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Flock size, diet composition, and habitat characteristics of the Ethiopian endemic Ankober Serin *Crithagra ankoberensis*

Abebayehu Dessalegn, Mundanthra Balakrishnan and Tilaye Wube

Summary

A study on the flock size, diet composition, and habitat characteristics of the Ankober Serin *Crithagra ankoberensis* was carried out at Simien Mountains National Park (SMNP) and Guassa Community Conservation Area (GCCA) between July 2014 and February 2016. The highest and lowest mean flock sizes were 130 (at SMNP) and 16 (both SMNP and GCCA), respectively. Flock size showed significant seasonal variation at both study sites. The dry and wet season mean flock sizes were 84.3 and 47.6 (SMNP), and 61.1 and 39.2 (GCCA). Flock size did not show significant variation at the two study sites. At both study sites the diet was dominated by leaves (80%) and seeds (90%) during the wet and dry seasons, respectively. Insects contributed about 10% and 3% of the diet during the wet season at GCCA and SMNP, respectively. Mosses contributed <3% of the diet at both study areas. A total of 39 plant species were recorded in Ankober Serin flocking sites. Of these, 29 and 22 were restricted to SMNP and GCCA, respectively, while 12 (31%) were shared. The habitat was dominated by herbs (53%–96%) with some portions of bare earth (4%–34%). The vegetation height was predominantly short (<30 cm) with estimated percentage proportions of 65%–77%, while tall (>60 cm) vegetation was less frequent (3.6%–9.7%). These habitat characteristics can be used as indicators of the presence of Ankober Serin.

Keywords Ankober Serin, Guassa Community Conservation Area, Simien Mountains National Park, flock size, habitat, diet composition

Introduction

Ankober Serin *Crithagra ankoberensis* is an Ethiopian endemic discovered in 1976 by John Ash (Ash 1979). Ash placed it under the genus *Serinus* and later it was grouped under *Carduelis* (Perlo 2009). A comprehensive taxonomic study of true finches by Zuccon *et al*. (2012) using nuclear and mitochondrial DNA sequencing suggested that the genus *Serinus* is polyphyletic and should be restricted to six species—*S. alario, S. canaria, S. canicollis, S. pusillus, S. serinus* and *S. syriacus*, while the remaining species including Ankober Serin should be placed under the reinstated genus *Crithagra*.

The holotype specimen was collected 3 km north of Ankober at an elevation of 2980 m. The distribution range of the species is not fully known. So far, it has been recorded from five locations in central and northern Ethiopia along the eastern escarpments of the central highland chains and the Simien Mountains at altitudes of 2800–4300 m (Vivero Pol 2001, van Perlo 2009). The distribution range includes: Ankober and the nearby areas such as Goshmeda, Kundi, and Debre Sina, Koreta in Guassa, Deneba, Abune Yosef Mountain in north Wollo, and Cheneke Camp and

Bhawit in Simien Mountains National Park (BirdLife International 2016). The species is also believed to be distributed in similar habitats along the eastern escarpments from Ankober to the Simien Mountains, specifically at Abuye Meda, Amba Farit, Guna and Choke Mountains (BirdLife International 2016).

Ankober Serin is a gregarious species, roosting and feeding in groups of up to 60 individuals. It is commonly seen mixed with Streaky *S. striolatus* and Brown-rumped *S. tristriatus* seedeaters (Vivero Pol 2001, BirdLife International 2016). These two species and *S. nigriceps* were observed by Ash at Ankober (Ash 1979). It feeds on grass and other seeds amongst lichen-covered rock as well as areas of open earth, while it is not seen on uncultivated land (Vivero Pol 2001). It is active and restless, and spends most of its time on rocks (Vivero Pol 2001). Breeding takes place between September and March; however, it is believed to reproduce during any time of the year following heavy rains (Ash 1979).

It has a restricted habitat preference for near vertical cliffs, and steep and vegetated slopes. It perches on lichen-covered rocks, bare earth, and short grazed pasture (Vivero Pol 2001). Over 40 species of plants were identified from their habitat at Ankober with the most common including, *Rumex nervosus*, *Alchemilla* spp., *Trifolium* spp., *Sida ternata*, *Erica arborea*, *Thymus serpyllum*, *Hebenstretia dentata*, *Scabiosa columbaria*, *Helichrysum* spp., *Pennisetum* spp., and *Androgon* spp. while the breeding area is dominated by *E. arborea* (Ash 1979).

