

## Bird communities in Kyambura Game Reserve, southwest Uganda

Many studies about tropical avifauna have been carried out in this century (for Africa: Moreau 1948, 1952, Beals 1970, Ulfstrand 1973, Ulfstrand & Alerstam 1977; for Central and South America: Skutch 1950, Klopfer and McArthur 1960, McArthur 1964, Snow and Snow 1964). Most of these studies drew comparisons with temperate habitats. Differences between habitats within one area were studied by Beals (1970) and Ulfstrand and Alerstam (1977) in Ethiopia and Zambia. Consequently, there is still much to be discovered about bird communities between different habitats in tropical Africa, and very little work has been done in Uganda. There are only species lists for the national parks, and even these are not complete as they provide no further ecological information. No species list or information about the bird communities was available for Kyambura Game Reserve.

This study was carried out with two main objectives. The first was to create an overall species list (and different lists for each habitat in Kyambura Game Reserve) and to compare this with the data for the neighbouring Queen Elizabeth National Park. Second, an attempt was made to compare two main habitats of the Reserve with regard to their diversity.

### METHODS

Kyambura Game Reserve (0°09'S, 30°08'E; Fig. 1) is located in southwest Uganda and was created as a buffer zone for the Queen Elizabeth National Park, which forms the western boundary across Kyambura Gorge. The northern boundary is the Kazinga Channel, which connects Lake Edward and Lake George and forms the eastern boundary. To the south are small villages and plantations. The area, located at a mean altitude of 1100 m, covers a total of 156 km<sup>2</sup> and encompasses several habitats. During the survey we distinguished 13 separate habitats.

The grassland is composed mainly of three grass species, all of which are fire tolerant and grow to 150 cm in height. Red Oat Grass *Themeda triandra* is the most widespread species, followed by Sword Grass *Imperata cylindrica*. In some areas, Lemon Grass *Cymbopogon nardus* can be found, especially after fires. Single fig trees *Ficus* sp. are common in some parts.

The wooded grassland has a higher density of trees, mainly acacias *Acacia sieberiana* and *Acacia gerrardii*. The grasses are the same species as in the grassland but seldom grow taller than 100 cm.

The bush grassland is covered by groups of *Capparis tomentosa* thickets, which shelter two common species of plants, wild jasmine *Jasminum* sp. and morning glory *Ipomea* sp. A common tree in this habitat is the Candelabra Tree *Euphorbia candelabrum*. The grasses are shorter and the main species are *Themeda triandra* and *Sporobolus pyramidalis*.

The bushland and bushthicket have the same vegetation but with an increasing percentage of bushes and an decreasing percentage of grasses. Together, they form the largest proportion of the plant communities in the Reserve. The amount of bare ground increases from zero in the grassland and wooded grassland up to 10% in some parts of the bushthicket.

The shores of the lakes, the Kazinga Channel and the swamps support mainly *Papyrus* *Cyberus papyrus*. The Kazinga Channel is lined by a tall grass *Vossia cuspidata*.

The forest habitat is composed mainly of *Cynometra* sp. trees and *Diospyros abyssinicus*. Where the forest is not too dense, the Wild Date Palm *Phoenix reclinata* grows in wetter areas. The neighbouring plantations consist of banana plants.

A total of 40 line transects were walked, 20 in bush grassland and 20 in wooded grassland, at the end of the dry season between 7 and 30 August. The identification distance was 20 m either side of the walking line. This distance is acceptable for open habitats (Pommeroy 1991). Transects were 500 m by 40 m, giving a total sample area of 40 ha for each habitat. The walking speed was, on average, 15 min per transect, as recommended by Bibby *et al.* (1992). More cryptic species such as cisticolas and sunbirds, which could not always be reliably identified to species level, were grouped together. Species such as raptors flying over the transect were not included. Each individual transect was determined by randomly selecting a point and taking a random compass bearing. Counts were conducted between 0800h and 1400h, because bird activity decreased in the afternoon (Pommeroy 1991). To reduce the error of edge effects in the three habitats, transects were not carried out in the vicinity of habitat borderlines.

