but only at a potential nest site; the male gives this call more frequently than the female. While cooing he keeps his head down to the ground and his tail upwards. When the pair has chosen a nest site the female may give this coo more frequently. This cooing has a positive influence on the ovulation.

During egg laying, the female will stand and slowly raise the fore body. The tail is hold horizontally and backwards. She appears to be straining for perhaps half a minute before the eggs drops. After laid she rest for some minutes before leaving the nest or incubation. Incubation is the duties of both sexes, and the length of the incubation period is about 14 days (Baptista *et al*., 1992: Gibbs *et al*., 2001).

3. Materials and methods

3.1. Description of the study area

Menz-Guassa Community Conservation Area is located in Amhara National Regional State, North Shoa Administrative zone and in Menz-Gera Midir wereda (district), about 260 kilometer far from North East of Addis Ababa. The area lies between 10^0 15' to 10^0 27'N latitudes and 39^0 45' to 39^0 49'E longitudes. The total area is estimated to be around 78 kilometer square. The area is among the Ethiopian highlands most pristine and secluded natural wonders. The area was established during 17 centuries and is one of the oldest conservation management systems in sub-Saharan Africa. The area is managed through a common property resource system by the communities living adjacent to the Guassa area, such as Guassa conservation council which has kebele and wereda level components and consists of both communities and local government representatives (Abraham Kidane, 2012; Solomon Tadesse and Demel Teketay, 2017).

3.2. Topography

The Guassa area ranges from 3200 to 3700 meters above sea level. The rugged mountain plateau is crosscut by gorges and river valley running westwards. The area forms the watershed between the Nile and Awash River systems and thus performs an important hydrological functions and catchment area. The eastern edge of the Guassa area falls away abruptly as cliff drop into the Great Rift Valley. Just 100 Km away, the land melts into the awash plain forming the floor of the Great Rift Valley (Abraham Kidane, 2012; Solomon Tadesse and Teketay Demel, 2017).

