BIOLOGIJA. 2021. Vol. 67. No. 4. P. 197–204

Seasonal changes in the structure of an avian community in an urban habitat in northern Namibia

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Two seasons of the year, dry and wet, are characteristic climate elements in southern Africa. Caused by differential precipitation, this seasonality induces seasonal variation in primary and secondary production. Birds are also affected. An avian community was studied in dry and wet seasons in an urbanised habitat of Tsumeb, a town situated in northern Namibia. Although both the species richness and the general dominance structure were similar in the dry and wet seasons, the avian community differed significantly in terms of population density of more common species in this town. Sörensen similarity index between the dry and wet seasons was low (I = 0.68). As expected, among granivorous species, the Laughing Dove (*Streptopelia senegalensis*), the Rosy-faced Parrot (*Agapornis roseicollis*), the House Sparrow (*Passer domesticus*), and the Southern Masked Weaver (*Ploceus velatus*) were much more numerous in the dry than in the wet season. However, contrary to expectation, the Blue Waxbill (*Uraeginthus angolensis*) was much more numerous in the wet than in the dry season. The Red-eyed Bulbul (*Pycnonotus nigricans*) was more common in the wet season, but other frugivorous species, the Red-faced Mousebird (*Urocolius indicus*), was more numerous in the dry than in the wet season.

Keywords: urban ornithology, population densities, Tsumeb

INTRODUCTION

There are two distinctive seasons of the year in southern Africa, the wet (rainy) season and the dry season. In northern Namibia, the rainy season extends from October to April while the dry season from May to September (Mendelsohn et al., 2009). Caused by differential precipitation, this seasonality induces similar seasonality in primary production, which in turn causes seasonality in animal life (Moreau, 1966; Smith, 1996).

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Birds are also affected by rainfall, but not equally in all biomes distinguished in this region. For example, in grassland biome, there is no much seasonal variation in the structure of avian communities caused by seasonal precipitation (Kopij, 2006), while such variations in avian assemblages are fairly conspicuous in woodland biome (Monadjem, 1993; Borghesio, Laiolo, 2004; Parker, 2012; Mulwa et al., 2013; Kopij, 2013, 2016, 2017) and in the assemblages of water birds (Kopij, Paxton, 2018, 2019a, 2019b). Knowledge of such variations is important for precise evaluation of species abundance and the role they play in avian communities and ecosystems at large (e.g., Borghesio, Laialo, 2004, Parker, 2012). This may also have methodological implications in planning the time for counting particular bird species (whether it is better to count them in the dry or wet season).

Little is known about the effect of seasonal precipitation on avian communities in human-modified biomes in Africa (cf. Moreau, 1966; Borghesio, Laiolo, 2004; Kopij, 2006, Parker, 2012). Mulwa et al. (2013) conducted studies on forest-farmland border in Kenya, while Kopij (2015) quantified the avian community in a farmland in northern Namibia. However, only Parker (2012) studied seasonal changes in the avian community in urbanised habitat within the grassland biome.

The aim of this study is to quantify seasonal variations in the structure of the avian community in an urbanised habitat located within the savannah biome.

METHODS

Tsumeb, a town situated in northern Namibia, was selected as the study area (Fig. 1). The town is surrounded by a unique vegetation type known as Kerstveld. It is a sort of mountain savannah. In most places, this unique vegetation type is replaced by artificially timbered parkland in the town (Fig. 2). The indigenous trees are mainly various species of acacias *Acacia* spp., African wattle *Peltophorum africanum*, and wild figs *Ficus* spp. The most common exotic trees are jacarandas *Jacaranda mimosifolia*, and gum trees *Eucalyptus* spp. (Fig. 3).

