Avian diversity and assemblages around Ruacana Waterfall, north-western Namibia

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Abstract

In 2011-2012, the line transect method was employed to study avian assemblages in the Koakoland (Mopane) Savanna around the Ruacana waterfall in the Kunene Region, north-western Namibia. In total 64 resident species were recorded, a number which was high in comparison with other bushy habitats. Simpson's Diversity Index was also high ($S = 0.96$). Group of dominant species (32.4%) comprised *Streptopelia capicola, Tockus erythrorhynchus, Plocepasser mahali, Pycnonotis nigricans* and *Lanioturdus torquatus*. The following species recorded as resident around Ruacana Waterfall were endemic to Namibia: *Poicephalus rueppellii, Phoeniculus damarensis, Lanioturdus torquatus, Tockus damarensis* and *Parus carpi*. Although the difference between the riparian and dry variety of the Mopane Savanna was insignificant in terms of biodiversity ($S = 0.97$ and $S = 0.92$ respectively), the number of species in dry bush was much lower than in the riparian bush (χ^2-test $= 4.76$; $p < 0.05$). Also the Sörensen similarity coefficient was unexpectedly low between the two habitat varieties ($I = 0.48$).

Keywords: community ecology, avian assemblages, Kunene River, waterfalls.

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1 Introduction

Biodiversity is a keystone concept of nature conservation all over the world. Searching for patterns of biodiversity should be, therefore, a basic aim of conservation biology. In the southern hemisphere, biodiversity constitutes a major wealth of many countries (Wilson 2002). Although Namibia, due to its aridity, has comparatively low species diversity, it has relatively high level of endemicity (Barnard 1998), and in this paper, I report on avian diversity and avian assemblages around the Ruacana Waterfall (Fig. 1), within so called Southwestern Arid Zone of southern Africa, which is recognized as an important endemic area in Africa (Barnard 1998). In particular, I compare species composition, dominance structure and relative abundance of birds resident (breeding) in an area close to the river bank and in the area few km away from the bank.

