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Structure of the breeding bird community along the urban gradient in a town on the Zambezi River, north-eastern Namibia

Grzegorz Kopij[1, 2]

[1] Department of Vertebrate Zoology, Wroclaw University of Environmental and Life Sciences, ul. Kożuchowska 5b, 510631 Wrocław, Poland

[2] Department of Integrated Environmental Science, Ogongo Campus, University of Namibia, Private Bag 5520 Oshakati, Namibia

A simplified mapping method was employed to quantify avian assemblages in three study plots in a modified riparian forest on the Zambezi River in the town of Katima Mulilo, NE Namibia. The plots were arranged along the urbanization gradient: plot A (34 ha; 0–1 km from centre of the town), plot B (27 ha; 1–2 km from the centre), and plot C (24 ha; 2–3 km from the centre; periphery). In total, 51 breeding bird species were recorded in all three plots. Five of them, *Columba livia domestica*, *Passer diffusus*, *Pycnonotus tricolor*, *Streptopelia senegalensis*, and *Uraeginthus angolensis* were classified as dominant species. The cumulative dominance was 69.9%. The overall population density of all breeding species increased with the urban gradient. In general, granivorous birds were by far the most numerous feeding guild comprising 68.7% of all breeding birds. Two other guilds, frugivorous and insectivorous birds, together comprised 28.9%. While the proportion of granivores decreased along the urban gradient from the town centre to its periphery, the proportion of insectivores increased. The proportion of birds nesting in/on buildings decreased, and the share of tree/shrub- and hole-nesting birds increased along the urban gradient. The diversity indices were relatively high in all plots. They decreased only slightly along the urban gradient (from the centre to the periphery). However, the Pielou's Evenness Index was comparatively low, but on a slight increase along the urbanization gradient. The Sorensen Similarity Index was low, but the values of the three studied plots were very similar.

Keywords: urban ecology, community ecology, population densities

INTRODUCTION

Urban ecology plays an increasingly important role in urban planning, nature conservation, environmental education, and the so-called citizen science. It is mainly because more and more people live in cities and towns, and usually they have contact with nature through an urbanized environment. Birds are especially attractive in that regard as they are ubiquitous and occur in large numbers even in city centres. They display very interesting

* Corresponding author. Email: grzegorz.kopij@up.wroc.pl, g.kopij@unam.na

behaviour and vocalization; like humans, they are of diurnal activity and rely mainly on audio-visual cues. They are also known as good indicators of environmental quality (Kopij, 2001a; Dunn, Weston, 2008; Magle et al., 2012).

However, studies on birds in urbanized habitats are scanty in many parts of the world (Dunn, Weston, 2008; Magle et al., 2012). Compared with hundreds of urban bird atlases produced in Europe (Luniak, 2017), there are only few available in Africa (Kopij, 2001a; 2015; 2016; 2018a; 2018b). Other quantitative studies on bird assemblages in urban habitats in this region of the world are also limited, and even semi-quantitative studies were conducted in only very few towns/cities (Kopij, 2000; 2001b; 2004; 2009; 2011; 2014; Parker, 2014). Therefore, any further studies on birds in such habitats in this region are urgently needed.

The presented study reports on birds breeding along the urban gradient in one of southern African towns. The aim of the study was to show how species diversity and population densities of particular species and their dominance change in relation to the distance from the town centre. It is expected that the more urbanized the area is, the lower the diversity and the higher cumulative dominance.

MATERIALS AND METHODS

Study area

The study was conducted in the town Katima Mulilo, Zambezi Region, Namibia (Fig. 1). The town is located on the right bank of the Zambezi River. The natural vegetation, which is now highly modified by human activity, comprises the Zambezi Riparian Forest (Mendelsohn et al., 2009). Among many others, indigenous wild trees include: African teak *Pterocarpus angolensis*, Albizias *Albizia* spp., apple leave *Lonchocarpus nelsii*, baobab *Adansonia digitata*, burkea *Burkea africana*, bushwillows *Combretum* spp., camel thorn *Acacia erioloba*, corkwoods *Commiphora* spp., false mopane *Guibourtia coleospermum*, jackal berry *Diospyros mespiliformis*, knob thorn *Accacia nigrescens*, Makalani palm *Hyphaene petersiana*, manketti *Schinziophyton rautanenii*, marula *Sclerocarya birrea*, mopane *Colophospermum mopane*, pod mahogany *Afzelia quanzensis*, silver clusterleaf *Terminalia sericea*, sausage tree *Kigelia africana*, sycomore fig *Ficus sycomorus*, and white bauhinia *Bauhinia petersiana*. The most common exotic trees are gums *Eucalyptus* spp., jacarandas *Jackaranda* sp., and she-oaks *Cassuarina* sp.

