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Using East African bird atlas data for ecological studies

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Comparison of computer-stored bird atlas data with environmental variables such as rainfall and altitude is relatively simple, and particularly useful where observers are sparse, as in most of the tropics. In East Africa there already exists a detailed data set for Kenya, whilst work is progressing in Uganda and Tanzania. In all three countries, atlas mapping is based upon squares of 1/2° side. The examples selected here, using data from Uganda and Kenya, illustrate some ways of using such information.

The distribution of the stonechat in relation to altitude provides a simple instance of making a quantitative statement rather than a qualitative one. But — unexpectedly — it also raises a question about the species' dispersal. Analyses of data for two species of ravens illustrate the interest of comparing close relatives. Overall, their distributions overlap widely, but much less so when only breeding records are considered. Ravens are only one of many superspecies in tropical Africa. Typically member species are allopatric or almost so; this is seen clearly in two species of sunbirds which are shown to differ significantly in their ecology.

The analysis of atlas data has wide potential, for example in framing useful ecological questions. And, where the mapping grid is finer, more precise analyses become possible.

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1. Introduction

Uganda is a moist, medium-altitude country which is close to the meeting point of four major areas of plant endemism (White 1983). Uganda's floral richness is reflected in its avifauna which, in proportion to its size, is the richest in tropical Africa, with almost 1000 species (Pomeroy & Lewis 1987). Neighbouring Kenya, which is more than twice as large, is also a species-rich area and has about 1060 (Lewis & Pomeroy 1989). So far, few of these many species has been studied in any detail. There are, of course, some exceptions, such as the lesser flamingo *Phoeniconaias minor* whose dependence on alkaline lakes is well understood (Vareschi 1978). But despite the general lack of ecological knowledge, there is an increasing amount of information on the distributions of birds in Africa, with several bird atlases already published and others planned.

It will be many years before there is an adequate knowledge of food, nesting requirements and so on to provide a detailed understanding of the distributions of most Afrotropical species. But in the meantime it is possible to make some progress by analysing distributions in terms of more general environmental data. Most African atlases use a grid based upon degrees of latitude and longitude. Ash & Pomeroy (1981) suggested that, wherever possible, the actual units should be 1/2° by 1/2°, that is quarters of a square degree or QSDs. These are relatively large units (at the equator, each is about 55 by 55 km), but the use of smaller squares would require very many more observers than are usually available.

Rainfall has long been recognised as the major ecological factor affecting birds in tropical Africa — although of course its effects are usually indirect (see for example Moreau 1950, Brown & Britton 1980). Similarly, many species' distributions are related to

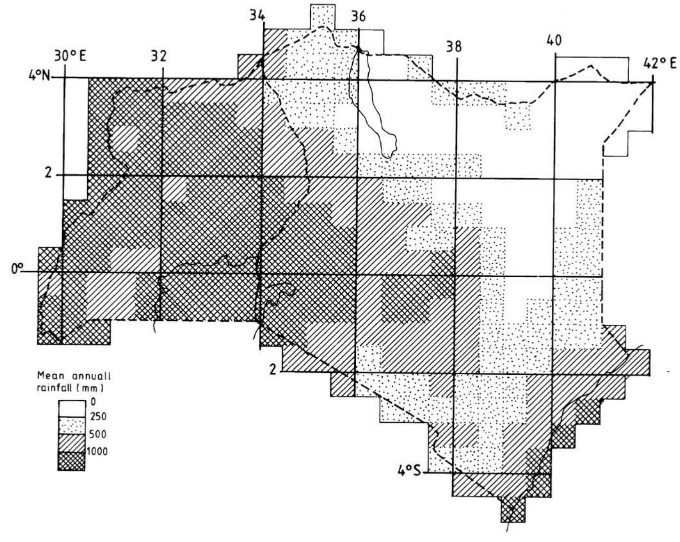

Fig. 1. Mean annual rainfall in Uganda and Kenya. Modal values are shown for each quarter square degree (QSD).

altitude (Moreau 1966, Britton 1980), a convenient measure but again acting indirectly, mainly through temperature.

Following the example of Sharrock (1976) and others, the Bird atlas of Kenya (Lewis & Pomeroy 1989) has transparent overlays which for Kenya include rainfall, altitude and forests. Fig. 1 reproduces the rainfall overlay, extended to show Uganda, too. The map shows modal values of the mean annual rainfall for each QSD, rather than the more familiar isopleths. The comparison of bird distributions with (in this case) annual rainfall then becomes a simple matter, as was first demonstrated by Pomeroy et al. in 1982.