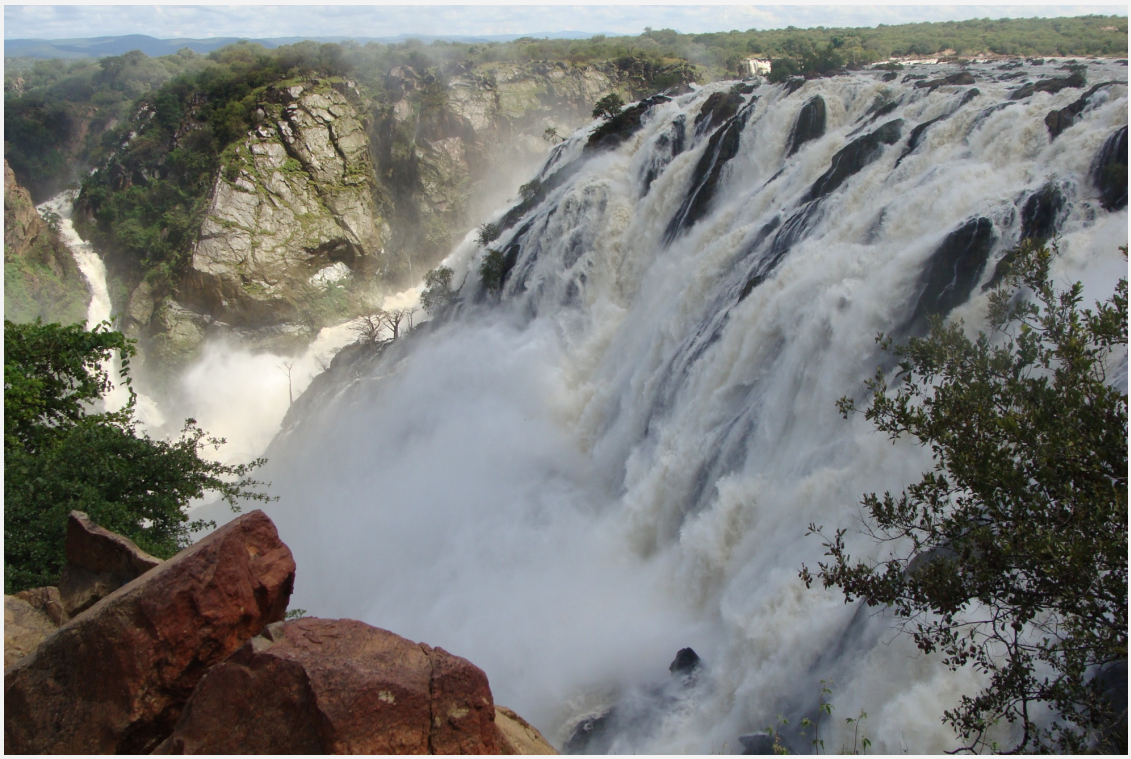

Figure 1: Ruacana Waterfall.

The Epupa-Ruacana stretch of the Kunene River (160 km) is listed as one of 19 important bird areas in Namibia, a priority site for nature conservation (Simmons et al. 2001). Like the Orange River, it forms a linear oasis in the semidesert and desert northern Koakoland. The source of the Kunene River is in Angola and the river enters Namibia through Ruacana Wa-

terfall. In the World Waterfall Database, the waterfall is listed as number 14 of the top 100 waterfalls in the world. Below the waterfall the Kunene River flows on Angolan/Namibian border through a distance of 340 km and joins the Atlantic Ocean in the Northern Namib Desert.

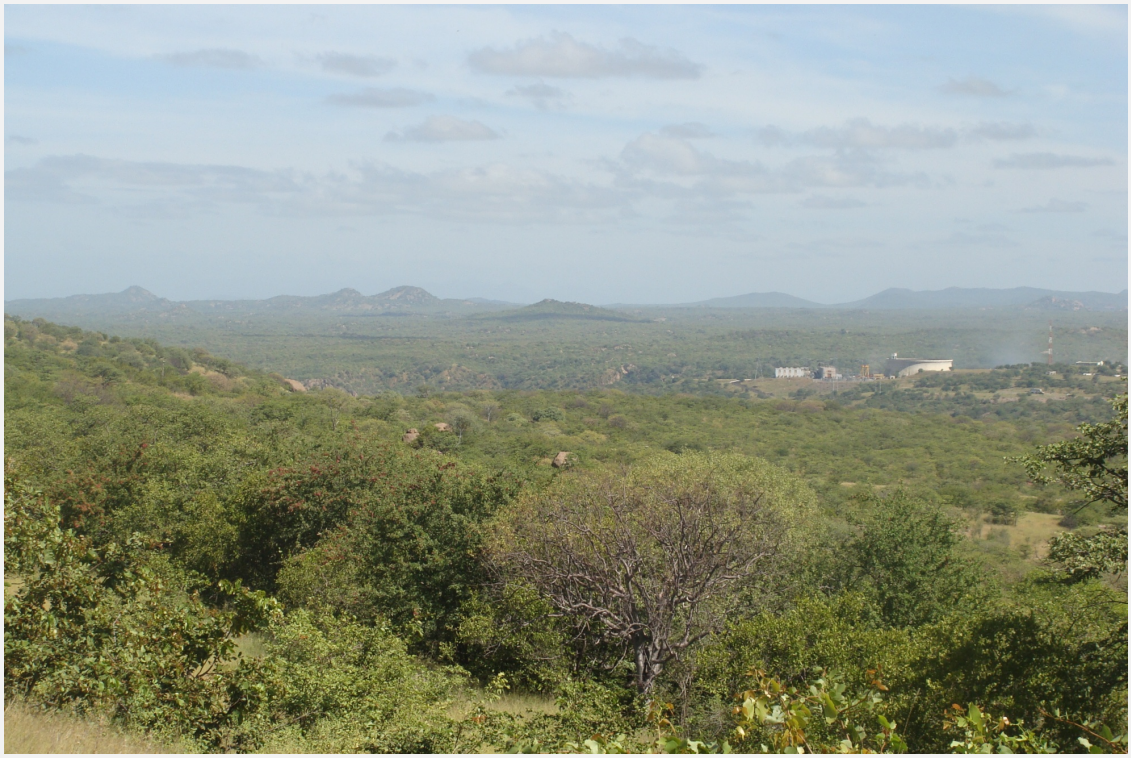

Figure 2: The Western Highland vegetation around Ruacana Waterfall.