Their IUCN Red List status is Vulnerable. Their main threat is habitat loss due to grazing and agricultural expansion (BirdLife International 2016).

Detailed knowledge of the ecology and population status of this species is not available due to a lack of research. The only available information on the species is limited to reconnaissance surveys and short-term observation records (See references in BirdLife International 2016). Therefore, this study contributed to the limited field data on Ankober Serin flock size, diet composition, and habitat characteristics based on a long-term study at two of its main distribution sites — Guassa Community Conservation Area (GCCA) and Simien Mountains National Park (SMNP).

Study areas

SMNP

Simien Mountains National Park (SMNP) is located within Amhara National Regional State, northeast of Gondar Town (13°01′–13°29′N and 37°50′–38°34′E; altitude 1900–4430 m). It is 886 km away from the capital Addis Ababa and 123 km from Gondar Town (Fig. 1A). SMNP is characterized by high plateaus, grassy plains, steep escarpments, deep gorges and sharp cliffs that resulted from heavy erosion of Trappean basalt layers (Mohr 1962). Rainfall is bimodal comprising two wet seasons from February to March, and from July to September, with mean annual precipitation of 1550 mm. SMNP is characterized by low temperatures. Minimum temperatures range between 2.5–4° C while the maximum is 18° C. There are often dry winds during the day, frosts may occur at night, and snow sometimes settles on the summit of Ras Dashen, elevation 4533 m (Hurni 1986, Magin 2001).

The vegetation at SMNP is considered as part of the Afro-alpine centre of plant diversity, with high levels of endemism due to past isolation. However, the diversity is low compared with other Afro-alpine regions due to the post-volcanic and post-glacial history (Magin 2001). Some of the plant species endemic to SMNP are stonecrop *Rosularia simiensis* and tussock grass *Festuca gilbertiana*. SMNP is home to 22 species

of large and medium-sized mammals including endemics, Walia ibex *Carpa walie*, Gelada baboon *Theropiticus gelada* and Simien fox *Canis simensis* (Puff & Nemomissa 2001, SMNP & EWCA 2013). Avian fauna diversity is estimated at over 180 species with five endemics (Hillman 1993, SMNP & EWCA 2013).

GCCA

Guassa Community Conservation Area is in the central highlands of the Rift Valley escarpment in North Shoa Zone, Gera–Keya Woreda of Amhara National Regional State (10°15′–10°27′N; 39°45′–39°49′E; altitude: 3200–3700 m). GCCA is 265 km northeast of Addis Ababa (Fig 1B).

Rainfall is bimodal with a long wet season from the end of June until September, and a short wet season in March and April. Mean annual precipitation and temperature is 917 mm and 12.8° C, respectively. Temperatures range from 7°C to 26° C (EWNHS 1996, Tefera *et al*. 2012). The topography is characterized by hills and valley bottoms interspersed with swamps and open areas of montane and Afro-alpine grassland. Dominant plant species are *Hagenia abyssinica*, *Olea europaea* subsp. *cuspidata*, *Juniperus procera*, *Podocarpus falcatus*, *Allophyllus abyssinicus*, *Festuca* spp., *Erica arborea*, *Hypericum revolutum, Lobelia* spp., and *Thymus* spp. (Tefera *et al*. 2005).

GCCA shares two iconic endemic mammals, the Gelada baboon and Simien fox, with SMNP. Other endemic mammals found in GCCA are Abyssinian hare *Lepus starcki,* Unstriped grass rat *Arvicanthis abyssinicus* and Abyssinian meadow rat *Stenocephalemus grisecauda* (SMNP & EWCA 2013). GCCA is also home to 26 highland biome bird species. Of these, Spot-breasted Lapwing *Vanellus melanocephalus*, Rouget's Rail *Rougetius rougetii*, Abyssinian Longclaw *Macronyx flavicollis*, and Black-headed Siskin *Serinus nigriceps* are endemic to Ethiopia (EWNHS 1996).

