

A note on the bird diversity at two sites in Khartoum, Sudan

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ABSTRACT

The diversity of bird species is expected to vary with habitat type even at the smallest spatial scales. In this paper, we describe a preliminary survey conducted for the avifauna at two locations in Khartoum city, namely, Sunut forest and Tuti Island. The ecology of both sites is influenced by their proximity to the Nile River and thus they are characterized by dense vegetation cover. Moreover, the two sites lie very close to each other, implying that the climatic conditions are virtually identical. However, the two sites differ with respect to one major environmental respect, that is, the intensity of human influence. Tuti Island represents a man-made habitat and the vegetation at the site is mainly agricultural. On the other side, Sunut forest is a natural habitat and the vegetation cover at the site is dominated by the wild *Acacia nilotica* trees. The goal of the study is to compare the bird composition between the two sites in order to assess the effect of habitat type on the spatial variation in the abundance and diversity of birds. Overall, forty one species were recorded at the two sites during a five-month period: twenty four species at Sunut forest and thirty species at Tuti Island. Statistical investigation of avian diversity using Shannon index has detected a significant difference between the two sites, most likely due to variable human impact.

Keywords: Urban avifauna, biodiversity, spatial variation, Sunut forest, Tuti Island, Shannon index.

INTRODUCTION

Urbanization has substantial and multiple influences on biological communities. Among vertebrates, these influences have been most thoroughly investigated in birds as they are extremely abundant and easily observable group. The avian community composition was found to change considerably within city limits (e.g. Emlen, 1974; Askins *et al.*, 1990; Bock *et al.*, 2001). Urbanization favours special life styles among birds; the omnivorous, granivorous, and cavity nesting species were found to be more represented within urbanization spots than at the surrounding regions that belong to the same habitat. Exotic species are also favoured by urbanization (e.g. house sparrow and European starling). Likewise, fragmentation of natural forests through agricultural activities and suburban development significantly affects the bird communities, as is documented by several studies. As a general trend, increased urbanization leads to an increase in avian biomass but a reduction in species richness. The major factor that underlies the urbanization effect on avifauna is the vegetation cover. Birds respond to both vegetation density and composition. Supporting this, urban areas that retain native vegetative characteristics retain more native species than those that do not (Scott Mills *et al.*, 1989; Marzluff, 1997).

Al-Sunut is a natural forest which borders the White Nile at the Mogran area, Khartoum (Figure 1). Sunut forest is a unique biotope; a poor savannah habitat impeded in the semi desert background of Northern Sudan (Shawki & Musnad, 1964).

As a consequence, the forest is characterized by high density of plant cover, mainly composed of *Acacia nilotica* trees (Mohamed, 1986; Ahmed, 1998). Moreover, it represents a hot spot of bird and invertebrate diversity; it has been estimated that the forest contains at least 70 bird species (among which 26 are migrants) together with a diverse invertebrate community (Cloudsely-Thompson, 1964; Nikolaus, 1987; Elobeid, 1990; Lado, 1994; Abd-Alrahman, 1998). The major environmental factor which underlies the unusual biodiversity at Sunut forest is the annual floods of the Nile River, which supplies the site with immense amounts of water and nutrient-rich sediments. Thus, the Sunut forest is considered as an inland wetland ecosystem (Altayeb & Hamed, 2003).

Tuti Island lies at the union of the Blue Nile with the White Nile, where they form the main River Nile (Figure 2). It is surrounded by three towns: Khartoum, Omdurman, and Khartoum north (Bahri). Omdurman city lies on the western bank of the island; Bahri on the Eastern side, While Khartoum faces the southern bank of the island. Tuti is the home of one small village founded in the late 15th century, with grassland being the main makeup of the island. In the past, the only approach to Tuti Island was via several ferries that cross the river regularly, but now the Tuti Bridge, a modern suspension bridge, has been completed and it is used instead. Tuti Island contains large agricultural areas all around it and is considered as a major source of fruits and vegetables for Khartoum's population. The annual flooding of the Nile frequently submerges the south-eastern part of the island (Salah Eldin, 1997).