In this paper, I first show how this approach can be used simply to quantify an aspect of birds' distributions. But it is also interesting to compare the distributions of closely-related species in this way. Hall & Moreau (1970) and subsequently Snow (1978) grouped many Afrotropical species into superspecies which are 'immediately descended from a common ancestor and are nearly or completely allopatric' (Hall & Moreau 1970). The question asked here is whether members of a superspecies are separated ecologically as well as geographically.

2. Methods

This paper is based upon combined data from Uganda and Kenya. Data on the distributions of birds in Kenya are from the Bird atlas of Kenya (Lewis & Pomeroy 1989) whilst those for Uganda are from M. Carswell (pers. comm.). Both atlas schemes use the QSD system, with records for each square classified as breeding, probable breeding or presence. In this paper, the first two are combined.

Modal values of altitude and mean annual rainfall for each QSD were taken by inspection from the atlases of Kenya and Uganda (Anon. 1967, 1970).

Between them Uganda and Kenya have some 315 QSDs. But not all have been thoroughly visited. Indeed, a map of coverage for the Kenya atlas (Lewis & Pomeroy 1989, page 8) shows that there were 13 QSDs with no records at all; for Uganda, about 12 squares have no records as yet (M. Carswell, pers. comm.). Even squares with some records vary considerably in the level of coverage.

Pomeroy & Lewis (1983) estimated that at least 300 species would be recorded from every square in Kenya if it was thoroughly covered. For the purposes of this paper, I have chosen an arbitrary level of 30 species per square in deciding which squares to include for conspicuous birds (in this case, ravens and stonechat) and 100 species for less conspicuous birds (sunbirds). The argument here is that if a particular square had received only a brief visit (and only 30 species recorded) there was still a high probability that ravens and stonechats, if present, would have been noted.

Thus in calculating, for example, the proportion of squares over 2000 m with records of stonechats (Fig. 2), I took as the maximum possible number of squares those which were over 2000 m and had at least 30 species recorded. This method reduces one major source of bias, namely that a larger proportion of upland, moist squares was covered fairly thoroughly than was the case for low altitude and/or dry squares.

3. Some examples

3.1. Stonechat

In East Africa, the stonechat *Saxicola torquata*, so familiar in much of Europe, is regarded by Britton (1980) as a 'common resident'. With the possible ex-

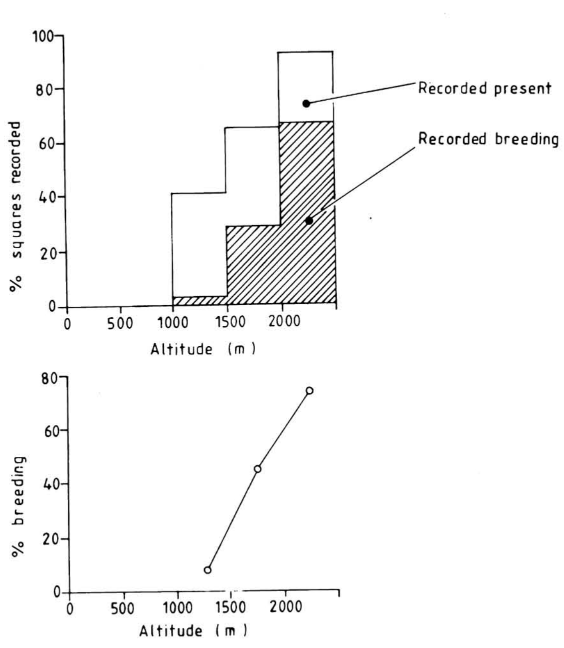

Fig. 2. Above: the proportion of QSDs occupied by the stonechat in each of five categories of altitude. — Below: the frequency of breeding records in each altitudinal category.

ception of a population in northern Uganda, birds in Uganda and Kenya belong to the race *axillaris*, which Britton describes as a mainly highland bird, occurring between 1100 and 3200 m. It is often seen near roads.

The Kenya atlas shows that stonechats have not been recorded in the coastal lowlands or the eastern plateau, and an analysis of the records of the two countries depicts this clearly (Fig. 2). Stonechats have been recorded in almost every square with an average altitude of 2000 m or more, and in none of those below 1000 m.

Stonechat nests are usually well hidden but nevertheless there are a good number of breeding records, especially for Kenya. Closer examination of the data shows a striking contrast in the proportions of squares with breeding records at different altitudes. For whilst stonechats nest in most squares over 2000 m, there are breeding records from only 7% of those between 1000 and 1500 m (Fig. 2). The simplest explanation for this pattern is that the stonechat is not in fact a resident, as had been supposed, but instead is a partial migrant, breeding most commonly at higher altitudes but dispersing to lower areas during the non-breeding season. Preliminary support for this idea comes from observations of Dittami & Gwinner (1985) at Lake Nakuru. Here, at an altitude of around 1750 m, adult stonechats were completely resident, but there was evidence that young birds dispersed, and some transient juveniles were recorded.