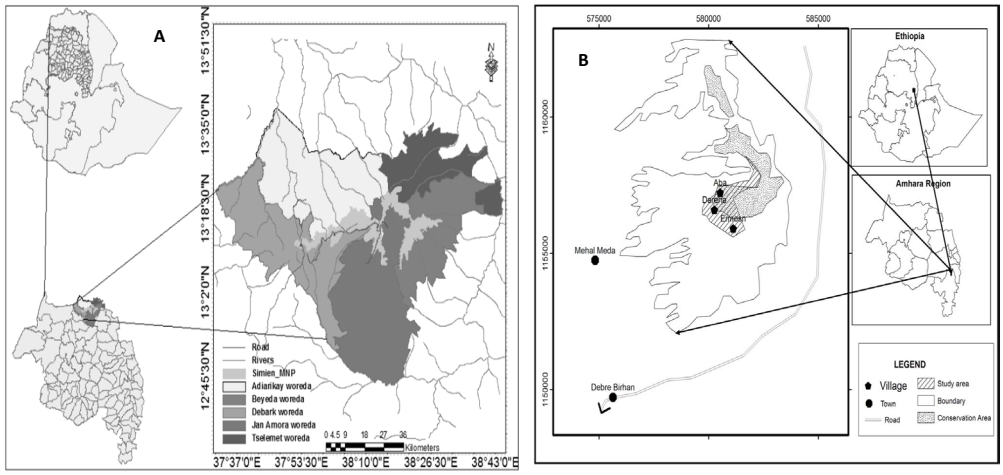

Figure 1. Map of Simien Mountains National Park (A) and Guassa Community Conservation Area (B).

Materials and methods

Flock size

An extensive search of Ankober Serin flocking sites was carried out at both study areas for more than 20 days. Finally, five flocking sites were selected at each of the study areas. Flocking sites were separated by a minimum of 1 km. Flock counts

were conducted during both dry and wet seasons between 2014–2016 (Wet season: July–August 2014 and 2015; Dry season: January–February 2015 and 2016). Each counting session lasted for three consecutive days in each season. Flock counts were conducted between 06:00 and 08:00. The first author and a trained field assistant conducted flock counts simultaneously to increase accuracy of the count. If there were significant variations, the counting was conducted again. Averages of the counts by both observers were recorded when the difference between the two counts were insignificant i.e. ≤5 birds.

Diet composition

Undigested remains in faecal droppings were used to determine diet composition. Fresh faecal samples were collected from two flocking sites in each of the study areas. Selection of the sites was determined based on their accessibility. Sites that were located on very steep slopes were excluded. A minimum of 10 fresh faecal droppings were collected from each of the flocking sites at both study areas during dry and wet seasons. Faecal samples were collected just after dropping to make sure they belonged to the serins. Diet composition was studied following the quantitative method of Robinson (2004). Pellets were stored in 70% ethyl alcohol until they were analysed using a 20x binocular microscope. First, the pellets were dissolved in 3 ml of water and the contents were determined using a point-quadrat method. For each sample, 0.1 ml of the suspension was mounted on a shallow-welled microscope slide. This was then placed over a grid of 72 points and the type of food item falling on each grid point was identified. This procedure was repeated five times for randomly selected, non-overlapping areas of the slide, resulting in a total of 360 grid positions counted for each sample.

Habitat analysis

Vegetation analysis of Ankober Serin habitats was conducted following Wiens & Rotenberry (1981). The same flocking sites used for diet analysis were included in the habitat analysis and these were designated as GCCA I, GCCA II, SMNP I, and SMNP II. Vegetation sampling points with a diameter of 4 m were established in each site. The number of sampling points ranged between 12 and 60, based on the size of the flocking site. The following four vegetation parameters were recorded at each sampling point:

I. *Composition*–plant species within a 2 m radius of the sampling points were recorded. Photographs of plants that could not be identified in the field were taken for later identification at the National Herbarium, Addis Ababa University.
II. *Structure and ground cover*–the vegetation structure (growth form) at each sampling point was categorized either as shrub or herb, and the ground cover was categorized as shrub, herb, or bare earth. The dominant growth form and ground cover was determined based on a visual assessment (Sutherland 2004).
III. *Height*–the highest stratum at each sampling point was measured using a measuring tape. Vegetation height was categorized as short (<30 cm), medium (30–60 cm), or tall (>60 cm). Based on the number of sampling points falling within each category, a percentage was calculated.