In this study, a preliminary survey has been conducted for the avifauna at Sunut Forest and Tuti Island during the period of October-March 2011-2012. The avian diversity at the two sites was compared statistically. The differences in bird species composition between agricultural and wild habitats were discussed in the light of the field data obtained at the two sites.

MATERIAL AND METHODS

Study sites

This study was carried out at two locations in Khartoum city: Sunut forest (15°35'N, 32°30'E) (Fig. 1) and Tuti Island (15°37'N, 32°31'E) (Fig. 2).

Climate

The climate of Khartoum is tropical desert. There are three seasons per year, cool winter, dry summer and a rainy season. Highest temperatures (45°C or more) are recorded in summer months (May-June) while lowest temperatures (22°C or less) are recorded during winter months (December-January). The average rainfall is about 150 mm per annum. Nile flooding takes place during the rainy season (July-October) and affects both sites.

Investigation of bird diversity

The survey was conducted between October 2011 to March 2012. Assessment of avifauna was based on bird observation. General observations were carried out by using a binocular (7x50) at least once a week for two study sites. Observations were carried out in different areas within the two studied sites. Species were identified by sight, using the field identification guide by Sinclair and Ryan (2003). Photographs of birds were taken by digital camera (Sony, 14.1 Mega pixels) whenever possible.

Statistical analysis

The species richness (R) was determined as the total number of bird species at each site. The Shannon diversity index was applied to compare the avian diversity (H') and species evenness (E) between the two sites. Species diversity was estimated according to the following equation:

$$H' = - \sum_{i=1}^R p_i \ln p_i$$

Where:

p_i = relative abundance of species "i".

R = total number of species.

H' = the Shannon Diversity Index.

Species evenness (equality) was calculated according the following formula:

$$E = H' / H_{\max} = H' / \ln R$$

Where:

E = species evenness.

H' = the Shannon Diversity Index.

H_{\max} = the value of H' if individuals in the community were completely evenly distributed.

R = total number of species.

RESULTS

Temporal changes

The variations in the species composition that were observed between different months were shown in the Tables (1 & 2). Both Sunut forest and Tuti Island have experienced considerable significant temporal variations in bird diversity and abundance. A comparison of the total abundance of individuals between Sunut forest and Tuti Island during the five months of study was presented in Table (3).

Table 1: Temporal variation in bird species composition at Sunut forest during the period of October-March, 2011-2012.

Common name	Scientific name	OCT.	NOV.	DEC.	FEB.	MAR.	Total
Grey Heron	<i>Ardea cinerea</i>	3	1	2	1	16	23
Black-Headed Heron	<i>Ardea melanocephala</i>	1	2	52	15	9	79
Little Egret	<i>Egretta garzetta</i>	23	28	33	62	90	236
Cattle Egret	<i>Bubulcus ibis</i>	25	24	70	20	29	168
Greater Flamingo	<i>Phoenicopterus roseus</i>	75	119	40	25	16	275
Pink-backed Pelican	<i>Pelecanus rufescens</i>	6	3	2	4	8	23
White-faced Duck	<i>Dendrocygna viduata</i>	0	0	2	2	2	6
Garganey	<i>Anas querquedula</i>	0	0	3	2	2	7
Black Kite	<i>Milvus migrans</i>	4	4	2	2	0	12
Senegal Thick-knee	<i>Burhinus senegalensis</i>	0	7	5	4	2	18
Little Ringed Plover	<i>Charadrius dubius</i>	13	14	8	2	1	38
Spur-winged Plover	<i>Vanellus spinosus</i>	19	15	9	4	0	47
Common Snipe	<i>Gallinago gallinago</i>	0	1	2	2	1	6
Black-winged Stilt	<i>Himantopus himantopus</i>	4	2	2	2	0	10
Black-tailed Godwit	<i>Limosa limosa</i>	6	5	4	5	7	27
Bar-Tailed Godwit	<i>Limosa lapponica</i>	10	6	2	1	1	20
Dunlin	<i>Calidris alpina</i>	6	6	2	2	0	16
Common Greenshank	<i>Tringa nebularia</i>	0	0	6	4	3	13
White-winged Tern	<i>Chlidonias leucopterus</i>	9	5	1	1	0	16
Pied Kingfisher	<i>Ceryle rudis</i>	6	1	1	1	1	10
Crested Lark	<i>Galerida cristata</i>	44	15	13	5	1	78
White Wagtail	<i>Motacilla alba</i>	1	2	2	2	1	8
Yellow Wagtail	<i>Motacilla flava</i>	4	5	3	4	4	20
House Sparrow	<i>Passer domesticus</i>	25	18	15	9	8	75
Total		282	283	281	181	202	1231

Table 2: Temporal variation in bird species composition at Tuti Island during the period of October-march, 2011-2012.

