Introduction

THIS ATLAS

The idea of a bird atlas is to show distributions in some detail. The first country in tropical Africa to have such an atlas was the Gambia (Jensen & Kirkeby 1980), and the second was the Sudan (Nikolaus 1987). Kenya is the third. There are also atlases for Tunisia (Thomsen & Jacobsen 1979) and Natal (Cyrus & Robson 1980). Soon there will be more (Fig. 1); within the next few years the whole of southern Africa will have been covered (Hockey & Ferrar 1985). Eventually, we hope, there will be an atlas of African birds, as one is planned for Europe.

This atlas originated with a proposal of the Ornithological Sub-Committee (OS-C) of the East African Natural History Society (EANHS) (OS-C 1979; Pearson 1979b). Other schemes for eastern Africa had already been initiated in Ethiopia, Somalia, Sudan and Zambia. In 1980, at the Fifth Pan-African Ornithological Congress in Malawi (PAOC V), various suggestions were made as to how African atlases might be standardised (Ash & Pomeroy 1981). One proposal was that the basic unit should be squares of half by half a degree, i.e. quarter square degrees (QSDs). Data for East Africa were requested on this basis, indicating months of records where possible, together with indications of breeding. Turner (1981) reported on the early progress of this scheme, and published a map of coverage for Kenya and Tanzania.

By late 1981, however, it was apparent that the relatively few observers in Tanzania and Uganda would make it difficult for an East African atlas to be accomplished with any rapidity. Meanwhile, the predictably faster accumulation of data for Kenya had already reached an advanced stage. Hence it was agreed to institute separate atlas schemes for each of the East African countries, to be co-ordinated by individuals rather than by the OS-C as a whole. This book is the product of the Kenyan scheme. A similar atlas is planned for Uganda (Carswell & Pomeroy 1984), whilst N.E. Baker is compiling data for Tanzania.

The primary purpose of the *Bird Atlas of Kenya* is to document the distributions of birds in Kenya as thoroughly as practicable, particularly for the period 1970-1984. For 871 of the species, this information is presented as maps which in most cases considerably amplify the accounts given by Britton (1980a). Further, they greatly facilitate analyses of distributions (see p. 13). The unmapped species are those with few records and/or squares (generally five or less); the squares where these species have occurred are listed.

Once the basis for a Kenyan atlas had been agreed, it was decided that the mapping should continue to be based on the QSD, rather than some multiple of a kilometre grid, which is almost universal in Europe (see for example Udvardy 1981). On the QSD system, Kenya is covered by 228 squares and part-squares, but had squares of 10 km been used, there would have been nearly 30 times as many. Clearly we could not have hoped to achieve more than a very scanty coverage on that scale.

The use of a coarser grid has an unexpected advantage. Many older records have only vague localities, such as 'Machakos' or 'Chalbi Desert'. We can usually place these quite adequately in the appropriate QSD but could only rarely have done so with 10 km squares, and such records would thus have been lost to the atlas. On the other hand, the QSD is really too large a unit for species with very specialised requirements.

At the inception of the atlas for Kenya, we decided to discard the use of monthly data, used in some schemes in southern Africa, but classed as optional at PAOC V (Ash & Pomeroy 1981).

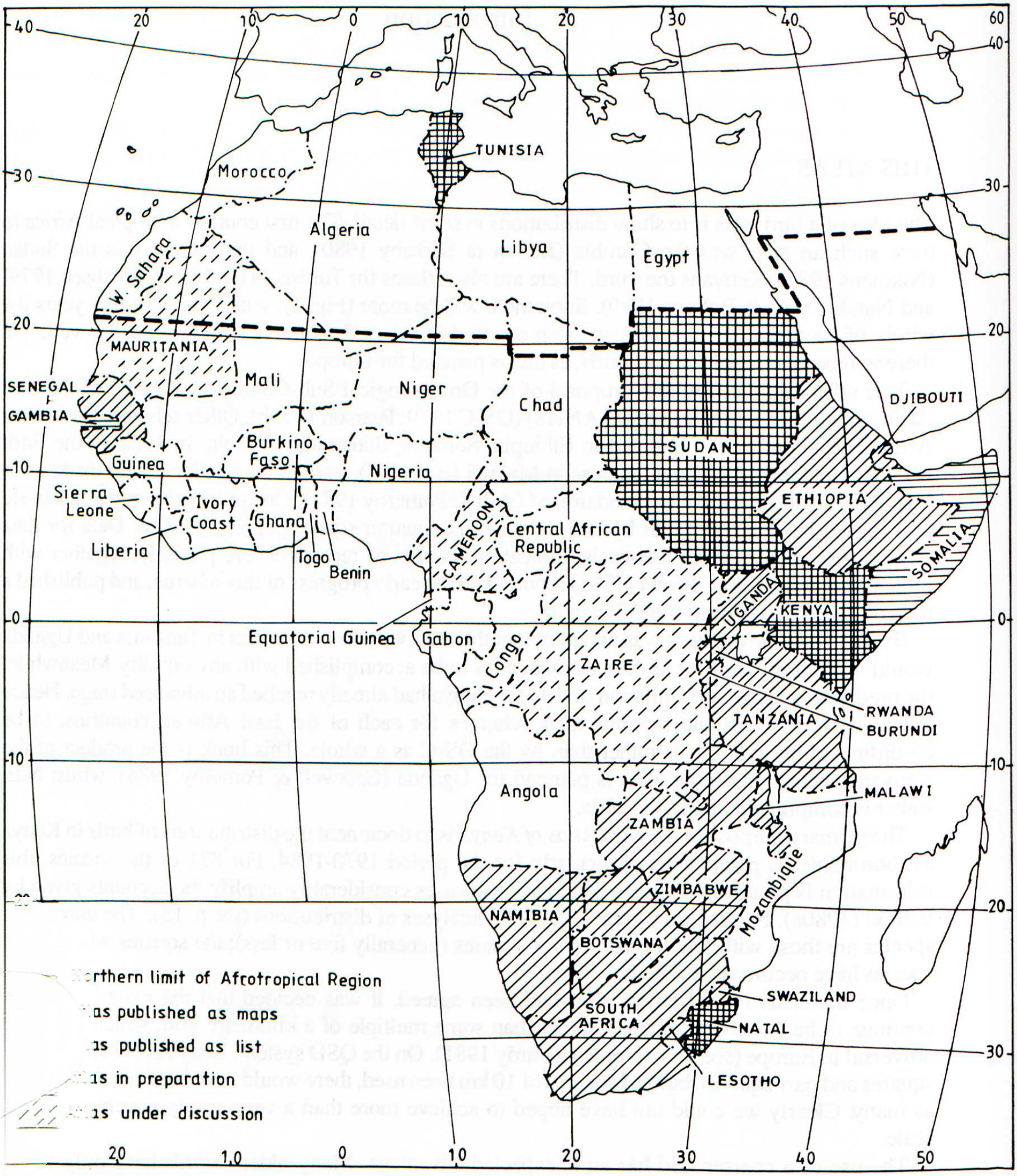

Fig. 1. Progress of atlassing in the Afrotropical Region. Based on information obtained at PAOC V (Ash & Pomeroy 1981) and PAOC VI, and from Hockey & Ferrar (1985). The dashed line at about 20°N is the boundary of the Afrotropical Region (Cramp & Simmons 1977). Note that Senegal and Gambia are shown separately here, whilst in the text they are referred to as Senegambia.