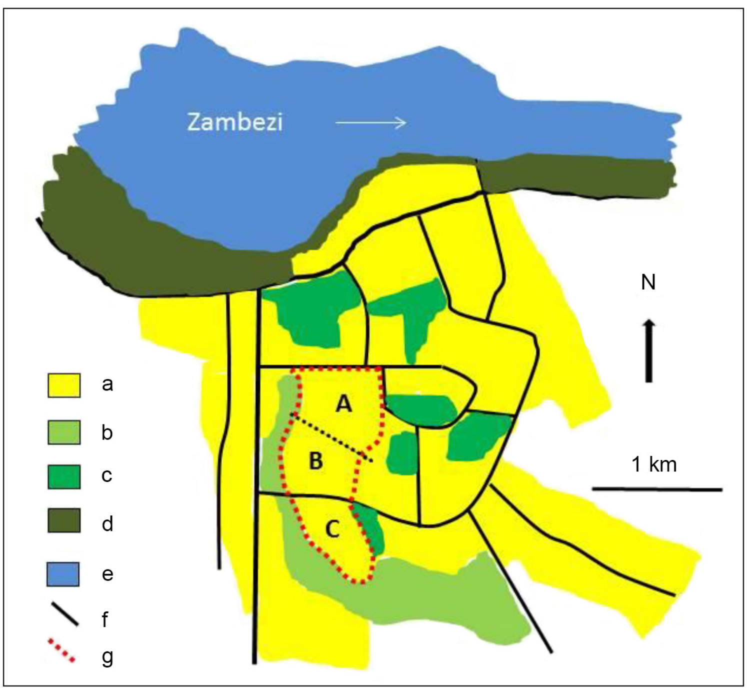

Fig. 1. Location of the study plots in the town of Katima Mulilo: a – built-up areas, b – open wetlands, c – remnant of acacia savanna, d – a riparian forest, e – the Zambezi River, f – roads, g – study plots (A, B, C)

Three plots were selected at different distances from the town centre (Fig. 1). Plot A (34 ha) was located 0 to 525 m from the centre, plot B (27 ha) 525–1050 m, and plot C (24 ha) 1050–1680 m from the centre. Plot A was built up in the 1950s–60s, plot B in the 1970s and 1980s, and plot C in the 1990s and the 2000s. Trees and shrubs were planted in respective periods around the buildings. In all plots, the main trees include fruit trees (mango, papayas, lemons) and such indigenous tree species as the Makalani palms, mopane, jackal berry, camel thorn, and silver tree. Most buildings are small one-storeyed houses with zinc-corrugated flat roofs surrounded by fences, often with some vegetables grown in small gardens.

The annual temperature in Katima Mulilo is 21°C. The average maximum temperature during the hottest month (September) is 35°C and the average minimum temperature during the coldest month (July) is 3°C. In the most humid month (February), the humidity is 80–90%, and only 10–20% in the least humid month (September). The average annual rainfall is about 700 mm, the highest in Namibia. Median annual rainfall is 550–600 mm. Most of the rains fall between November and March. Figure 2 shows monthly rainfall in Katima Mulilo during the study period (2014–2015).

Methods

A simplified mapping method was employed (Bibby et al., 2012; Sutherland, 1996). Each plot was surveyed twice during the dry season (June 2014) and twice during the wet season (February–March 2015). Birds were counted along all streets. Counts were conducted in the mornings under calm and cloudless weather. At least two records of an individual showing territorial or breeding behaviour at the same site were interpreted as an occupied territory, which in most cases was equal to the number of breeding pairs. In the case of the red-billed woodhoopoe *Phoeniculus purpureus* or the arrow-marked babbler *Turdoides jardineii*, it was equal to the breeding pair and all the helpers of this pair (co-operatively breeding species), while in the case of polygynous species the number of females was taken to estimate the population density. The number of breeding pairs of the rock dove *Columba livia domestica* was estimated by counting all individuals roosting on roofs and dividing their number by two.

