


POPULATION DENSITIES AND COMMUNITY STRUCTURE OF BIRDS IN A KALAHARI WOODLAND TRANSFORMED TO A FARMLAND, NE NAMIBIA

Grzegorz Kopij

University of Namibia, Department of Integrated Environmental Science; Ogongo Campus, Private Bag, 5520, Oshakati, Namibia
✉ gkopij@unam.na  Grzegorz Kopij <https://orcid.org/0000-0001-7614-1983>

Abstract. In 2014–2015, the line transect method has been employed to assess population densities and community structure of birds in a farmland recently transformed from a Kalahari Woodland, eastern Zambezi Region, NE Namibia. In the total 57 breeding resident and six Palearctic migrants have been recorded. There were four dominant species (Cape Turtle Dove, Emerald-spotted Dove, Blue Waxbill and Dark-capped Bulbul) comprising together 30.1% of all breeding birds. The proportion of Cape Turtle Dove to Laughing Dove was 0.81 : 0.19 ($n = 26$). This study supports the «intermediate disturbance hypothesis». The number of species in the farmland was higher than on transects of similar length in the neighbouring pristine Kalahari Woodland. The dominance structure was also similar in both habitats compared. However, the avian communities differed in the proportions of main ecological guilds.

Key words: community ecology, intermediate disturbance hypothesis, agroecosystem, diversity.

Густота і структура населення птахів лісової місцевості в Калахарі (Північно-Східна Намібія), трансформованої в сільгоспугіддя. - Г. Копій. - Беркут. 29 (1-2). 2020. - У 2014–2015 рр. проведені маршрутні обліки птахів на ділянці сільгоспугіддя у Калахарі, на яку недавно була перетворена лісова місцевість. Загалом виявлено 57 місцевих видів і 6 палеарктичних мігрантів. У гніздовому населенні домінували 4 види (південноафриканська горлиця, бронзовоплямиста лісова горлиця, ангольський астрильд і триколірний бюльбюль), чисельність яких становила разом 30,1% від загальної. Дослідження підтвердило справедливості «гіпотези середнього порушення». Кількість видів у сільгоспугіддях виявилася вищою, ніж на суміжній території первинної лісової місцевості. Населення птахів у обох біотопах було схожим за структурою домінування, але відрізнялось співвідношенням екологічних груп птахів.

Ключові слова: екологія угруповань, гіпотези середнього порушення, агроекосистема, різноманіття.

Introduction

Throughout the 20th century, forests, savannahs and grasslands in Africa have been transformed extensively by pastoral and crop agriculture. This expansion inevitably leads to habitat destruction fragmentation and degradation. As a result most animal specialists, especially the larger ones, disappear or at the best, greatly reduce their population size, and are replaced by small generalists (Mangnall, Crowe, 2003). So, it is widely known that populations of many wild animal species suffer due to this transformation. However, it has been also documented that some other species, mostly generalists, such as such rats, gerbils, mice, bulbuls, weavers, doves and sparrows proliferate (Bolwig et al., 2006; Sogah, 2012).

A typical African farmland tend to be a mosaic of woodlands, savannas, grasslands and arable fields. In farmlands, the richest biodiversity is characteristic for less intensive, structurally heterogenous areas, where some woody vegetation still exists (Humble, 2007; Kopij, 2013, 2015, 2018; Nadng'ang'a et al., 2013). In some cases, conversion of natural ecosystems to agro-ecosystems may even lead initially to an increase in biodiversity and species richness. The survival of many wild animal species in agro-ecosystems depend on the way they adapt to live in these transformed habitats, and the way the pristine ecosystems are transformed into agro-ecosystems (Humble, 2007).

Most studies on avian populations and communities in Africa are conducted in natural habitats, whereas man-modified ecosystems, such as urban and farmland areas, are neglected (Humble, 2007), despite the fact that pristine habitats are shrinking, while agriculture lands are rapidly spreading. Only few of them attempted to study community structures of birds associated with agro-ecosystems (Kopij, 1998, 2006, 2013, 2015, 2018; Mangnall, Crowe, 2003; Waltert et al.,

2005; Bolwig et al., 2006; Humle, 2007; Mulwa et al., 2012; Sogah, 2012; Gove et al., 2013) and still fewer provide data on population density of particular species (Kopij, 2006, 2013, 2015, 2018; Humle, 2007).