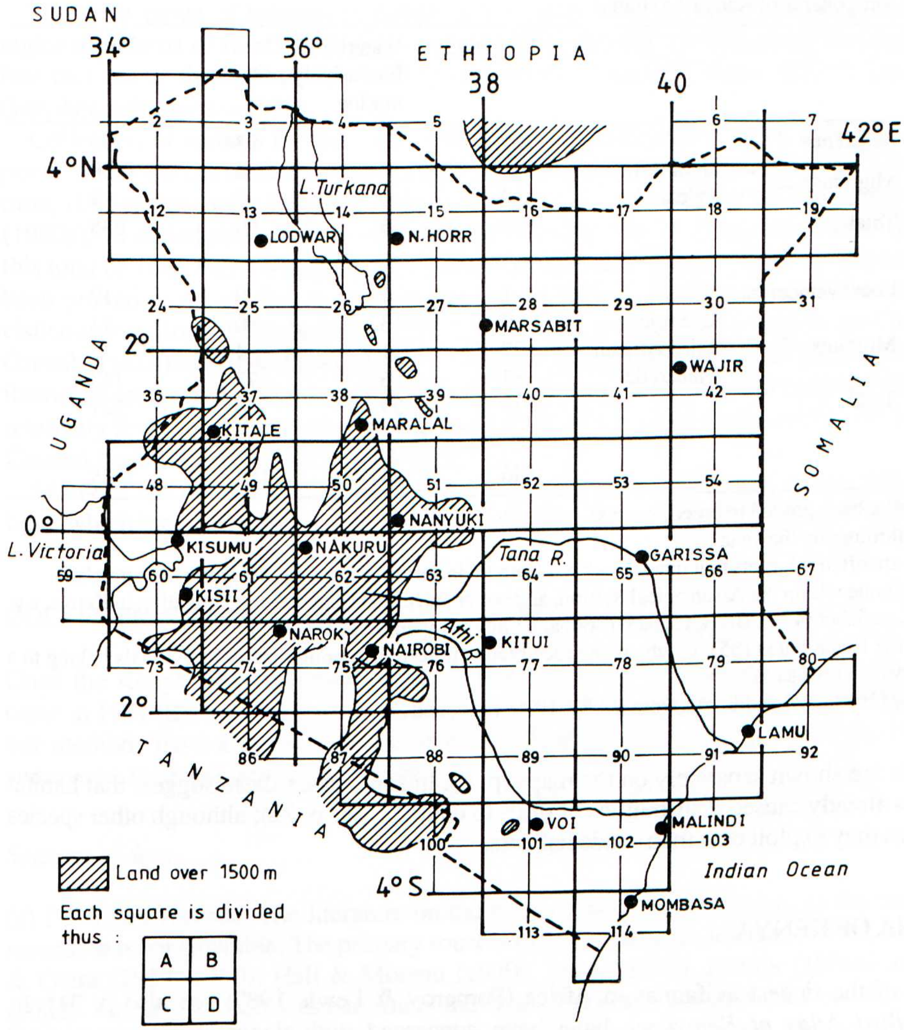

Fig. 2. Kenya base map, showing Quarter-square-degree (QSD) numbers, the main towns and rivers, and land over 1500 m in altitude.

Instead, we concentrated on presence and on breeding records, both for recent records and those prior to 1970.

The human population of Kenya is increasing by about 4% annually, and this, together with the adoption of new land-use practices and people's rising expectations, is leading directly and indirectly to many habitat modifications, of which the most striking are deforestation and desertification. Conversion of native forest to plantation, or forest and woodland to arable land, and improved agricultural techniques, naturally result in extensive changes in bird populations (Carlson 1986a; Pomeroy & Muringo 1980).

Not all changes are of recent occurrence, however. The settlement of the highlands by Europeans in the early decades of the present century was accompanied by widespread bush clearance and deforestation (M. Blundell *in litt.*). Where they differ from records for the period 1970-1984,

Table 1. The major components of Kenya's avifauna

			Landbirds	Waterbirds Exclusively marine	 Others	Totals
Breeding species[a]	Residents[b]		701	5	93	799
	Migrants[c]	Intra-African[d]	26	0	4	30
		Palearctic[e]	7	0	2	9
	Total		734	5	99	838
Non-breeding species	Local wanderers		1	9	9	19
	Migrants	Oceanic	0	13	0	13
		Intra-African	27	1	4	32
		Palearctic	84	6	73	163
	Total		112	29	86	227
Overall totals			846	34	185	1065

a: not all of these have been proved to breed; see text.
b: found in Kenya throughout the year.
c: vagrants, which are often migrants that have wandered from their normal routes, are not shown separately.
d: species which migrate within the Afrotropical Region, and which have also been recorded breeding in Kenya, e.g. Chestnut-bellied Kingfisher (436), Black Cuckoo (366) and Grey-rumped Swallow (561).
e: species such as the Black Kite (135), in which one race breeds in Kenya although many individuals belong to a different, migratory race (or races).
(Based on Pomeroy (1981), with additions from EABR 1979-1984, and *Scopus* 9).

Pre-1970 records are shown separately on the maps (p. 6). In some cases these suggest that habitat modification has already caused distributions of birds to contract (see p. 22); although other species have expanded as they exploit new man-made habitats.

THE AVIFAUNA OF KENYA

Kenya has one of the richest avifaunas in Africa (Pomeroy & Lewis 1987; see also p. 31). In compiling the *Bird Atlas of Kenya* we have been concerned with documenting our present knowledge of this avifauna and in showing how that information can be interpreted and used, for example in promoting conservation of endangered species and their habitats, and in ecological studies.

The area of Kenya is some 582 600 km², which is close to the average size of African countries. Within this area are found an unusual diversity of habitats, which are well described and illustrated by Britton (1980a). Lind & Morrison (1974) give more details of the different vegetation types, whilst the rangelands, which make up so much of the country, are fully described by Pratt & Gwynne (1977).

Kenya is predominantly a dry country, only about a quarter of the land being capable of supporting rain-fed agriculture; this is mostly at the coast, in the highlands of the south and west, and near Lake Victoria (Fig. 2). The same areas naturally support most of the human population, estimated in 1986 as about 20 millions. Away from the highlands, there are only two permanent rivers of any size, the Athi-Galana-Sabaki system and the Tana, and both of these arise in the highlands. Increasingly the flow in these rivers is being affected by hydroelectric dams and irrigation schemes.

The wide range of habitats in Kenya is a reflection of the great altitudinal range and distinct regional patterns of rainfall. Consequently most species have well-defined distributions. The very few that occur throughout the country include the Laughing Dove (333)*, Drongo (566) and Grey-headed Sparrow (990).

Collection of records for this atlas mainly ceased at the end of 1984, although data from some poorly known areas (mainly in the far north) continued to be accepted until late 1985. By this latter time, 1065 species were included on the Kenyan list. These comprise the 1053 mentioned by Britton (1980a), 13 added since then (EABR; *Scopus* 9:53-54, 110-111) and one deleted (Parker 1984). Of this total of 1065 some 838 (79%) are believed to breed in Kenya (Table 1), but as yet not all have been proved to do so. For example, there are no Kenyan breeding records for several species of cisticola (*e.g.* Boran (728) and Foxy (731)), or for various forest birds such as the Cameroon Sombre Greenbul (614) or Shrike Flycatcher (795). Since it is unlikely that any of these species is migratory, it must be assumed that they breed locally. The north and east of the country,including the coast, have relatively few breeding records, largely because of lack of observation (see p. 10, and as examples, Crested Lark (543) and Superb Starling (890)).

Many of the non-breeding species are Palearctic migrants (Table 1; p. 28), although others are birds which breed elsewhere in Africa. The latter are usually referred to as intra-African migrants.

