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RESEARCH ARTICLE

Avian assemblages in lowland and foothill agro-ecosystem in Lesotho

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During the years 1996-2001, the line transect method has been employed to assess the species composition, dominance structure and relative abundance of birds resident in traditional farmlands, in the lowlands (10 transects with the total length of 43.9 km) and foothills (10 transects with the total length of transects 46.5 km) of Lesotho, southern Africa. This has been done to show the role of this farming in biodiversity conservation. A total of 76 resident species have been recorded in farmlands of Lesotho, 62 species in the lowlands and 53 species in the foothills. In the lowland farmlands the dominant group was composed of 6 species, namely the Prinia, Cape Bunting, Cinnamon-breasted Bunting, Cape Canary, Neddicky and Common Quail (35.8 %); in the foothills the group was composed 5 species: Karoo Prinia, Cape-turtle Dove, Laughing Dove, Cape Bunting and Cape Canary (35.9 %). Eighteen species bred in significantly different densities in lowlands and foothills. While insectivorous birds were more numerous in the lowland than foothill, the reverse was true with granivorous birds. Those two guilds comprised together 78% and 83% in the lowland and foothill respectively. The proportion of species in each guild was similar. In the lowland farmland the following eight species were more common that in the foothill farmlands, while in foothill farmland 10 species were more numerous than in lowland farmland. Species diversity and evenness were strikingly high and similar in lowlands and foothills, although Sorensen Similarity Index between these two areas was low (I = 0.44). Both species diversity and structure of dominance in avian communities in Lesotho farmlands indicate that the traditional farming play a positive role in biodiversity conservation.
Key words: biodiversity conservation, sustainable agriculture, population densities, avian assemblages.

Introduction

Studies on birds in agroecosystems constitute one of the most important aspects of bird conservation, as large proportion of birds are dependent on this ecosystem (Wilson et al. 2009). This is especially true in regard to Europe and USA, where agroecosystems constitute a dominant (often more than 50%) total land cover in most countries. Birds in agro-ecosystem attracted therefore enormous attention of researchers (Harding et al. 1994, Newton 2017).

However, much less is known about birds in agro-ecosystem in Africa (Kopij 2006a). Most studies refer to human-wildlife conflicts, without special concern on the avian ecology and conservation in this ecosystem. For example, no quantitative studies ever were conducted on avian assemblages in agroecosystem of Namibia (Kopij 2014) or Lesotho (Ambrose et al. 2000).

Agriculture in Lesotho is, as in many other African countries, still a major source of economic growth. The agriculture utilizes c. 50% of the country's labor force and provides 18.2% of the GDP. The major agriculture products include: maize, sorghum, wheat, barley, cattle, goats and sheep (Moyo et al. 1993). Lowlands and foothills form the main agricultural zones. In lowlands arable farming predominates, while in foothills mixed pastoral and arable farms is practiced (Ambrose et al. 2000).

Unfortunately, steep slopes, overgrazing and intensive maize production has led to acute soil depletion and erosion in this country, with rates of net erosion varied between 100-2000 t/ km^2/year (Moyo et al. 1993). Terracing, grass stripping, and the construction of dams and irrigation canals are widely employed to contract this heavy loss of soil (Ambrose et al. 2000).

So called conservation agriculture can also substantially prevents the erosion. It is a form of farming on soil that are easily eroded or regarded as unproductive. Since this faming is in a harmony with the nature, it may also contribute towards biodiversity conservation. Since birds are good indicators of environmental quality (Sutherland 1996), I have

decided to investigate avian assemblages associated with Lesotho farmland, where conservation farming is employed to a large extend, to test the role it plays in biodiversity conservation.

Since natural vegetation is better preserved in the foothills than in lowlands, and human pressure at large is much higher in the lowlands than in foothills of Lesotho, I have expected that both the species diversity, and population densities will be higher in the foothills than in lowlands.

Study area

The study was conducted in lowlands (included Senque Valley) and in foothills of Lesotho, southern Africa (Table 1).

Table 1. Routs designed in lowland and foothill farmlands in Lesotho and time expenditure.