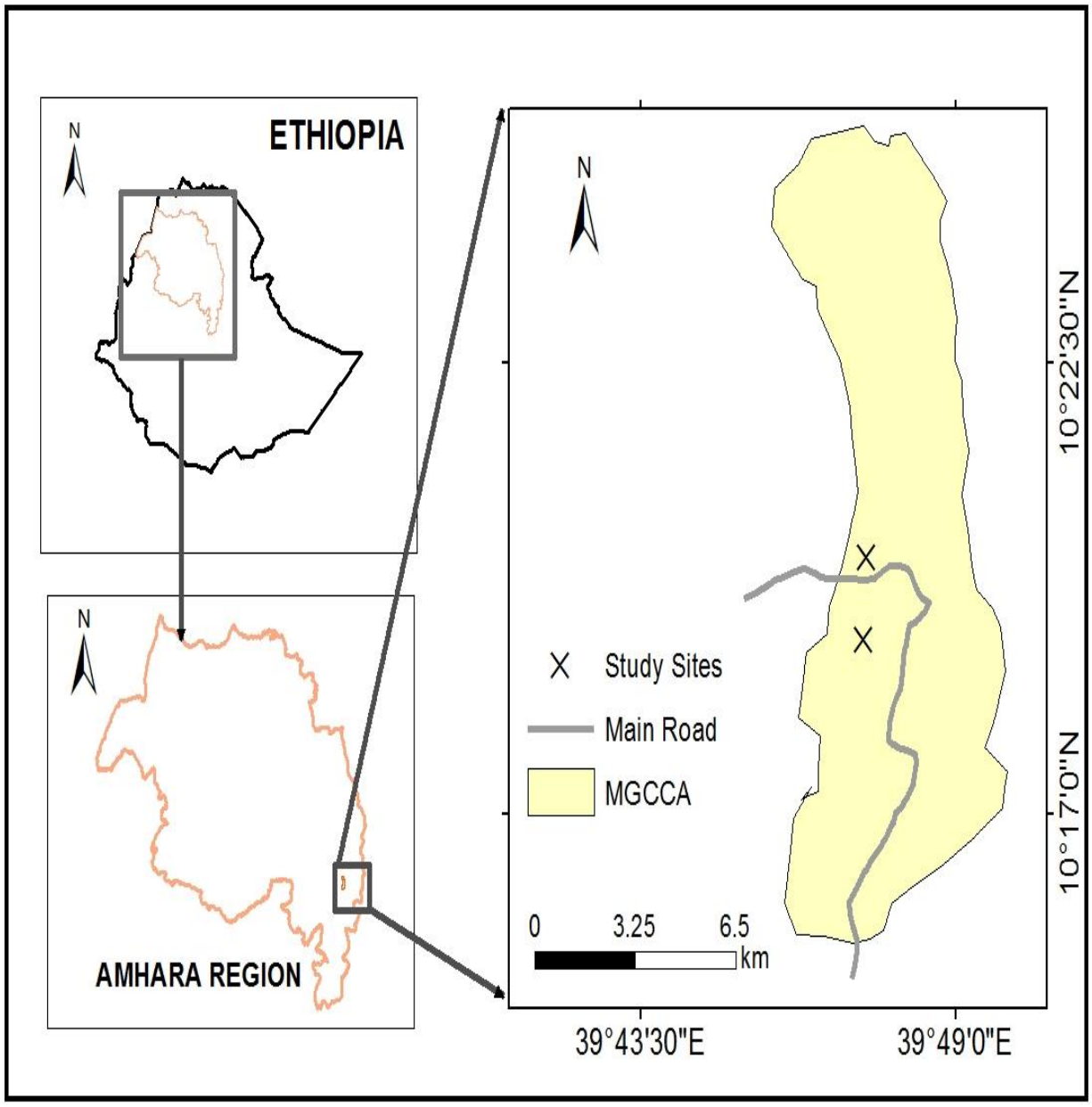

Figure 2. Map of the study area

3.3. Climate

3.3.1. Rainfall and temperature

Annual rainfall for Guassa averages is 1200 mm to 1600 millimeter. This is characterized by mild days and cold nights. In the driest months (December through February) the day time temperature can rise to 23^0C while at night it can fall to -10^0C. There is a frequent frost and fog in the dry and wet seasons. The temperature variation is less in the wet season with a day temperature of 12^0C and night time temperature of 3^0C (Abraham Kidane, 2012; Solomon Tadesse and Demel Teketay, 2017).

3.4. Biodiversity

3.4.1. Fauna

Menz Guassa Community Conservation Area has numerous endemic birds and others, such as White collared pigeon (*Columba albitorques*), Wattled ibis (*Bostrychia carunculata*), Blue winged goose (*Cyanochen cynaptera*), Spot breasted plover (*Vanellus melanocephalus*) and Global endangered Ankober serin (*Crithagra ankoberensis*), and several raptors, including the Bearded vulture (*Gypaetus barbatus*), Auger buzzard (*Buteo augur*), Golden eagle (Aquila chrysaetos) and wildlife species including the iconic Ethiopian wolf (*Canis simensis*), Gelada baboon (*Theropithecus gelada*), and Abyssinia hare (*Lepus habessinicus*), Leopard (*Panthera pardus*), Grey duiker (*Sylvicapra grimmia*), Klipspringer (*Oreotragus oreotragus*), and six different types of rodents (Abraham Kidane,2012; Solomon Tadesse and Teketay Demel, 2017; Yihenew Aynalem and Bezawork Afework, 2018).

3.4.2. Flora

The vegetation of the Guassa area is characterized by afro alpine vegetation with which different communities exists. The area contains different dominant habitats such as *Festuca grass land* (Guassa grass) from which the area takes its name, Shrubland, and Erica moorland (Abraham Kidane, 2012; Solomon Tadesse and Teketay Demel, 2017; Yihenew Aynalem and Bezawork Afework, 2018).

3.5. Materials

The materials that were used during the study period were binoculars to observe the birds, stopwatch to measure the time during their activities pattern's, GPS, Newspaper, and data sheet, pencil, plastic bags and other stationary materials to record data during the study period.