COLLECTION AND COMPILATION OF DATA

Once the Kenya Atlas scheme had been launched, data accumulated rapidly. Over 8000 records came in 1981 (the first year), 22 000 more in 1982, a further 5000 in 1983 and 3500 in 1984. Most of our methods have already been reported (Lewis & Pomeroy 1982ab, 1983ab, 1984). Below we summarise the most important aspects.

Sources of data

(a) Published records. The literature on the birds of Kenya is extensive, so the task of abstracting records was considerable. The primary sources of reference were Jackson (1938), Mackworth-Praed & Grant (1957, 1960), Hall & Moreau (1970), Snow (1978), Britton (1980a) and Brown *et al.* (1982). Jackson himself was extremely thorough and it was not generally considered necessary to re-check references which he quotes. Numerous other sources were checked however; they all feature in the bibliography.

In the periodical literature, many important papers, especially for earlier years, have appeared in *The Ibis* (abstracted back to 1894), but large amounts of material were also found in the *Bulletin of the British Ornithologists' Club* (abstracted back to 1930), the *EANHS Bulletin* (abstracted in total), the *Journal of the East African Natural History Society and National Museum* (abstracted in total) and *Scopus* (abstracted in total), with lesser amounts from *Alauda* (abstracted back to 1960), *Ardea* (back to 1960), *The Auk* (back to 1960), the *East African Wildlife Journal* (later the *African Journal of Ecology)* (abstracted in total), *Le Gerfaut* (back to 1960), *Journal für Ornithologie* (back to 1970), *The Ostrich* (back to 1950) and *Die Vogelwarte* (back to 1969).

As with other sources of information, exact localities were not always easy to determine, despite reference to the comprehensive gazetteers of the United States Board on Geographic Names (1964),

* The numbers following species names in this book, for example Common Bulbul (609), refer to their serial numbers in the main part of the atlas, where scientific names are given.

Britton (1980a) and Jackson (1938). Furthermore, reference is commonly made to areas greater in size than a QSD, thus: 'common in Machakos District'. In such instances, the species was only entered in the QSD actually containing the settlement named, while records like 'common in Tsavo West' were only entered in the QSD containing most of that park, *i.e.* QSD 89C. It should be stressed however that we followed a policy of 'if in doubt, leave it out', and no unusual records (those of uncommon species or birds apparently out of range) were mapped in this way.

(b) Museum skins. The whole collection of bird skins in the National Museums of Kenya at Nairobi was examined; this entailed checking more than 22 000 specimens. Here again, some localities could not be determined with certainty and those records were omitted.

(c) Contributions received direct from observers. This was by far the greatest source of records, yielding in excess of 30 000 by Dec. 1984. More than 200 people contributed (they are acknowledged on p. XI), several providing more than 5000 records, although naturally there were many duplicates. In contrast to the first two categories, most of these records refer to the recent period, 1970-1984. The publication in 1981 of the *Check-list of the Birds of Kenya* (by the Ornithological Sub-Committee of the EANHS) greatly simplified the process, observers being supplied with copies into which they entered their records. The procedures for vetting records are given in the next section.

(d) Planned safaris. The authors and other observers made a number of visits to poorly covered areas specifically for the purpose of obtaining atlas records. More commonly, contributors modified their routes whilst travelling through Kenya, making additional stops purposely to seek records in various places. In addition, David Pearson has covered much of Kenya whilst recording the seasonal distributions of Palearctic migrants (Pearson 1978, 1982, 1984b). Despite these efforts, substantial parts of eastern Kenya, and to a lesser extent the north-west, were scantily covered (see p. 9).

(e) Nest record cards were a major source of information on breeding. The many thousands of cards for Kenya were checked up to the end of 1983, and appropriate information was abstracted. Queries were resolved by corresponding with the observers.

(f) The East African Ringing Scheme. Ringing in Kenya has been concentrated at several places, including Nairobi 75B, Magadi 75C, Nyanza and the coast. Of particular importance has been the ringing station at Ngulia Lodge in Tsavo West National Park 101A (Pearson & Backhurst 1976b; Backhurst & Pearson 1977ab-1984; Backhurst *et al.* 1986). Several Palearctic migrants have been recorded mainly or even exclusively from this site, for example River Warbler (688) and Savi's Warbler (689). In addition, the East African Bird Ringing Reports were abstracted (Blencowe 1960b, 1962d; Smart 1967; Backhurst 1968 annually to 1974, 1977, 1981b).

(g) Comparatively little sea-watching has been done off Kenya's coast, so that pelagic species are the least known sector of the avifauna. But observations such as those of Britton (1981), Taylor (1982a),Pearson & Coverdale (1984), and the Hemphills' (EABR 1982-1985), show that increased efforts would be rewarded.

Categories of data

The atlas maps use symbols to indicate the nine categories of records. These are set out in Table 2. A record in any recent category (on or since 01 Jan. 1970) was considered to supersede an earlier

Table 2. Mapping symbols

Status*	Earlier (or pre) records (up to & including 31 Dec 1969)	Recent (or post) records (on or since 01 Jan 1970)
Presence		
Probable breeding		
Confirmed breeding		

Combined records, occurring only where an Earlier record has a higher status than a Recent one (see text) are:

Recent presence and earlier probable breeding	
Recent presence and earlier confirmed breeding	
Recent probable breeding and earlier confirmed breeding	

* See Table 3 for definitions of breeding status.

Table 3. Categories of observations considered as indicating *probable breeding* or *confirmed breeding*, based the European grades as set out in Sharrock (1976)

Probable breeding	Confirmed breeding
Pair observed in suitable habitat in breeding season	Distraction display or injury feigning
Evidence of a permanent territory (e.g. song) on at least two occasions a week or more apart, at the same place	Used nest or egg shells found
	Nest with eggs
	Adult incubating
Egg in oviduct (museum specimen)	Adult entering or leaving nest hole (or similar site) in circumstances indicative of an occupied nest
Courtship and display by non-migratory species	Adult carrying faecal sac
Visiting probable nest site	Adult carrying food for young
Nest building activities, including hole excavation	Recently fledged young of nidicolous species, or downy young of nidifugous species
Agitated reaction of adult to observer	Adult feeding young (only for non-migratory species)
Brood patch (on bird in hand)	

Note that attempts at breeding which are known to have failed prior to egg-laying are not included in either category.

record of equal or lower status. Thus, if a bird was present in a particular QSD in both 1965 and 1984, it is shown only as a recent record. But had the 1965 record been one of probable breeding whilst that of 1984 was only a 'presence' record, then the combined symbol would be 'recent presence and earlier probable breeding' (see Table 2). For species whose squares are few enough simply to be listed, rather than illustrated by a map, earlier records are termed 'pre', whilst recent ones are termed 'post'. Pre-1970 (*i.e.* earlier) records that were superseded by recent ones were not usually retained in our files, unless the species concerned is rare in Kenya.