No.	Rout	Length [km]	Date	Time	Hours/ minutes
	Lowlands	**43.9**			**26.35**
1	Between Matsieng and Tlouoe Plateau	6.5	05.12.2000	08.10-12.00	3.40
2	Morija surroundings	1.5	14.10.2000	09.25-10.10	0.45
3	Matsieng surroundings	1.5	30.09.1999	17.15-18.00	0.45
4	Nazareth-Ha Ramotšoana	4.2	04.04.1996	10.45-12.30	2.15
5	Nazareth-Machacha foothills	4.0	04.04.1996	14.00-16.00	2.00
6	Nazareth-Seklutlong-Ha Mapuma	7.1	13.12.1999	07.00-10.30	3.30
7	Nazareth surroundings	9.5	02.01.1999	08.15-13.30	5.15
8	Senqu Valley: Bethel-Ha Teboko-Lekholong	5.2	03.01.1997	06.20-09.00	2.40
9	Senqu Valley: Lekholang ha Mahkofola-Liboti	8.0	03.01.1997	09.00-13.00	4.00
10	Senqu Valley: Villa Maria-Masitise	1.8	27.02.2001	10.40-12.25	1.45
	Foothills	**46.5**			**27.00**
11	Dikolobeng-St. Benedict	6.9	11.04.1999	06.15-10.00	3.45
12	St. Bernard-Fraser	6.1	12.04.1999	11.45-15.00	3.15
13	Sefikeng-Ohotseng	2.0	24.10.2001	10.15-11.05	0.50
14	Bushemns' Pass-Malehloane	2.0	06.10.2001	09.00-10.00	1.00
15	Ha Ralejone surroundings	2.1	11.08.2001	09.20-10.20	1.00
16	Nyakosuba-Popanyane	3.2	08.04.2000	08.45-10.20	1.35
17	Popanyane-Popa	5.0	08.04.2000	10.20-13.00	2.40
18	Popa-Ha Matabele	4.1	08.04.2000	13.00-15.00	2.00
19	Moitšupeli-Matamo-Ha Hubeum-Moitšupeli	5.8	15.08.2000	09.00-12.00	3.00
20	Moitšupeli-St John's-Patisi Ha Mohake	9.3	12.12.2001	07.20-14.20	5.00

Lowlands are regarded as the land below 1700 m a.s.l. while foothills are between 1700 and 2200 m a.s.l. Lowlands (total surface – 6 051 km^2) form a strip of land lying along its northeast-southwest border and extending eastward to the Cave Sandstone Foothills. The foothills (total surface – 2 964 km^2) form a narrow band bordering the highlands to the east and lowlands to the west, constituting therefore an intermediate region between the highlands and the lowlands (fig.1). The Senque Valley Zone is below 1800 m a. s. l. and occupies 3 398 km^2 (Moyo et al. 1993; Ambrose et al. 2000). Since the natural vegetation comprises the Highveld Grassveld in lowlands and Senque Valley, and both zone lay below 1 800 m a.s.l., they are combined in this study. In foothills and highlands, the natural vegetation is Afromontane Grassland (Acocks 1988).

The average rainfall in Lesotho is 730 mm per annum (Moyo at al. 1993). In lowlands it varies from 600 mm to 800 mm per annum, while in highlands from 800 mm to 1200 mm per annum; 85% of the rain falls from October through April (Ambrose et al. 2000).

The crop lands occupy 7 540 km^2 (24.9% of the country's surface area). Most of it occupies lowlands (3201 km^2), foothills (1 048 km^2) and Senque Valley (838 km^2). The remaining 2 477 km^2 occur in highlands (Moyo et al. 1993). The maize occupies c. 50%, and sorghum c. 25% of the arable area (Moyo et al. 1993). Livestock include sheep (c.46%), goats (c.33%), cattle (c.18%) and horses (c. 3%) (Ambrose et al. 2000). They are all pastured extensively on communal grazing grounds.

In lowlands, arable grounds dominate, where maize and sorghum are the main cultivated plants. There are also some heavily overgrazed and degraded pastures (with high erosion). Human pressure is very high and natural vegetation is almost totally destroyed. In the foothills, pastures for the cattle, sheep and goats dominate. The grazing pressure is high, but natural vegetation is relatively well-preserved. Arable grounds are located mostly in the river valleys.