Statistical analysis

Pair-wise t-tests were used to compare flock sizes between wet and dry seasons. An independent sample t-test was used to compare the total bird counts between GCCA and SMNP. Levels of significance were based on 95% confidence rates. Analyses were conducted on SPSS ver. 17.

Results

Flock size

Mean flock size was higher during the dry season than the wet season in both GCCA (61.1 vs 39.2) and SMNP (84.3 vs 47.6). The seasonal variation in flock size at the two study areas was statistically significant ($p = 0.046$ at GCCA and $p = 0.021$ at SMNP) (Fig. 2 A & B). The highest mean flock size (n = 130) was recorded from SMNP flocking site (SF5) while the lowest (n = 16) was recorded from both GCCA (GF5) and SMNP (SF3) (Fig.2 A & B).

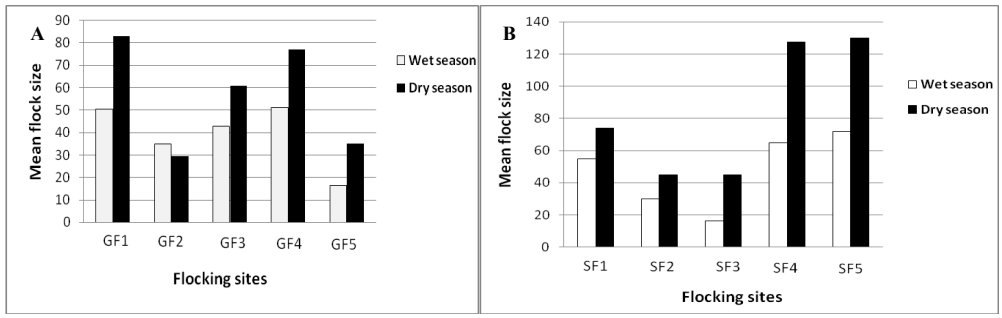

Figure 2. Mean flock size during the wet and dry seasons at GCCA (A) and SMNP (B) (GF = GCCA flocking site; SF = SMNP flocking site).

The highest total mean number of birds was recorded during the dry season at SMNP (n = 421.5) while the lowest was during the wet season at GCCA (n = 196). SMNP had a higher total number of birds during both seasons than GCCA, but the difference was not statistically significant ($p = 0.52$ wet season, $p = 0.31$ dry season) (Fig. 3).

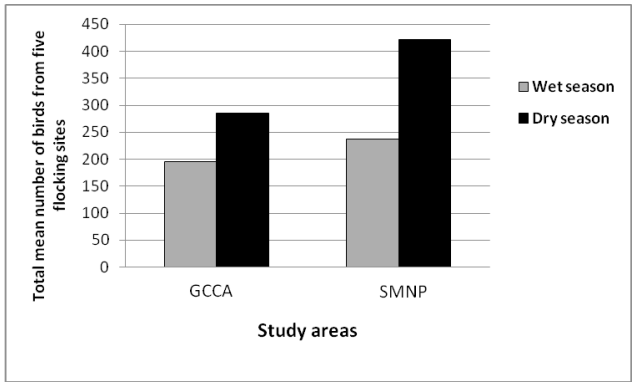

Figure 3. Total mean number of birds from five flocking sites during wet and dry seasons at GCCA and SMNP.

Diet composition

Diet composition showed a similar pattern at both GCCA and SMNP. Leaves and seeds significantly dominated the diet during the wet and dry seasons, respectively. Leaves represented 80% of the diet during the wet season, while seeds represented 90% during the dry season (Fig. 4). Insects and mosses combined made little contribution (≤10% per season) and they were relatively more common in the wet season than the dry season (Fig. 4).