Common name	Scientific name	OCT.	NOV.	DEC.	FEB.	MAR.	TOTAL
Little Egret	<i>Egretta garzetta</i>	3	4	2	9	2	20
Cattle Egret	<i>Bubulucus ibis</i>	5	9	5	27	3	49
Black kite	<i>Milvus migrans</i>	11	2	4	0	3	20
Little Ringed Plover	<i>Charadrius dubius</i>	6	4	1	2	0	13
Spur-winged Plover	<i>Vanellus spinosus</i>	6	0	1	1	1	9
Green Sandpiper	<i>Tringa ochropus</i>	3	4	0	0	0	7
Dunlin	<i>Calidris alpine</i>	3	4	3	2	0	12
Mourning Collared Dove	<i>Streptopelia decipiens</i>	11	8	10	3	3	35
Laughing Dove	<i>Spilopelia senegalensis</i>	25	23	18	31	22	119
Namaqua Dove	<i>Oena capensis</i>	3	0	0	0	0	3
Rose-ringed parakeet	<i>Psittacula krameri</i>	7	4	4	3	4	22
Senegal Coucal	<i>Centropus senegalensis</i>	3	4	1	2	2	12
Common swift	<i>Apus apus</i>	5	4	0	0	0	9
Blue-naped Mousebird	<i>Urocolius macrourus</i>	3	4	4	2	2	15
Pied Kingfisher	<i>Ceryle rudis</i>	1	1	1	1	1	5
Eurasian Hoopoe	<i>Upupa epops</i>	1	0	0	0	0	1
Little Bee-eater	<i>Merops pusillus</i>	4	4	7	9	15	39
Crested Lark	<i>Galerida cristata</i>	752	980	997	1010	990	4729
Barn Swallow	<i>Hirundo rustica</i>	4	4	0	1	1	10
White-headed Babbler	<i>Turdoides leucocephala</i>	9	7	2	0	0	18
White Wagtail	<i>Motacilla alba</i>	2	2	3	2	1	10
Yellow Wagtail	<i>Motacilla flava</i>	2	2	2	1	2	9
Black Scrub Robin	<i>Cercotrichas podobe</i>	1	0	0	0	0	1
Common Bulbul	<i>Pycnonotus barbatus</i>	7	5	2	2	1	17
Lesser Grey Shrike	<i>Lanius minor</i>	2	3	3	2	1	11
House Sparrow	<i>Passer domesticus</i>	75	130	98	137	99	539
Greater Blue-eared Starling	<i>Lamprotornis chalybaeus</i>	15	0	0	0	0	15
African Silverbill	<i>Lonchura cantans</i>	2	0	0	0	0	2
Red-billed Firefinch	<i>Lagonosticta senegala</i>	2	2	2	1	2	9
Blue-billed Firefinch	<i>Lagonosticta rubricata</i>	2	1	1	1	1	6
TOTAL		975	1215	1171	1249	1156	5766

Table 3: Temporal variation in bird abundance at the study sites.

Month	TA* at Sunut forest	TA* at Tuti Island	TOTAL
Oct.	284	975	1259
Nov.	283	1215	1498
Dec.	281	1171	1452
Feb.	181	1249	1430
Mar.	202	1156	1358
TOTAL	1231	5766	6997

* TA= Total abundance

Spatial variations

Variations in the bird composition between the two sites of the study were shown in Table (4).