The dominance is expressed as the percentage of the total number of breeding pairs of a given species in relation to the total number of all breeding pairs of all species. Eudominant species is defined as comprising 10% and

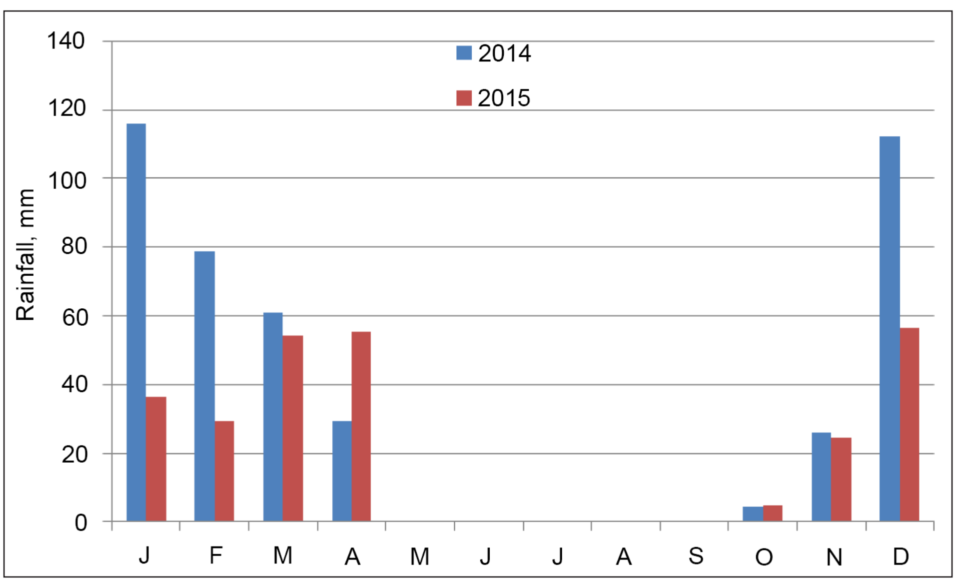

Fig. 2. Monthly rainfall in Katima Mulilo, 2014–2015

more of all pairs of all species recorded, dominant – between 5 and 9.9%, and subdominant species as comprising 2–4.99%.

The following guilds were distinguished:

A. Diet: F – frugivorous, G – granivorous, I – insectivorous, N – nectarivorous, O – omnivorous, R – carnivorous; B. Nesting: B – buildings, H – tree holes; T – trees or shrubs.

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

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

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:

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

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.

In addition, the community dominance index and Sörensen's coefficient were used to characterize the avian community.

1) Community dominance index:

$I = (n_1 + n_2)/N$

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

2) Sörensen's coefficient:

$I = 2C/A + B$

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

Systematics and the nomenclature of bird species follow Hockey et al. (2005).

RESULTS AND DISCUSSION

Fifty-one species of breeding birds were recorded in all three plots in total (App. 1). This constitutes less than 42% of all bird species recorded as breeding resident in this town (Kopij, 2016). Five of them, rock dove *Columba livia domestica*, grey-headed sparrow *Passer diffusus*, dark-capped bulbul *Pycnonotus tricolor*, laughing dove *Streptopelia senegalensis*, and blue waxbill *Uraeginthus angolensis* were classified as dominant species; in fact, they were eudominant, as the contribution of each of them was higher than 10%. The cumulative dominance was 69.9% (Table). Only two species, the fork-tailed drongo *Dicrurus adsimilis* and the mourning collared-dove *Streptopelia decipiens*, were classified as subdominants (6.8% combined). Both cumulative and community dominance increased with the urban gradient from the periphery to the centre, but the number of dominant species, i.e., five, remained the same (Table).

In most southern African towns and cities investigated so far, *Streptopelia* doves are among the most numerous bird species (Kopij, 2000; 2001a; 2001b; 2006; 2009; 2011; 2014; 2015; 2016; 2018a; 2018b). In Katima Mulilo, they comprised 22% of all breeding birds (this study). In each plot their contribution varied between 19.3% and 24.4% (App. 1). Four *Streptopelia* species were recorded as breeding in all those plots, a situation rather unusual for Namibia (Kopij, 2014) and for southern Africa in general, where two species usually occur (Kopij 2006). The overall proportion of *Streptopelia*-species (in all three study plots): *S. senegalensis* : *S. capicola* : *S. semitorquata* : *S. decipiens* was as: 0.71 : 0.03 : 0.06 : 0.20 ($n = 87$ breeding pairs of all dove species). The strong dominance of *S. senegalensis* is characteristic for most, if not all, towns in Namibia (Kopij, 2014; 2018a).