The purpose of this study was to estimate population densities and community structure of birds breeding in a farmland recently transformed from the Kalahari woodland. It has been expected that due to the «intermediate disturbance hypothesis» (Wilkinson, 1999), both the species richness and biodiversity still remains relatively high in this area.

Study area and methods

The line transect method (Sutherland, 1996; Bibby et al., 2012) has been employed. The transect is located ca. 3 km W of Katima Mulilo, eastern Zambezi Region, NE Namibia. Beginning of the transect was at S 17° 30' 30'', E 24° 13' 70''; and the end at: S 17° 30' 94'', E 24° 14' 51''. Birds were surveyed on this transect for times: 1) 15.03.2014, 2) 15.08.2014, 3) 19.10.2014, 4) 31.03.2015. Counts were conducted in the mornings under calm and cloudless weather.

The transect run through a farmland recently transformed from a Kalahari Woodland. The farmland was dominated by maize and sorghum cultivations, while the woodland was represented by Zambezian Baikiaia woodland (Kopij, 2017), a subset of the Kalahari Woodland (Mendelsohn et al., 2009). Most of the woody vegetation has been removed; but in some places regrowth (secondary vegetation) already appeared (Fig.). The total amount of rainfall in 2014 (427 mm) was much higher than that in 2015 (261.6 mm).

The dominance is expressed here as the percentage of the total number of pairs of a given species in relation to the total number of all pairs of all species recorded. A dominant species is defined as that comprising 5% and more of all individuals



Table 1

Breeding bird community in a farmland converted from the Kalahari Woodland

Населення птахів у сільгоспудіях, трансформованих із ліистої місцевості в Калахарі