Methods

A farmland is defined here as a land utilized mainly (>50%) for crop production, together with interlaced natural grassy areas, pastures, shrubs, tree clumps, marshes and other natural and semi-natural vegetation. The line transect method (Bibby et al. 1992) has been employed. Counts were conducted during the years 1996-2001, as to exclude the effect of differential rainfall. Ten sites were selected in lowlands and Senque Valley and 10 in foothills (Fig. 1). In each selected site, transects have been designed to count all resident birds. The total length of transects was 43.9 km in lowlands and 46.5 km in foothills (Table 1). Each transect was surveyed once, mostly in wet season and in the mornings. A total of 53 hours and 35 minutes were spent on counting. Depending on transect length, 45 min. – 5 hours and 15 min. were spent on each transect; on average 2.6 hours (SD = 1.45). Only resident (potentially breeding) species were counted, excluded were vagrants and visitors. As recommended for the line transect method, a pair of the resident species was the census unit (Bibby et al., 1992). Records of single birds, or families were interpreted as a pair. In polygynous species, the number of females was assumed as an equivalent of the 'breeding pair'.

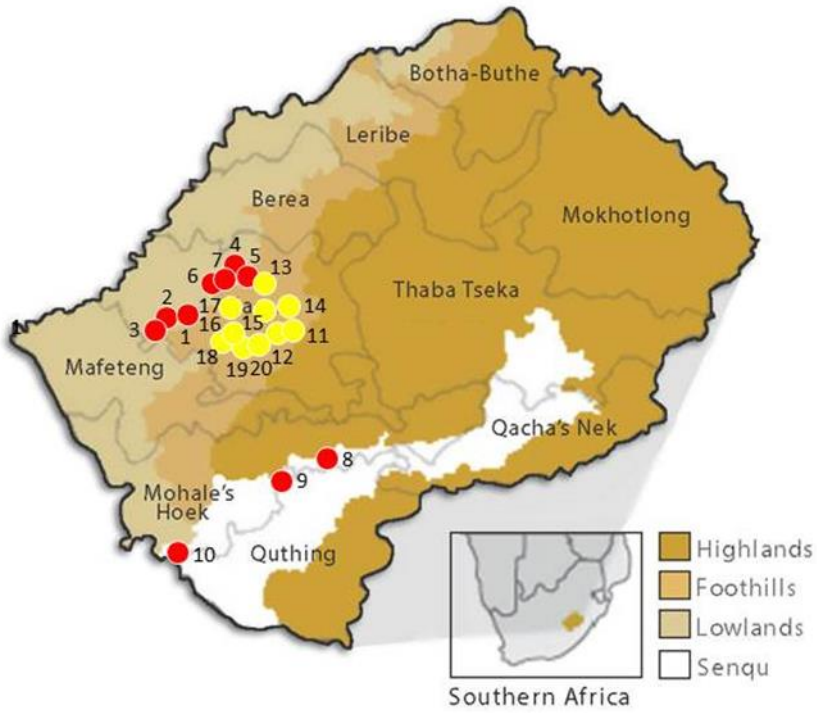

Fig. 1. Map of Lesotho showing ecozones and administrative districts. Study plots in lowlands are indicated with red dots, those in foothills – with yellow dots (number as in Table 1).

For each bird species, the following parameters were calculated (Table 2): 1) N – number of potentially resident pairs recorded; 2) %D – dominance expressed as the proportion of resident pairs of a given species to the total number of all resident pairs of all species recorded, expressed as a percentage 3) F – frequency of occurrence, defined as the percentage of transects, where a given species was recorded to the total number of transects in given area; 4) Ind. – index of abundance calculated as the percentage of the number of resident pairs of a given species in relation to the most numerous species

The following indices were used to characterize the diversity and evenness of the communities:

1) Shannon's diversity index: $H' = -\sum p_i \log p_i$

where: p_i is the proportion of breeding pairs belonging to the *i*th species

2) Simpson's diversity index: $D = ((\sum n(n-1))/N(N-1)$

where: n – total number of breeding pairs belonging to a given species, N – total number of breeding pairs of all species

3) Pielou's evenness index: $J' = (-\sum p_i \log p_i)/\log S$

where p_i is the proportion of breeding pairs belonging to the *i*th species; S – total number of species. J' varies between 0 and 1. The less variation between species in a community, the higher J' is.

4) Community dominance index: $DI = (n_1 + n_2)/N$

where n_1, n_2 – number of pairs of two most abundant species, N – total number of pairs of all species.

5) Sörensen's Coefficient: I = 2C/A+B

where A – the number of bird species in lowlands, B – the number of bird species in foothills, C – the number of bird species common to both areas.