3.6. Methods

3.6.1. Preliminary survey

Study survey of birds around Guassa Community Conservation Area was carried out to gather relevant information in both seasons. In this survey, an overall view of birds specifically to White collared pigeon of the area was conducted. The topographical features as well as vegetation cover of the area were assessed.

3.6.2. Data collection

Based on the information collected and site selected during the preliminary survey, field data were gathered. Data was recorded for 10 days during the wet season and 10 days during the dry season) depending on the weather conditions and time of the day. Data were collected early morning, mid-day and late afternoon when most of White collared pigeons were active. Binoculars as well as naked eye observation were used during data collection.

3.6.3. Activity patterns

The diurnal activity patterns of White collared pigeon were collected during both wet and dry seasons. Activities were recorded using scan sampling method throughout the study period (Luke, 2018). During the observation period, a group or an individual bird was followed at a distance of 5-10 meter. Five minutes scan samples were taken at interval of 10 minutes. The observation were made from early morning to late evening dividing the day into three timeslots; morning 7:00-9:00 am, mid-day 12:00-2:00 pm, and late afternoon 4:00-6:00 pm. The activities were divided into six major categories: feeding (picking grains or preys, and swallowing), Scanning (scanning surrounding actively), Flying (in flying), Preening (comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, and tail shaking), Resting (dozing with head retracted and eyes closed), and others (activities, such as calling, and mating (Asokanel *et al*., 2010; Martin et al, 2013; Kidist Ameha and Bezawork Afework, 2018).

3.6.4. Foraging habit

To collect data about the diet composition of White collared pigeon, repeated observation was carried out during the wet and dry seasons. Time spent on foraging was recorded using focal sampling methods following (Bonter, 2013; Antonio, 2015; Hussain *et al*., 2019).

Individual bird was followed from distance of 5-10 meters. Observation was made under good weather conditions, avoiding bad weather conditioning or when drizzling and heavy rain (Rheingantz *et al*., 2011). Data were collected early in the morning from 8:00-10:00 am, and late afternoon 2:00-4:00 pm, when most of the species were engaging in feeding activities. To find the focal bird, observer walked slowly (approximately 4km/h) across the study area and every bird that was actively feeding was identified as focal bird (Luke, 2018). 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 resume normal activity patterns in the presence of the observer (Block, 1991; Atkison, 2013). Time data on behaviour (per minute) was collected. A stopwatch was used to record time of the duration of activity.

Observations began as soon as the focal bird began foraging. When the focal individual stopped foraging or lost from the sight before 30 seconds, data were not considered. 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 (Michael *et al*., 1994; Wilkinson, 2010; Coogan *et al*., 2018; Kidist Ameha and Bezawork Afework, 2018; Yonas Dagne and Bezawork Afework, 2019).

3.6.5. Data analysis methods

Data were analyzed using SPSS version 20 computer software programs and Microsoft EXCEL. Comparison was made on means for sample from a normal distribution. Two way ANOVA was used to make multiple comparisons for mean rates in activity pattern recorded in the early morning, mid-day and late afternoon. To determine whether there was a difference among activity and food items consumed in different seasons (wet season and dry season) a one-way analysis of variance (ANOVA) was used.

4. Results

4.1. Activity patterns

White collared pigeons were observed engaged in daily activities of feeding, scanning, flying, preening, resting, and showing other antagonistic activities (Figure 3). The recorded data shows variation in day time duration among the most commonly observed activities in the same season and between seasons. Feeding activity comprised highest (80.5%), followed by scanning (7.8%), flying (5.6%), others (3%), preening (2.5%), and resting (0.7%) in wet season. During the dry season, feeding activity (62.1%) was also the highest followed by scanning (20.2%), flying (6.7%), others (4.5%), preening (4.4%), and resting (2.1%). Comparison of wet and dry seasons activities showed insignificant variation ($P > 0.05$) and only scanning activity was statistically significant between the seasons ($F_{1,\ 185.75} = p < 0.05$).