The mapping method was employed to count birds (Sutherland, 1996; Bibby, et al. 2012). Three transects were surveyed during the dry season in 2017, and three transects were also designed in

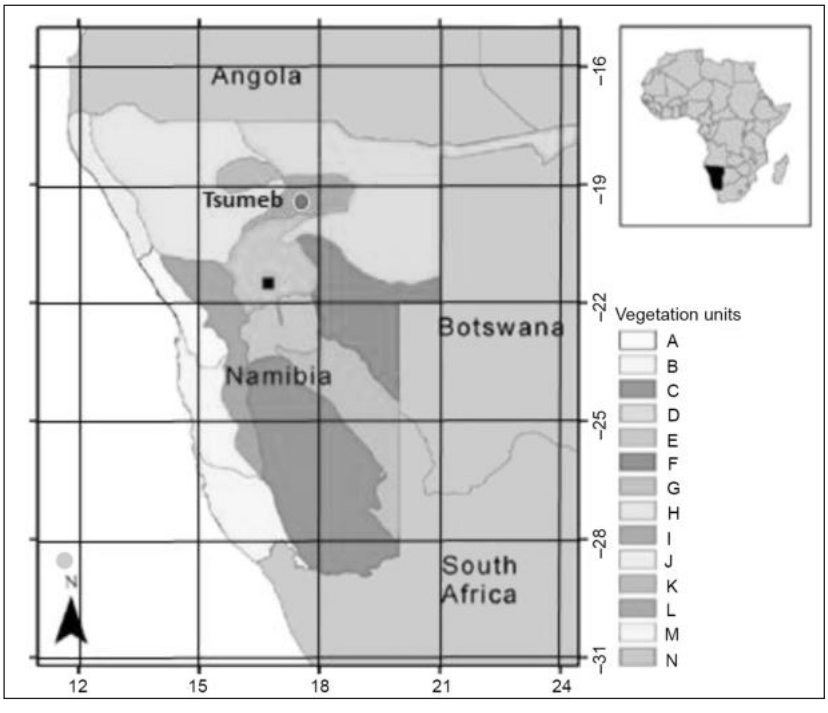

Fig. 1. Location of the town of Tsumeb in Namibia on the background of vegetation types. A – Central Namib, B – Desert & Succulent Steppe, C – Dwarf Scrub Savanna, D – Forest Savanna & Woodlands, E – Highland Savanna, F – Camel Thorn Savanna, G – Mixed Tree and Shrub Savanna, H – Mopane, I – Mountain Savanna and Karstveld, J – North Namib, K – Saline Desert with Dwarf Savanna, L – Semi Desert & Savanna Transition, M – Southern Namib, N – Thorn Bush Savanna

Fig. 2. A bird's-eye view of the town of Tsumeb. The study area is marked in a broken red line

Fig. 3. The central part of Tsumeb

the wet season of 2019 (Table 1). These transects ran along streets. Counts were conducted under calm and cloudless weather. To count night birds (owls, nightjars, thick-kneels), two night surveys (from one to 2.5 hours after sunset) were conducted in the town on 21 and 23 April 2019.

The dominance is expressed as the percentage of the total number of pairs of a given species in relation to the total number of all

Table 1. **Transects and time expenditure**

No.	Date	Time	Length
a	03.09.2017	07.15–08.10	c. 2 km
b	03.09.2017	08.10–10.12	c. 4 km
c	03.09.2017	10.12–11.10	c. 2 km
d	21.04.2019	07.00–08.00	c. 2 km
e	23.04.2019	07.05–08.05	c. 2 km
f	23.04.2019	08.05–09.05	c. 2 km

pairs of all species recorded. The dominant species is defined as that comprising 5% and more of all individuals of all species recorded, and the subdominant species as comprising 2–4.99%. The cumulative dominance is defined as the sum of dominance values of all dominant species. The community dominance index was calculated as follow:

$DI = (n_1 + n_2)/N$,

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

The following guilds were distinguished:

diet: *G* – granivorous, *I* – insectivorous, *F* – frugivorous, *N* – nectarivorous, *V* – vegetarian, *C* – carnivorous.

nesting: *TS* – in trees or shrubs, *H* – in holes, *B* – in/on buildings, *V* – herbaceous vegetation.