Dominant bird species is defined as comprising at least 5% of the total number of all resident pairs; while subdominant that comprising 2-4.9% of that total. Systematics and nomenclature of bird species follow Hockey et al. (2005).

Table 2. Parameters and indices characterizing breeding bird community in the lowland and foothill farmlands in Lesotho.

Parameter	Lowlands	Foothills
Number of species	62	53
Number of breeding pairs	627	623
Cumulative dominance (%)	35.8	35.9
Number of dominant species	6	5
Community dominance (DI)	0.15	0.17
Shannon's Diversity Index (H')	1.57	1.53
Simpson's Diversity Index (D)	0.99	0.99
Pielou's Evenness Index (J')	0.88	0.89

Results

A total of 76 resident species have been recorded in farmlands of Lesotho, 62 species in the lowlands and 53 species in the foothills (Table 2, App. 1). The difference is, however, not statistically significant (x^2-test, $x^2 = 0.70$, $p>0.05$).

In the lowland farmlands the dominant group was composed of six species, namely the Karoo Prinia *Prinia maculosa*, Cape Bunting *Emberiza capensis*, Cinnamon-breasted Bunting *Emberiza tahapisi*, Cape Canary *Serinus canicollis*, Neddicky *Cisticola fulvicapilla* and Common Quail *Coturnix coturnix* (App.1). They formed together 35.9%. In the foothills the group was composed of 5 species: Karoo Prinia, Cape Turtle-Dove *Streptopelia capicola*, Laughing Dove *Streptopelia senegalensis*, Cape Bunting and Cape Canary (together 36.0%). So, the proportion of dominant species (cumulative dominance) was almost identical in lowlands and foothills (Table 2). Also the community dominance was strikingly similar in both areas compared (Table 2). However, only Karoo Prinia, Cape Canary and Cape Bunting were dominant species in both lowland and foothill farmlands (App.1).

Subdominant species were more numerous both in the lowlands (12 species) and in foothill (9 species). However, their contribution was lower (38.9% and 28.7% in lowlands and foothills respectively) than that of dominant species (Table 2). Dominant and subdominant species composed 81.5% of all resident pairs in lowlands and 64.7% in foothills.

In the foothill farmlands four species occur on transects with a frequency higher than 80%: Karoo Prinia, Cape Bunting, Laughing Dove and Cape Robin-Chat *Cossypha caffra* ; while in the lowland farmland only the Laughing Dove occurred with a frequency higher than 80% (App. 1).

Overall population density of all breeding birds was slightly higher in lowlands (15.3 pairs / 1 km) than in foothills (13.4 pairs / 1 km). Eighteen species bred in significantly different densities in lowlands and foothills (App.1). In lowlands, the following species bred in higher densities than in foothills: Cinnamon-breasted Bunting, Neddicky, Common Quail, Grey-headed Sparrow *Passer diffusus*, Yellow-crowned Bishop *Euplectes afer*, and House Sparrow *Passer domesticus*. On the other hand the following species bred in much higher densities in the foothills than in lowlands: Cape Turtle-Dove, Laughing Dove, African Quailfinch *Ortygospiza atricollis*, Rock Martin *Ptyonoprogne fuligula* , Cape Sparrow, Malachite Sunbird *Nectarinia famosa*, Common Waxbill *Estrilda astrild*, Wing-snapping Cisticola *Cisticola ayresii*, Cape Grassbird *Sphenoeacus afer*, Cape Long-claw *Macronyx capensis*, Pied Staring *Spreo bicolor* and Southern Red Bishop *Euplectes orix* (App. 1).

In the lowland farmland the following species were more common that in the foothill farmlands: Cinnamon-breasted Bunting, Neddicky, Common Quail, Red-capped Lark *Calandrella cinerea*, Grey-headed Sparrow, House Sparrow, Malachite Sunbird, and Yellow-crowned Bishop. On the other hand, the following species were more common in the foothill farmland than in the lowlands: Cape Turtle-Dove, Laughing Dove, African Quailfinch, Rock Martin, Cape Sparrow, Cape Long-claw, Pied Starling, Common Waxbill, Speckled Pigeon *Columba guinea*, Southern Red Bishop and Grey-winged Francolin *Scleroptila afra* (App. 1).