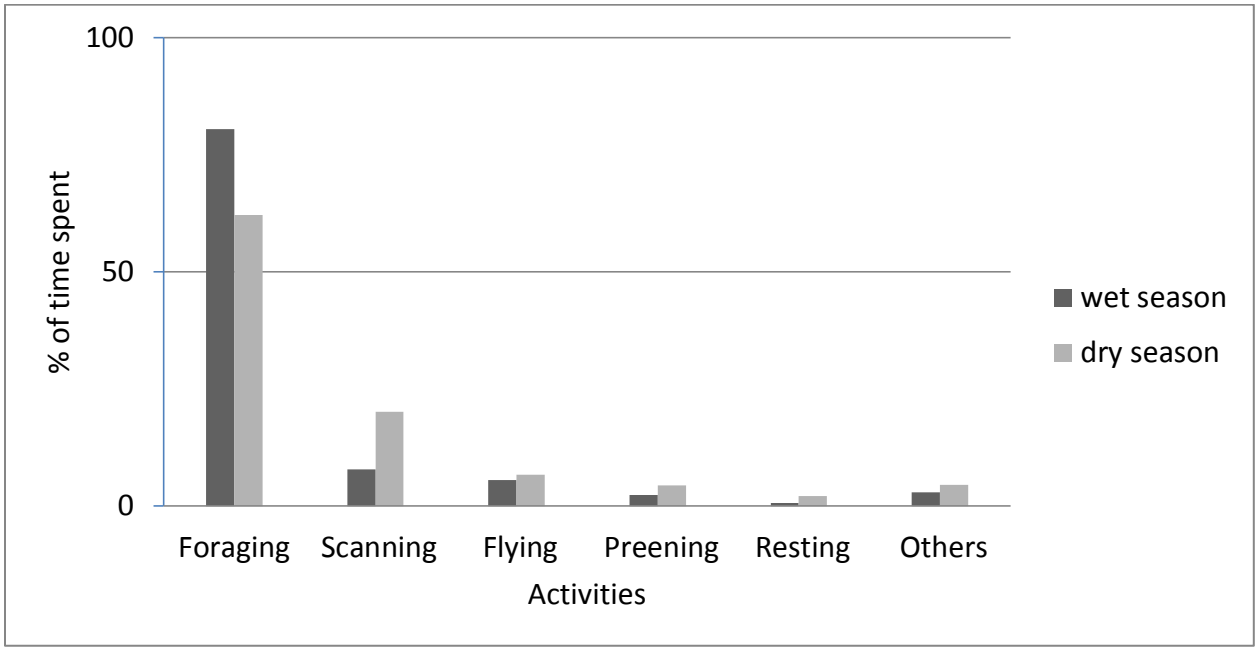

Figure 3. Activity patterns of White collared pigeon during wet and dry seasons.

Comparison of activities in the three time slots showed that feeding was the highest percentage time spent during wet and dry seasons (Table 1). There were no significance differences in the different activities between wet and dry seasons in the three time slots ($p > 0.05$).

Table 1. Percentage activity white collared pigeon during different time slots of the day in wet and dry seasons

Activity	Time slots (hour)					
	7:00-9:00 (morning)		12:00-2:00 (mid-day)		4:00-6:00 (late afternoon)	
	Wet	Dry	Wet	Dry	Wet	Dry
Feeding	49.3	65.8	83.1	60.9	67.3	49.6
Scanning	15.5	22.1	7.1	14.1	10.2	22
Flying	21.2	8	4	1	18.5	10.6
Preening	5.6	0.8	2.2	7.8	2	13
Resting	4.2	0.6	0.5	5.8	0	2.4
Others	4.2	2.7	3.1	10.4	2	2.4

During wet season among the six activities feeding was the highest in percentage in all hours of the day in all time blocks compared to other activities (Figure 4).

