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AVIAN COMMUNITIES OF A MIXED MOPANE-ACACIA SAVANNA IN THE CUVELAI DRAINAGE SYSTEM, NORTH-CENTRAL NAMIBIA, DURING THE DRY AND WET SEASON

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Avian Communities of a Mixed Mopane-Acacia Savanna in the Cuvelai Drainage System, North-Central Namibia, During the Dry and Wet Season. Kopij G. — Studies were conducted by means of the Line Transect Method in late rainy season (March), in the middle of dry season (July) and at beginning of rainy season (November). The total length of all transects was c. 11 km. In total, 70 resident and 13 non-resident species were recorded. The number of species in dry season was significantly lower than in rainy season (χ^2 -test: 14.1; $p < 0.01$). The highly significant seasonal differences in abundance were recorded for the following species: *Streptopelia senegalensis*, *Streptopelia capicola*, *Uraeginthus angolensis*, *Cisticola juncidis*, *Upupa africana*, *Cynniris mariquensis*, and *Numida meleagris*. In overall, five species have been classified as dominants: *Streptopelia senegalensis*, *Streptopelia capicola*, *Uraeginthus angolensis*, *Plocepasser mahali* and *Cypsiurus parvus*. They comprised together 43.9 %. Significant variations in the dominance structure between the wet and dry season have been evidenced. Granivores were much more numerous in the dry than in the wet season, while for the insectivores the reverse was true. Although Sorensen Coefficient was much the same between all three seasons, the Shannon's Diversity Index was lower in July than in March and November.

Key words: community ecology, avian assemblages, range management.

Сообщества птиц смешанной мопане-акациевой саванны в границах дренажной системы Лувелай, северной и центральной частей Намибии, во время сухого и влажного сезонов. Копий Г. — Исследования проводили с помощью метод линий трансект в конце сезона дождей (март), в середине сухого сезона (июль) и в начале сезона дождей (ноябрь). Общая протяжённость всех трансект составила приблизительно 11 км. Всего было отмечено 70 резидентных и 13 нерезидентных видов птиц. Количество видов в сухой сезон был значительно ниже, чем в сезон дождей (χ^2 -тест: 14,1, $p < 0,01$). Столь значительные сезонные различия в численности были отмечены для следующих видов: *Streptopelia senegalensis*, *Streptopelia capicola*, *Uraeginthus angolensis*, *Cisticola juncidis*, *Upupa africana*, *Cynniris mariquensis* и *Numida meleagris*. В целом 5 видов были классифицированы как доминантные: *Streptopelia senegalensis*, *Streptopelia capicola*, *Uraeginthus angolensis*, *Plocepasser mahali* and *Cypsiurus parvus*. Вместе они составили 43,9 % общего количества видов. Значительные колебания в структуре доминирования видов во влажном и сухом сезонах очевидны. Зерноядные птицы гораздо более многочисленны в сухой сезон, чем в сезон дождей, а для насекомоядных характерна обратная зависимость. Хотя коэффициент Сьёрнсена был сходным во время всех трёх сезонов, индекс разнообразия Шеннона в июле был ниже, чем в марте и ноябре.

Ключевые слова: экология сообществ, сообщества птиц, организация пастбищного хозяйства.

Introduction

In recent years, an important international long-term project has been initiated in Africa, so called "BI-OTA Transect and Biodiversity Observatories in Southern Africa" (Biodiversity..., 2010 a, b, c). It aims to monitor climatic changes by investigation of plant and animal communities, as well as geology and climatic conditions. The transect starts in Cape Town and runs through Great Karoo of South Africa and Namibian sites, such as Oranjemund, Karios, Nabaos, Windhoek, Okahandja, Sonop and Mutompo. The transect ends in Ongongo, north-central Namibia (Biodiversity..., 2010 a, b, c).

In some of these observatories, preliminary qualitative studies on avian diversity have been conducted. In the final BIOTA Observatory "Ogongo" (S42), no studies on birds have been, however, projected so far (Biodiversity..., 2010 a, b, c). The aim of this study was to fulfill this gap by investigating species diversity and seasonal changes in avian assemblages in this important monitoring observatory.