The avian diversity

The avian diversity at each site was calculated according to Shannon diversity index (Table 5). The species richness (R value) for Tuti was higher than that of Sunut forest (i.e. 30 & 24, respectively). The value of Shannon index (H') was lower at Tuti than that at Sunut forest (i.e. 1.5 & 2.33, respectively). The species evenness (E value) was lower at Tuti than that at Sunut forest (i.e. 0.44 & 0.73, respectively).

Table 4: Comparison of bird abundance between Sunut forest and Tuti Island.

No.	Species	TA at Tuti Island	TA at Sunut Forest	Total	No.	Species	TA at Tuti Island	TA at Sunut forest	Total
1	Grey Heron	0	23	23	22	Laughing Dove	94	0	94
2	Black-headed Heron	0	79	79	23	Namaqua Dove	1	0	1
3	Little Egret	17	236	253	24	Rose-ringed parakeet	15	0	15
4	Cattle Egret	44	168	212	25	Senegal Coucal	9	0	9
5	Greater Flamingo	0	275	275	26	Common swift	4	0	4
6	Pink-backed Pelican	0	23	23	27	Blue-naped Mouse-bird	12	0	12
7	White-faced Duck	0	6	6	28	Pied Kingfisher	4	10	14
8	Garganey	0	7	7	29	Eurasian Hoopoe	1	0	1
9	Black kite	9	12	21	30	Little Bee-eater	35	0	35
10	Senegal Thick-knee	0	18	18	31	Crested Lark	3977	78	4055
11	Little- ringed Plover	3	38	41	32	Barn Swallow	6	0	6
12	Spur-winged Plover	3	47	50	33	White-headed Babbler	9	0	9
13	Common Snipe	0	6	6	34	White Wagtail	8	8	16
14	Black-winged Stilt	0	10	10	35	Yellow Wagtail	7	20	27
15	Black-tailed Godwit	0	27	27	36	Black Scrub Robin	1	0	1
16	Bar-tailed Godwit	0	20	20	37	Common Bulbul	10	0	10
17	Green Sandpiper	4	0	4	38	Lesser Grey Shrike	9	0	9
18	Dunlin	9	16	25	39	House Sparrow	464	75	539
19	Green Shank	0	13	13	40	Greater Blue-eared Starling	11	0	11
20	White-winged Tern	0	16	16	41	African Silverbill	1	0	1
21	Mourning Collared Dove	24	0	24		TOTAL	4791	1216	6007

* TA= Total abundance.

Table 5: Comparison of bird diversity between Sunut forest and Tuti Island.

No.	Species	RA at Tuti island	RA at Sunut forest	No.	Species	RA at Tuti island	RA at Sunut forest
1	Grey Heron	---	0.01	22	Laughing Dove	0.02	--
2	Black-headed Heron	---	0.07	23	Namaqua Dove	0.001	---
3	Little Egret	0.003	0.19	24	Rose-ringed parakeet	0.004	----
4	Cattle Egret	0.008	0.14	25	Senegal Coucal	0.002	---
5	Greater Flamingo	---	0.23	26	Common swift	0.002	---
6	Pink-backed Pelican	---	0.02	27	Blue-naped Mousebird	0.003	---
7	White-faced Duck	---	0.01	28	Pied Kingfisher	0.001	0.01
8	Garganey	---	0.01	29	Eurasian Hoopoe	0.0007	---
9	Black kite	0.003	0.01	30	Little Bee-eater	0.007	---
10	Senegal Thick-knee	---	0.01	31	Crested Lark	0.82	0.06
11	Little-ringed Plover	0.002	0.03	32	Barn Swallow	0.002	---
12	Spur-winged Plover	0.002	0.04	33	White-headed Babbler	0.003	---
13	Common Snipe	---	0.01	34	White Wagtail	0.002	0.01
14	Black-winged Stilt	---	0.01	35	Yellow Wagtail	0.002	0.02
15	Black-tailed Godwit	---	0.02	36	Black Scrub Robin	0.0007	---
16	Bar-tailed Godwit	---	0.02	37	Common Bulbul	0.003	---
17	Green Sandpiper	0.001	-----	38	Lesser Grey Shrike	0.002	---
18	Dunlin	0.002	0.01	39	House Sparrow	0.09	0.067
19	Green Shank	---	0.01	40	Greater Blue-eared Starling	0.003	0
20	White-winged Tern	---	0.01	41	African Silverbill	0.0003	0
21	Mourning Collared Dove	0.006	---				

* RA= Relative abundance.