Such a situation will only be resolved by more detailed studies, involving ringing. Unfortunately comparatively few Afrotropical species are ringed at present, most ringers preferring to concentrate on Palearctics because of higher recovery rates (Pomeroy 1978).

3.2. Ravens

Of the six species of *Corvus* in East Africa, the white-necked raven *C. albicollis* and the fan-tailed *C. rhipidurus* are largely allopatric. Hall & Moreau (1970) place them in a superspecies, together with *C. crassirostris*, the thick-billed raven of the Ethiopian highlands. The white-necked occupies eastern Africa from Kenya and Uganda to the Cape, whilst the fan-tailed frequents the lower parts of north-eastern Africa, from Kenya and Uganda to Egypt.

Typically, both East African ravens are seen in pairs but they also form flocks, sometimes numbering hundreds, especially outside the breeding season, when they are probably territorial (Goodwin 1976). Britton (1980) considers flocking as evidence of 'wandering'. Both species are scavengers and are commonly associated with rural settlements, where they are highly conspicuous. However, they usually breed on remote cliffs, making their nests hard to find and consequently there are rather few breeding records.

There is a wide overlap in the recorded distributions of these two ravens in west-central Kenya and eastern Uganda (Fig. 3). But there is almost no overlap in breeding records: all but one of the squares with breeding records of the fan-tailed are north of the equator, and all but one of those for the white-necked are south of it. However, there are records of probable breeding for both species in the Ndoto mountains of northern Kenya.

An analysis of the atlas records for Uganda and Kenya (Fig. 4) shows that the white-necked has a marked preference for highland areas, particularly while breeding, whilst the fan-tailed is most common in the driest areas, from which the white-necked is completely absent. The small numbers of breeding records could reflect widespread wandering. And since neither species is likely to begin breeding until several years old, breeding birds may form only a

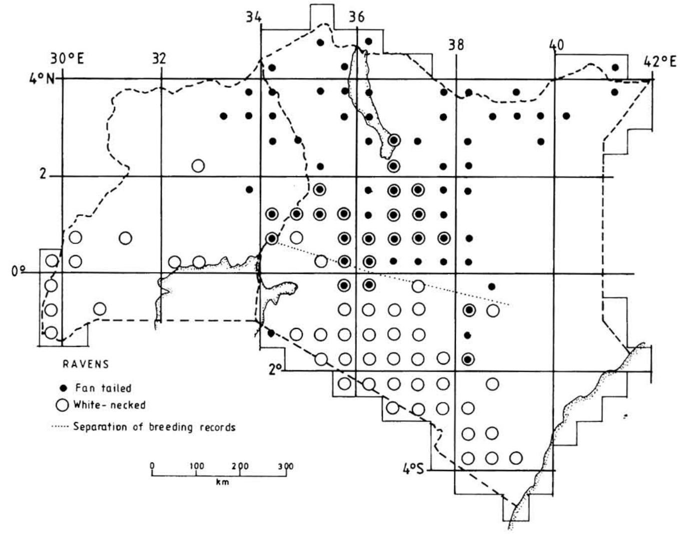

Fig. 3. The distribution of fan-tailed and white-necked ravens of Uganda and Kenya. The symbols are placed conventionally at the centres of each QSD for which there is at least one record of the species.

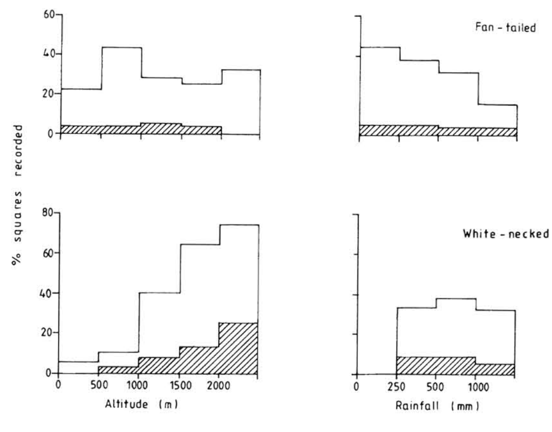

Fig. 4. The proportion of QSDs occupied by two species of raven in relation to altitude and rainfall.

small part of their populations, as in other scavengers such as vultures and marabous *Leptoptilos crumeniferus*.