Species	Count dates				Overall		
	15.03	15.08	19.10	31.03	n	d	%d
1	2	3	4	5	6	7	8
Acacia Pied Barbet <i>Tricholaema leucomelas</i>	3	2	2	1	3	1.4	1.8
African Grey Hornbill <i>Lophoceros nasutus</i>	2	0	3	2	3	1.4	1.8
African Hoopoe <i>Upupa africana</i>	0	1	1	0	3	1.4	1.8
Black-backed Puffback <i>Dryoscopus cubla</i>	1	1	0	0	3	1.4	1.8
Black-chested Prinia <i>Prinia flavicans</i>	2	2	0	1	3	1.4	1.8
Black-collared Barbet <i>Lybius torquatus</i>	0	0	1	0	3	1.4	1.8
Black-throated Canary <i>Crithagra atrogularis</i>	1	0	0	0	1	0.5	0.6
Blue Waxbill <i>Uraeginthus angolensis</i>	8	6	8	12	12	5.5	7.1
Broad-billed Roller <i>Eurystomus glaucurus</i>	2	0	0	0	2	0.9	1.2
Brown-crowned Tchagra <i>Tchagra australis</i>	1	2	0	3	3	1.4	1.8
Brubru <i>Nilaus afer</i>	3	3	1	2	3	1.4	1.8
Cape Starling <i>Lamprolornis nitens</i>	2	1	0	1	2	0.9	1.2
Cape Turtle Dove <i>Streptopelia capicola</i>	21	12	9	17	21	9.5	12.4
Common Scimitar <i>Rhinopomastus cyanomelas</i>	0	0	0	1	1	0.5	0.6
Crested Barbet <i>Trachyphonus vaillantii</i>	2	0	0	1	2	0.9	1.2
Crested Francolin <i>Peliperdix coqui</i>	1	0	1	0	1	0.5	0.6
Crimson-breasted Shrike <i>Laniarius atrococcineus</i>	1	2	1	1	2	0.9	1.2
Dark-capped Bulbul <i>Pycnonotus tricolor</i>	4	3	2	9	9	4.1	5.3
Diderick Cuckoo <i>Chrysococcyx caprius</i>	2	0	0	0	2	0.9	1.2
Emerald Cuckoo <i>Chrysococcyx cupreus</i>	1	0	0	0	1	0.5	0.6
Emerald-spotted Dove <i>Turtur chalcospilus</i>	9	3	7	2	9	4.1	5.3
Fork-tailed Drongo <i>Dicrurus adsimilis</i>	3	3	2	1	3	1.4	1.8
Golden-breasted Buntig <i>Emberiza flaviventris</i>	0	1	0	0	1	0.5	0.6
Green Wood Hoopoe <i>Phoeniculus purpureus</i>	0	1	1	0	1	0.5	0.6
Green-winged Melba <i>Pytilia melba</i>	0	0	1	3	3	1.4	1.8
Grey Go-away-bird <i>Corithaixoides concolor</i>	3	0	1	2	3	1.4	1.8
Grey-backed Camararopt. <i>Camaroptera brevicaudata</i>	7	2	2	0	7	3.2	4.1
Jacobin Cuckoo <i>Clamator jacobinus</i>	1	0	0	0	1	0.5	0.6
<u>Laughing Dove <i>Streptopelia senegalensis</i></u>	1	0	0	5	5	2.3	2.9
Lilac-breasted Roller <i>Coracias caudatus</i>	0	1	1	1	1	0.5	0.6
Long-billed Crombec <i>Sylvietta rufescens</i>	3	2	0	1	3	1.4	1.8
Long-tailed Paradise Whydah <i>Vidua paradisaea</i>	1	0	1	0	1	0.5	0.6
Magpie Shrike <i>Urolestes melanoleucus</i>	0	0	1	0	1	0.5	0.6
Marico Flycatcher <i>Melaenornis mariquensis</i>	2	2	0	1	2	0.9	1.2
<u>Marico Sunbird <i>Cynnirys mariquensis</i></u>	1	1	0	4	4	1.8	2.4
Meyer's Parrot <i>Poicephalus meyeri</i>	1	0	0	0	1	0.5	0.6
Mosque Swallow <i>Cecropis senegalensis</i>	1	1	0	0	1	0.5	0.6
<u>Orange-breasted Bushshrike <i>Chlorophoneus sulfuropectus</i></u>	6	1	0	0	6	2.7	3.5
Pied Crow <i>Corvus albus</i>	0	1	0	1	1	0.5	0.6
Pirit Batis <i>Batis pirit</i>	0	0	0	1	1	0.5	0.6
Rattling Cisticola <i>Cisticola chiniana</i>	8	3	1	1	8	3.6	4.7
Red-billed Oxpecker <i>Buphagus erythrorhynchus</i>	0	0	0	1	1	0.5	0.6
Red-faced Mousebird <i>Urocolius indicus</i>	0	1	0	0	1	0.5	0.6
Scarlet-chested Sunbird <i>Chalcomitra senegalensis</i>	2	0	0	0	2	0.9	1.2
Shaft-tailed Whydah <i>regia</i>	2	0	3	0	3	1.4	1.8
Southern Black Tit <i>Melaniparus niger</i>	0	1	0	1	1	0.5	0.6
Southern Grey-headed Sparrow <i>Passer diffusus</i>	0	1	0	0	1	0.5	0.6
Southern Masked Weaver <i>Ploceus velatus</i>	0	1	0	0	1	0.5	0.6



End of the Table 1

Закінчення таблиці 1

1	2	3	4	5	6	7	8
Southern Yellow-billed Hornbill <i>Tockus leucomelas</i>	0	1	0	1	1	0.5	0.6
Swamp Boubou <i>Laniarius bicolor</i>	2	0	3	0	3	1.4	1.8
Village Indigobird <i>Vidua chalybeata</i>	2	0	0	0	2	0.9	1.2
Violet-eared Waxbill <i>Granatina granatina</i>	1	0	0	2	2	0.9	1.2
White-browed Coucal <i>Centropus superciliosus</i>	1	0	0	0	1	0.5	0.6
White-browed Scrub Robin <i>Cercotrichas leucophrys</i>	4	2	4	3	4	1.8	2.4
Yellow-bellied Greenbul <i>Chlorocichla flavirostris</i>	1	1	0	2	2	0.9	1.2
Yellow-billed Kite <i>Milvus aegyptius</i>	0	1	0	0	1	0.5	0.6
Yellow-fronted Tinkerbird <i>Pogoniulus chrysoconus</i>	1	1	0	2	1	0.5	0.6
Total	120	67	57	86	170	77.3	100

Explanation. n – number of breeding pairs, d – density (number of pairs per 1 km), %d – dominance. Dominant species indicated with bold case, while subdominant are underlined.

