

## Avian diversity in hedgerows, preference to hedgerow types and their conservation at Angacha (Kembatta), central Ethiopia

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**Abstract** The present study aimed to investigate avian diversity in hedgerows at Angacha, in the Kembatta zone, Ethiopia. Transect and point-count methods were deployed to determine avian diversity, species richness, similarity and preferences across five sub study sites. Diversity and preferences of birds to hedgerow types varied in relation to their vegetation composition and structure. Five endemic species, i.e., Rüppel's Black Chat (*Cossyfa semirufa*), the White-cheeked Turaco (*Tauraco leucotis*), the Banded Barbet (*Lybius undatus*), the Abyssinian Oriole (*Oriolus monacha*) and the Wattled Ibis (*Bostrychia carucullatta*) were recorded in the thick hedgerow type. Thickness, height and width of hedgerows affected the diversity, distribution and habitat preference of birds. Thick hedgerow types showed the highest avian species diversity, richness and similarity. There was a high correlation between the hedgerow diversity and its bird diversity, which was directly associated with habitat quality. Bird species diversity and preference for hedgerow types require important conservation and management priorities.

**Keywords** avian diversity, hedgerows, preference to hedgerow types, species richness and similarity

### Introduction

Hedgerows are agricultural field boundaries with natural, remnant vegetation, grown and managed during the shift from communal to individual agricultural practices (Baudry et al., 2000). They were developed in response to the inherent physical and biological characteristics associated with the prevalent culture. Plant species diversity and composition of hedgerows depend on the interest of individual farmers and the community. Currently, Angacha is the only hedgerow growing region in Ethiopia with diverse hedgerow plant species

and complex vegetation structures. Hedgerow habitat quality depends on plant species composition, diversity and its associated fauna (Hinsley and Bellamy, 2000). Local communities use these hedgerows as sources of fuel and construction material; hedgerows have ecological and cultural values (Baudry et al., 2000). Hedgerows can also serve as a corridor and refuge, play a role in soil conservation and runoff catchments and provide nesting, feeding and wintering sites for birds (Pollard et al., 1974; Burel, 1996; Rappole et al., 2003; Kati and Sekercioglu, 2006).

Modified habitats, such as hedgerows, support substantial bird diversity (Hughes et al., 2002; Sodhi et al., 2005). However, the diversity of avian species and their response vary, depending on vegetation composition and structure (Chamberlain et al., 2000; Sekercioglu, 2002; Sodhi et al., 2005). The most important factors

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associated with species richness, abundance and breeding of hedgerow birds are the size (height, width or volume) and the abundance of trees (Hinsley and Bellamy, 2000; Brambilla et al., 2009).

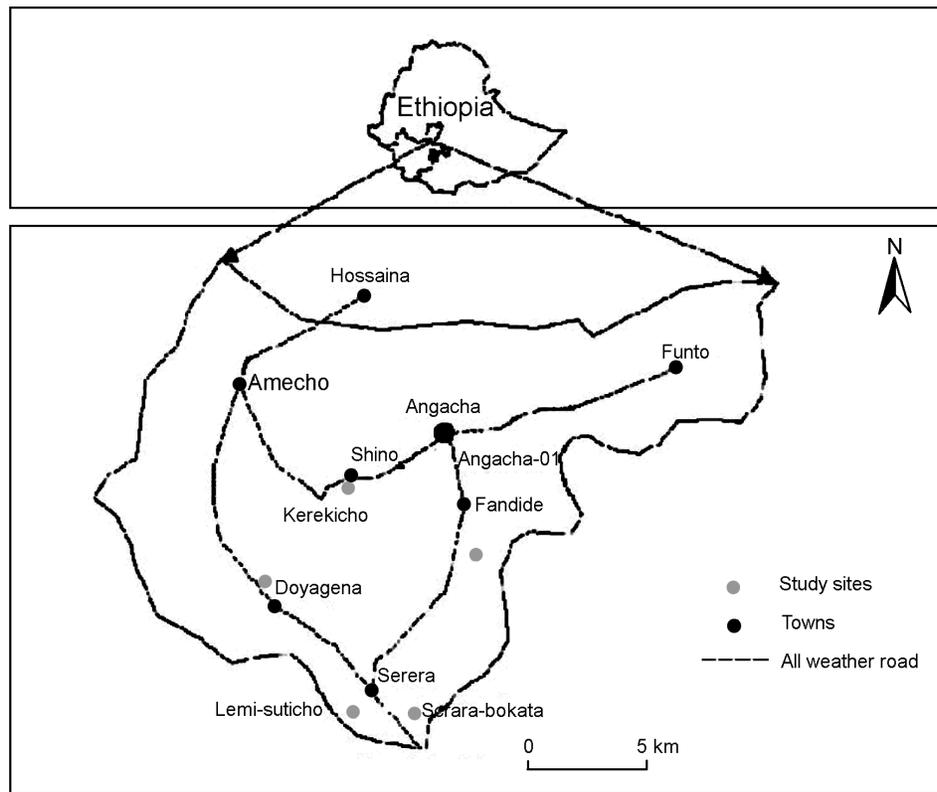
Intensification of agriculture is the main threat to farmland bird diversity, especially for less abundant species (Chamberlain et al., 2000; Whittingham and Evans, 2004). Hedgerow bird population recovery requires restoration of nesting covers such as shrubs, woodland and understories (Peach et al., 2004; Peh et al., 2006).