We used the following equations (Shannon 1948) to measure the bird diversity and to compare the different habitats:

$$\text{bird species diversity (BSD)} = - \sum_{i=1}^n p_i \ln p_i, \quad (1)$$

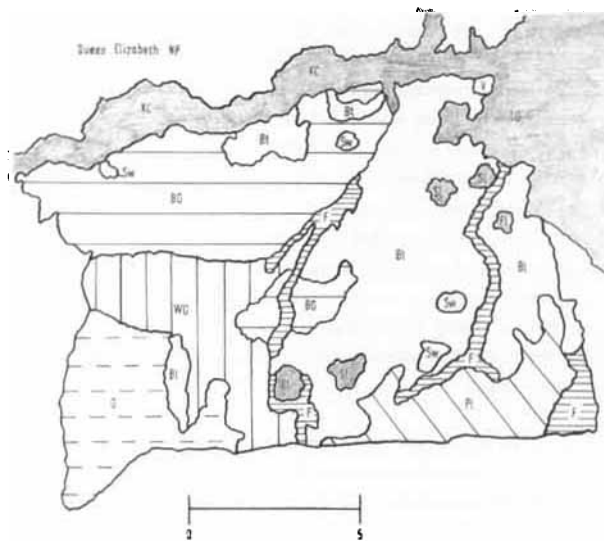
$$\text{equal common species (ECS)} = e^{\text{BSD}}, \quad (2)$$

$$\begin{aligned} \text{BSD diff} = & - \sum_{i=1}^{p+q} \frac{p_i + q_i}{2} \ln \frac{p_i + q_i}{2} \\ & + \frac{1}{2} (\text{BSD}_p + \text{BSD}_q). \quad (3) \end{aligned}$$

The bird species diversity (BSD) is calculated by multiplying the proportion of the *i*th species with its logarithm and summing. The number of equal common species (ECS) can be ascertained using Eq. 2 (McArthur 1964). It estimates how many bird species have a similar density in a given habitat, based on the transect results and makes the BSD more comparable. The difference between two habitats is measured by BSD diff. This term can vary between zero, which means that the two habitats have an identical avifauna, and 0.693 (ln2), which means that the two habitats have completely different birds. These equations have been used in several studies (McArthur 1964, McArthur *et al.* 1966), and the values are comparable.

### RESULTS

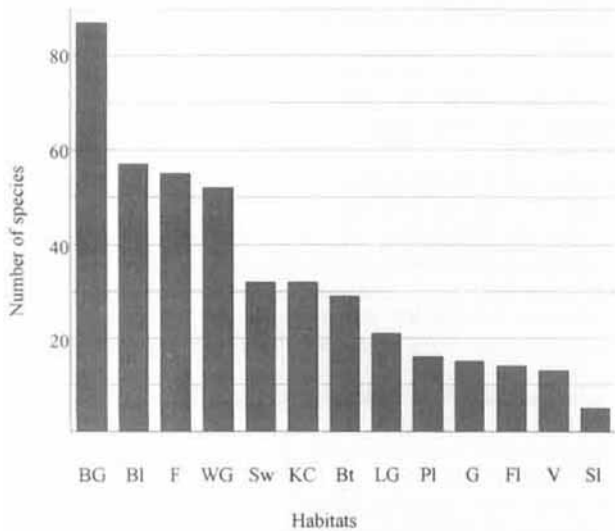
During the 3 months of investigation, a total of 234 bird species were identified, belonging to 58 families. Queen Elizabeth National Park contains 538 species (migrants included) in an area of 1978 km<sup>2</sup>. Migrants from Europe were not present during our survey, so the total number of species occurring in the Kyambura Game Reserve is much higher.



**Figure 1.** Map showing the 13 habitat types present in Kyambura Game Reserve (KC = Kazinga Channel, LG = Lake George, FI = freshwater lake, SI = saltwater lake, Sw = swamp, F = forest, BG = bush grassland, BI = bushland, Bt = bushthicket, WG = wooded grassland, G = grassland, V = village, PI = plantation). The scale line represents 5 km.