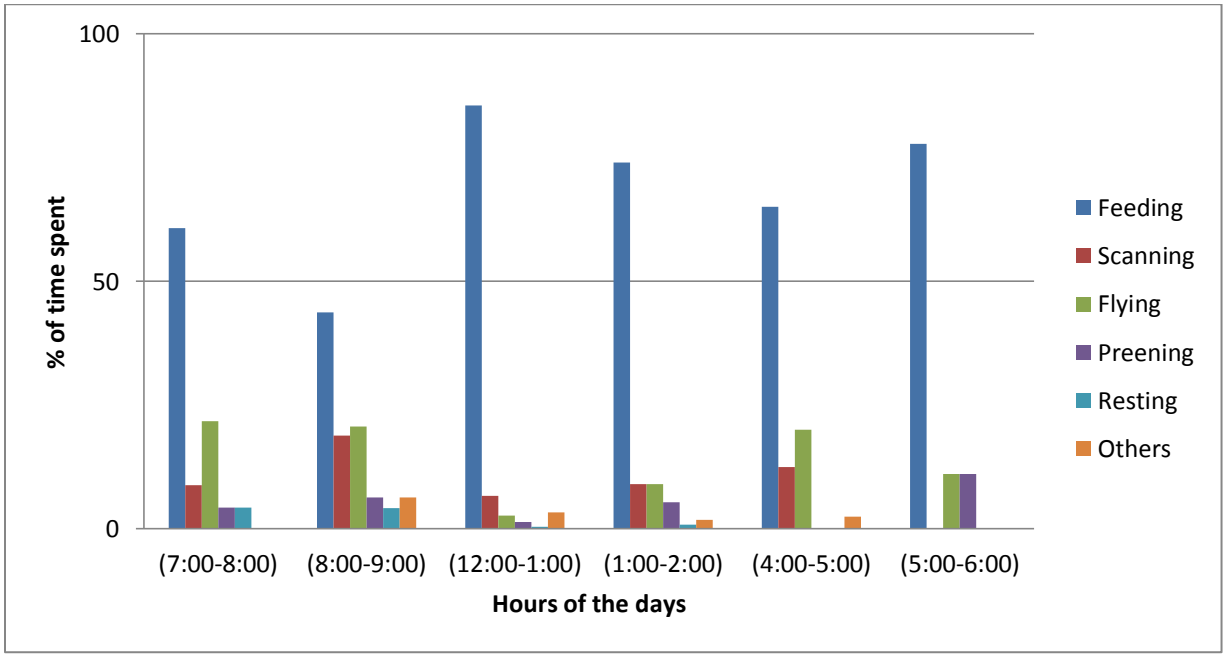

Figure 4. Activity patterns of White collared pigeon in different hour during wet season.

During dry season among, the six activities feeding comprised highest percentage in all hours of the day except between 5-6 pm when flying was highly pronounced (Figure 5).