Two to three *Passer* species are recorded as common breeding residents in most southern African towns (Kopij, 2000; 2001a; 2001b; 2006; 2009; 2011; 2014; 2015; 2018b). In this study, however, only one species was recorded but it was eudominant in all study plots. In all southern African towns investigated, doves and sparrows comprise the bulk of the avian community.

The overall population density of all breeding species increased along the urban gradient. It was possible to test the differences in

Table 1. **Characterization of the breeding bird community along an urbanized gradient in Katima Mulilo, Northeast Namibia**

Parameter	Plot A	Plot B	Plot C	Plots 1+2+3
Number of species and pairs				
Number of species	34	32	39	51
Number of breeding pairs	184	117	96.5	397.5
Overall population density (pairs/100 ha)	541.2	433.3	427.1	465.9
Dominance				
Number of dominant species	5	5	5	5
Cumulative dominance (%)	76.5	68.3	59.1	69.9
Community dominance (DI)	0.42	0.33	0.33	0.32
Indices				
Shannon's diversity index (H')	2.44	2.44	2.67	2.76
Simpson's diversity index (D)	0.87	0.90	0.90	0.90
Pielou's evenness index (J')	0.69	0.71	0.73	0.70
Feeding guilds (%)				
Granivores	74.6	62.0	61.5	68.7
Insectivores	6.4	14.2	17.5	11.4
Frugivores	15.35	20.9	17.4	17.5
Nectarivores	2.1	2.2	1.5	2.0
Carnivores	0.3	0.4	0.5	0.4
Nesting guilds (%)				
Trees/shrubs	49.3	68.5	65.3	59.1
Holes	6.3	6.9	9.2	7.2
Buildings	43.9	24.7	24.9	33.8

population densities between the three study plots for six bird species statistically (x^2-test; expected values larger than five; $df = 2$). Only population densities of the red-eyed dove were different ($x^2 = 31.2$; $p < 0.01$), while the differences were statistically insignificant for all the other species, namely: grey-headed sparrow ($x^2 = 4.4$; $p > 0.05$), dark-eyed bulbul ($x^2 = 0.7$; $p > 0.05$), Cape turtle-dove ($x^2 = 1.4$; $p > 0.05$), blue waxbill ($x^2 = 0.3$; $p > 0.05$), and mourning dove ($x^2 = 0.02$; $p > 0.05$).

In overall, granivorous birds were by far the most numerous feeding guild comprising over 68.7% of all breeding birds. Such a situation is characteristic of urban habitats (Chace, Walsh, 2006). Two other guilds, frugivorous and insectivorous birds, comprised together additional 28.9% (Table). The contribution of all other guilds was much lower (together 2.5%). While the proportion of the granivores has decreased along the urban gradient from the town centre to its periphery, that of insectivores increased. The proportion of the birds nesting in/on building decreased, and that of tree/shrub- and hole-nesting birds increased along the urban gradient (Table). The G-test shows that the differences for granivores, insectivores, and frugivores were statistically highly significant.

The diversity indices were relatively high in all plots. They only slightly decreased along the urban gradient (from the centre to the periphery). However, the Pielou's Evenness Index was comparatively low, but it was on a slight increase along the urbanization gradient (Table). The Sörensen Similarity Index was low, but of a very similar value between the three studied plots (I = 0.36 between plot A and plot B, I = 0.37 between plot A and plot C, and I = 0.34 between plot B and plot C).

CONCLUSIONS

Contrary to expectations, no significant changes were recorded in the number of species and diversity evenness indices in avian community along the urbanization gradient. Also, population densities of more numerous birds did not change significantly along this gradient as only the proportions of main feeding and nesting guilds changed significantly along this gradient. More profound changes along the urban gradient in avian communities are expected to exist in larger cities, but this premise requires further investigations.