Figure 2 shows the number of species in each of the 13 habitats. The bush grassland contained the highest number of species (87), followed by the bushland (57) and the forest (55). Only a few specialized species live on the salt lakes, which contained only five bird species.

The habitats in which counts were taken were bush grassland and wooded grassland, because they form large parts of the Reserve. The transect data are shown in Table 1. For additional in-



**Figure 2.** Number of species found in the different habitats at Kyambura Game Reserve (BG = bush grassland, BI = bushland, F = forest, WG = wooded grassland, Sw = swamp, KC = Kazinga Channel, Bt = bushthicket, LG = Lake George, PI = plantation, G = grassland, FI = freshwater lake, V = village, SI = saltwater lake).

**Table 1.** Results of the transect (500 m × 40 m) counts of birds in the two habitats in Kyambura Game Reserve

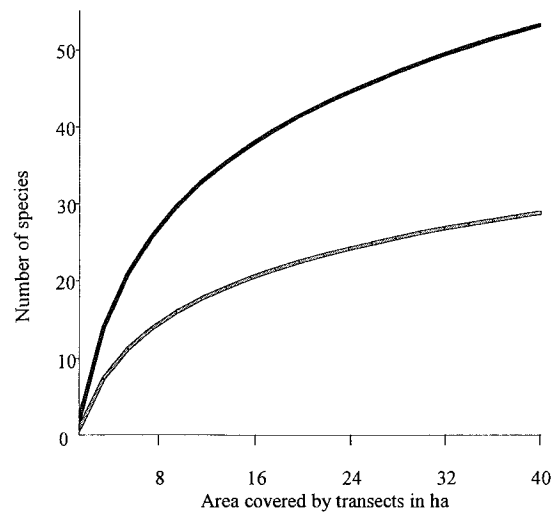
	Bush grassland	Wooded Grassland
Number of species	48	26
Mean per transect	9.3	4.4
s.d.	3.4	2.5
Coeff. var. in %	11.4	6.0
Number of birds	469	142
Mean per transect	23.5	7.1
s.d.	13.8	4.9
Coeff. var. in %	190.9	24.2
Bird density per ha	11.7	3.6

formation on the density of particular species, see Appendices 1 and 2.

The coherence between the covered area and the number of recorded species was assessed (Fig. 3). The curves show a clear tendency, but as Figure 3 reveals, even at the end they were still increasing.

Many more species were recorded in the bush grassland (Table 1), and it also had a higher density of birds per hectare. The standard deviations and the coefficients of variance indicate that there were no large differences between single transects, with one exception. A flock of Red-billed Queleas *Quelea quelea* was observed in the bush grassland, which increased the coefficient of variance significantly.

The bird species diversity was higher in the bush grassland (3.093) than in the wooded grassland (2.948). Thus the number of equal common species was higher in the bush grassland (22 to 19). The difference between the bird species diversities in the two habitats was 0.288 or 33.4%. Random samples of five transects fluctuated less in



**Figure 3.** Accumulative abundance curves between the area covered by the transects and the number of species recorded in the bush grassland (upper curve:  $n = 20$ ,  $r = 0.987$ ,  $P < 0.0001$ ; regression:  $y = -9.62 + 17.05 \ln x$ ) and wooded grassland (lower curve:  $n = 20$ ,  $r = 0.957$ ,  $P < 0.0001$ ; regression:  $y = -5.63 + 9.38 \ln x$ ).

their bird species diversity in the bush grassland ( $3.093 \pm 0.17$ ) than in the wooded grassland ( $2.948 \pm 0.69$ ). This indicates that the birds were more uniformly distributed in the bush grassland in comparison with the wooded grassland, where concentrations were more often observed.

## DISCUSSION

Kyambura Game Reserve would prove to hold many more species than we have recorded during our survey if studied in all seasons. Although we had conducted a total abundance count in our transects, it was not fully representative because the vegetation is not uniform.