Пояснення. n – кількість гніздових пар, d – густина населення (кількість пар на 1 км), %d – домінування. Види-домінанти виділені жирним шрифтом, субдомінанти – підкреслені.

of all species recorded, while subdominant – that comprising 2–4.99%.

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: $H' = -\sum p_i \ln p_i$

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

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

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

● 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;

● 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.

● Sørensen'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 nomenclature of bird species follow Hockey et al. (2005). Scientific names of bird species are listed in Table 1.

Results and discussion

In total 57 breeding resident and six Palearctic migrants have been recorded (Tables 1 and 2). In the pristine Kalahari Woodland the number of species on each 1.2 km transect ranged from 35 to 53 with an average $x = 43$. However, the total number of species recorded on all 10 transects ($n = 88$) was much higher (Kopij, 2017).

There were four dominant species (Cape Turtle Dove, Emerald-spotted Dove, Blue Waxbill and Dark-capped Bulbul) comprising together 30.1% of all breeding birds. In the



The 2.2 km transect (red broken line) on the background of the farmland converted from the Kalahari Woodland. Маршрут довжиною 2,2 км серед сільгоспугідь, трансформованих із лісної місцевості в Калахарі.

Table 2

Number of individuals of Palearctic migrants counted on the transect

Кількість особин палеарктичних мігрантів, облікованих на маршрутах

Species	15.03	15.08	19.10	31.03
<i>Luscinia luscinia</i>	3	0	0	0
<i>Acrocephalus palustris</i>	16	0	0	0
<i>Lanius collurio</i>	9	0	11	0
<i>Hippolais icterina</i>	2	0	0	0
<i>Muscicapa striata</i>	0	0	1	0
<i>Hirundo rustica</i>	0	0	30	0
Total	28	0	42	0



Table 3

Characterisation of breeding bird community in a Kalahari Woodland transformed to farmland

Характеристика населення птахів сільгоспугідь, трансформованих із лісної місцевості в Калахарі.

Parameter	Value
Number of species and pairs	
Number of species	57
Number of breeding pairs	170
Overall population density (pairs/1 km)	77.3
Dominance	
Number of dominant species	4
Cumulative dominance (%)	30.1
Community dominance (DI)	0.19
Indices	
Shannon's Diversity Index (H')	3.64
Simpson's Diversity Index (D)	0.97
Pielou's Evenness Index (J')	0.90
Feeding guilds (%)	
Granivorous	37.1
Insectivorous	36.4
Frugivorous	18.2
Nectarivorous	3.6
Rest	4.7
Nesting guilds (%)	
Trees/shrubs	72.9
Holes	15.9
Herbs/grass	10.6
Ground	0.6

pristine Kalahari Woodland the number of dominant species on each transect ranged from 5 to 7 with an average $x = 3.8$ (Kopij, 2017).

The group of subdominant species was composed of the Grey-backed Camaroptera, Orange-breasted Bush-shrike, Marico Sunbird, White-browed Scrub Robin and Laughing Dove. They comprised together 15.3% of all breeding birds. Diversity and evenness indices were high (Table 3).

Granivorous and insectivorous were the most numerous guilds. They were almost in equal proportion, comprised together 73.5%. In the pristine Kalahari Woodland, insectivorous birds were much more numerous than the granivores (Kopij, 2017).

Most birds nested in the farmland in trees or shrubs, with much smaller proportion of those nesting in holes or in herbaceous/grass vegetation (Table 3). Similar proportions were also recorded in a Kalahari Woodland in a pristine stage (Kopij, 2017).

It is interesting to note that in the farmland, the proportion of Cape Turtle Dove to Laughing Dove was $0.81 : 0.19$ ($n = 26$). In the neighbouring pristine Kalahari Woodland, on 12 km transect, the Laughing Dove was not recorded at all, while the Cape Turtle Dove was a dominant species (Kopij, 2017). However, in the neighbouring urbanized habitat (214 ha), the Laughing Dove ($n = 122$ pairs) was much more numerous than the Cape Turtle Dove ($n = 12$ pairs). It therefore appears that the Laughing Dove is a sensitive bio-indicator of habitat

transformation. More the woodland/savannah habitat is transformed, the more numerous is the Laughing Dove and the less numerous is the Cape Turtle Dove. However, the more natural are those habitats the more numerous is the Cape Turtle Dove, while the Laughing Dove is less numerous (Table 2).