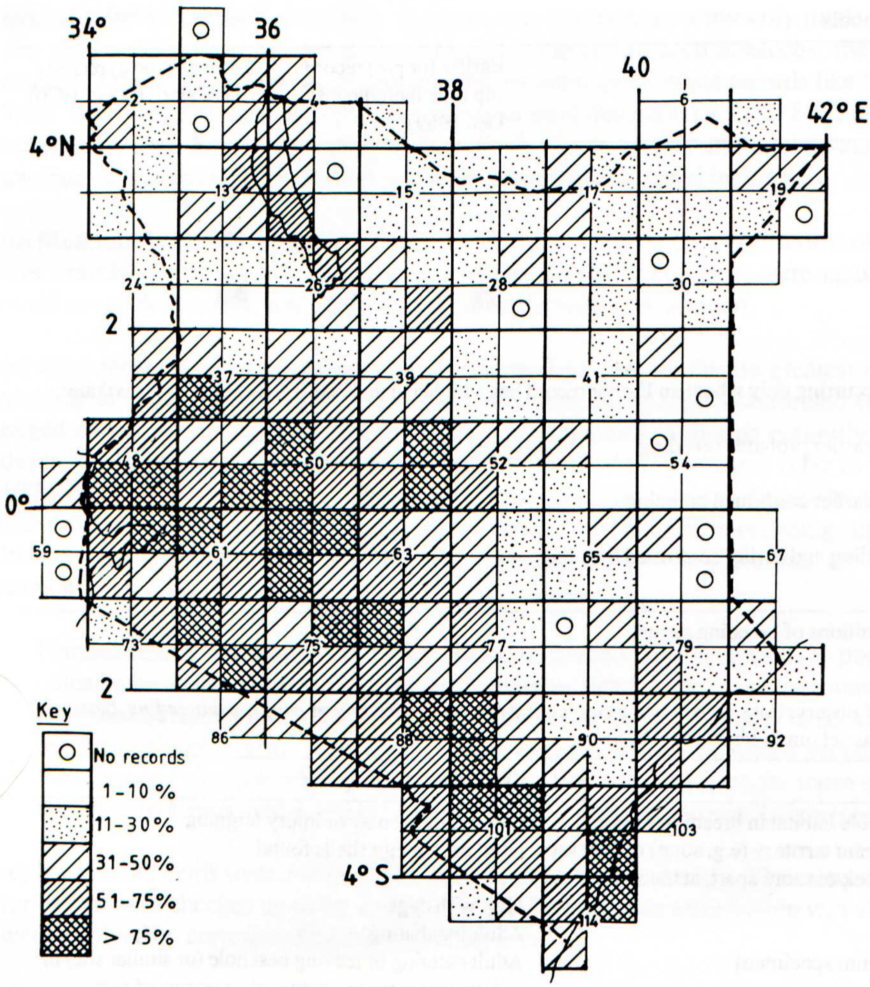

Fig. 3. The estimated coverage of each QSD when data-collection ended. For details, see text.

The application of the terms 'probable breeding' and 'confirmed breeding' follows a widely used system in Europe (Table 3). A few minor modifications have been made; for example in species for which there is no known evidence of migration, such as most cisticolas, an adult feeding young away from a nest is considered as confirmed breeding.

Where necessary, we corresponded with observers to clarify the categories of their records, or concerning any unusual records or those with insufficient detail. Records of rarities or of species seen in unusual localities (category 'S' of the EABR (see for example EABR 1983, p. 107)) are included only if they have been accepted by the Ornithological Sub-Committee of the EANHS. Other records of less common species were adjudicated by ourselves, basing our judgement on (a) ranges accepted by Britton (1980a), (b) the premise that distributions invariably follow some pattern, related to the species' ecology, and (c) our personal experience.

The atlas shows the broad patterns of distributions of birds on a national scale, rather than specific localities. In a small proportion of cases, records which could not be located precisely were entered in the square where we thought it most likely that they had been made. This happened more frequently in the drier parts of Kenya, where topographical maps show so little detail that the observer himself often experiences difficulty in knowing his precise location.

Although the title of this book is *A Bird Atlas of Kenya*, a few of the observations included on the maps were made just outside the country, although within a square that is also partly Kenya (examples of such QSDs are 2C, 31A, 48A and 86B). This is because many of the areas along Kenya's borders are poorly covered by birdwatchers and by including records from border squares, regardless of which side of the border they come from, the patterns of distribution become clearer. However, this procedure was not followed when (a) the species concerned was rare in Kenya or new to the Kenyan avifauna, or (b) the record came from a habitat not found in the Kenyan part of the square.

Full information has been kept on all unusual records, so that if necessary re-assessment will be possible in the future. All records relating to the Atlas, except those derived from published sources, are deposited in the National Museum, Nairobi, and the Library of the British Museum (Natural History) at Tring. Copies of the computer diskettes used to produce the maps are also held by both of these institutions.

Methods of compilation

Data from all sources, after checking where necessary, were entered into copies of the *Check-list of the Birds of Kenya* (OS-C 1981), using one column for each QSD. For the less usual records, the entries were initialled for easy reference to their sources. In turn, the data from the check-lists were used to prepare draft maps for each species: there were thus two complete sets of data in addition to the original records from which they were compiled.

The maps in this atlas are reproduced from originals made on a BBC Microcomputer Model B, using a programme by A.R.D. Taylor (see Appendix). To ensure accuracy, the computer maps have been carefully checked against the hand-entered originals. There were two major advantages in entering the data into the computer: firstly in producing the maps, and secondly in analysing the distributions (see p. 13).

Coverage

Figure 3 shows the estimated coverage for each QSD, based on the method of Pomeroy & Lewis (1983). Briefly this was as follows. We assumed that the number of species recorded from a square reflected both habitat diversity and observer effort. Two measures of habitat diversity were used: the altitudinal range within the square, r, and the number w of types of water body it contained. Observer effort, e, was scored on a 10-point scale, with a maximum of 5 for effort by observers resident in the square and a further 5 for visiting birdwatchers. Using updated data for 33 comparatively well-known QSDs, we derived a multiple linear regression to predict the number of species, S:

$$S = 255.5 + 0.033r + 24.6w + 19.2e$$

The equation was highly significant statistically ($P << 0.001$).

We then proceeded to estimate the maximum number of species to be expected from each QSD on the assumption of maximum observer effort (i.e., e was set to 10). Then the observed numbers of species for each QSD were expressed as percentages of the estimated maxima, and the results plotted to give Figure 3. No allowance was made for part squares having a smaller area.

The highest estimated total of possible species for any one QSD is 643, shared by 36D and 63A; they include Mts Elgon and Kenya respectively. The highest actually achieved were 618 in 75B (Nairobi: 100% of estimate) and 552 in 62A (Nakuru: 90%).