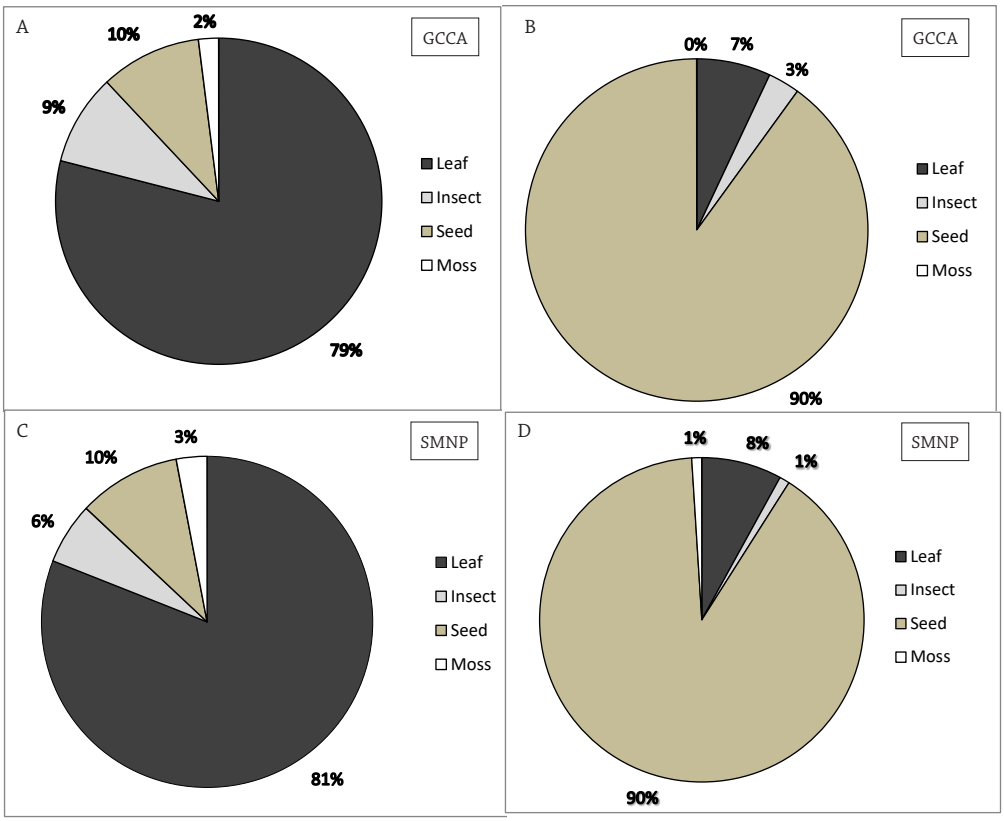

Figure 4. Proportion of diet items during the wet (A & C) and dry (B & D) seasons at both GCCA and SMNP.

A total of 39 plant species were identified from Ankober Serin habitats in GCCA and SMNP. Of these, 29 were recorded in SMNP and 22 at GCCA. The two areas shared 12 species (31%) of the total, n = 39 (Table 1).

Ground cover showed a similar pattern in all flocking sites. Herbs dominated in each site (53%–96%), while shrubs had the least coverage (0–13%; Table 2).

Table 1. Plant species recorded from Ankober Serin *Crithagra ankoberensis* flocking sites at GCCA and SMNP.

No.	Species name	GCCA	SMNP
1	*Aeonium leucoblepharum*	x	x
2	*Agrostis quinquesta*		x
3	*Agrostis sclerophylla*		x
4	*Alchemilla abyssinica*	x	
5	*Alchemilla bachitii*		x
6	*Andropogon spp*	x	x
7	*Bidens macroptera*		x
8	*Carduus schimperi*	x	x
9	*Carex spp.*	x	x
10	*Cerastium octandrum*		x
11	*Crassula alba Forssk*	x	x
12	*Crassula schimperi*		x
13	*Cynodon Spp.*	x	
14	*Cynoglosum coeruleum*	x	x
15	*Dianthoseris schimperi*	x	x
16	*Euphorbia schemperi*		x
17	*Euryops pinifolius*	x	
18	*Festuca macrophylla*		x
19	*Galium simense*	x	
20	*Helichrysum citrispinum*		x
21	*Helichrysum splendidum*	x	
22	*Haplocarpha schimperi*	x	
23	*Hypericum revolutum*		x
24	*Kniphofia foliosa*	x	x
25	*Lobelia rhyncopetalum*		x
26	*Myosotis vestergrenii*		x
27	*Plectranthus lanuginosus*	x	
28	*Primula verticillata*		x
29	*Ranunculus schimperi*	x	x
30	*Rumex steudelii*	x	
31	*Sagina afroalpina*		x
32	*Salvia merjamie*	x	x
33	*Satureja pseudosimensis*		x
34	*Satureja punctata*	x	
35	*Satureja simensis*	x	x
36	*Senecio nanus*		x
37	*Thymus schimperi*	x	x
38	*Thymus serrulatus*		x
39	*Utrica simensis*	x	