Study area

The study was conducted in UNAM Rangeland, which is situated in the BIOTA Observatory "Ogongo" in the Cuvelai Drainage System, c. 50 km NW of Oshakati, Outapi District, Omusati Region (17°07' S, 15°31' E). It is an extensive sandy plain, c. 1100 m a. s. l., partly flooded almost on annual basis (usually December–June). It is located in a prime summer rainfall zone, with mean annual precipitation of 400–500 mm (Mendelsohn et al., 2000, 2009). A total of 411 vascular plant species, 3 vegetation classes, 7 associations and 7 sub-associations were described there (Kangombe, 2007).

The Cuvelai Drainage System is situated in Ovamboland, north-central Namibia. It comprises a network of hundreds of meandering oshanas (canals), separated by sodic sands covered with Koakoland savanna (Mendelsohn et al., 2000). The system occupies 14 773 km²; of which 5957 km² is cleared or fenced, while 1926 km² is transformed into cultivated land (Mendelsohn et al., 2000). In 2000, c. 563 000 people inhabited this area. The climate is semiarid. Almost all rains (96 %) fall in summer (November–April), with 2/3 in January–March. The amount of rain varies from year to year, usually within 400–500 mm per annum (Mendelson, Weber, 2011). The average temperature of the coolest months (June–August) is 17 °C and that of the warmest months (October–January) 25 °C.

Within the Koakoland (Mopane) savanna, seven vegetation units have been recognized (Giess, 1971). Ogongo falls within Mopane-fruit trees-oshana-mosaic. This unit occupies an area of 1706 km², where 277 km² is transformed into cultivated fields and 832 km² is cleared or fenced. About 78 000 people inhabit this unit, while the livestock capacity is 22 LAU per 100 ha (Mendelsohn, Weber, 2011).

The vegetation of dry land in the study area is dominated by shrubs and trees of *Colophospermum mopane*. Among fruit trees the most common are: morula *Sclerocarya birrea*, *Berchemia discolor*, *Schinziophyton rautanenii* and the makaloni palms *Hyphaena petesiana*. Other tree/shrub species which also occur in this vegetation are *Acacia erioloba*, *A. nilotica*, *Zizyphus mucronata*, *Combretum* spp., *Ficus* spp. (Biodiversity..., 2010 a). The vegetation of oshanas is dominated by grasses and sedges. On the margins, the most common species are *Willkommia sarmantosa*, *Eragrostis trichophora* and *Sporobolus iocladius*; wetter places are occupied mainly by *Eragrostis rotifer*, *Eragrostis viscose*, *Diplachne* spp., *Brachiaria deflexa*, *Elytrophorus globularis*, and among sedges: *Cyperus halpan*, *Kyllinga albiceps* and *Pycerus* spp., *Nymphaea* spp. and other floating plants occur in deep open water (Mendelsonh, Weber, 2011).

Methods

Studies were carried out in late rainy season (10 Feb., 7 March 2012) in the middle of dry season (5, 18, 28 July 2011) and at beginning of rainy season (4, 14 Nov. 2011). The Line Transect Method (Bibby et al., 1992, Kopij, 2006) has been employed to quantify avian assemblages (frequency of occurrence and relative abundance). Ten transects were designed to cover main variation of the Mopane-Acacia savanna (table 1). Each transect was about 1 km long. Counts were conducted in the mornings by walking slowly and recording all seen and heard birds. The total length of all transects was c. 11 km. For resident birds, a breeding pair was a census unit, while for non-resident species, the census unit was an individual.

For resident birds a breeding pair was a census unit, while for non-resident species, all individuals were counted.

The following parameters were used to describe the avian assemblages: 1) species diversity (number

Table 1. Transects designed for counting resident bird species in the Ogongo Rangeland

Таблица 1. Трансекты, разработанные для подсчёта видов птиц на пастбищах Огонго

Transect number	Coordinates for starting point	Coordinates for ending point	Habitat type
1	17°41'03" S, 15°17'61" E	17°41'42" S, 15°17'49" E	Acacia savanna; pasture
2	17°41'42" S, 15°17'49" E	17°41'75" S, 15°17'48" E	Acacia savanna; pasture
3	17°41'75" S, 15°17'48" E	17°41'80" S, 15°17'93" E	Acacia savanna; pasture
4	17°41'80" S, 15°17'93" E	17°41'20" S, 15°18'14" E	Acacia savanna; pasture
5	17°41'20" S, 15°18'14" E	17°41'03" S, 15°17'60" E	Combretum savanna; pasture
6	17°40'86" S, 15°18'28" E	17°40'78" S, 15°18'85" E	Mopane savanna; pasture
7	17°40'78" S, 15°18'85" E	17°40'83" S, 15°19'79" E	Mopane savanna; pasture
8	17°40'83" S, 15°19'79" E	17°41'54" S, 15°19'45" E	Mopane savanna; pasture
9	17°41'54" S, 15°19'45" E	17°41'35" S, 15°19'10" E	Mopane savanna; pasture
10	17°41'35" S, 15°19'10" E	17°40'73" S, 15°18'03" E	Mopane savanna; oshana, pasture