Both the Shannon's and the Simpson's Diversity Indices were very high and almost identical in the lowlands and foothills, as was also the Pielou's Evenness Index (Table 2). However, the Sörensen Similarity Index was unexpectedly low ($I = 0.44$).

The G-test ($G=81.4$) has shown significant differences ($p<0.01$) in the proportion (number of resident pairs) of feeding guilds. While insectivorous birds were more numerous in the lowland than foothill, the reverse was true with granivorous birds (Fig. 2). Those two guilds comprised together 78% and 83% in the lowland and foothill respectively (Fig. 2). The proportion of frugivorous birds was more equal (Fig. 2). However, the proportion of species in each guild was strikingly similar.

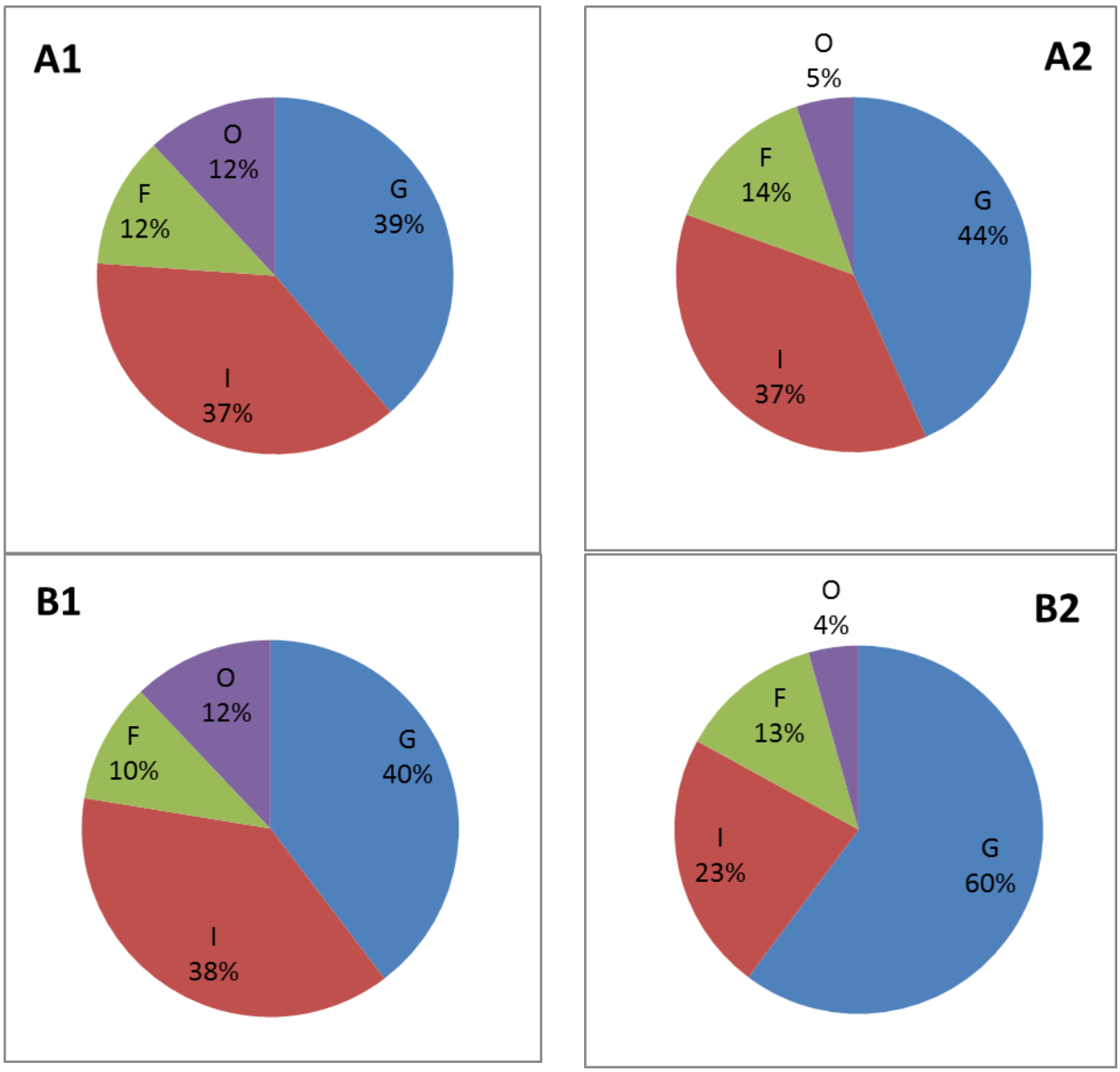

Fig 2. Proportions of main feeding guilds of avian assemblages in A) lowland, and B) foothill farmlands of Lesotho. 1 – based on the number of species (N = 67 in lowlands, N = 58 in foothills); 2 – based on the number of resident pairs (N = 672 in lowlands, N = 523 in foothills); G – granivores, I – insectivores, F – frugivores, O – other

Discussion

Agro-ecosystems may constitute an important environment for numerous bird species, because they are often a dominant component of landscapes.