Table 2. Proportion of ground cover of Ankober Serin *Crithagra ankoberensis* habitats at GCCA and SMNP.

Flocking sites	Herbs	Shrubs	Bare earth
GCCA I	53%	13%	34%
GCCA II	75%	2%	23%
SMNP I	96%	0%	4%
SMNP II	69%	8%	23%

Short vegetation height dominated in all of the four sampled flocking sites (65%–77%), followed by medium height (19%–24%; Table 3).

Table 3. Proportion of vegetation height categories at Ankober Serin *Crithagra ankoberensis* flocking sites.

	Height category		
Flocking sites	Short (< 30 cm)	Medium (31–60 cm)	Tall (> 60 cm)
GCCA I	77. 1%	19.2%	3.6%
GCCA II	74.7%	19.7%	5.6%
SMNP I	75.1%	19.2%	5.7%
SMNP II	65.6%	24%	9.7%

Discussion

The present study documents the highest flock size (n = 130) compared to previous records of n = 15 (Ash 1979) and n = 60 (Vivero Pol 2001). Seasonal variation in flock size has also been reported in other species (Delestrade 1994, South & Pruett-Jones 2000, Sundar 2006). However, some species also show non-variable flock size over a long period (Ervin 1977). Food availability appears to be the main factor that governs foraging flock size. In sparrows that feed on barely seeds, the optimum flock size, also called equilibrium flock size, was determined by the size of a foraging patch that has the densest seeds and the density of seeds outside of this patch (Barnard 1980). A similar influence of food availability on flock size was suggested for the Asian Openbills *Anastomus oscitans* (Sundar 2006). Flock size is also correlated with the amount of energy intake. Goldfinches *Carduelis carduelis* consume more food in larger flocks than when they are foraging solitarily by minimizing the time spent on vigilance and increasing their rate of pecking (Glück 1986). Flock size variation is also related to the breeding season. Monk Parakeets *Myiopsitta monachus* showed a decrease in flock size at the beginning of the breeding season (beginning of spring) and an increase in the fall and early winter (South & Pruett-Jones 2000). The observed seasonal variation in flock size in Ankober Serin could be assumed to be influenced by the breeding season. The species breeds after heavy rains (Ash 1979). Thus, if breeding has the same influence on flock size as observed in Monk Parakeets, the decreased flock size during the wet season might be as a result of breeding activities. However, the effect of forage density on flock size needs to be investigated in future studies.

Previous studies have shown that variation in the diet of birds can be affected by breeding status (Molokwu *et al*. 2011), migration (Bolser *et al*. 2013), and food availability (Karmiris 2017). The dietary shift of Ankober Serin between leaves (wet season) and seeds (dry season) might be explained by the latter. It also appears that Ankober Serin consumes insects opportunistically as a source of animal protein.

The number of plant species recorded from GCCA and SMNP is almost the same as recorded by Ash (1979). However, some of the commonly occurring species described in Ash (1979) including *Trifolium* spp., *Sida ternate*, *Hebenstretia dentate*, and *Scabiosa columbaria* were absent. Ash also indicated *Erica arborea* as the dominant plant species at the breeding site of Ankober Serin. In the present study, *E. arborea* was not recorded in the flocking sites, but it was observed outside of them.

Our results revealed an association of Ankober Serin flocking sites with short plant heights (< 30 cm) that are dominated by herbs with some proportion of bare earth and shrubs. These habitat features can be used as indicators of the presence of Ankober

Serin in future studies and surveys. We recommend protection of these habitats as part of future conservation actions for Ankober Serin.

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