of species recorded); 2) % F — frequency of occurrence of each species, defined as the percentage of transects, where a given species was recorded to the total number (N = 10 transects) of transects surveyed; 3) % N — 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. Dominant species is defined here as comprising at least 5 % of the total number of all resident pairs; while subdominant that comprising 2–4.9 % of that total.

The nomenclature of bird species follows that of Roberts..., 2005. Two indices were used to compare diversity of avian assemblages: Sørensen's Coefficient (S), and Shannon's Diversity Index (H):

$$S = 2C/A + B,$$

where A — the number of bird species in area A, B — the number of bird species in area B, C — the number of bird species common to both area;

$$H = -\sum p_i \times \ln p_i,$$

where p_i — proportion of pairs belonging to i -species.

Differences in the densities of particular species in various seasons were tested with χ^2 -test. The number of recorded resident pairs (for breeding species) or individuals (for non-breeding species) was taken into account for this testing.

Results and discussion

In total, 70 resident and 13 non-resident species were recorded: 57 in late rainy season, only 24 in the middle of dry season and 57 at the beginning of rainy season (table 2, 3). The number of species in dry season was, therefore, significantly lower than in rainy season (χ^2 -test: 15.8; $p < 0.01$). The highly significant seasonal differences in abundance were recorded for the following species: Laughing Dove *Streptopelia senegalensis*, Cape Turtle-Dove *Streptopelia capicola*, Blue Waxbill *Uraeginthus angolensis*, Zitting Cisticola *Cisticola juncidis*, African Hoopoe *Upupa africana*, Marico Sunbird *Cynniris marioquensis*, and Helmeted Guineafowl *Numida meleagris*. Also for species such as the Red-billed Hornbill *Tockus erythronotus*, Red-billed Buffalo-Weaver *Bubalornis niger*, Red-faced Mousebird *Urocolius indicus*, Brubru Shrike *Nilaus afer*, Lilac-breasted Roller *Coracias caudatus*, Pied Crow *Corvus albus* and Scaly-feathered Finch *Spizocorys conirostris* statistically significant seasonal differences were recorded. All doves were much more common at the end of rainy season and in dry season than at the beginning of rainy season. However, for most species (80.6 %) not statistically significant differences in seasonal abundance have been shown.

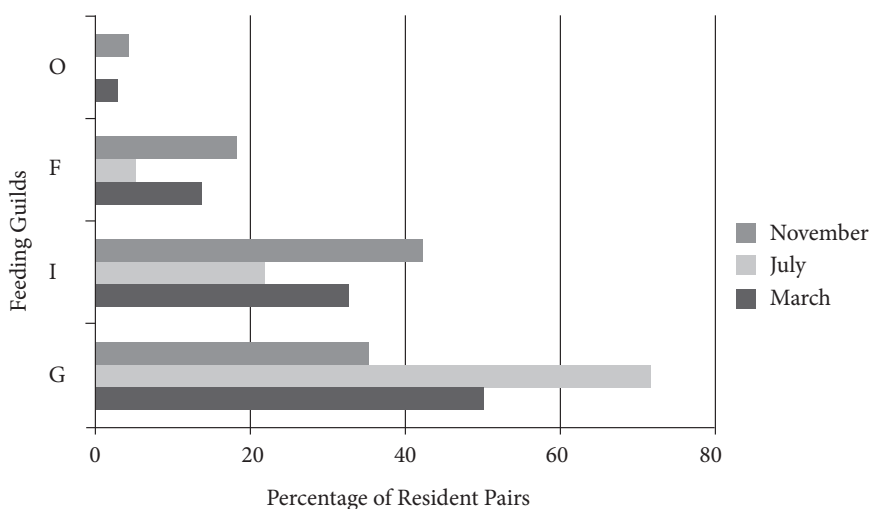


Fig. 1. Seasonal changes in percentage contribution of main feeding guilds in avian assemblage in mixed Mopane-Acacia savanna (F — frugivores, G — granivores, I — insectivores, O — other guilds).