Ruacana Waterfall is well-known destination for ecotourism in Namibia. The scenic beauty of the waterfall attracts attention of tourist from all over the world (e.g. Sutherland 1994). Despite the fact that the Ruacana Waterfall was not included as a birding site by Damasius & Marais (1999), it is in fact a well-known birding site (e.g. Sutherland 1994, Simmons et al. 2001). This is mainly due to relatively high level of biodiversity and the occurrence of some endemic species in this area. Over 300 bird species have been recorded in the Ruacana river valley on Namibian side (Braine 1990, Simmon et al. 2001).

However, many of the bird species recorded in Kunene river valley are only visitors to the area or Palearctic migrants. Although some simple checklists of bird species were published (Simmons et al. 2001), to date no attempt was made to quantify any components of this unique wildlife.

2 Study area

Ruacana Waterfall (Fig. 1) is located on the Kunene River in the Koakoland, Kunene Region, north-western Namibia, at S17°23'37", E14°13'01"; 780 m a.s.l. The waterfall is 120 m high and 700 m wide in full flood.

The Hippo Pools (Otjipahuriro) community camp site is situated on the bank of the Kunene River, ca. 4 km below the waterfall. The vegetation in the area around the waterfall is classified as Western Highlands (Mopane Savanna) (Fig. 2), which is a type of Acacia tree-and-shrub Savanna (Giess 1971). The mean annual rainfall is relatively low, i.e. 300-350 mm (Mendelsohn et al. 2009).

The tree and shrub diversity in this biome is relatively high (Mannheimer & Curtis 2009). The following are the more common species: *Acacia nilotica, A. erioloba, A. mellifera, Berchemia discolor, Boscia albitrunca, Colophospermum mopane, Combretum apiculatum, C. collinum, C. imbere, Commiphora glaucescens, C. africana, C. angolensis, C. glanulosa, Catophractes alexandrii, Dichrostachys cinerea, Diospyros mespiliformis, Grewia bicolor, Kirkia acuminata, Rhigozum brevispinosum, Terminalia prunoides*, and *T. sericea*.

The natural vegetation in Kunene region is well-preserved and the land is used almost exclusively (in 2001: 68 224 people, and only 150 km^2 out of 11 5154 km^2 cleared for crops) as a pasture for cattle, sheep, goats and donkeys (in 2000: 255 200, 133 900, 547 400, 11 800 exx. respectively) (Mendelsohn et al. (2009). There is rather low number of wild ungulates, such as kudu *Tragelaphus strepsiceros*, eland *Taurotragus oryx*, springbok *Antidorcas marsupialis*, steenbok *Raphicerus campestris* and common duiker *Sylvicapra grimmia* (Mendelsohn et al. 2002).

The average annual temperature around Ruacana Waterfall is 20-22°C, average minimum temperature during the coldest month is 6-8°C, and average maximum temperature during the hottest month is 34-36°C. The average annual rainfall is 300-350 mm (Mendelsohn et al. 2002).

Studies were conducted in riparian (wet) bush on the river bank (0-0.2 km from the bank) in and just below the Hippo Pool camping, and further high, in drier bush, 4-6 km south-east of the camping site (Table 1).

3 Methods

Studies were carried out during the years 2011-2012. The line transect method in the American version (cf. Bibby et al. 1992, Sutherland 1996, Kopij 2013, 2014) has been employed to quantify the avian community, i.e. the frequency of occurrence, dominance and relative abundance of all resident species.

In total, 7 counts were conducted, one in dry season (01 August 2011) and the remaining in wet season (January-February 2012) (Table 1). Three transects were surveyed in riparian bush and 4 transects in dry bush. The total length of transects in riparian bush was c. 9 km, and in the drier bush also 9 km.

Table 1: Transects and time expenditure around Ruacana Waterfall (RW).