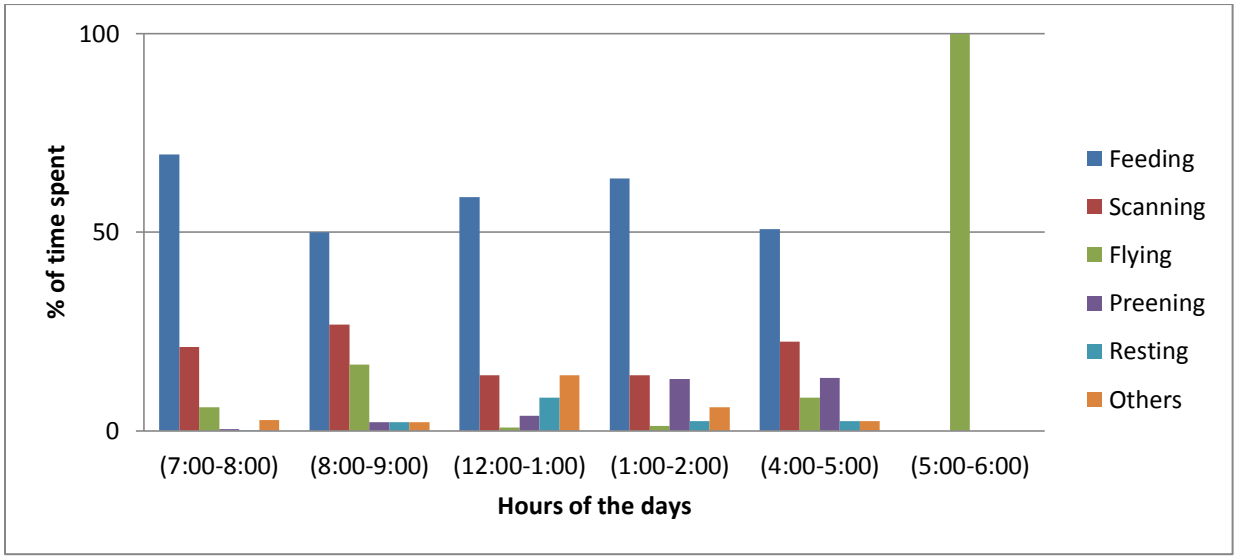

Figure 5. Activity patterns of white collared pigeon in different hour during dry season.

4.2. Foraging habit

White collared pigeons were observed foraging grains and grasses during the wet and dry seasons in the study area (Figure 6, Table 2). Their diet consisted of grains (90%) and grasses (10%) during the wet season and grains (96.4%) and grasses (3.6%) during the dry season. During foraging, White collared pigeons walked and picked food items and occasionally observed run picking food items. There was a significance difference ($F_{1, 3}$=344, $P < 0.05$) in the types of food items consumed by white collared pigeon between wet and dry seasons.

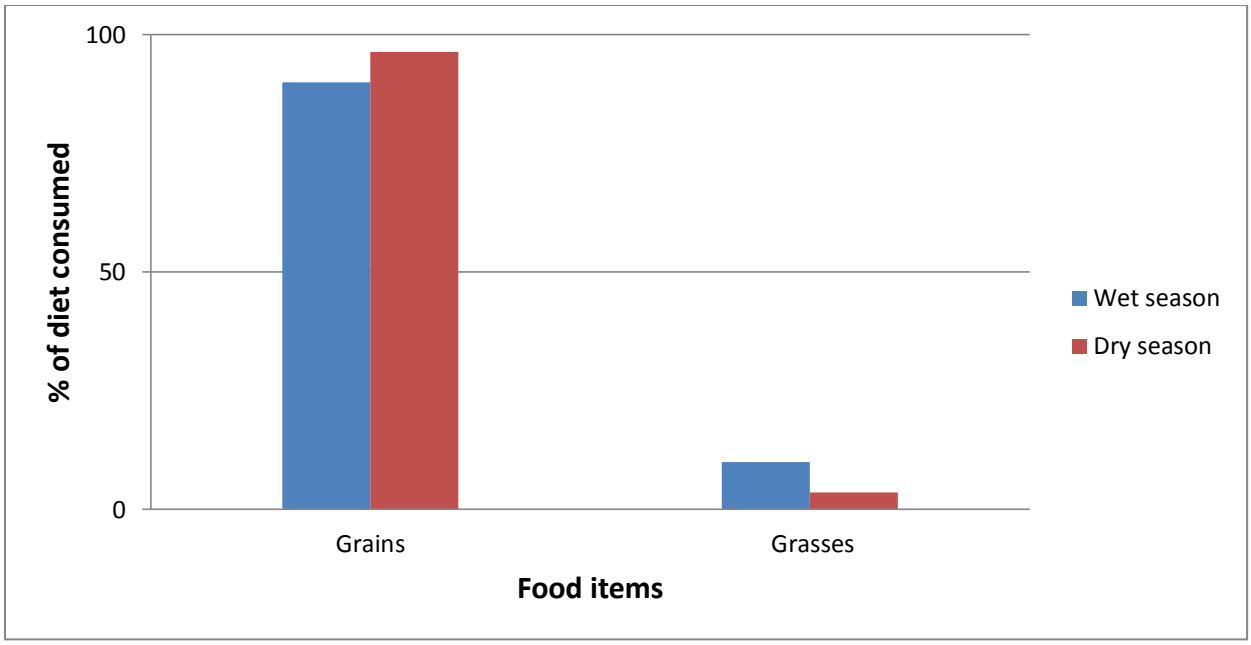

Figure 6. Diets of white collared pigeon during wet and dry seasons.