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

Shannon's diversity index:

$H' = -\Sigma\, p_i \ln p_i$

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

Simpson's diversity index:

$D = ((\Sigma n(n\text{-}1))/N(N\text{-}1)$

where *n* is the total number of breeding pairs belonging to a given species, N – the total number of breeding pairs of all species.

Pielou's evenness index:

$J' = (-\Sigma\, p_i \ln p_i)/\ln S$

where p_i is the proportion of breeding pairs belonging to the *i*th species; *S* – the total number of species. *J'* varies between 0 and 1. The less variation between species in a community, the higher *J'* is (Jongman et al., 1987).

Similarity among avian communities (during the dry and wet seasons) was investigated using the Sörensen's Coefficient:

$I = 2C/A+B$

where *A* is the number of bird species in one plot, *B* – the number of bird species in another plot, and *C* – the number of bird species common to both plots.

Systematics and nomenclature of bird species follow Hockey et al. (2005). Scientific names of birds recorded on transects are listed in Table 3.

RESULTS AND DISCUSSION

In total, 28 breeding (resident) bird species were recorded during the dry and the wet seasons on the transects in the town of Tsumeb (Tables 2, 3). In overall (during the wet and dry seasons), six dominant species were distinguished: the Red-eyed Bulbul (18.3% of potentially breeding pairs of all species), the Laughing Dove (16.4%), the Red-faced Mousebird (15.5%), the Blue Waxbill (14.9%), the African Palm Swift (11.4%), and the Cape Glossy Starling (5.6%). Thus the dominant species comprised 82.1% of all resident pairs altogether, while the remaining 12 species comprised only 17.9%. Only two non-breeding bird species were recorded on transects: the Wattled Starling *Creatophora cinerea* (transect a: 70 individuals) and the Red-headed Quelea *Quelea quelea* (transect a: one individual).

Six dominant species were distinguished – the Laughing Dove, the Red-eyed Dove *Streptopelia semitorquata*, the Rock Dove, the Dark-caped Bulbul *Pycnonotus tricolor*, Karoo Thrush *Turdus smithi*, and the Common Myna *Acridotheres tristis* – out of 60 species recorded in an urbanised woodland surrounded by grasslands in Pretoria. Collectively, they comprised 39.8% of all adult birds recorded (Parker 2012), therefore much less than in Tsumeb. The difference in the cumulative dominance resulted probably from different number of bird species recorded in Pretoria ($n = 60$) and Tsumeb ($n = 28$).

The most distinguished feature of the avian assemblage in the inner part of Tsumeb was the relatively high population density of the Bradfield's Hornbill. Although only one pair was recorded on transects, 4–5 occupied territories were in fact located in the town (Fig. 4B). Also, 2–3 territories of the *Accipiter* hawks, three territories of the African Hoopoe, and single territories of the Lilac-breasted Roller were recorded (Fig. 4C). Among night birds, the Barn Owl *Tyto alba*, the Pearl-spotted Owl *Glaucidium capense*, and the African Scops Owl *Otus senegalensis* were recorded (Fig. 4A). However, no nightjars *Caprimulgus* spp., and no thick-knee *Burhinus* spp. were ever heard.