3.3. Sunbirds

The amethyst sunbird *Nectarinia amethystina* and the green-throated, *N. rubescens*, are two members of a superspecies (Hall & Moreau 1970). The third number, the carmelite sunbird *N. fuliginasa* is a West African species. As sunbirds go, these are large, mainly black, and with rather long, heavy beaks. The amethyst ranges from southern Somalia to South Africa, and the green-throated from Cameroun to western Kenya.

The two species in East Africa are almost completely allopatric (Fig. 5); where both are shown as occupying the same QSD they were recorded from different localities. The green-throated is typically a bird of forests and forest edges. In contrast, the amethyst is found in a wide range of more open wooded habitats, including mangroves (Britton 1980).

Despite being members of a superspecies, the two sunbirds show considerable ecological differences. These are reflected in their distributions with respect to altitude and rainfall (Fig. 6). The amethyst is most numerous at higher altitudes, but is recorded throughout the altitudinal range; it is also rare in the driest areas. The green-throated in East Africa is not found below 1000 m, although it descends to the coast in West Africa. In Uganda and Kenya it is confined to forested areas — as reflected by its absence from squares receiving less than 1000 mm/yr of rain. The distribution of forests is patchy (Hamilton 1984) and so is that of the bird.

The amethyst sunbird is known to make seasonal movements in southern Tanzania (Britton 1980) but in Kenya and Tanzania both species are believed to be

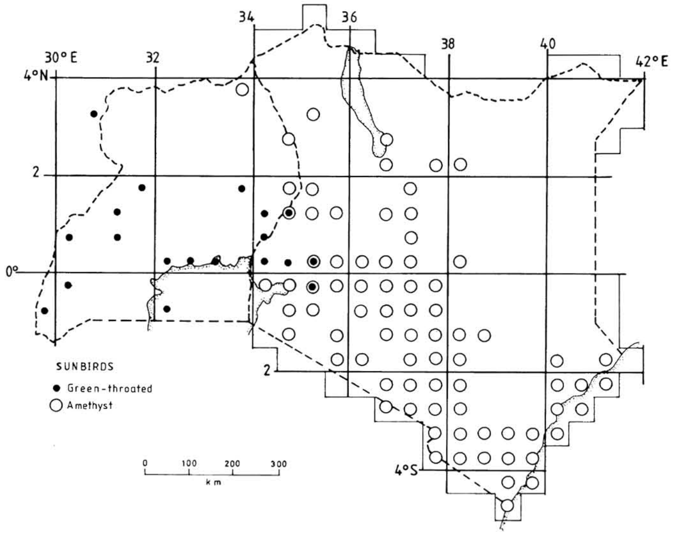

Fig. 5. The distribution of amethyst and green-throated sunbirds in Uganda and Kenya.

largely resident. Breeding records for the amethyst follow a similar pattern to that for total records, as would be expected of a resident species. The green-throated is as yet poorly known. It is generally uncommon in southern Uganda (Carswell 1986) and Brown & Britton (1980) reported only 7 breeding records for East Africa.

4. Conclusions

The avifauna of East Africa remains poorly known in comparison with that of Europe. There are many species but few observers. At present, therefore, only rather simple analyses — such as those described here — are practicable. Yet they are useful, in at least two ways. Firstly, they enable one to make more detailed and quantitative statements about birds' distributions. These may lead, as in the case of the stonechat, to further questions.

Secondly, the analyses provide a method of comparing species. The two examples presented here confirm the views of Hall & Moreau (1970:xiv) that even superspecies, which are thought to have separated comparatively recently, already 'diverge in their habits and ecology'. This has been further documented by Pomeroy & Sekabiira (1990) who show that a large majority of superspecies consist of species from two or more ecological zones.

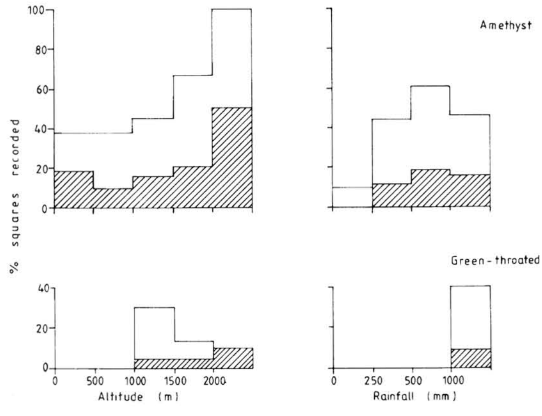

Fig. 6. The proportion of QSDs occupied by two species of sunbird in relation to altitude and rainfall.

As more observations accumulate, so will more precise analyses become possible. Meanwhile, the use of broad environmental features such as rainfall and altitude will continue to assist us in the search for patterns of distribution.

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