The recorded number of species (Table 2) constitutes about 1/3 of all resident (breeding) species recorded in Lesotho so far (Bonde 1993, Ambrose et al. 2000). Avian assemblages in 11 various habitats in South African grasslands comprised 33-57 species (on average 44. 1), and only in one habitat (bushy vegetation on slopes along the Clarens Formation Sandstone Cave), it reached 75 species (Kopij 2006). Even in Sehlabathebe National Park the number of resident species was much lower (N=33) than in the farmlands (Kopij 2002). All these indicate relatively high avian diversity in traditional farming areas both in the lowlands and in foothills. It is, however, important to point out that not all the species are strictly associated with farmland as breeding habitat. Some of them use neighboring rock cliffs, shrubs, tree clumps or rivers as nesting sites, with arable ground being part of their territories or/and feeding grounds.

Exceptionally high species diversity recorded both in lowlands and foothills indicate that from biological point of view the agro-ecosystem is Lesotho play a positive role in nature conservation, despite the fact that it causes serious soil erosion. It was unexpected to record the slightly higher number of species in foothills in comparison with lowlands, as more natural vegetation is preserved in the foothills. Highly transformed lowlands may, however, bring some novel micro-habitats, such as gardens, clumps and rows of exotic trees, dams, built-up areas. Natural predation may also be lower in the lowlands than in the foothills. These factors may compensate for the lack of natural vegetation, hence both the species richness and species diversity is equally high in the lowlands and foothills.

Since farmlands are dominated by crops representing grass family (Graminaceae), large proportion of granivorous birds are expected in the feeding guilds, but in Lesotho agro-ecosystems the granivorous birds were, in general, equally numerous as the insectivorous birds. Lowlands may be more abundant in arthropods, hence the proportion of insectivorous birds was higher in the lowlands than in foothills, while abundance of natural grasses in foothills may provide more seeds for granivorous birds, hence their higher proportion in the foothills in comparison with lowlands.

Both the species diversity and structure of dominance in avian communities in Lesotho farmlands may also indicate that the traditional farming practicing in Lesotho play a positive role in biodiversity conservation. It should be, however, emphasized that the farmlands preserve species which are, in general, not endangered. For efficient conservation of endangered species, a net of nature reserves should be, therefore, established in the farmlands as suggested by Kopij (2001, 2010).

Appendix 1. Resident bird communities in arable fields in the lowlands and foothills of the Drakensberg. Dominant species indicated with bold case.