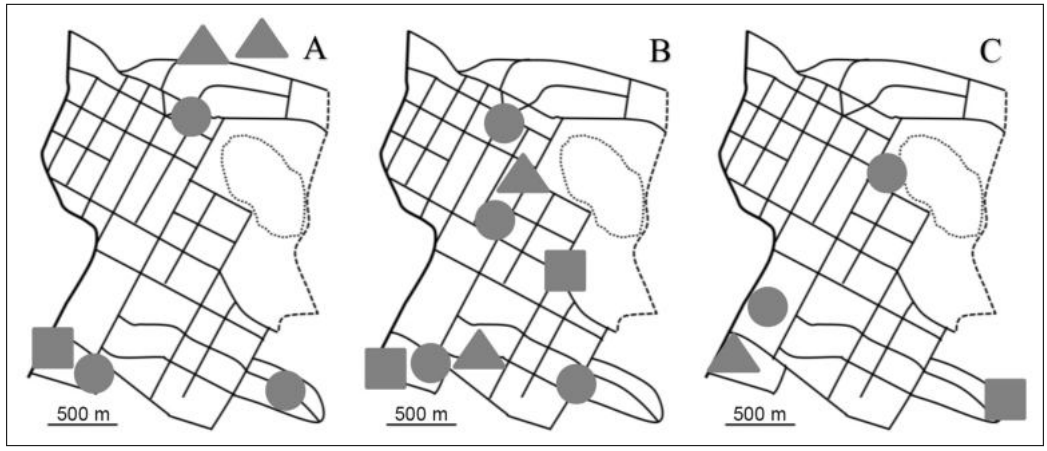

Fig. 4. Distribution of breeding pairs of selected bird species in Tsumeb in 2019. *A* – Pearl-spotted Owl (circle), African Scops Owl (triangle) and Barn Owl (square); *B* – Bradfield's Hornbill (circle), Grey Hornbill (triangle), and *Accipiter* hawk (square); *C* – African Hoopoe (circle), Lilac-breasted Roller (triangle) and a breeding colony of the Little Swift (c. 50 nests)

The population density of the Cape Glossy Starling was also exceptionally high. So far, Tsumeb is the only town in Namibia where the Cape Glossy Starling could be classified as a dominant species. On the other hand, a strikingly low density of the Rosy-faced Lovebird was recorded, despite the fact that suitable nesting sites and food resources were available. In the neighbouring town of Grootfontein, it is a common (probably dominant) resident species, nesting communally in *Washingtonia* palms (Kopij, own observation).

Comprising more than 20% of all breeding birds in Namibian towns (Kopij, 2016, 2018, 2019, 2020), sparrows comprised only 2.6% in Tsumeb, with the exotic House Sparrow as the only sparrow species recorded. Also, the overall contribution of *Streptopelia* doves was relatively low (17.0%). Two species were recorded, the Laughing Dove and the Cape Turtle Dove, with very strong dominance of the former. The recorded proportion was 0.96: 0.04, respectively (n = 79 breeding pairs of both species).

Although both species richness and the general dominance structure were similar in the dry and the wet season, the avian community differed significantly in terms of population density of more common species (Table 2). The Sörensen Similarity Index between the dry

Table 2. **Characteristics of the breeding bird community in Tsumeb in the dry and wet seasons**

Parameter	September 2017	April 2019
Number of species and pairs		
Number of species	18	20
Number of breeding pairs	190	274
Dominance		
Number of dominant species	6	6
Cumulative dominance (%)	78.5	89.4
Community dominance (DI)	0.46	0.43
Indices		
Shannon's Diversity Index (H')	2.28	2.13
Simpson's Diversity Index (D)	0.84	0.85
Pielou's Evenness Index (*J'*)	0.79	0.71
Feeding guilds (%)		
Frugivorous	42.6	44.5
Granivorous	44.8	34.7
Insectivorous	12.7	20.2
Others	0.0	0.8
Nesting guilds (%)		
Trees/shrubs	90.6	87.3
Holes	3.7	11.0
Buildings	4.7	1.1
Others	0.0	0.8

and the wet seasons was $I = 0.68$. As expected, among granivorous species, the Laughing Dove, the Rosy-faced Parrot, the House Sparrow, and the Southern Masked Weaver were much more numerous in the dry than in the wet season. However, contrary to expectation, the Blue Waxbill was far more numerous in the wet than in the dry season. It is important to point out that although the Blue Waxbill is a granivorous species, it feeds its chicks with insects (Hockey et al., 2005). The frugivorous Red-eyed Bulbul was more common in the wet season, while other frugivorous species, the Red-faced Mousebird, was more numerous in the dry than in the wet season.