Table 2. Types of grasses present at specific feeding areas of white collared pigeon

Local name	**Botanical name**	**Family name**	**Habit**
Cherenfa	*Euryops pinifolius* A. Rich	Astaraceae	Herb
Yemider Kosso	*Alchemilla pedata* A. Rich	Rosaceae	Herb
Guden	*Ranunculus oreophytus* Del.	Ranunculaceae	Herb
Gicha	*Cyperus spp*.	Cypreraceae	Herb
Lit	*Malva verticillate* L.	Malvaceae	Herb
Chegogit	*Galium spurium*	Rubiaceae	Herb
Hulegeb	*Salvia merjamie* F.	Lamiaceae	Herb
Teseri	*Pennisitum spp*.	Poaceae	Herb

5. Discussion

Daily activity patterns in avian species are affected by several factors including the need to balance the risk of predation and starvation, weather, availability of food and temperature (Mary *et al*., 2017). The diurnal time activity budget of the white collared pigeon was characterized by time allocation to feeding, scanning, flying, preening, resting and other activities. As compared to the other different activities, feeding was reported as the most common activity in white collared pigeon. This finding is similar to findings in other bird species, such as West African Thrush (*Turdus pelios*) (Akinpelu and Oyedipe, 2004), Hamerkop (*Scopus umbretta*) *(*Yonas Dagne and Bezawork Afework, 2018*),* Africa Jacana (*Actophilornis africanus*) (Kidist Ameha and Bezawork Afework, 2019).

A study on other tropical birds, such as Egyptian Geese (*Alopochen aegyptica*), Red-knobbed Coots (*Fulicata cristata*), Glossy ibises (*Plegadis falcinellus*) and Yellow-billed ducks (*Anas undulata*) at Lake Ol'Bolossat in Kenya also confirmed that feeding was significantly allocated more time than any other activity (Njeri and Kinyamario, 2012). The allocation of a large proportion of time to feeding was probably due to feeding being a very critical activity that allows the birds to meet its energy requirements required for its survival (Markman, 2014). Many species of birds are known to exhibit high feeding rate early in the morning and evening hours. However, in white collared pigeon they were also observed in mid-day hours. Morning foraging is to replace energy depleted during the night and late afternoon is to build energy reserve for the night hours (Bonter, 2013; Goeij *et al*., 2003). The mid-day foraging could be attributed to the need for high energy requirement associated with weather condition.

White collared pigeon feed on a variety of grains, such as wheat, barley, maize, pea, bean, wild weeds, lentil, and occasionally they feed on grasses (Vivero, 2001; Redman, 2009; Weldemeriam Tesfahunegn, 2016). In study area white collared pigeons were observed more dominantly feeding grains and occasionally grasses from grain field and moorland areas. The result of this study revealed that compared to the different diet, the largest proportion of white collared pigeon comprised of grains diet (90%) during wet season and (96.4%) during the dry season). This is due to white collared pigeon preferred grains diet than the others. Foraging habitat preference of white collared pigeon during both seasons was on the grain field areas. This was due to the food abundance is greater than other micro-habitats.

Scanning was the second main diurnal activity in white collared pigeon and this may be associated with bird's vigilante to avoid predation. Scanning was also a key activity in the birds, such as Helmeted guinea fowl (*Numidia meleagris*) (Tewodros Kumsa and Afework Bekele. 2013), African \Spoonbill (*Platalea alba*) (Eshetu Moges and Mundathra Balakrishnan. 2014). Scanning activity was higher during the dry season than the wet season in white collared pigeon. This difference may be due to more sufficient food during wet season and less in dry season so the birds spend scanning as part of their resting activity.