No.	Habitat	Co-ordinates	Length [km]	Count date	Count time
A	Riparian bush, below RW	S18.16.34/E13.46.36	c. 4	01.08.2011	16.30-18.30
B	Riparian bush, below RW	S18.16.34/E13.46.36	c. 3	22.01.2012	16.30-18.00
C	Riparian bush, below RW	S18.16.34/E13.46.36	c. 2	23.01.2012	06.30-07.30
D	Dry bush, 6 km SE of RW	S17.23.69/E14.14.49// S17.23.69/E14.14.49	c. 1.5	24.01.2012	10.00-10.40
E	Dry bush, 6 km SE of RW	S17.23.69/E14.14.49// S17.23.69/E14.14.49	c. 2	11.02.2012	06.40-07.20
F	Dry bush, along a road downhill to RW	S17.23.70/E14.14.56// S17.24.30/E14.15.75	c. 3.5	11.02.2012	07.20-09.00
G	Dry bush, along the pipe uphill from RW	S17.24.40/E14.15.79// S17.24.48/E14.14.85	c. 2	11.02.2012	09.00-09.50

Counts were conducted in the mornings from c. 7 a.m. till c. 10 a.m. by walking slowly and recording all seen and heard birds. Observations were aided with 10 × 50 binoculars. Roberts' Bird Guide (Chittenden 2007) was helpful in identification of some uncommon species.

The following parameters were used to describe the avian assemblages:

1. species diversity (N-number 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 ($N = 7$ transects) of transects surveyed;

3. $\%N$ - dominance expressed as the proportion of resident pairs of a given species to the total number of all breeding pairs of all species recorded, expressed as a percentage.

Simpson's Diversity Index (D) was used to calculate diversity of avian assemblages:

$$D = 1 - \sum \left(\frac{n}{N}\right)^2,$$

where:
n - total number of pairs of particular bird species;
N - total number of pairs of all bird species; and
if $D = 0$ there is no diversity, while there is infinite diversity if $D = 1$.

Sörensen's Coefficient, I, was used to compare diversity of avian assemblages:

$$I = \frac{2C}{A+B}$$

such that
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 areas.

Singing male, an individual showing territorial or breeding behavior (breeding display, nest-building, food-transportation) or an occupied nest (with eggs or chicks) were regarded as a breeding pair, which constituted a census unit in this study.

Dominant species is defined here as comprising at least 5% of the total number of all breeding pairs; while subdominant that comprising 2.0-4.9% of that total.

Differences in the number of species between particular habitats were tested with χ^2- test. The nomenclature of bird species follows that of Hockey et al. (2005).

4 Results

In total, 64 resident bird species were recorded in Ruacana Waterfall area, and the overall Simpson's Diversity Index was very high ($S = 0.96$).

The dominant group comprising 32.4% was composed of five species: Cape Turtle-Dove *Streptopelia capicola*, Red-billed Hornbill *Tockus erythrorhynchus*, White-crowned Sparrow-weaver *Plocepasser mahali*, Red-eyed Bulbul *Pycnonotis nigricans* and White-tailed Shrike *Lanioturdus torquatus*.

The following species were identified as subdominants: African Darter *Anhinga rufa*, African Palm Swift *Cypsiurus parvus*, Blue Waxbill *Uraeginthus angolensis*, Fork-tailed Drongo *Dicrurus adsimilis*, Grey Hornbill *Tockus nasutus*, Grey-headed Sparrow *Passer diffusus*, Red-billed Spurfowl *Pternistes adspersus*, Swamp Boubou *Laniarius bicolor*, White-bellied Sunbird *Cinnyris talatala*, and Yellow-bellied Bulbul *Chlorocichla flaviventris*. They comprised together 26.2%. Altogether, the dominant and subdominant species comprised, therefore, 58.6% of all breeding pairs recorded.