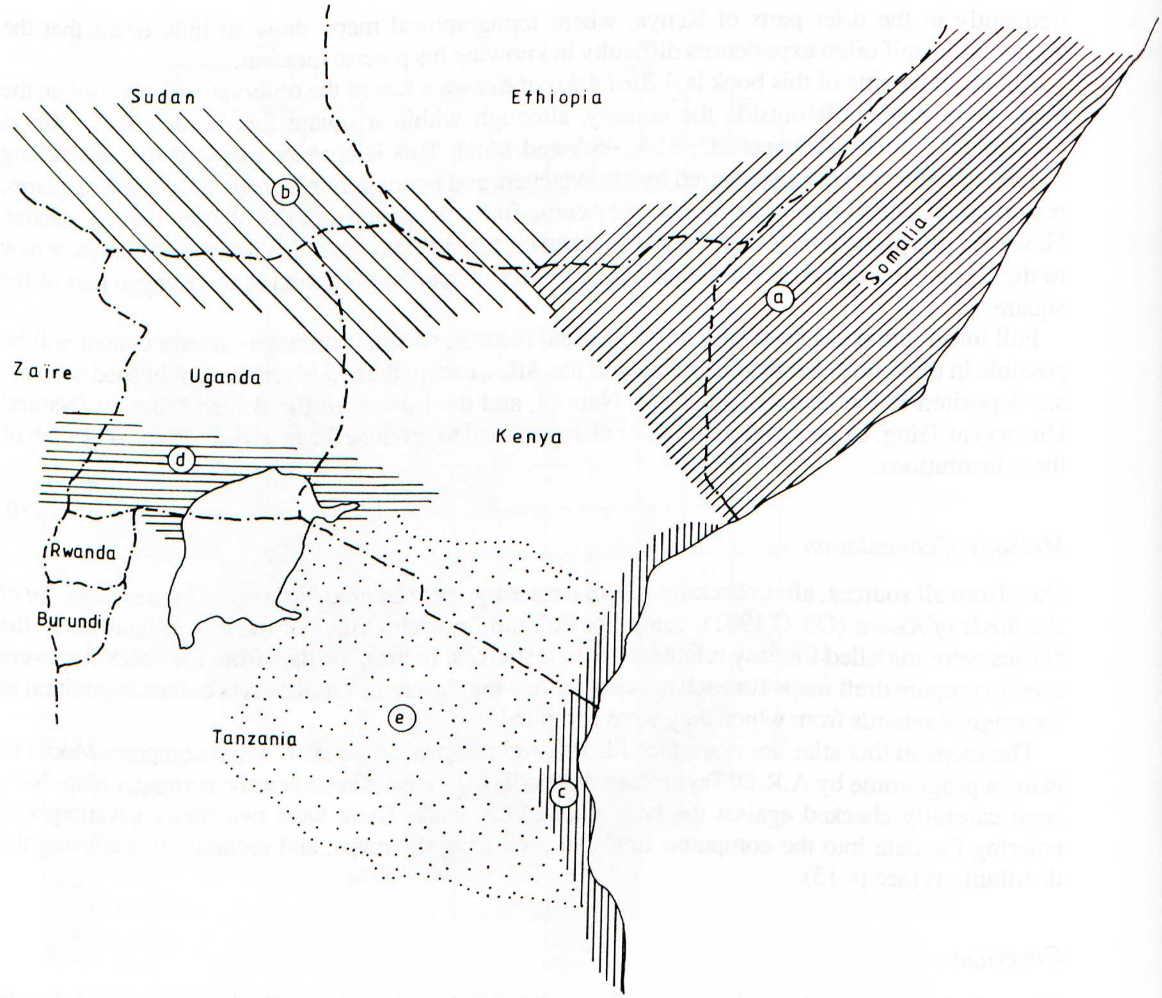

Fig. 4. Five types of distribution of species which reach the limits of their range in Kenya. (a) the dry Horn of Africa; (b) the dry northern tropics, including the Sahel; (c) the eastern coastal strip; (d) the moist west; (e) the southern tropics. For further details, see text.

But even for the driest squares, the predicted number of species is 448, were they to be intensively watched over a period of years. The fact that 474 have already been recorded for the arid Voi square (101B: 88%) shows that it is indeed possible. Many species are added to the list of such squares after rare but spectacular spells of prolonged rain, such as much of Kenya experienced in 1977.

Only 13 QSDs completely evaded observation. Luckily, they are widely scattered, principally in the east where the topography and vegetation are comparatively uniform. Two others (59BD) are in Lake Victoria. We believe that despite these gaps the *patterns* of distribution for all but a few species are clear from the maps. Nevertheless, it is also true that from our estimates, a coverage of more than 50% was only achieved in 72 squares, almost all of them in the highlands and coastal regions. Thus, Kenya's highland avifauna is in general well covered, whilst the dryland squares, almost equal in richness and diversity, are not. Compare, for example, the distribution of the Tawny-flanked Prinia

(743), for which coverage is probably complete or nearly so, with its equally conspicuous dry country relative, the Pale Prinia (744), where large gaps are apparent. For less conspicuous species, the dry country coverage is apt to be poor: see for instance Red-naped Bush Shrike (848) and Grosbeak Canary (1060).

Breeding data for dry country species are particularly sparse. It is obvious for example that Williams' Bush Lark (535) must breed in Kenya, since it is endemic, yet we do not have a single breeding record. It is in fact difficult to obtain breeding records in arid areas, because a majority of the species there only breed after rains, which are sporadic, and which also make many such areas impassable by road. Such coverage as there is for dry country species' breeding is largely confined to the more accessible places like the Tsavo 89C 101AB and Amboseli 88C National Parks, or the few localities where birdwatchers have been resident, such as Baringo 50A and Wajir 42A. Thus for species with a wide distribution, such as the Little Bee-eater (442), the apparent lack of breeding in the north could be real, but might equally well reflect the lack of observers. This source of bias must be borne in mind when interpreting maps of dry country species.

INTERPRETATION OF THE MAPS

Our present knowledge of the requirements of most bird species is very limited, yet such information can be of vital importance in understanding their distributions and conservation needs. Conversely, by attempting to analyse distributions we may gain insights into the species' requirements.

Distributions can be considered at two levels. Firstly there is the species' *range*, which is the overall geographical area within which it occurs. The maps in Brown *et al.* (1982) and Mackworth-Praed & Grant (1957, 1960) are of this type. Secondly, there are the particular localities within that range where the species is found: these are largely a reflection of its habitat requirements. The maps in this atlas, whilst showing more detail than the overall range, are not of large enough scale to show individual localities. As an example, the Common Bulbul (609) has a range which includes almost the whole of the Afrotropical Region and extends into the Palearctic. But even within Kenya it is absent from some parts, notably the montane zones and open grasslands, whilst in the drylands it is largely confined to wooded habitats along watercourses.

Types of distribution

Several attempts have been made to analyse the distributions of birds in the Afrotropical Region as a whole (notably Moreau 1966, Crowe & Crowe 1982), or substantial parts of it (*e.g.* Diamond & Hamilton 1980).

Many types of distribution are represented on the maps in this atlas. Firstly, on a global scale, Kenya represents only a very small part of the world range of such species as the Osprey (141) and the Barn Owl (381). A larger number of species occur throughout most of the Afrotropical Region, *e.g.* the Hamerkop (44), the Didric Cuckoo (374) and the Drongo (566). Some Palearctic species also occur throughout the Afrotropical Region during the northern winter: the Wood Sandpiper (263) and Eurasian Swallow (553) are in this category. At the other extreme are Kenya's most localised endemic species, *e.g.* the Sokoke Scops Owl (383) and Clarke's Weaver (959), both restricted to the Sokoke-Arabuko Forest 102B (see p. 28).

Species at the edge of their range

There are a large number of species that occupy discrete areas of the Afrotropical Region, and many of these reach the edge of their range in Kenya (see p. 31). Five categories can be recognised (Fig. 4).

a) Birds originating in the Horn of Africa, *i.e.* Ethiopia, Somalia and perhaps north-eastern Kenya, and having their western or south-western limits in Kenya or north-eastern Tanzania. Examples include Somali Bee-eater (451), Pale Prinia (744), Golden Pipit (824), Shelley's Starling (888) and Golden-breasted Starling (893).

b) Species that occur from the west of Africa across the northern tropics, in some cases along the arid southern edge of the Sahara (the Sahel), to reach the south-eastern extremity of their range in north-west Kenya. Examples include Fox Kestrel(157), Abyssinian Roller (453), Red-breasted Wheatear (637) and Yellow-billed Shrike (868).

c) Species confined to the east coast of Africa, extending only limited distances inland, *e.g.* Mangrove Kingfisher (440), East Coast Batis (797), Black-breasted Glossy Starling (877), Mouse-coloured Sunbird (936) and Zanzibar Red Bishop (973).

d) Species from the west African equatorial forests or adjacent lowlands which extend eastwards to Kakamega and other western forests. Examples are Grey Parrot (346), Grey-throated Barbet (489), Splendid Glossy Starling (882), Green-throated Sunbird (933) and Red-headed Malimbe (968).

e) Species which, widespread in southern Africa, have their northern limits in southern Kenya. Examples are Rufous-bellied Heron (33), Dickinson's Kestrel (154), Brown-hooded Kingfisher (437), Green-capped Eremomela (766) and Southern Red Bishop (971).