DISCUSSION

At Sunut forest and Tuti Island, both the density and species composition of birds were found to vary with months. The temporal variation in bird community structure could be attributed to two different factors: first, bird migrational patterns; during the period of observation, some migrating birds (local and palaeartic migrants) arrive at the study sites, using them as breeding grounds or as stopover sites for food supply. The seasonal movements of migrational birds to and from the study sites are likely to exert deep influence on the avifauna composition. The second factor that underlies the temporal variation is the cyclic changes in plant cover and insect density that are induced by the seasonal cycle of water availability. These changes

affect food availability and thus the attractiveness of the sites for the different species of birds.

In this study, the abundance and diversity of bird species has been compared between two sites at Khartoum that are, Tuti Island and Sunut forest. The two sites are characterized by extremely similar climate, since they are separated only by few kilometers. Moreover, the plant cover and the seasonal variation at both sites are deeply influenced by the annual flooding of the Nile River, since they are partially submerged during the autumn months. Unlike the surrounding arid region, water is available throughout the year, due to the proximity to the Nile. In addition, The Nile flooding supplies both sites with immense amounts of nutrient-rich sediments. As a consequence, the habitat quality and the plant cover at both sites are considerably richer than that at the surrounding, semi-desert region of Khartoum. However, the two sites differ with respect to one critical factor that is, the intensity of human impact; the habitat at Tuti is shaped by agricultural activities; the island contains a small village that is surrounded by agricultural fields where vegetables and fruits are grown. On the other side, Sunut forest remains a wild habitat to a large extent; the plant cover at the site is dominated by *Acacia nilotica* trees and agricultural activities are limited to the narrow band extending along the White Nile River bank.

Because vegetation cover is known to have a strong influence on the avifauna (Scott Mills *et al.*, 1989), it is expected that the bird diversity at the two sites will vary following the habitat difference. Overall, the findings of the present study support this prediction. The numbers of bird species observed at the two sites showed considerable difference, with Tuti Island representing higher species richness; 30 species of birds have been reported at Tuti compared to 24 species at Sunut forest. The total abundance of individual birds at Tuti Island was substantially higher than that at Sunut forest. In addition to the numbers of species and individuals, the species composition at the two sites showed considerable variation; each of the two sites was found to host bird species not found in the other site (e.g. Parakeet at Tuti and Duck at Sunut). Moreover, the highly abundant species also differs between the two sites, with the Crested Lark being the most abundant in Tuti while the Greater Flamingo was the most abundant in Sunut. Interestingly, although both species richness and abundance were relatively higher at Tuti, the value of Shannon diversity index was higher at Sunut. The reason is that the relative abundance of bird species is more even at Sunut, while at Tuti few species represent most of the community.

Despite the apparent similarity between Tuti Island and Sunut forest and their proximity to each other, the marked variation in bird community structure suggest the existence of considerable habitat variability that affects bird communities at the two sites. The most important habitat difference regards the floral structure; in Sunut forest, one tree species, *Acacia nilotica*, dominates the plant cover, while in Tuti Island the flora is much more diverse and complex, containing variable trees, shrubs, grasses and herbs. This difference implies that Tuti have a wider range of microhabitats for different species of birds and hence the higher species richness at Tuti. Another important habitat difference is that the extensive agricultural activity at Tuti Island leads to higher food availability for resident and migrating birds. Due to agriculture, Tuti is more attractive for both seed-eating and insect-eating birds. In Sunut forest, agriculture is limited to the narrow external zone that borders the White Nile. Most of the forest area lacks any vegetation cover except *A. nilotica* trees. Moreover, the buildings at Tuti Island provide shelter and nesting grounds for many species of birds that are not available at Sunut forest. On the other side, aquatic birds

such as ducks may be especially attracted to Sunut forest because of the presence of water pools within the inner part of the forest that are isolated from human activities.