Species	Lowlands (43.9 km)				Foothills (46.5 km)				Chi^2-test	
	N	%D	F	Ind.	N	%D	F	Ind.	X^2	p
Acacia Pied Barbet	2	0.3	10	3.92	0	0	0	0		
African Pipit	14	2.08	30	27.45	18	2.89	60	30	0.57	
African Quailfinch	7	1.04	40	13.73	21	3.37	50	35	14	0.01
African Reed-Warbler	1	0.15	10	1.96	0	0	0	0		
African Stonechat	12	1.79	20	23.53	16	2.57	70	26.67	0.67	
Alpine Swift	0	0	0	0	1	0.16	10	1.67		
Bearded Vulture	0	0	0	0	2	0.32	20	3.33		
Black Crow	4	0.6	40	7.84	7	1.12	60	11.67	1.13	
Black Swift	2	0.3	10	3.92	0	0	0	0		
Black-shouldered Kite	0	0	0	0	1	0.16	10	1.67		
Black-throated Canary	5	0.74	30	9.8	0	0	0	0		
Blue Korhaan	1	0.15	10	1.96	1	0.16	10	1.67		
Bokmakierie	23	3.42	70	45.1	23	3.69	60	38.33	0	
Cape Bunting	34	**5.06**	70	66.67	47	**7.54**	80	78.33	2.49	
Cape Canary	38	**5.65**	60	74.51	33	**5.3**	70	55	0.33	
Cape Grassbird	2	0.3	10	3.92	11	1.77	60	18.33	20.25	0.01
Cape Longclaw	2	0.3	20	3.92	8	1.28	30	13.33	9	0.01
Cape Robin-Chat	31	4.61	60	60.78	19	3.05	80	31.67	2.32	
Cape Sparrow	4	2.53	20	7.84	24	3.85	40	40	32	0.01
Cape Turtle-Dove	21	3.13	70	41.18	60	**9.63**	70	100	36.21	0.01
Cape Wagtail	7	1.04	30	13.73	9	1.44	30	15	0.29	
Cape Weaver	0	0	0	0	1	0.16	10	1.67		
Cape White-eye	21	3.13	30	41.18	11	1.77	50	18.33	2.38	
Cinnamon-breasted Bunting	40	**5.95**	70	78.43	10	1.61	30	16.67	11.25	0.01
Cloud Cisticola	3	0.45	10	5.88	0	0	0	0		
Common Fiscal	9	1.34	50	17.65	5	0.8	30	8.33	0.89	
Common Quail	39	**5.8**	20	76.47	4	0.64	20	6.67	15.71	0.01
Common Waxbill	4	0.6	20	7.84	11	1.77	20	18.33	6.13	0.05
Drakensberg Rock-jumper	0	0	0	0	8	1.28	40	13.33		
Fairy Flycatcher	0	0	0	0	1	0.16	10	1.67		
Familiar Chat	4	0.6	30	7.84	3	0.48	20	5		
Greater Striped Swallow	3	0.45	20	5.88	0	0	0	0		
Grey-headed Sparrow	26	3.87	80	50.98	8	1.28	50	13.33	6.23	0.05
Grey-winged Francolin	1	0.15	10	1.96	8	1.28	30	13.33		
Ground Woodpecker	3	0.45	20	5.88	3	0.48	20	5		
Hadeda Ibis	2	0.3	20	3.92	0	0	0	0		
Hamerkop	1	0.15	10	1.96	0	0	0	0		
Helmeted Guineafowl	2	0.3	10	3.92	0	0	0	0		
House Sparrow	12	1.79	40	23.53	2	0.32	20	3.33	4.17	0.05
Jackal Buzzard	4	0.6	20	7.84	8	1.28	50	13.33	2	
Karoo Prinia	51	**7.59**	60	100	44	**7.06**	90	73.33	0.48	
Lanner Falcon	1	0.15	10	1.96	0	0	0	0		
Large-billed Lark	1	0.15	10	1.96	0	0	0	0		
Laughing Dove	22	3.27	80	43.14	40	**6.42**	80	66.67	7.36	0.01

Levaillant's Cisticola	1	0.15	10	1.96	3	0.48	20	5		
Little Swift	2	0.3	10	3.92	0	0	0	0		
Long-tailed Widowbird	1	0.15	10	1.96	2	0.32	20	3.33		
Malachite Sunbird	17	2.38	60	33.33	4	0.64	20	6.67	4.97	0.05
Mountain Chat	3	0.45	30	5.88	1	0.16	10	1.67		
Neddicky	39	**5.8**	70	76.47	9	1.44	50	15	11.54	0.01
Olive Thrush	2	0.3	10	3.92	0	0	0	0		
Pied Crow	3	0.45	30	5.88	0	0	0	0		
Pied Starling	2	0.3	10	3.92	8	1.28	20	13.33	9	0.01
Pin-tailed Whydah	2	0.3	20	3.92	3	0.48	10	5		
Red-capped Lark	16		20	31.37	1	0.16	10	1.67	7.03	0.01
Red-collared Widowbird	18	2.23	30	35.29	10	1.61	30	16.67	1.78	
Red-eyed Bulbul	15	0.6	30	29.41	12	1.93	70	20	0.3	
Red-eyed Dove	3	0.45	20	5.88	0	0	0	0		
Red-winged Starling	20	2.98	60	39.22	13	2.09	50	21.67	1.23	
Rock Kestrel	3	0.45	30	5.88	0	0	0	0		
Rock Martin	4	0.6	20	7.84	20	3.21	40	33.33	32	0.01
Rock Pipit	5	0.74	30	9.8	5	0.8	30	8.33	0	
Southern Bald Ibis	0	0	0	0	1	0.16	10	1.67		
Southern Masked Weaver	0	0	0	0	1	0.16	10	1.67		
Southern Red Bishop	10	1.49	10	19.61	0	0	0	0	5	0.05
Speckled Mousebird	3	0.45	20	5.88	3	0.48	10	5		
Speckled Pigeon	4	0.6	20	7.84	11	1.77	40	18.33	6.13	0.05
Streaky-headed Seedeater	3	0.45	20	5.88	0	0	0	0		
Swainson's Spurfowl	2	0.3	10	3.92	5	0.8	30	8.33		
Village Indigo	0	0	0	0	1	0.16	10	1.67		
Wailing Cisticola	15	2.23	20	29.41	25	4.01	60	41.67	3.33	
White-necked Raven	2	0.3	20	3.92	1	0.16	10	1.67		
White-winged Widowbird	0	0	0	0	4	0.64	30	6.67		
Wing-snapping Cisticola	2	0.3	20	3.92	11	1.77	30	18.33	20.25	0.01
Yellow-crowned Bishop	13	1.93	30	25.49	1	0.16	10	1.67	5.54	0.05
Zitting Cisticola	3	0.45	20	5.88	0	0	0	0		
Total	672	100.00	00	1317.65	623	100.00	00	1038.33		