Ecological factors affecting distributions

Within its overall range, the distribution of a species reflects its ecological requirements. In some cases these are obvious – Pel's Fishing Owl (388) is virtually restricted to large rivers, the Scarlet-tufted Malachite Sunbird (928) to the montane zones and the Mountain Greenbul (615) to highland forests.

However, amongst the more widespread species, factors that limit their distributions are often less obvious. Indeed, the requirements of the majority are simply not known, for even though we can say that the Buff-bellied Warbler (749) is 'characteristic of acacia canopies in bushed, wooded and forest edge environments', it is not the trees themselves that it needs (except for nest sites), but certain of the insects that live on them. There are likely to be several hundred species of insects to be found on a tree such as *Acacia xanthophloea*, only comparatively few of which will be taken by the warbler. The almost total lack of knowledge at this level prevents us from achieving a better understanding of birds' distributions.

One of the more puzzling patterns of bird distribution in Kenya, seen in a number of species, consists of two more or less separate populations, one at the coast and the other in the highlands. It is true that these are the wettest areas of Kenya (see Fig. 6) but in fact rainfall at the coast is substantially lower than in the highlands, and, because it is hotter and has a fairly severe dry season, the coast is much less humid (Fig. 7). Furthermore, the structure and composition of coastal forests is very different from those in the highlands. In many species with both coastal and highland populations, two races are involved, suggesting that they have begun to evolve differences in the two areas in response to the different environments. Examples are the Speckled Mousebird (425), Black-headed Batis (798) and Black-winged Red Bishop (974).

Nevertheless, there are several environmental variables which are well known to influence distribution, albeit indirectly in most cases. For aquatic species, the extent and type of water bodies are obviously important. Similarly, many bird species, both aquatic and terrestrial, are restricted to a certain range of altitudes. It is extremely unlikely that they are actually responding to altitude itself, but to a large extent altitude determines temperature. In turn, temperature controls many aspects of plant growth, and all birds depend, directly or indirectly, upon plants. So by relating bird distributions to altitude, we are taking a short cut: and altitude is familiar and easy to determine.

Another major influence, particularly on terrestrial species, is that of rainfall. Some species, such as sandgrouse and doves, need water to drink, but the main effects of rainfall are again indirect, especially through plants. Three aspects of rainfall are important: its amount, its seasonality and its reliability. The last of these is quite closely correlated with the first: the lower the mean rainfall, the less reliable it is.

Taken together, temperature and rainfall are important in determining the type of natural vegetation to be found in an area; a third factor is soil type, which can modify the vegetation considerably. Increasingly too, man himself is deciding upon the type of vegetation he wants on his farm or in his garden or pond, although he too is constrained to some extent by temperature, rainfall and soil.

We have already mentioned man's impact upon the distributions of birds through such activities as deforestation (see p. 3). But of course some birds have spread as a result of man's activities. A good example is the Little Swift (424) which, formerly confined to the vicinity of cliffs for breeding, has increased both its range and numbers by nesting on permanent buildings. Also spreading is the House Sparrow (992), which was introduced to the coast by man early in this century. Its numbers remained low for many years but in the early 1980s it began spreading quite rapidly inland, apparently following the road from Mombasa 114B towards Nairobi 75B (Lewis 1983c).

Relating distributions to climate and vegetation

In preparing the text for each species, we used a series of transparent overlays, which are reproduced as Figures 5-11. Three of them, for altitude, rainfall and wooded habitats, also appear on the overlay accompanying this book. They are designed to fit over the atlas maps of individual species, to enable the reader to examine correlations of environment and distribution at first hand.

Before proceeding, we would add a word of caution. The existence of a correlation between, for example the distribution of the Dusky Turtle Dove (332) and areas of high altitude, does not *prove* that the dove prefers high altitudes. In fact, as we suggested earlier, it is the plants which provide the dove's food that are likely to matter most to it, and the distributions of the plants may quite possibly be determined by temperature: many highland species are unable to thrive at the higher temperatures of lowland areas.

We considered five environmental factors in relation to the distributions of birds in Kenya: altitude, rainfall, moisture, forests and woodlands, and, for aquatic species, types of water bodies.

Altitude

The altitude overlay (reproduced also as Fig. 5) shows the approximate *average* altitude of each QSD. The information was taken from the 1:250 000 topographical maps of the Survey of Kenya. Clearly, average values have more meaning for parts of the country where the altitudinal range within a QSD is relatively small, as in the east and much of the north, than for mountainous regions. The most extreme case is QSD 63A, which contains Mt. Kenya and has a range exceeding 3500 m. But despite being a rather coarse measure, average altitudes vary sufficiently for the general pattern of the highlands, the eastern plateau and the coastal plains to show clearly.

A good example of a species whose distribution correlates clearly with altitude is the Singing Bush Lark (527), which is mainly found above 400 m but below 1800 m. In contrast, the Robin Chat (670) is a typical highland species, rarely seen below 1500 m.

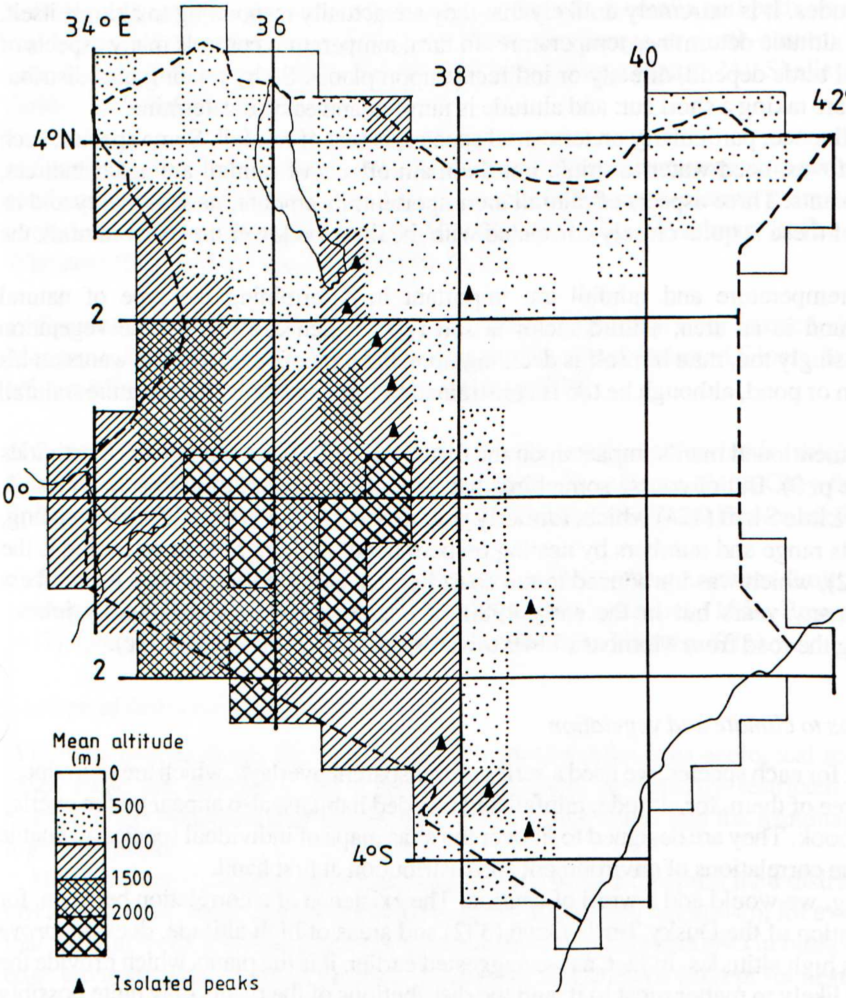

Fig. 5. Mean altitude for each QSD, and important outlying mountains. Based on Survey of Kenya topographical maps.