Parker (2012) recorded a relative stability of a suburban bird community compared to the neighbouring indigenous vegetation. He showed, however, conspicuous seasonal differences in the abundance of most frugivorous and nectarivorous birds. According to him, suburban habitat provides a relatively constant food and water supplies throughout the year, and birds from surrounding natural habitats may take refuge from the scarcity of these resources in the dry season by migrating to suburban habitats.

As expected, the proportion of insectivorous birds was higher in the wet than in the dry season, while the reverse was true in the case of granivorous birds. The proportion of frugivorous birds was similar in both seasons (Table 3), although more frugivorous birds were expected in the dry season when more fruits were available. In a forest-farmland habitat in Kenya, Mulwa et al. (2013) showed that

Table 3. **Breeding bird community in the suburbs of Tsumeb in the dry (September 2017) and wet (April 2019) seasons**

Species name		September 2017					April 2019				
Common	Scientific	a	b	c	N	D	d	e	f	N	D
Acacia Pied Barbet	*Tricholaema leucomelas*	0	0	0	0	0.0	0	1	2	3	1.1
Afican Palm Swift	***Cypsiurus parvus***	**6**	**3**	**3**	**12**	**6.3**	**15**	**19**	**9**	**43**	**15.7**
African Hoopoe	*Upupa africana*	2	1	0	3	1.6	0	0	0	0	0.0
Black-backed Puffback	*Dryoscopus cubla*	1	0	0	1	0.5	0	0	1	1	0.4
Black-throated Canary	*Crithagra atrogularis*	1	0	1	2	1.1	0	0	0	0	0.0
Blue Waxbill	***Uraeginthus angolensis***	**8**	**4**	**2**	**14**	**7.4**	**25**	**20**	**10**	**55**	**20.1**
Bradfield's Hornbill	*Tockus bradfieldii*	0	0	0	0	0.0	1	0	0	1	0.4
Cape Glossy Starling	***Lamprotornis nitens***	1	2	0	3	1.6	**7**	**12**	**4**	**23**	**8.4**
Cape Turtle Dove	*Streptopelia capensis*	1	1	1	3	1.6	0	0	0	0	0.0
Crowned Lapwing	*Vanellus coronatus*	0	0	0	0	0.0	1	0	0	1	0.4
Feral Pigeon	*Columba livia*	0	0	0	0	0.0	0	0	0	0	0.0
Fork-tailed Drongo	*Dicrurus adsimilis*	4	0	2	6	3.2	2	4	3	9	3.3
Goshawk	*Accipiter* sp.	0	0	0	0	0.0	0	0	1	1	0.4
Grey Hornbill	*Tockus nasutus*	0	1	0	1	0.5	0	1	1	2	0.7
Grey Lourie	*Corythaixoides concolor*	0	0	0	0	0.0	2	0	0	2	0.7
Ground Thrusher	*Turdus litsitsirupa*	1	0	0	1	0.5	0	0	0	0	0.0
House Sparrow	*Passer domesticus*	0	1	8	9	4.7	0	2	1	3	1.1
Laughing Dove	***Streptopelia senegalensis***	**23**	**8**	**12**	**43**	**22.6**	**15**	**10**	**8**	**33**	**12.0**
Namaqua Dove	*Oena capensis*	0	0	0	0	0.0	0	0	1	1	0.4
Pearl-spotted Owl	*Glaucidium capense*	0	0	0	0	0.0	0	0	1	1	0.4
Rattling Cisticola	*Cisticola chiniana*	0	2	0	2	1.1	0	0	0	0	0.0