Рис. 1. Сезонные изменения в процентном отношении основных характеров питания в сообществах птиц в смешанной мопане-акациевой саванне (F — плоядные, G — зерноядные, I — насекомоядные, O — другие способы питания).

Table 2. Seasonal changes in frequency and dominance of residential avian assemblage in mixed Mopane-Acacia savanna

Таблица 2. Сезонные изменения по частоте и доминированию резидентных птичьих сообществ в смешанной мопане-акациевой саванне

Species	March		July		November		Total		x ² -test
	% F	% N	% F	% N	% F	% N	% F	% N	
<i>Streptopelia senegalensis</i>	90	13.3	100	21.0	60	2.9	83	11.9	35.2**
<i>Uraeginthus angolensis</i>	40	4.2	100	14.5	100	14.5	80	10.8	19.0**
<i>Streptopelia capicola</i>	100	13.6	90	10.3	50	2.9	80	8.9	24.9**
<i>Plocepasser mahali</i>	60	4.5	70	7.9	80	4.3	70	5.4	2.1
<i>Cypsiurus parvus</i>	50	5.1	50	7.6	80	8.1	60	6.9	2.2
<i>Tockus erythrorhynchus</i>	70	3.1	40	1.7	70	5.8	60	3.6	9.6*
<i>Cisticola chinina</i>	70	4.8	30	2.4	70	4.1	57	3.8	4.2
<i>Laniarius atrococcineus</i>	30	2.0	80	4.5	60	4.1	57	3.4	2.5
<i>Corythaixoides concolor</i>	50	3.1	50	2.8	60	3.5	53	3.1	0.8
<i>Dicrurus adsimilis</i>	30	1.7	40	2.4	70	3.2	47	2.4	1.8
<i>Upupa africana</i>	10	0.3	40	2.1	80	4.6	43	2.3	14.8**
<i>Prinia maculata</i>	60	2.8	0	0.0	60	2.9	40	2.0	10.0**
<i>Crithagra atrogularis</i>	60	3.4	10	0.3	50	1.7	40	1.9	10.0**
<i>Bubalornis niger</i>	50	1.7	40	5.5	20	1.4	37	2.7	8.3*
<i>Tricholaema leucomelas</i>	50	3.1	0	0.0	50	3.2	33	2.2	11.0**
<i>Oena capensis</i>	20	0.6	70	5.2	10	0.6	33	1.9	17.5**
<i>Urocolius indicus</i>	40	2.0	0	0.0	60	2.3	33	1.5	7.6*
<i>Nilaus afer</i>	60	2.0	0	0.0	40	1.2	33	1.1	6.8*
<i>Francolinus swainsonii</i>	40	2.2	20	1.0	30	0.9	30	1.4	3.4
<i>Rhinopomastus cyanomelas</i>	40	1.7	10	0.3	30	0.9	27	1.0	4.0
<i>Ploceus velatus</i>	10	0.6	20	1.4	40	1.7	23	1.2	1.7
<i>Parisoma subcaeruleum</i>	30	1.4	0	0.0	40	1.7	23	1.1	5.5
<i>Passer diffusus</i>	40	1.7	0	0.0	30	1.2	23	1.0	5.6
<i>Tchagra senegala</i>	20	0.6	0	0.0	50	1.4	23	0.7	5.1
<i>Agapornis roseicollis</i>	20	0.8	0	0.0	40	2.6	20	1.2	10.7**
<i>Sylvietta rufescens</i>	20	0.8	0	0.0	40	1.2	20	0.7	3.9
<i>Coracias caudatus</i>	10	0.3	50	2.1	0	0.0	20	0.7	8.9*
<i>Phoeniculus purpureus</i>	20	0.4	20	0.7	20	1.2	20	0.8	2.0
<i>Milvus aegyptius</i>	30	1.1	0	0.0	20	0.6	17	0.6	3.8
<i>Numida meleagris</i>	20	1.4	10	4.5	10	0.3	13	1.9	11.8
<i>Emberiza flaviventris</i>	20	1.4	10	0.3	10	0.9	13	0.9	2.8
<i>Apalis flavida</i>	30	2.0	0	0.0	10	0.3	13	0.8	10.9**
<i>Lanioturdus torquatus</i>	20	1.1	0	0.0	20	1.2	13	0.8	4.0
<i>Cinnyris mariquensis</i>	0	0.0	0	0.0	40	2.0	13	0.7	13.8**
<i>Buphagus africanus</i>	20	0.6	0	0.0	30	0.9	17	0.5	0.2
<i>Tockus nasutus</i>	10	0.3	20	0.7	10	0.3	13	0.4	0.5
<i>Cisticola juncidis</i>	30	2.5	0	0.0	0	0.0	10	0.9	17.8**
<i>Lamprotornis nitens</i>	20	0.6	0	0.0	10	0.6	10	0.4	2.1
<i>Bradornis mariquensis</i>	10	0.3	0	0.0	20	0.9	10	0.4	3.6
<i>Merops hirundineus</i>	20	0.8	0	0.0	10	0.3	10	0.4	3.2
<i>Estrilda erythronotus</i>	20	0.6	0	0.0	10	0.3	10	0.3	2.2
<i>Corvus albus</i>	0	0.0	0	0.0	30	0.9	10	0.3	6.2*
<i>Sporopipes squamifrons</i>	10	0.3	10	0.3	10	0.3	10	0.3	0.0
<i>Pycnonotis tricolor</i>	10	0.6	0	0.0	10	0.3	7	0.3	2.2
<i>Spizocorys conirostris</i>	0	0.0	0	0.0	20	0.9	7	0.3	6.2*
<i>Chrysococcyx caprius</i>	10	0.3	0	0.0	10	0.3	7	0.2	1.1
<i>Cercotrichas paena</i>	0	0.0	0	0.0	20	0.6	7	0.2	4.1
<i>Merops pusillus</i>	10	0.3	0	0.0	10	0.3	7	0.2	1.1
<i>Galinula chloropus</i>	20	0.6	0	0.0	0	0.0	7	0.2	4.3
<i>Anthoscopus minutus</i>	0	0.0	0	0.0	20	0.6	7	0.2	4.1
<i>Hirundo albogularis</i>	10	0.3	0	0.0	10	0.3	7	0.2	1.1
<i>Eurocephalus anguitimens</i>	10	0.3	0	0.0	10	0.3	7	0.2	1.1
<i>Egretta intermedia</i>	0	0.0	0	0.0	20	0.6	7	0.2	4.1
<i>Vanellus armatus</i>	0	0.0	0	0.0	10	0.6	3	0.2	4.1
<i>Butorides striatus</i>	10	0.6	0	0.0	0	0.0	3	0.2	4.3