There are no previous studies on hedgerows and their birds at Angacha. Sustaining this unique habitat in Ethiopia requires management and conservation. Hence, the present study was aimed to assess and compare three types of hedgerows and their bird diversity, species richness, relative abundance and seasonal composition at Angacha. It helps to devise management measures in order to sustain hedgerows and their faunal diversity, given the present decline of bird diversity and biodiversity in general.

## Study area and methods

The present study area was located at the Kembatta Zone, 260 km south of Addis Ababa, Central Ethiopia. This area is situated at elevations ranging from 2100 to 3028 m a.s.l. (Fig. 1). The area has a bimodal rainfall pattern with a mean annual rainfall of 1631 mm and mean annual temperature of 20°C. The short rainy season (January or March) is irregular with light rainfall, while the long rainy season (June to September) is characterized by high intensity rains in July. The most common plant species of hedgerows are Arsenic bush (*Senna septemtrionalis*), Justicia comata (*Justicia schimperiana*), Bitter leaf (*Vernonia amygdalina*), Croton (*Croton macrostachys*) and Erythrina abyssinica (*Erythrina brucei*).

The present study was carried out from March to August 2010, covering both dry and wet seasons. Surveys of twenty days were carried out per month using point-count and line-transect methods (Bibby et al.,



**Fig. 1** Map of Angacha with its sub study sites (Source: Ethiopian Mapping Authority, 1998).

1992; Gibbons et al., 1998). The height and width of the vegetation of the hedgerows were estimated and/or measured (Baudry et al., 2000). Based on the variation in thickness, hedgerows were grouped into one of the following three types: 1) open farmland with fences to dispersed bordering hedges (0–2 m) of  $S_1$ ; 2) thin hedgerows (2–5 m) of  $S_2$  and  $S_3$ ; and 3) thick or dense hedgerows ( $\geq 5$  m) of  $S_4$  and  $S_5$ .

The hedgerows were located at 0.5 to 1 km distance from each other as shown in Fig. 2. Given this condition, the study site, Angacha was divided into five sub-sites with a total of 125 point counts. Each sub-site had five sampling units and 25 point counts. Five sampling point counts with five replicates were performed per hedgerow type per season per sub-study site. In order to minimize double counting of birds, point counts were made at a distance of 200 m at the junction of hedgerow networks, following the method by Hinsley and Bellamy (2000). In each point count per hedgerow type, bird counts were made at a 25 m radius of a point count by direct observation within 5–10 min.