Appendix. **Residential area along an urbanization gradient in Katima Mulilo, NE Namibia. A – close to the centre (34 ha), B – at mid-distance from the centre (27 ha), C – far from the centre (24 ha); N – number of pairs, d – density (pairs/10 ha), D – dominance (%). Abbreviations for guilds: feeding: F – frugivorous, G – granivorous, I – insectivorous, N – nectarivorous, O – omnivorous, R – carnivorous; nesting: B – buildings, H – tree holes; T – trees or shrubs. Dominant species are indicated in bold type.**

Species	Guilds		Number of pairs			Pairs/10 ha			Dominance (%)			All plots (1+2+3)		
	Feed	Nest	A	B	C	A	B	C	A	B	C	N	d	D
Amadina erythrocephala	G	T	1	0	0	0.3	0.0	0.0	0.5	0	0	1	0.1	0.3
Bubalornis niger	G	T	1	0	1	0.3	0.0	0.4	0.5	0	1	2	0.2	0.5
Campethera abingoni	I	H	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Centropus superciliosus	I	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Chalcomitra senegalensis	N	T	1	1	0	0.3	0.4	0.0	0.5	0.9	0	2	0.2	0.5
Chlorocichla flaviventris	F	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Chlorophoneus sulfureopectus	F	T	0	0.5	0.5	0.0	0.2	0.2	0	0.4	0.5	1	0.1	0.3
Cinnyris mariquensis	N	T	3	0.5	1	0.9	0.2	0.4	1.6	0.4	1	4.5	0.5	1.1
Cinnyris talatala	N	T	0	1	0	0.0	0.4	0.0	0	0.9	0	1	0.1	0.3
Columba livia domestica	**G**	**B**	**47**	**10**	**6**	**13.8**	**3.7**	**2.5**	**25.5**	**8.5**	**6.2**	**63**	**7.4**	**15.8**
Coracias caudatus	I	H	0.5	1	1	0.1	0.4	0.4	0.3	0.9	1	2.5	0.3	0.6
Corvus albus	O	T	1.5	0.5	1	0.4	0.2	0.4	0.8	0.4	1	3	0.4	0.8
Corythaixoides concolor	F	T	0	0.5	1	0.0	0.2	0.4	0	0.4	1	1.5	0.2	0.4
Cossypha heuglini	I	T	1	1	0.5	0.3	0.4	0.2	0.5	0.9	0.5	2.5	0.3	0.6
Cypsiurus parvus	I	T	1	4	3	0.3	1.5	1.3	0.5	3.4	3.1	8	0.9	2
Dicrurus adsimilis	I	T	2.5	2.5	5	0.7	0.9	2.1	1.4	2.1	5.2	10	1.2	2.5
Dryoscopus cubla	I	T	0.5	0.5	0	0.1	0.2	0.0	0.3	0.4	0	1	0.1	0.3
Glaucidium perlatum	I	H	1	0	0	0.3	0.0	0.0	0.5	0	0	1	0.1	0.3
Halcyon senegalensis	I	H	1	0	0	0.3	0.0	0.0	0.5	0	0	1	0.1	0.3
Hedydipna collaris	N	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1