Overall, it appears that the avian community at Tuti Island is characterized by higher abundance of birds, higher species richness, but less species evenness than that at Sunut forest. Urban sites are theoretically expected to show lower richness than respective wild sites (see introduction). The reason why this rule does not apply to the case of the urban Tuti Island and the wild Sunut forest is that the former has much more heterogeneous and diverse plant cover than the later, thus attracting birds with variable feeding habits and life styles. The availability of food sources at Tuti Island causes the higher bird abundance but it also leads to the lower species evenness at the site; agriculture favors particular species of birds (e.g. insectivorous, granivorous species) thus driving these species toward large population sizes and reducing the overall species equality/evenness at Tuti Island.

The diversity at Tuti Island and Sunut forest is threatened by the increasing urbanizational development taking place at Khartoum, especially the pressure posed by the construction activities (e.g. the Sunut construction project and Tuti Bridge) (Eltayeb *et al.* 2012). Thus, it is important to establish a database on the biological diversity at the two sites so as to guide future management plans and conservation activities taking place there. We recommend future research to adopt larger scale of observation, both spatially and temporally. Moreover, the diversity of other key group such as plants and arthropods should be investigated as well in order to provide an integrated view for the ecological status at the two sites. Biodiversity surveys should cover the surrounding semi-desert area so as to distinguish the biodiversity patterns that are specific to each site from those characterizing the entire Khartoum region.

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Fig. 1(a): Sunut forest.



Fig. 1(b): Sunut forest (satellite image).



Fig. 2(a): Tuti Island.

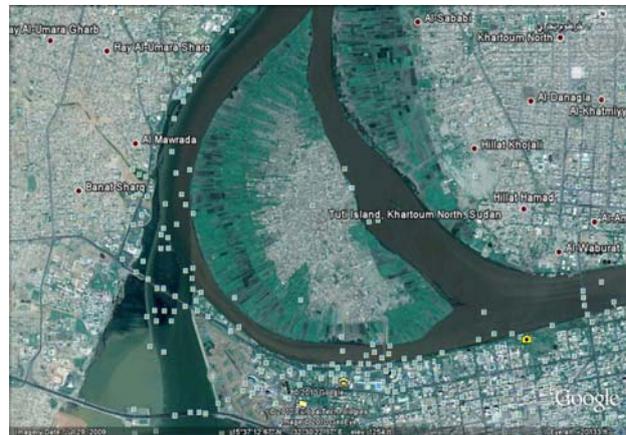


Fig. 2(b): Tuti Island (Satellite image).

ARABIC SUMMARY

تنوع الطيور في موقعين بالخرطوم- السودان

عثمان صلاح* و ايهاب ادريس*

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إن التنوع الحيوي للطيور يتأثر بقوة بطبيعة الموطن و لهذا فمن المتوقع أن تتباين أنواع و أعداد الطيور بين المواطن المختلفة. في هذه الورقة نصف دراسة مسحية تمت علي تنوع الطيور في موقعين بمدينة الخرطوم: غابة السنط و جزيرة توتي. إن بيئة كلا الموقعين تتحدد بشكل كبير بقربهما لنهر النيل و لهذا فكلاهما يتصف بغطاء نباتي كثيف. بالاضافة إلي ذلك فإن الموقعان متقاربان جغرافيا مما يعني تطابقا في الظروف المناخية بينهما. إلا أن الموقعان يختلفان فيما يتعلق بعامل بيئي أساسي ألا وهو درجة التأثير البشري، فجزيرة توتي مكونه أساسا من أراضي زراعية و مناطق سكنيه أما غابة السنط فهي غابه شبه طبيعيه تشكلها أشجار السنط و يقل فيها النشاط البشري. هدفت الدراسة إلي مقارنة تركيبية الطيور بين الموقعين من أجل تقدير تأثير طبيعة الموطن علي التباين المكاني في أعداد و أنواع الطيور. تم رصد 41 نوعا من الطيور خلال فترة خمسة أشهر: 24 نوعا في غابة السنط و 30 نوعا في جزيرة توتي. عند مقارنة تنوع الطيور في المنطقتين إحصائيا باستخدام معادلة شانون تمت ملاحظة فرق معنوي بينهما يرجح أن يكون بسبب تفاوت الأثر البشري.