Results of this study revealed that apart from feeding and searching for food, other common activities of the White collared pigeon observed were flying and preening. Allocation of time for flying can probably be attributed to the need for an optimal forager to increase feeding efficiency by flying to other areas, and due to disturbances by human activities and inter-and intra-specific interactions. Preening occupied a small portion of the time budget and was usually performed in the early morning and late evening. Many bird species, such as Ferruginous Pochard (*Aythyanyroca*) (Muzaffar, 2004), White-breasted kingfisher (*Halcyon smyrnensis)* (Ali *et al*., 2010) have been recorded spending time on this activity.

6. Conclusion and Recommendations

6.1 Conclusion

The scientific study of activity pattern and feeding behavior of birds has great importance, to understand the relationship of season and time of the day factor on the activity pattern and feeding behaviour of birds. The study provided key knowledge on activity pattern and feeding behaviour of White collared pigeon, and how it was influenced by factors of seasonality and time of the day.

White collared pigeon in this study area spent most of the time budget on feeding in both seasons. In the three observation periods of the day (early morning, mid-day and late afternoon), feeding and scanning were the two dominant activities of the time budget. In both seasons White collared pigeons predominantly consumed grains. This may be the species prefer grains than the other food items.

6.2. Recommendations

Further studies for longer periods will be important to get more information about the white collared pigeon and facilitate conservation measure. The diet and feeding behaviour of the white collared pigeon require longer-term studies on the species. This may include use of stomach content analysis, and fecal sample analysis. In this study diversity and distributions of white collared pigeon did not included. It's more important to know detailed information about the species if it should be included. In addition white collared pigeon is endemic species of only Ethiopia and Eritrea; so it's important to give attention to the species and consider the importance of the species to conservation area.

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Appendix

Plate A.

Plate B.

Plate A and B, White collared pigeons feeding in study area (Photo by Fasil Abera, 2021)

Plate C.

Plate D.

Plate C and D, White collared pigeons feeding in Mehal meda town (Photo by Fasil Abera, 2021)

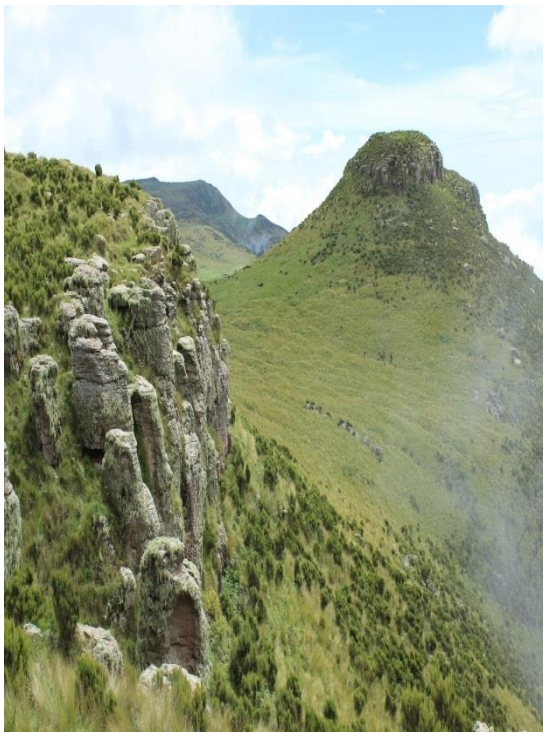

Plate E Plate F

Plate E and F. Roosting sites (cliffs) of white collared pigeons in study area (Photo, Fasil Abera, 2021)

Habitat types of the study area (Photo by Fasil Abera, 2021)

Declaration

I Fasil Abera Disasa confirm that the work present in this thesis is my own where information has been derived from other sources; I confirm that this has been indicated in the thesis. The material contained in this thesis has not previously been submitted for a degree at Addis Ababa University or any other university and all the sources of materials used for thesis are acknowledged.

Name Fasil Abera Disasa

Signature.....

Date October 2021

Place Addis Ababa University

This thesis has been submitted for examination with my approval an academic advisor

Advisor, Bezawork Afework Bogale (PhD)

Signature.....

Date, October, 2021.