The bird species diversity in the Reserve is remarkably high in comparison with data from Central America. McArthur *et al.* (1966) reported diversities between 0.76 and 3.39 for Panama and between 0.51 and 2.32 for Puerto Rico in grassland, savannah, scrub and forest habitats. The values for Kyambura Game Reserve (2.95 for the wooded grassland and 3.09 for the bush grassland) were at the upper limits. Comparisons with densities in Africa and temperate regions reveal different results. Ulfstrand and Alerstam (1977) reported a density of between 8.5 and 17.4 birds per ha for woodlands in Zambia. Svensson (1974) reported densities ranging from 6.0 to 17.5 birds per ha for various habitats in Sweden. The densities of birds at Kyambura were between 3.6 and 11.7, significantly lower. It seems that European habitats support a larger bird density than the Reserve, while the species diversity of tropical regions supports two to three times as many species as temperate regions (McArthur 1969, Ulfstrand & Alerstam 1977). Various theories attempt to explain the phenomenon of diversity. Beals (1970) stressed that a greater plant diversity leads to a greater diversity of insects and birds. This was denied by McArthur and McArthur (1961) and McArthur (1964, 1965). Average plant communities are up to four times richer in species in the tropics than in temperate regions (Beals 1970). Dobzhansky (1950) stressed that natural selection is controlled mainly by physical environment in temperate regions and more by biological competition in the tropics. In addition, Moreau (1948) found small ecological niche overlap in the tropics, proof for a high level of specialization. This leads to more limited food supplies (Skutch 1966). The bird density was less but species richness was greater at Kyambura in comparison with temperate regions. The ecological niches of these very heterogeneous habitats are small and support many specialized species. The fact that the patchiness of the habitat encourages a greater species richness was also stressed by McArthur *et al.* (1962) and Beals (1970). Examples of bird families with a high level of specialization to avoid interspecific competition are the sunbirds Nectariniidae and the kingfishers Alcedinidae, of which eight and ten species, respectively, were recorded in the Reserve.

The patchiness of the habitat influences the diversity and so any change in the proportion of the habitats in the Reserve would have serious consequences. A natural process in the Reserve is the increase of the wooded grassland, where new trees spread into bush grassland and grassland. This is normally checked by browsers, such as the African Elephant *Loxodonta africana*, Giraffe *Giraffa camelopardalis*, Impala *Aepyceros melampus* and dikdiks *Rhynchotragus* sp. These browsers significantly inhibit the growth of young acacias

(Belski 1984). At present, only the African Elephant and dikdik occur in Kyambura and only in small numbers and in some months. Bush grassland supports more than 60 species of bushes and shrubs, providing a diverse food resource for birds and other animals, while the wooded grassland is limited to acacia trees, less than six grass species and a scattering of bushes. A further increase of the wooded grassland may lead to a decrease of the avifauna of the Reserve. However, certain bird species were recorded only in the wooded grassland within Kyambura Game Reserve and not outside it, and thus it remains an essential habitat for these. Such species were African Hobby *Falco cuvieri*, Greater Kestrel *Falco rupicoloides*, Coqui Francolin *Francolinus coqui* and Grey-headed Kingfisher *Halcyon leucocephala*.

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#### APPENDIX 1

Bird counts on bush grassland transects (n = 20 transects, birds listed in order of density)