There are a number of isolated mountains in northern and eastern Kenya, such as Mt Marsabit 27D 28C and the Taita Hills 101A, which support characteristic species. The more extensive of these are also indicated on the overlay, helping to interpret the distributions of some of the species occurring near their summits. Examples are the Eastern Double-collared Sunbird (922) and the Montane White-eye (938).

Rainfall

The *National Atlas of Kenya* (Survey of Kenya 1970) provides a map showing mean annual rainfall for the whole country, and this was used as a basis for Figure 6 and the corresponding overlay. There is a distinct similarity between the patterns of Figures 5 and 6: but there are important differences too. Most notable is the zone of higher rainfall along the coast.

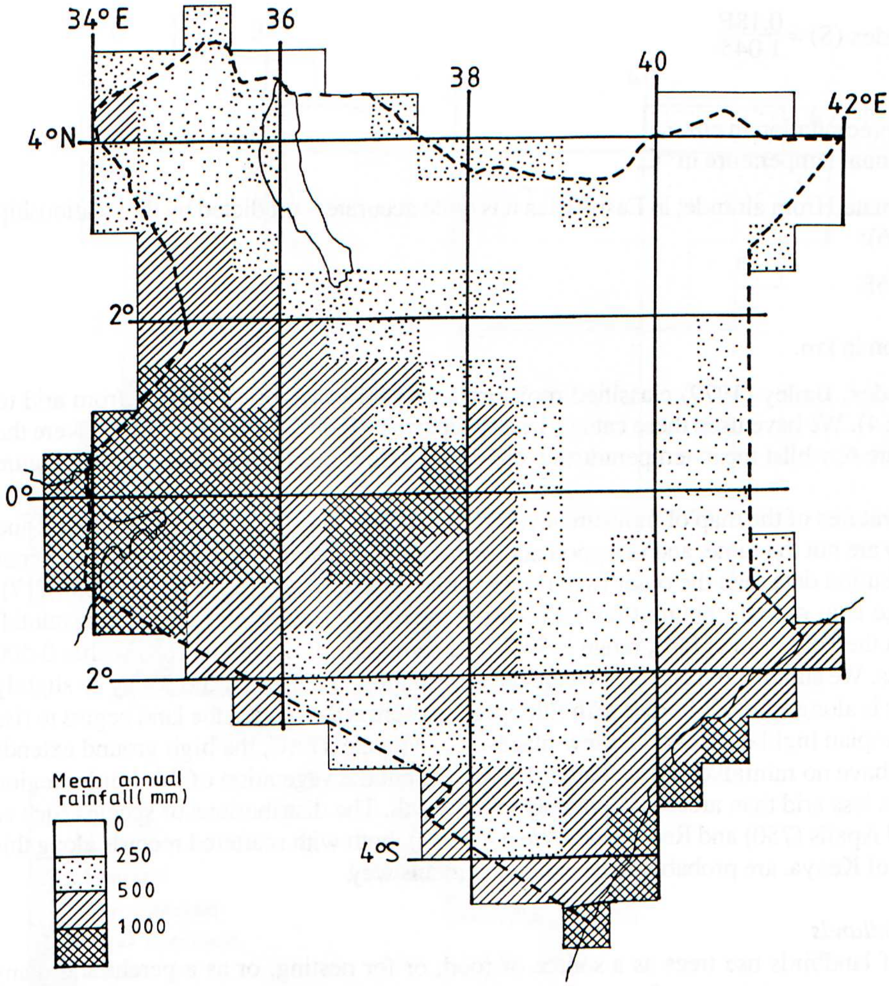

Fig. 6. Mean annual rainfall for each QSD, based upon maps in the National Atlas of Kenya (Survey of Kenya 1970).

Good examples of species whose distributions apparently reflect rainfall are the Tawny-flanked Prinia (743), characteristic of areas with more than 500 mm yr^{-1} of rain, both coastal and inland; and the Pale Prinia (744), almost confined to areas with less than 500 mm yr^{-1}.

Moisture index

The indirectness of the effects of both altitude and rainfall on bird distributions has led us to consider another measure, namely a moisture index. Many studies have shown that plant growth and production are closely correlated to both temperature and rainfall (see for example Leith 1972). These two parameters contribute to estimates of evapo-transpiration, together with estimates of radiation and wind, but the latter are rarely available. We therefore used the simpler moisture index. One of the more generally accepted versions is Bailey's Moisture Index (Bailey 1979), which takes the form:

$$\text{Moisture Index (S)} = \frac{0.18P}{1.045^{t}}$$

where

P = annual precipitation in cm
t = mean annual temperature in °C,

t can also be estimated from altitude; in East Africa it is quite accurately predicted by the relationship (Kenworthy 1966):

$$t = 30.2 - 6.5E$$

where

E = elevation in km.

Based on this index, Bailey (1979) classified moisture levels into categories ranging from arid to perhumid (Table 4). We have used these categories in preparing Figure 7. The rainfall data were the same as for Figure 6, whilst mean temperatures were derived from the altitude data used for Figure 5.

The general features of the map of moisture levels (Fig. 7) clearly resemble those for rainfall and altitude, but they are not the same, and in a good number of cases the moisture map provides a better 'fit' to the distribution data than the other two. For example, in the Wing-snapping Cisticola (717), 90% of the range is in moist subhumid-humid areas, compared to 63% in the 1000+ mm rainfall category. And in the Pale Prinia (744), range is 93% arid-semiarid, compared to 78% within 0-500 mm rainfall areas. We should note one area where the information in Figures 6 and 7 may be slightly misleading. This is along Kenya's border with Ethiopia. Just across the border, the land begins to rise towards the Ethiopian highlands, and in a few places, *e.g.* Moyale 17AC, the high ground extends into Kenya. We have no rainfall data for southern Ethiopia, but the vegetation of this border region suggests that it is less arid than areas immediately to the south. The distributions of species such as Yellow-breasted Apalis (750) and Red-headed Weaver (969), both with scattered records along this northern border of Kenya, are probably to be explained in this way.