This study supports the «intermediate disturbance hypothesis», which suggest that species richness and species diversity in a given area is the highest when ecological disturbance (e.g. deforestation) is intermediate, i.e. neither too high, nor too low. This is because species that thrive at both early and late stages of vegetation succession may coexist (Wilkinson, 1999). The number of species in the farmland in the presented study was even higher than on transects of similar length in the pristine Kalahari Woodland (Kopij, 2017). The dominance structure was also similar in both habitats compared. However, the avian communities differed only in the proportions of main ecological guilds.

REFERENCES

- Bibby C.J., Burgess N.D., Hill D.A., Mustoe S. (2012): Bird Census Techniques, 2nd ed. Academic Press, London.
- Bolwig S., Pomeroy D., Tushabe H., Mushabe D. (2006): Crops, trees, and birds: Biodiversity change under agricultural intensification in Uganda's farm landscapes. - *Danish J. Geography*. 106 (2): 115-130.
- Gove A.D., Hylander K., Nemomissa S., Shimelis A., Enkossa W. (2013): Structurally complex farms support high avian functional diversity in tropical montane Ethiopia. - *J. Tropical Ecology*. 29 (2): 87-97.
- Hockey P.A.R., Dean W.R.J., Ryan P.G., Maree S. (eds.) (2005): Roberts' Birds of Southern Africa. John Voelcker Bird Book Fund, Cape Town.
- Humble M.F. (2007): The density and diversity of birds on farmland in West Africa. - Ph. D. thesis. Univ. St. Andrews, St. Andrews' (UK).
- Kopij G. (1998): Winter bird community of an intensively farmed area at Bainsvlei near Bloemfontein. - *Mirafr*. 15 (2): 18-21.
- Kopij G. (2006): The Structure of Assemblages and Dietary Relationships in Birds in South African Grasslands. Wyd. Akad. Rolniczej we Wrocławiu, Wrocław.
- Kopij G. (2013): Avian Assemblages in Natural and Modified Koakoland (Mopane) Savanna in the Cuvelai Drainage System, North-Central Namibia. - *Lanioturdus*. 46 (5): 22-33.
- Kopij G. (2015): Seasonal changes in avian communities in a farmland in the Cuvelai Drainage System, northern Namibia. - *Ornithological Observations*. 6: 73-81.
- Kopij G. (2017): Structure of avian assemblages in Zambezi Baikiaea woodlands, northern Namibia. - *Zoology & Ecology*. 27: 1-10.
- Kopij G. (2018): Avian assemblages in lowland and foothill agro-ecosystem in Lesotho. - *Acta Biologica Sibirica*. 4 (4): 81-88.
- Mangnall M.J., Crowe T.M. (2003): The effect of agriculture on farmland bird assemblages on the Agulha Plain, Western Cape, South Africa. - *African J. Ecology*. 41 (3): 266-276.
- Mendesohn J., Jarvis A., Roberts C., Robertson T. (2009): Atlas of Namibia. A Portrait of the Land and its People. Sunbird Publishers, Windhoek.
- Mulwa R.K.M., Bohring-Gaes K., Schleuning M. (2012): High bird species diversity in structurally heterogeneous farmland in western Kenya. - *Biotropica*. 44 (6): 801-809.
- Nadng'ang' a K., Njoroge J.B.M., Githiru M. (2013): Vegetation composition, and structures influence bird species community assemblages in the highland agriculture of Nyandoroua, Kenya. - *Ostrich*. 84 (3): 171-179.
- Sogah S.G. (2012): The effect of difference in agro-ecosystems on the diversity and distribution of avifauna in selected areas in the western regions of Ghana. - M. Sc. thesis. Kwame Nkrumah University of Science & Technology, Kumasi (Ghana).
- Sutherland W.J. (ed.) (1996): Ecological census techniques. A handbook. Cambridge Univ. Press. Cambridge (UK).
- Waltert M., Bobo K.S., Sainge M.S., Fermon H., Muhlenberg M. (2005): From Forest to Farmland: Habitat Effects on Afrotropical Forest Bird Diversity. - *Ecol. Appl.* 15 (4): 1351-1366.
- Wilkinson D.M. (1999): The Disturbing History of Intermediate Disturbance. - *Oikos*. 84 (1): 145-147.