Table 3. **(Continued)**

Species name		September 2017					April 2019				
Common	Scientific	a	b	c	N	D	d	e	F	N	D
Red-eyed Bulbul	***Pycnonotus nigricans***	**12**	**5**	**5**	**22**	**11.6**	**26**	**17**	**20**	**63**	**23.0**
Red-faced Mousebird	***Urocolius indicus***	**20**	**9**	**15**	**44**	**23.2**	**6**	**12**	**10**	**28**	**10.2**
Red-headed Finch	*Amadina erythrocephala*	0	0	0	0	0.0	0	1	0	1	0.4
Rosy-faced Parrot	*Agapornis roseicollis*	9	0	0	9	4.7	0	0	0	0	0.0
Southern Masked Weaver	***Ploceus velatus***	**7**	**4**	**3**	**14**	**7.4**	0	2	0	2	0.7
White-browed Scrub Robin	*Cercotrichas leucophrys*	0	1	0	1	0.5	0	0	0	0	0.0
Zitting Cisticola	*Cisticola juncidis*	0	0	0	0	0.0	0	0	1	1	0.4

Explanations: a, b, c, d, e, f – number of breeding pairs recorded on a given transect (cf. Table 1), N – total number of breeding pairs recorded, D – dominance (percentage of the total number of breeding pairs of a given species in relation to the total number of breeding pairs of all species). Dominant species are indicated in bold type.

frugivorous species richness fluctuated anticyclically, while insectivorous species richness fluctuated synchronously. This may suggest local-scale movements across habitat boundaries of some frugivorous species and lack of such movements in insectivorous species. It appears that in the quite uniform urbanised woody habitat of Tsumeb, such movements did not take place. In Tsumeb, the frugivores may adjust population densities and food requirements through seasonal breeding rather than through local migration.

The resident avian community in Tsumeb is rather poor both in terms of species richness and dominance structure. This could have been caused by the removal of natural vegetation from most parts of the town. In order to bring back more wildlife to the town and beautify it, future urban planning should consider planting (in form of avenues, hedgerows, or clumps of greenery) indigenous trees and shrubs (e.g. *Acacia* spp., *Comiphora* spp., *Ficus* spp., *Grewia* spp., *Sclerocaya birrea*) in some places in the town (for example, around sport fields, the cemetery, churches, schools, and hotels) to attract more bird species and other valuable groups of wildlife.

Received 4 October 2021
Accepted 4 November 2021

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PAUKŠČIŲ BENDRUOMENĖS STRUKTŪROS SEZONINIAI POKYČIAI MIESTO BUVEINĖJE ŠIAURĖS NAMIBIJOJE

Santrauka

Pietų Afrikos klimatui būdingi du metų laikai – sausasis ir drėgnasis. Šis sezoniškumas, nulemtas skirtingo kritulių kiekio, sukelia sezoninius pirminės ir antrinės produkcijos pokyčius. Paukščių bendruomenė buvo tiriama sausuoju ir drėgnuoju metų laiku urbanizuotoje buveinėje Tsumebo mieste, Namibijos šiaurėje. Nors rūšių gausa ir bendra dominavimo struktūra abiem metų laikais buvo panašūs, šiame mieste gerokai skyrėsi dažnesnių rūšių populiacijos tankis. Sörenseno panašumo indeksas tarp sausojo ir drėgnojo sezonų buvo mažas (I = 0,68). Kaip ir tikėtasi, grūdaėdžių rūšys, tokios kaip mažasis purplelis (*Streptopelia senegalensis*), rausvaveidis agapornis (*Agapornis roseicollis*), naminis žvirblis (*Passer domesticus*) ir juodakaklis audėjas (*Ploceus velatus*), buvo gausesnės sausuoju nei drėgnuoju metų laiku. Ir priešingai, nei tikėtasi, mėlynojo grenadino (*Uraeginthus angolensis*) buvo daugiau drėgnuoju metų laiku. Raudonakė bulbulė (*Pycnonotus nigricans*) labiau buvo paplitusi drėgnuoju metų laiku, tačiau kitų vaisiaėdžių rūšių, tokių kaip raudonveidis pilkasis pelėpaukštis (*Urocolius indicus*), buvo daugiau sausuoju metų laiku.

Raktažodžiai: miesto ornitologija, populiacijos tankiai, Tsumebas