Appendix. **(continued)**

Species	Guilds		Number of pairs			Pairs/10 ha			Dominance (%)			All plots (1+2+3)		
	Feed	Nest	A	B	C	A	B	C	A	B	C	N	d	D
Hirundo smithii	I	B	2	2	2	0.6	0.7	0.8	1.1	1.7	2.1	6	0.7	1.5
Indicator indicator	I	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Lamprotonis australis	F	H	3	2	1	0.9	0.7	0.4	1.6	1.7	1	6	0.7	1.5
Lamprotornis nitens	F	H	3	0.5	2	0.9	0.2	0.8	1.6	0.4	2.1	5.5	0.6	1.4
Laniarius bicolor	I	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Laniarius major	I	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Lonchura cucculata	G	T	0.5	0	0.5	0.1	0.0	0.2	0.3	0	0.5	1	0.1	0.3
Lybius torquatus	F	H	1	0	1	0.3	0.0	0.4	0.5	0	1	2	0.2	0.5
Merops pusilus	I	H	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Milvus aegyptius	R	T	0.5	0.5	0.5	0.1	0.2	0.2	0.3	0.4	0.5	1.5	0.2	0.4
Motacilla aguimp	I	B	1	0	0	0.3	0.0	0.0	0.5	0	0	1	0.1	0.3
Nilaus afer	I	T	0	1	0	0.0	0.4	0.0	0	0.9	0	1	0.1	0.3
Oena capensis	G	T	0.5	0	0.5	0.1	0.0	0.2	0.3	0	0.5	1	0.1	0.3
Passer diffusus	**G**	**B**	**31**	**17**	**16**	**9.1**	**6.3**	**6.7**	**16.8**	**14.5**	**16.6**	**64**	**7.5**	**16.1**
Phoeniculus purpureus	I	H	0	1	0	0.0	0.4	0.0	0	0.9	0	1	0.1	0.3
Ploceus velatus	G	T	2	0	1	0.6	0.0	0.4	1.1	0	1	3	0.4	0.8
Ploceus xanthopterus	G	T	0	1	0	0.0	0.4	0.0	0	0.9	0	1	0.1	0.3
Poicephalus meyeri	F	H	1	1	0.5	0.3	0.4	0.2	0.5	0.9	0.5	2.5	0.3	0.6
Pycnonotis tricolor	**F**	**T**	**19**	**19**	**9**	**5.6**	**7.0**	**3.8**	**10.3**	**16.2**	**9.3**	**47**	**5.5**	**11.8**
Rhinopomastus cy-anomelas	I	H	0	0.5	0	0.0	0.2	0.0	0	0.4	0	0.5	0.1	0.1
Streptopelia capicola	G	T	1.5	1	0.5	0.4	0.4	0.2	0.8	0.9	0.5	3	0.4	0.8
Streptopelia decipiens	G	T	6	5.5	5.5	1.8	2.0	2.3	3.3	4.7	5.7	17	2.0	4.3
Streptopelia semi-torquata	G	T	2	2	1	0.6	0.7	0.4	1.1	1.7	1	5	0.6	1.3
Streptopelia senega-lensis	**G**	**T**	**26**	**20**	**16**	**7.6**	**7.4**	**6.7**	**14.1**	**17.1**	**16.6**	**62**	**7.3**	**15.6**
Tauraco schalowi	F	T	0.5	0	0.5	0.1	0.0	0.2	0.3	0	0.5	1	0.1	0.3
Terpsiphone viridis	I	H	1.5	2	2.5	0.4	0.7	1.0	0.8	1.7	2.6	6	0.7	1.5
Turdoides jardineii	I	T	0	1	0	0.0	0.4	0.0	0	0.9	0	1	0.1	0.3
Turtur afer	G	T	0	0	0.5	0.0	0.0	0.2	0	0	0.5	0.5	0.1	0.1
Uraeginthus ango-lensis	**G**	**T**	**18**	**14**	**16**	**5.3**	**5.2**	**6.7**	**9.8**	**12**	**10.4**	**42**	**4.9**	**10.6**
Urocolius indicus	F	T	1	1	1	0.3	0.4	0.4	0.5	0.9	1	3	0.4	0.8
Vidua chalybeata	G	T	1	2	1	0.3	0.7	0.4	0.5	1.7	1	4	0.5	1
Total			184	117	96.5	54.1	43.3	42.7	100	100	100	397.5	46.8	100