T-tests at a 95% CI and ANOVAs were carried out using SPSS software, version 13 to test avian diversity and distribution in hedgerow types per season. Further, an Excel computer program was used to record data to determine the Shannon-Wiener diversity index and the Simpson similarity index in order to determine species

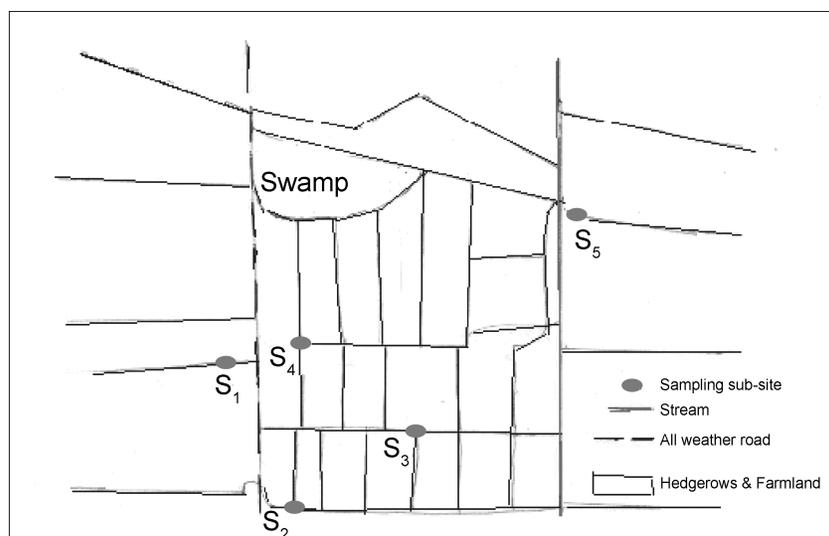
diversity, similarity and relative abundance per type of hedgerow.

## Results

A total of 27 species of birds from 18 families were identified during both the dry and wet seasons in open, thin and thick hedgerows (Table 1). Of these, 25 species were recorded during the dry season and 27 in the wet season. Among the 27 species identified, 5 species were recorded during the dry season in open types of hedgerows, 13 in thin types and 22 in thick hedgerow types.

High species richness was observed in thick hedgerows. Species richness in the three types of hedgerows ranged from 5 to 22 during dry season and from 6 to 24 during the wet season. There were variations in the bird species richness among hedgerow types ( $t = 3.361$ ,  $p < 0.05$ ) but not between seasons. The highest species diversity was obtained in the thick hedgerow type. Compared with other hedgerow types, thick hedgerows harbored high endemism (Table 2). Species similarity was high between thin and thick hedgerow types followed by open and thin types during both dry and wet seasons. The least similarity was observed between open and thick types (Table 3).

The distribution of avian species among the hedgerow types were 22.2% in open hedgerows, 55.5% in thin



**Fig. 2** Modeled study area hedgerow types and their thickness. Birds point-counts represent a total of 45 transects and 125 point counts.  $S_1 = 0\text{--}2$  m (open),  $S_2 = 2\text{--}3$  m and  $S_3 = 3\text{--}5$  m (Thin),  $S_4$  and  $S_5 \geq 5$  m (Thick).

**Table 1** Recorded avian species and their relative abundance in different hedgerow types during both wet and dry seasons