Species	March		July		November		Total		x ² -test
	% F	% N	% F	% N	% F	% N	% F	% N	
<i>Prionops plumatus</i>	0	0.0	0	0.0	10	0.6	3	0.2	4.1
<i>Terathopius ecaudatus</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Batis pirit</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Elanus caeruleus</i>	0	0.0	0	0.0	10	0.3	3	0.1	2.1
<i>Euplectes afer</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Psophocichla litsitsirupa</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Campethera abingoni</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Polyboroides typus</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Scopus umbretta</i>	0	0.0	0	0.0	10	0.3	3	0.1	2.1
<i>Streptopelia decipiens</i>	0	0.0	0	0.0	10	0.3	3	0.1	2.1
<i>Euplectes orix</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Hirundo semirufa</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
<i>Emberiza tahapisi</i>	0	0.0	10	0.3	0	0.0	3	0.1	1.7
<i>Chalcomitra senegalensis</i>	0	0.0	0	0.0	10	0.3	3	0.1	2.1
<i>Turnix sylvatica</i>	10	0.3	0	0.0	0	0.0	3	0.1	2.1
Total number of pairs		355		290		345		991	

Note. Dominant species are indicated with bold case. Level of significance: * — significant difference ($p < 0.05$), ** — highly significant difference ($p < 0.01$).

However, significant variations in the dominance structure between the wet and dIn overall, five species have been classified as dominants: Laughing Dove *Streptopelia senegalensis*, Cape Turtle-Dove *Streptopelia capicola*, Blue Waxbill *Uraeginthus angolensis*, White-browed Sparrow Weaver *Plocepasser mahali* and African Palm Swift *Cypsiurus parvus*. They comprised together 43.9 %. Except for the last species, all of them have also the highest (> 70 %) frequency of occurrence on transects. Subdominants were represented by nine species and comprised together 25.5 % of all resident pairs.