Although the difference between the riparian and dry variety of the Mopane Savanna was insignificant in terms of biodiversity ($S = 0.97$ and $S = 0.92$ respectively), the number of species in dry bush was much lower than that in the riparian bush (χ^2-test $= 4.76$; $p < 0.05$). Also the Sörensen similarity coefficient was unexpectedly low between the two habitat varieties ($I = 0.48$). Beside typical waterbirds, such as Three-banded Plover *Charadrius tricollaris*, Pied Kingfisher *Ceryle rudis*, Giant Kingfisher *Megaceryle maxima* and African Pied Wagtail *Motacilla aguimp*, few other species were recorded only in the riparian bush, namely Red-billed Spurfowl *Pternistes adspersus*, African Hoopoe *Upupa africana*, Mourning Dove *Streptopelia decipiens*, Grey Lorie *Corythaixoides concolor*, African Palm Swift *Cypsiurus parvus*, and Swamp Boubou *Laniarius bicolor*. The following species appear to be much common in dry than in wet variety of the Western Highland vegetation: Cape Turtle-Dove *Streptopelia capicola*, Grey Hornbill *Tockus nasutus*, Red-billed Hornbill *Tockus erythrorhynchus*, Sparrow-weaver *Pocepasser mahali*, White-bellied Sunbird *Cinnyris talatala*, Common Scimitarbill *Rhinopomastus cyanomelas* and Rüpppell's Parrot *Poicephalus ruepelli*. Interestingly, the White-tailed Shrike *Lanioturdus torquatus* was recorded only in the dry bush, while the ubiquitous Laughing Dove *Streptopelia senegalensis* - only in the riparian bush, which represented slightly disturbed environment.

Table 2: Number of potentially breeding pairs on transects in the Western Highland vegetation in the Ruacana Waterfall area. *A-G* - particular transects (with numbers of potentially breeding pairs), *N* - total number of pairs, *%D* - dominance, *F* - number of transects where species was recorded, *%F* - frequency of occurrence on transects. Dominant species are indicated with bold case.