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References

1. Bibby CJ, Burgess ND, Hill DA. Bird censuses techniques. Academic Press: London; 2012.
2. Chace JF, Walsh JJ. Urban effects on native avifauna: a review. Landscape Urban Plan. 2006; 74: 46–69.
3. Dunn AM, Weston MA. Review of terrestrial bird atlases of the world and their application. Emu. 2008; 108: 42–67.
4. Hockey PAR, Dean WRJ, Ryan PG, Maree S, editors. Roberts' birds of Southern Africa. Cape Town: John Voelcker Bird Book Fund; 2005.
5. Kopij G. Birds of Maseru. NUL J Res (Roma, Lesotho), 2000; 8: 104–51.
6. Kopij G. Atlas of birds of Bloemfontein. Roma. (Lesotho)/Bloemfontein (RSA): Department of Biology, National University of Lesotho/ Free State Bird Club; 2001a.
7. Kopij G. Birds of Roma Valley, Lesotho. Roma (Lesotho): Department of Biology, National University of Lesotho; 2001b.
8. Kopij G. Bird communities of a suburb habitat in South African Highveld during the wet and dry season. Zeszyty Naukowe AR Wrocław, Zootechnika, 2004; 50: 205–11.
9. Kopij G. The structure of assemblages and dietary relationships in birds in South African grasslands. Wrocław: Wydawnictwo Akademii Rolniczej we Wrocławiu; 2006. 128 p.
10. Kopij G. Quantitative studies on birds breeding in Ladybrand, eastern Free State, South Africa. Zeszyty Nukowe UP we Wrocławiu, Biologia i Hodowla Zwierząt, 2009; 58: 121–7.
11. Kopij G. Avian diversity in ruderal and urbanized habitats in Lesotho. Berkut, 2011; 20(1/2): 22–28.
12. Kopij G. Avian assemblages in urban habitats in North-central Namibia. ISTJ N. 2014; 3(1): 64–81.
13. Kopij G. Avian diversity in an urbanized South African grassland. Zoology Ecology. 2015; 25(2): 87–100.
14. Kopij G. Birds of Katima Mulilo town, Zambezi Region, Namibia. ISTJN. 2016; 7: 85–102.
15. Kopij G. 2018a. Provisional atlas of breeding birds of Swakopmund in the coastal Namib Desert. Lanioturdus. 51(2): 2–12.
16. Kopij G. 2018b. Atlas of birds of Kasani. Babbler. 64: 3–15.
17. Luniak M. Urban ornithological atlases in Europe: a review. In: Murgui E., Hedblom H, editors. Ecology and conservation of birds in urban environments. Heidelberg: Springer; 2017; 209–23.
18. Magle SB, Hunt VM, Vernon M, Crooks KR. Urban wildlife research: past, present, and future. Biological Conservation. 2012; 155: 23–32.
19. Mendelsohn J, Jarvis A, Roberts C, Robertson T. Atlas of Namibia. A portrait of the land and its people. Cape Town: Sunbird Publishers; 2009.
20. Parker V. The birds of the Groenkloof conservation Complex, Pretoria. Orn. Observ. 2014; 5: 81–100.
21. Sutherland WJ. Ecological Census Techniques: a handbook. Cambridge University Press, Cambridge (U.K.), 1996.

Grzegorz Kopij

PERINČIŲ PAUKŠČIŲ BENDRUOMENĖS ŠIAURĖS RYTŲ NAMIBIJOS MIESTE PRIE ZAMBEZĖS UPĖS

Santrauka

Taikant paprastą kartografavimo metodą, buvo įvertintas paukščių populiacijos kiekis trijuose sklypuose Katima Mulilo mieste, modifikuotame pakrantės miške prie Zambezės upės (Šiaurės rytų Namibija). Sklypai buvo išdėstyti urbanizacijos kryptimi: A sklypas (34 ha; 0–1 km nuo miesto centro), B sklypas (27 ha; 1–2 km nuo centro) ir C sklypas (24 ha; 2–3 km nuo centro; pakraštyje). Iš viso šiuose sklypuose užregistruota 51 perinčių paukščių rūšis. Penkios iš jų: *Columba livia domestica, Passer diffusus*, *Pycnonotus tricolor*, *Streptopelia senegalensis* ir *Uraeginthus angolensis* buvo klasifikuojamos kaip dominuojančios rūšys. Bendras dominavimas – 69,9 %. Bendras visų perinčių paukščių populiacijos tankis didėjo urbanizacijos gradiento kryptimi. Apskritai grūdus lesančių paukščių populiacija buvo viena iš gausiausių ir apėmė 68,7 % visų perinčių paukščių. Kitos populiacijos, vaisiaėdžiai ir vabzdžiaėdžiai, sudarė 28,9 %. Grūdus lesančių paukščių populiacija nuo miesto centro iki pakraščio mažėjo, vabzdžiaėdžių – didėjo. Ant pastatų lizdus sukančių paukščių dalis mažėjo, o medžiuose, krūmuose ir kiaurymėse lizdus sukančių paukščių dalis didėjo priklausomai nuo miesto urbanizacijos krypties (nuo centro į pakraščius). Įvairovės indeksai buvo aukšti visose srityse. Jie nepastebimai mažėjo priklausomai nuo miesto urbanizacijos krypties (nuo centro į pakraščius). Gana žemas Pielou tolygumo rodiklis šiek tiek didėjo priklausomai nuo urbanizacijos krypties. Sorensen panašumo indeksas buvo žemas, labai panašus į kitų tirtų sričių.

Raktažodžiai: miesto ekologija, bendruomenės ekologija, populiacijos tankumas