N – number of potentially resident pairs recorded; %D – dominance expressed as the proportion of resident pairs of a given species to the total number of all resident pairs of all species recorded, expressed as a percentage; F – frequency of occurrence, defined as the percentage of transects, where a given species was recorded to the total number of transects in given area; Ind. – index of abundance calculated as the percentage of the number of resident pairs of the most numerous species.

References

Acocks, J. P.H. (1988). Veld types of South Africa. Mem. Bot. Sur. S. A. 57: 1-146.

Ambrose, D., Talukdar, S., Pomela, E.M. (2000). Biological diversity in Lesotho: a country study. Maseru: National Environment Secretariat.

Bibby, C.J., Burgess, N.D., Hill, D.A. (1992). Bird census technique. London: Academic Press.

Bonde, K. 1993. Birds of Lesotho: a guide to distribution past and present. Pietermaritzburg: University of Natal Press.

Harding, N.J., Green, R.E., Summers, R.W. (1994). The Effect of Future Changes in Land Use on Upland Birds in Britain. Sandy: RSPB.

Hockey, P.A.R., Dean, W.R.J., Ryan, P.G., Maree, S. (eds.) (2005). Roberts' Birds of Southern Africa. Cape Town: John Voelcker Bird Book Fund.

Kopij, G. (2001). Areas proposed for environmental education and biodiversity conservation in Maseru district, Lesotho. P.150-167. In: Mokuku T., Bitso L. and Lana A. F. (eds.). Environmental education for sustainable development: African Perspectives. Maseru, October 2001.

Kopij, G. (2002). The birds of Sehlabathebe National Park, Lesotho. Koedoe 45 (1): 65-78.

Kopij, G. (2006a). The structure of assemblages and dietary relationships in birds in South African grasslands. Wrocław: Wydawnictwo Akademii Rolniczej we Wrocławiu.

Kopij, G. (2006b). Bird assemblages in natural and urbanized habitats in Morija area, Lesotho. Zeszyty Naukowe Uniwersytetu Przyrodniczego we Wrocławiu, nr 548, Biologia i Hodowla Zwierząt 54: 69-77.

Kopij, G. (2010). Sandstone plateaus as bird refugia in Lesotho lowlands, southern Africa. Berkut 19(1/2): 39-48.

Kopij, G. (2014). Namibian Wildlife Bibliography from the earliest time to 2010. Katima Mulilo, University of Namibia.

Morelli, M., Tryjanowski, P. (2017). Birds as Useful indicator of high Nature Value Farmland. Springer.

Moyo, S., O'Keefe, P., Sill. M. (1993). The southern African environment: Profiles of SADC Countries. London: Earthscan Publications.

Newton, I. (2017). Farming and birds. Harper Collins.

Sutherland, W.J. (1996). Ecological census techniques: a handbook. Cambridge (U.K.): Cambridge University Press.

Wilson, J. D., Evans, A.D., Grice, P.V. (2009). Bird conservation in agriculture. Cambridge: Cambridge University Press.

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