Species	Riparian bush					Dry bush						Total			
	A	*B*	*C*	*N*	*%D*	*D*	*E*	*F*	*G*	*N*	*%D*	*N*	*%D*	*F*	*%F*
African Darter	4			4	3.8			7		7	4.7	11	4.3	2	29
African Golden Oriole			2	2	1.9			2		2	1.4	4	1.6	2	29
African Hoopoe	3	1		**4**	3.8					0	0.0	4	1.6	2	29
African Palm Swift	7			**7**	6.6					0	0.0	7	2.8	1	14
African Pied Barbet				0	0.0				1	1	0.7	1	0.4	1	14
Black-backed Puffback	1			1	0.9					0	0.0	1	0.4	1	14
Blue Waxbill	4			4	3.8	2		1	2	5	3.4	9	3.5	4	57
Bradfield's Hornbill				0	0.0	2				2	1.4	2	0.8	1	14
Brubru			1	1	0.9					0	0.0	1	0.4	1	14
Burchell's Starling	1			1	0.9			1		1	0.7	2	0.8	2	29
Cape Reed Warbler	1			1	0.9					0	0.0	1	0.4	1	14
Cape Turtle-Dove	1	1	1	**3**	**2.8**	**1**	**1**	**6**	**4**	**12**	**8.1**	15	5.9	7	100
Cardinal Woodpecker				07	0.0			1		1	0.7	1	0.4	1	14
Carp's Tit				0	0.0			1	2	3	2.0	3	1.2	2	29
Cinderella Waxbill				0	0.0			1		1	0.7	1	0.4	1	14
Cinnamon-breasted Bunting	1			1	0.9					0	0.0	1	0.4	1	14
Damara Hornbill	1			1	0.9					0	0.0	1	0.4	1	14
Diederick Cuckoo		1		1	0.9					0	0.0	1	0.4	1	14
Emerald-spotted Dove	1	1		2	1.9	1				1	0.7	3	1.2	3	43
Familiar Chat	1			1	0.9					0	0.0	1	0.4	1	14
Fork-tailed Drongo	4	1		**5**	**4.7**				**1**	**1**	**0.7**	6	2.4	3	43
Giant Kingfisher	1	1		2	1.9					0	0.0	2	0.8	2	29
Golden-breasted Bunting				0	0.0	1	1			2	1.4	2	0.8	2	29
Greater Striped Swallow	2			2	1.9					0	0.0	2	0.8	1	14
Grey Hornbill		1		**1**	**0.9**			**3**	**1**	**4**	2.7	5	2.0	3	43
Grey Lorie	2	1		**3**	2.8					0	0.0	3	1.2	2	29
Grey-headed Kingfisher		1		1	0.9					0	0.0	1	0.4	1	14
Grey-headed Sparrow	1	1	2	4	3.8	1		1		2	1.4	6	2.4	5	71
Ground Thrush	1			1	0.9			1	1	2	1.4	3	1.2	3	43
Hamerkop	1			1	0.9					0	0.0	1	0.4	1	14
Helmeted Guineafowl	1			1	0.9					0	0.0	1	0.4	1	14
Laughing Dove	2	1	1	**4**	3.8					0	0.0	4	1.6	3	43
Little Bee-eater	1		1	2	1.9					0	0.0	2	0.8	2	29
Little Swift			1	1	0.9					0	0.0	1	0.4	1	14
Long-billed Crombec				0	0.0	1			1	2	1.4	2	0.8	2	29
Long-tailed Starling		1		1	0.9					0	0.0	1	0.4	1	14
Monteiro's Hornbill				0	0.0	1				1	0.7	1	0.4	1	14
Mourning Dove	1		1	**2**	1.9					0	0.0	2	0.8	2	29
Orange River Francolin				0	0.0	2	1		1	4	2.7	4	1.6	3	43
Pale-winged Starling	1			1	0.9					0	0.0	1	0.4	1	14
Paradise Flycatcher		1		1	0.9				2	2	1.4	3	1.2	2	29
Pear-spotted Owlet		1		1	0.9					0	0.0	1	0.4	1	14
Pied Kingfisher	2	1		**3**	2.8					0	0.0	3	1.2	2	29
Pied Wagtail		1		1	0.9					0	0.0	1	0.4	1	14
Red-billed Firefinch	1			1	0.9					0	0.0	17	0.4	1	14
Red-billed Hornbill	2		1	**3**	**2.8**		**1**	**10**	**4**	**15**	10.1	18	7.1	5	71
Red-billed Spurfowl	4	2		6	5.7					0	0.0	6	2.4	2	29
Red-eyed Bulbul	2			**2**	**1.9**		**3**	**7**	**2**	**12**	8.1	14	5.5	4	57
Rüpppell's Parrot	1			1	0.9			2	1	**3**	2.0	4	1.6	3	43
Scimitar-billed Wood-Hoopoe				0	0.0	1		1	1	**3**	2.0	3	1.2	3	43
Southern Masked Weaver	2			2	1.9					0	0.0	2	0.8	1	14
Sparrow-Weaver	3		1	**4**	**3.8**	**3**	**6**	**7**	**7**	**23**	15.5	27	10.6	6	86
Striped Cuckoo	1			1	0.9					0	0.0	1	0.4	1	14
Swamp Boubou	3	1	1	**5**	4.7					0	0.0	5	2.0	3	43
Tchagra sp.			1	1	0.9					0	0.0	1	0.4	1	14
Three-banded Plover	1			1	0.9					0	0.0	1	0.4	1	14
Water Dikkop			1	1	0.9					0	0.0	1	0.4	1	14
White-breasted Sunbird	1			1	0.9		1		4	5	3.4	6	2.4	3	43
White-crested Helmet-Shrike				0	0.0			1		1	0.7	1	0.4	1	14
White-crowned Shrike	2			2	1.9		1			1	0.7	3	1.2	2	29
White-tailed Shrike				0	0.0	5	5	8	5	**23**	15.5	23	9.1	4	57
Yellow-bellied Bulbul		1		1	0.9			2	2	**4**	2.7	5	2.0	3	43
Yellow-billed Oxpecker			1	1	0.9		1			1	0.7	2	0.8	2	29
Yellow-breasted Apalis			1	1	0.9			1		1	0.7	2	0.8	2	29
Total number of species	37	19	15	**52**		12	10	20	18	**32**		64			
Total number of pairs	69	20	17	106		21	21	64	42	148		254			
Simpson's Diversity Index	0.96	0.95	0.93	0.97		0.88	0.83	0.91	0.91	0.92		0.96			

5 Discussion

Among dominant species recorded around Ruacana the Red-eyed Bulbul, White-browed Sparrow-Weaver and Cape Turtle-Dove are often reported as such in many other areas in southern Africa (Kopij 2006). However, the Red-billed Hornbill and White-tailed Shrike are not known to be dominant species in any other vegetation type in this subcontinent (Hockey et al. 2005; Kopij 2006, 2013, 2014).