Bird species recorded	Scientific name	Hedgerow types		
		0–2 m (open)	2–5 m (thin)	> 5 m (thick)
Groundscraper Thrush	<i>Psophocichia litsitsirupa</i>	0.0133(–)	0.0266 (–)	– (–)
Mountain Thrush	<i>Turdus abyssinicus</i>	0.0067(0.0158)	0.0200 (0.0213)	– (–)
Ruppell's Robin Chat	<i>Cossyfa semirufa</i>	– (–)	0.0333 (0.0284)	0.0533 (0.0426)
Ruppell's Black Chat	<i>Myrmecocichla melaena</i> *	– (–)	0.0067 (–)	– (–)
Common Fiscal	<i>Lunius collaris</i> *	0.0067 (0.0071)	0.0133 (0.0212)	0.0333 (0.284)
Swainson's Sparrow	<i>Passer swainsoni</i>	0.0133 (0.01442)	0.0133 (0.0212)	0.0400 (0.0355)
Red-cheeked Cordon Bleu	<i>Uraegenatusbengalus</i>	– (–)	0.0133 (0.0071)	0.0133 (0.0071)
Village Weaver	<i>Ploceus cucullatus</i>	0.0133 (0.0071)	0.0200 (0.0142)	0.0267 (0.0284)
Red-billed Firefinch	<i>Laganosticta senegala</i>	0.0200 (0.0284)	0.0333 (0.0426)	0.0709 (0.0709)
African Paradise Flycatcher	<i>Terpsiphone vividis</i>	– (–)	– (–)	0.0067 (0.0071)
Towny Flanked Prinia	<i>Prinia subflava</i>	– (–)	0.0133 (0.0142)	0.0200 (0.0212)
Common Bulbul	<i>Pycnonotusbarbatus</i>	– (–)	0.0200 (0.0284)	0.0600 (0.0567)
Green-backed Honeyguide	<i>Prodotiscus zambesiae</i>	– (–)	0.0467 (0.0567)	0.0867 (0.0851)
Variable Sunbird	<i>Cinniris vnustus</i>	– (–)	0.0200 (0.0142)	0.0467 (0.0425)
Tekezze Sunbird	<i>Necatarinia teacazze</i>	– (–)	0.0067 (0.0071)	0.0067 (0.0071)
Scarlet-chested Sunbird	<i>Chalcometra senegalensis</i>	– (–)	0.0067(0.0071)	0.0067(0.0071)
White-cheeked Turaco	<i>Tauraco leucotis</i> *	– (–)	– (–)	0.0200 (0.0142)
Banded Barbet	<i>Lybius undatus</i> *	– (–)	– (–)	0.0133 (0.0071)
Black-billed Barbet	<i>Lybiusguifisobalito</i>	– (–)	– (–)	0.0067 (0.0071)
Abyssinian Oriole	<i>Orolus monacha</i> *	– (–)	– (–)	0.0600 (0.0567)
Sacred Ibis	<i>Thresciomis aethopicus</i>	– (–)	– (–)	0.0200 (0.0142)
Hadad Ibis	<i>Bostrychia hagedash</i>	– (–)	– (–)	0.0133 (0.0142)
Glossy Ibis	<i>Piegedisfalcinellus</i>	– (–)	– (–)	0.0333 (0.0284)
Wattled Ibis	<i>Bostrychia carucullata</i> *	– (–)	– (–)	0.0467 (0.0425)
Hamerkop	<i>Scopus umbreta</i>	– (–)	– (–)	0.0133 (0.0071)
Egyptian Goose	<i>Alopachen aegypticus</i>	– (–)	– (–)	0.0267 (0.0142)
African Grey Hornbill	<i>Tockus nasutus</i>	– (–)	– (–)	0.0067 (0.0071)

Note: – means absence; inside ( ) is dry season avian relative abundance (individuals per population per hedgerow types), and outside ( ) is wet season avian relative abundance; \* means endemic species.

**Table 2** Species richness and diversity indices during both dry and wet season

Season	Hedgerow types	Species richness	$H'$	$H_{\max}$	$H'/H_{\max}$	$D'$	% species
Dry	Open	5	0.037	1.61	0.023	27.02	20.0
	Thin	13	0.482	2.56	0.190	2.07	55.6
	Thick	22	0.778	3.09	0.610	1.28	85.0
Wet	Open	6	0.042	1.80	0.023	23.81	22.2
	Thin	15	0.083	2.71	0.031	12.05	55.6
	Thick	24	0.500	5.50	0.091	1.50	88.9

Note: species richness = number of species per hedgerow type per season.  $H'$  = Shannon-Wiener's index,  $D'$  = Simpson's index.

hedgerows and 88.9% in thick hedgerows. The highest preference was observed for the thick hedgerow type (Table 2). Relative abundance varied during dry and wet seasons for different hedgerow types. During dry

and wet seasons, the relative abundance of the Green-backed Honey Guide (*Prodotiscus zambesiae*) was highest in thick and thin hedgerows, followed by the Red-billed Firefinch (*Laganosticta senegala*) in relation to

**Table 3** Species similarity among the hedgerow types during dry and wet seasons

Season	Hedgerow types	Open	Thin	Thick
Dry	Open		0.38	0.18
	Thin	0.38		0.55
	Thick	0.18	0.55	
Wet	Open		0.40	0.25
	Thin	0.40		0.63
	Thick	0.25	0.63	

other species per hedgerow per season. But the relative abundance of the red-billed fire finch was the highest within open hedgerows.