However, significant variations in the dominance structure between the wet and dry season have been evidenced. While in the middle dry season (July) dominant species ($n = 7$) comprised 72 % of all pairs recorded, at the beginning and at the end of the wet season, they comprised only 28.4 % (3 spp.) and 26.9 % (2 spp.) respectively. Species composition was also different. Only the African Palm Swift was recorded as dominant species in all three seasons.

Granivores and insectivores clearly dominated over other feeding guilds in all three seasons (fig. 1). Granivores were by far more numerous in the dry than in the wet season,

Table 3. Seasonal changes in frequency and dominance of non-residential avian assemblage in mixed Mopane-Acacia savanna

Таблица 3. Сезонные изменения по частоте и доминированию нерезидентных птичьих сообществ в смешанной мопане-акациевой саванне

Species	March		July		November		Total		x ² -test
	% F	% N	% F	% N	% F	% N	% F	% N	
<i>Phylloscopus trochilus</i>	20	10.3	0	0.0	20	1.4	13	3.0	2.8
<i>Quelea quelea</i>	0	0.0	0	0.0	30	93.5	10	77.8	259.9**
<i>Hippolais icterina</i>	30	17.2	0	0.0	0	0.0	10	3.0	10.0**
<i>Merops apiaster</i>	0	0.0	0	0.0	30	2.2	10	1.8	6.1*
<i>Leptoptilos crumeniferus</i>	20	10.3	0	0.0	0	0.0	7	1.8	6.0*
<i>Ardea melanocephala</i>	0	0.0	0	0.0	20	1.4	7	1.2	3.9
<i>Phalacrocorax africanus</i>	10	3.4	0	0.0	10	0.7	7	1.2	1.0
<i>Plectropterus gambiensis</i>	10	34.5	0	0.0	0	0.0	7	6.0	20.0**
<i>Ardeola rufiventris</i>	10	10.3	0	0.0	0	0.0	3	1.8	6.0*
<i>Ciconia episcopus</i>	10	6.9	0	0.0	0	0.0	3	1.2	4.0
<i>Buteo vulpinus</i>	0	0.0	0	0.0	10	0.7	3	0.6	1.9
<i>Egretta alba</i>	10	3.4	0	0.0	0	0.0	3	0.6	2.0
<i>Muscicapa striata</i>	10	3.4	0	0.0	0	0	3	0.0	2.0
Total number of birds	13	29	0	0	12	139	24	167	

while for the insectivores the reverse was true. On the other hand, frugivores and birds from other feeding guilds (carnivores, nectarivores, herbivores, omnivores) were more numerous in the wet than in the dry season (fig. 1). Granivores are most common in the time of the highest seed abundance, which is the end of wet season; while insectivores are most numerous at the beginning of wet season, when insects and other arthropods are most active.

Among 13 non-resident species, 5 were Palearctic migrants: Willow Warbler *Phylloscopus trochilus*, Icterine Warbler *Hippolais icterina*, Spotted Flycatcher *Muscicapa striata*, European Bee-eater *Merops apiaster* and Steppe Buzzard *Buteo rufinus*. All other non-resident species, except for Red-billed Quelea, were water birds. The latter was by far the most abundant non-breeding species.

Although the number of species recorded in July (N = 24) was much lower than that recorded in March (N = 57) and November (N = 57), the Sørensen Coefficient of assemblage similarity was much the same between all three seasons: March/July S = 0.54; March/November S = 0.52; July/November S = 0.54. However the Shannon's Diversity Index was lower in July (H = 1.13) than in March (H = 1.49) and November (H = 1.52).

More than 65 bird species (including non-residents) have not been recorded in any BIOTA Observatories in Namibia (Biodiversity..., 2010 a). The highest numbers have been recorded in the Woodland savanna, 60 km SW of Rundu (56 species) and in Thornbush savanna, Toggekry near Windhoek (65 species) (Biodiversity..., 2010 a). From this comparison, it looks as if in the Mixed Mopane-Acacia savanna, the bird diversity is one of the highest in Namibia. However, a number of resident bird species in BIOTA Observatories were probably unrecorded, and if so the comparison may not be valid. It should be, however, kept in mind that also in the present studies not all species were recorded; some rare and/or elusive species could pass undetected. Although the method employed in this study allow calculating dominance and relative abundance of particular species, population density can only be roughly estimated.

In conclusion, the avian diversity in the mixed Mopane-Acacia savanna in the Cuvelai Drainage System in north-central Namibia is relatively rich and diverse. Both species composition and the dominance structure of the avian communities differ seasonally, being lower in the dry than in wet season.

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