Contrary to expectation, the Laughing Dove was recorded only in the riparian bush, being virtually absent from dry bush. It was probably because the riparian bush represented disturbed environment, which is highly preferred by the Laughing Dove (Hockey et al. 2005). On the other hand the White-tailed Shrike appears to avoid such disturbed environment.

The following species recorded as resident around the Ruacana Waterfall are endemic to Namibia: Rüppell's Parrot, Violet Wood-Hoopoe *Phoeniculus damarensis*, White-tailed Shrike, Damara Hornbill *Tockus damarensis*, Carp's Tit *Parus carpi*. Two other so called near-endemics: Bare-cheeked Babbler *Turdoides gymnogenys*, and Herero Chat *Namibornis herero*, were recorded in the Kunene River Valley by Harrison et al. (1997). Certain tree species, such as *Colophospermum mopane* and *Commiphora* spp. which occur only in this savanna type (Mannheimer & Curtis 2009) may play an important role as source of food (mainly fruits, seeds) for these species.

Furthermore there were few species which in Namibia occur in Kunene River Valley only, and again they can be find more than 1000 km away in the Okavango and Zambezi river Valleys. The following species belong to this group: Bradfield's Hornbill *Tockus bradfieldi*, Swamp Boubou, Speckled Weaver *Ploceus ocularis*, Grey-headed Bush-Shrike *Malacontus blanchoti*, Meve's Starling *Lamprotornis mevesii*. Few other species from this group were recorded in the Kunene River Valley by Harrison et al. (1997): Hartlaub's Babbler T*urdoides hartlaubi*, Jameson's Firefinch *Lagonosticta rhodopereia*, Ashy Flycatcher *Muscicapa carulescens*, Purple Indigobird *Vidua purpurascens*, Terrestrial Bulbul *Phyllastrephus terrestris*, Grey-rumped Swallow *Pseudhirundo griseopyga*. It is, however, not sure whether they were also recorded around Ruacana Waterfall. Species belonging to this group reach southern limits of their geographical range in Namibia (Kunene River valley). They extend further south only in the eastern part of southern Africa (Hockey et al. 2005), as for their occurrence the presence of permanent rivers is indispensible.

Two species occur nowhere else in southern Africa, except for the Ruacana Waterfall area and along the Kunene River: Rufous-tailed Palm-Thrush *Cichladusa ruficauda* and Cinderella Waxbill. The latter species together with the Heroro Chat can be regarded as key species in the whole Koakoland. Both species reach in Namibia the southern limits of its geographical range in Africa.

Figure 3: The Pearl-spotted Owlet.

Two other species the Pearl-spotted Owlet *Glaucidium perlatum* (Figure 3) and the Yellow-billed Oxpecker *Buphagus africanus* (Figure 4) can be considered as faunistic peculiarities in this area. The later species is known as feeding on ticks parasiting some domestic and wild ungulates (Figure 4) are of special interest in this area. The later species is known as feeding on ticks parasiting some domestic and wild ungulates which are abundant in the Kunene Region (Mendelsohn et al. 2009). The Yellow-billed Oxpecker is also included in the Red Data Book as an endangered species, and therefore require very special attention of conservationists.