## Discussion

Avian species richness, diversity, composition and endemics vary in relation to hedgerow types. These characteristics are positively associated with the variability in hedgerow plant species richness, composition and heterogeneity (Chamberlain et al., 2000; Bradbury, et al., 2001; Newton, 2004). The present study revealed the impact of hedgerow types with their variability in vegetation structure and heterogeneity of avian communities. This might be associated with the provision of cover, food, nest and nesting material. The observed high species richness, diversity and avian preferences as well as endemism for thick hedgerows and the poor community structure in open hedgerow demonstrate the impact of heterogeneity of hedgerow vegetation and its types.

During both dry and wet seasons, high avian species similarity was observed between thick and thin hedgerow types followed by open and thin types. Shared vegetation structures and provision of common resources might have contributed to this similarity. However, species similarity deviated between open and thick hedgerows. Seasonal similarity within hedgerow types was high for thick hedgerows and was least for open types (Pollard et al., 1974; Bradbury et al., 2001). This suggests a preference of avifauna to different hedgerow types and their high ecological value. This was realized in the present study with a nearly exclusive habitation

of endemic birds in thick, well managed hedgerows. Thus, the complexity of farmland boundaries (hedgerows) determined them as the habitat for the prevalent bird species (Bradbury et al., 2001).

Intensification of agriculture and pressure from population growth affected habitat quality of hedgerows. Thinning and removal of hedgerow plants and plowing to their base reduced the habitat quality where the bird species community was poor (Whittingham and Evans, 2004). In the present study, the association of the White-cheeked Turaco (*Tauraco leucotis*) and Banded Barbet (*Lybius undatus*) with indigenous fruiting trees of thick hedgerows above 5 m, such as *Erythrina brucei*, showed ecological interaction of the indicator hedgerow plant species and the preference of its associated birds. However, a loss of hedgerows reduced habitat quality, causing their bird populations to decline (Peach et al., 2004).

High species diversity, richness and endemism in thick hedgerow types during dry and wet seasons show their preference due to the availability and provision of various essential resources. Despite this, bird species preference and similarity among hedgerow types deviated considerably where the highest similarity was observed in thin and thick hedgerows during both dry and wet seasons. Habitats where natural communities are altered to managed ecosystems, conservation and regulation of hedgerows are important for the maintenance of bird distributions, diversity and ecosystem services, given the scenario of challenging changes in climate. Therefore, in order to manage and conserve hedgerows and their avian diversity, a certain amount of awareness of hedgerows and their ecological interaction with birds, as well as their role in crop production, is required. Mitigative actions are needed for the region in order to restore and conserve hedgerows as a pool for biodiversity and panacea to their loss.

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## 埃塞俄比亚中部Angacha地区树篱鸟类多样性、对树篱类型的偏好及其保护

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**摘要:** 本文旨在研究埃塞俄比亚中部 Angacha 地区树篱中的鸟类多样性。采用样线法及样点法调查了五个子地点的鸟类多样性、丰富度、相似度及对生境的偏好等指标。树篱中鸟类多样性及其对树篱类型的偏好因其植被组成及结构的不同而有所差异。在树篱生境中记录到 5 个特有鸟种，即卢氏歌鸲 (*Cossyfa semirufa*)、白颊蕉鹃 (*Tauraco leucotis*)、横斑拟鸲 (*Lybius undatus*)、黑头林鹑 (*Oriolus monacha*) 及肉垂鹑 (*Bostrychia carucullata*)。树篱的稠密度、高度及宽度影响到鸟类的多样性、丰富度及相似度。较密的树篱常常拥有较高的鸟类物种多样性、丰富度和相似性。组成树篱的植物多样性及其鸟类多样性之间呈高度相关，并与生境质量直接相关。树篱中鸟类多样性较高，并且一些鸟类对某些类型的树篱有明显的偏好，这就对当地树篱优先保护与管理提出了要求。

**关键词:** 鸟类多样性，树篱，对树篱的偏好，物种丰富度及相似度