Species or family	No. of birds	Mean no. of birds per transect	Birds per ha
<i>Hirundo rustica</i>	80	4.00	2.00
<i>Colius striatus</i>	48	2.40	1.20
<i>Pycnonotus barbatus</i>	42	2.10	1.05
<i>Quelea quelea</i>	40	2.00	1.00
<i>Streptopelia capicola</i>	28	1.40	0.70
<i>Cisticola</i> sp.	23	1.15	0.58
<i>Hirundo daurica</i>	19	0.95	0.48
<i>Merops albicollis</i>	18	0.90	0.45
<i>Laniarius erythrogaster</i>	16	0.80	0.40
Ploceidae sp.	14	0.70	0.35
<i>Mirafrja rufocinnamomera</i>	13	0.65	0.33
Nectariniidae sp.	12	0.60	0.30
<i>Lanius excubitorius</i>	11	0.55	0.28
<i>Macronyx croceus</i>	11	0.55	0.28
<i>Colius macrourus</i>	10	0.50	0.25
<i>Vanellus lugubris</i>	8	0.40	0.20
<i>Myrmecochicla nigra</i>	7	0.35	0.18
Turdoididae sp.	6	0.30	0.15
Phasianidae sp.	5	0.25	0.13
<i>Cameroptera brevicaudata</i>	5	0.25	0.13
<i>Streptopelia semitorquata</i>	5	0.25	0.13
<i>Vanellus senegallus</i>	5	0.25	0.13
<i>Remiz caroli</i>	3	0.15	0.08
Alaudidae sp.	3	0.15	0.08
<i>Hirundo semirufa</i>	3	0.15	0.08
<i>Francolinus squamatus</i>	3	0.15	0.08
<i>Cossypha heuglini</i>	3	0.15	0.08
<i>Anthreptes collaris</i>	2	0.10	0.05
<i>Merops pusillus</i>	2	0.10	0.05
<i>Merops superciliosus</i>	2	0.10	0.05

#### APPENDIX 1

Continued

Species or family	No. of birds	Mean no. of birds per transect	Birds per ha
<i>Lagonosticta senegala</i>	2	0.10	0.05
<i>Lamprotornis purpuropterus</i>	2	0.10	0.05
<i>Turtur tympanistria</i>	2	0.10	0.05
<i>Centropus superciliosus</i>	2	0.10	0.05
Turdidae sp.	1	0.05	0.03
<i>Turtur chalcospilos</i>	1	0.05	0.03
Muscicapidae sp.	1	0.05	0.03
<i>Caprimulgus nubicus</i>	1	0.05	0.03
<i>Macrodipteryx vexillarius</i>	1	0.05	0.03
<i>Vidua macroura</i>	1	0.05	0.03
Turnicidae sp.	1	0.05	0.03
<i>Hirundo abyssinica</i>	1	0.05	0.03
<i>Aquila rapax</i>	1	0.05	0.03
Laniidae sp.	1	0.05	0.03
<i>Cinnyricinclus leucogaster</i>	1	0.05	0.03
Sylviidae sp.	1	0.05	0.03
<i>Psalidoprocne albiceps</i>	1	0.05	0.03
<i>Serinus mozambicus</i>	1	0.05	0.03

#### APPENDIX 2

Bird counts on wooded grassland transects (n = 20 transects, birds listed in order of density)

Species or family	No. of birds	Mean no. of birds per transect	Birds per ha
<i>Merops albicollis</i>	16	0.80	0.40
<i>Macronyx croceus</i>	15	0.75	0.38
Alaudidae sp.	12	0.60	0.30
<i>Cisticola</i> sp.	12	0.60	0.30
<i>Hirundo rustica</i>	9	0.45	0.23
Phasianidae sp.	9	0.45	0.23
Ploceidae sp.	8	0.40	0.20
<i>Remiz caroli</i>	7	0.35	0.18
Sylviidae sp.	7	0.35	0.18
<i>Lanius excubitorius</i>	6	0.30	0.15
<i>Centropus superciliosus</i>	6	0.30	0.15
<i>Laniarius erythrogaster</i>	5	0.25	0.13
<i>Streptopelia capicola</i>	4	0.20	0.10
<i>Pycnonotus barbatus</i>	4	0.20	0.10
<i>Colius striatus</i>	4	0.20	0.10
<i>Melaenornis edolioides</i>	3	0.15	0.08
<i>Myrmecochicla nigra</i>	3	0.15	0.08
<i>Macrodipteryx vexillaris</i>	2	0.10	0.05
<i>Eremomela</i> sp.	2	0.10	0.05
<i>Cinnyricinclus leucogaster</i>	2	0.10	0.05
Nectariniidae sp.	1	0.05	0.03
<i>Hirundo daurica</i>	1	0.05	0.03
<i>Indicator indicator</i>	1	0.05	0.03
<i>Lagonosticta senegala</i>	1	0.05	0.03
<i>Tchagra jamesi</i>	1	0.05	0.03
<i>Eupodotis melanogaster</i>	1	0.05	0.03