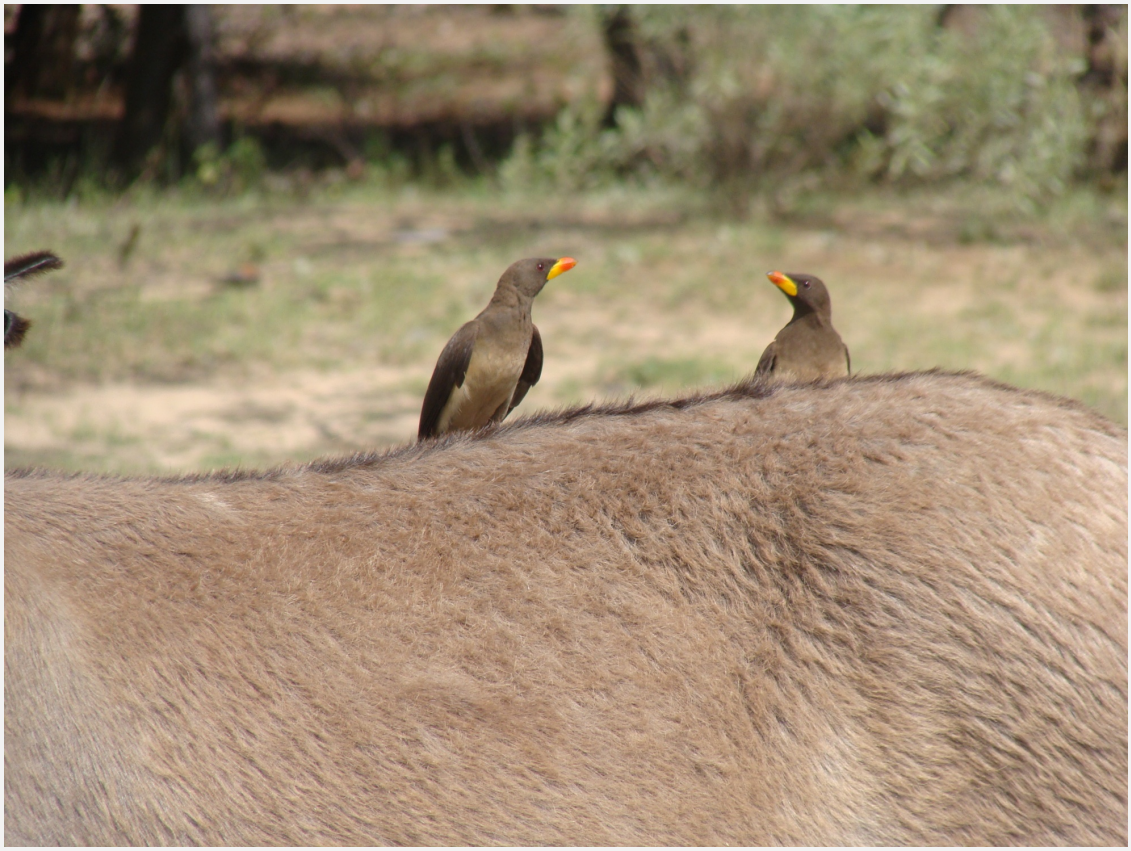

Figure 4: The endangered species - Yellow-billed Oxpecker feeding on ticks attached to donkey's skin.

The Pearl-spotted Owl is very difficult to find and to observe, but since it has nested in the Hippo Pools camping site, this made any observations much easier to conduct.

The number of resident species recorded around Ruacana Waterfall ($n = 64$) is relatively high. The quantitative data on avian assemblages in the savanna biome in Namibia, as well as in other African countries are scanty. In South African grasslands in 12 habitats investigated,

the number ranged from 33 to 75, with the mean value being at $\chi^2 = 46.7(sd = 11.7)$ (Kopij 2006). In Koakoland (Mopane) Savanna in Ogongo Game Reserve, Omusati Region, in the dry season - 35, in wet season - 46 species (Kopij 2013), therefore numbers lower than those recorded around Ruacana Waterfall. In urbanized and rural habitats in the Cuvelai Drainage System, north-central Namibia, numbers of resident species were even lower, ranging from 6 to 34 ($\chi^2 = 20.2, n = 16$), with Simpson's diversity index ranging from 0.61 to 0.89 (Kopij 2014). Even in Ruacana town, located only c. 20 km from the waterfall, only 27 species were recorded, and Simpson's Diversity Index was $S = 0.93$ (Kopij 2014).

In conclusion, it should be pointed out that the bird life around Ruacana Waterfall represents relatively high diversity and endemicity. Both the diversity and the structure of assemblages changes gradually in relation to the distance from the permanent water course. The study shows that Ruacana Waterfall and the area around it is not only important as ecotourist destination for its scenic beauty, but also birdlife in this area is diverse and unique to certain extend. It is, therefore, fully justified to protect the area in the form of a nature reserve, or even, together with the whole Kunene Valley, as a national park.

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