Forests and woodlands

Many species of landbirds use trees as a source of food, or for nesting, or as a perch: and many waterbirds also nest or perch in trees. In non-forested areas too, the numbers of bird species increase

Table 4. Categories of moisture, based on Bailey's (1979) Moisture Index, which see for further details

Value of Moisture Index, S	Term	
		Most arid
1.2	Arid	
		Less arid
2.5		
	Semiarid	
4.7		
	Dry subhumid	
6.4		
	Moist subhumid	
8.7		
	Humid	
16.2		
	Perhumid	

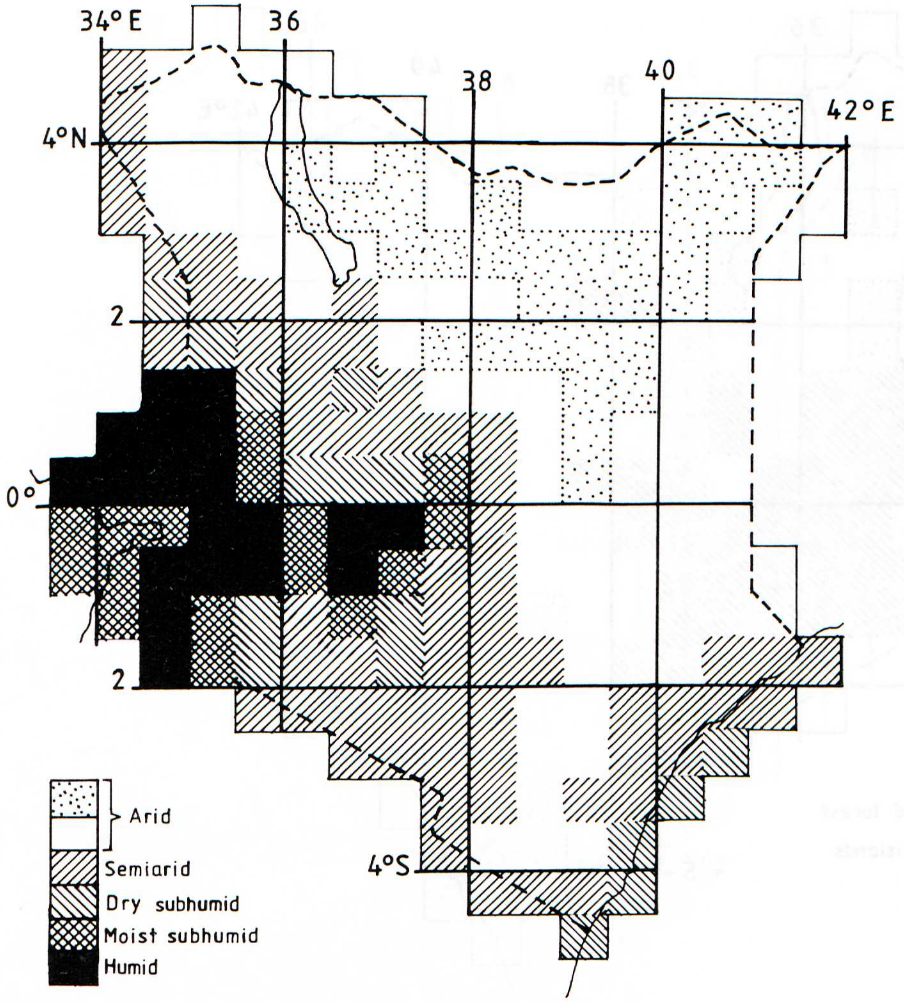

Fig. 7. Values of Bailey's Moisture Index for each QSD, determined as described in the text. See also Table 4.

in proportion to the amounts of woody vegetation – that is, trees and shrubs (Pomeroy & Tengecho 1986). However, by far the greatest bulk of woody vegetation is to be found in forests, which in the tropics are extraordinarily rich in insect species. These in turn support a rich diversity of birds, almost all of them breeding in the forest. (In contrast, whilst semiarid woodlands may support as many species of birds as a forest, far fewer of them breed in any particular woodland (Pomeroy & Lewis 1987).)

In Figures 8 and 9, forests and woodlands are shown separately, but are combined on the overlay. Ecologists generally define forests as places where the canopies of the trees form a continuous layer, and indeed canopies of individual trees commonly overlap each other. We took the distribution of forests mainly from the 1:250 000 topographical maps of the Survey of Kenya, supplemented by our own field knowledge and that of several colleagues. The minimum extent of forests considered for Figure 9 and the overlay was not defined precisely but was never less than 2 km² and usually more than 10 km². Several types of forest were included.

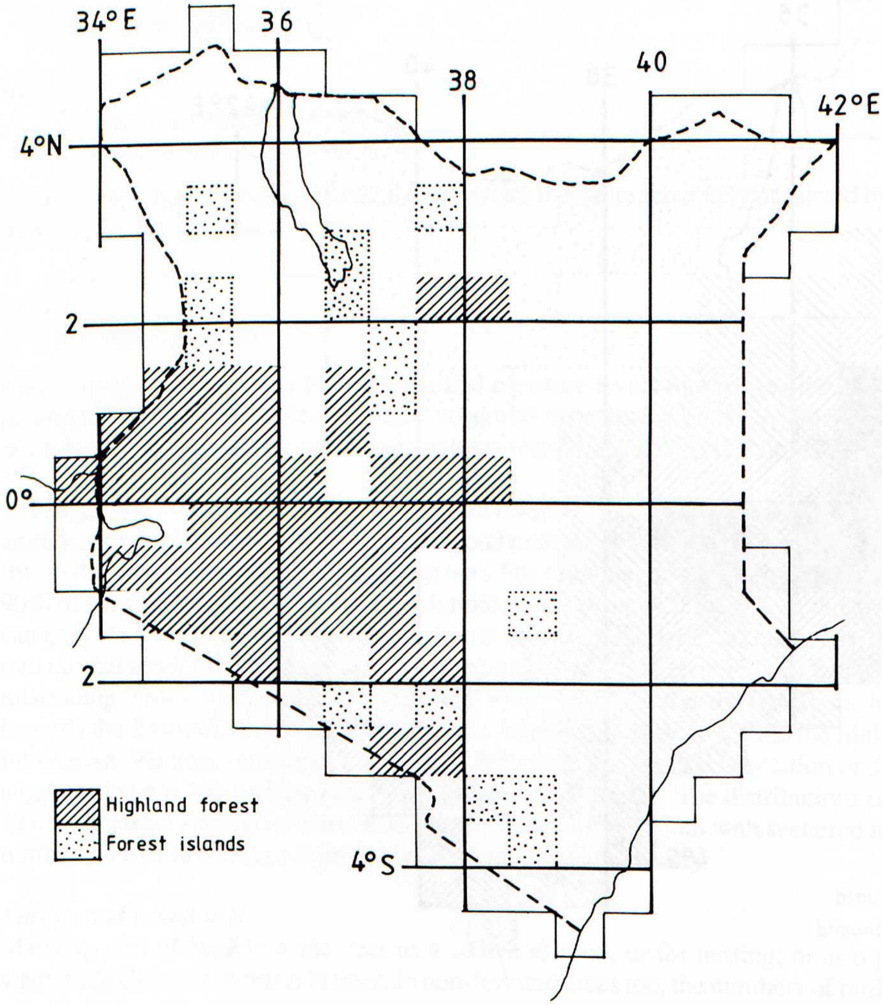

Fig. 8. Distribution of QSDs containing highland forests or forest islands.

a) Highland forests, generally above 1500 m, *e.g.* Marsabit 27D 28C, Aberdares 62BD, Kenya 63AB, Elgon 36D and Mau 61BD 62C. On lower slopes in the drier areas, *e.g.* Cheranganis 37CD and Ngurumans 74D 75C, forest gives way to woodland. Many highland forests are dominated by bamboo at higher altitudes (mainly above 2500 m (Lind & Morrison 1974)). The only published studies of highland forest birds in Kenya are those of Zimmerman (1972) and Carlson (1986a).

b) Island forests are of great interest and importance (see for example Diamond & Keith 1980). Higher altitude forests are found on most of the isolated peaks shown on Figure 5; medium altitude forest islands include the Chyulu Hills 88D and Mt Endau 77B. Groundwater from the Chyulu Hills supports an important forest at nearby Kibwezi 88B. Each of the forests in this category is separated by a considerable distance from the others and from the main highland forest blocks. The significance of this in terms of species distribution is discussed on page 14.

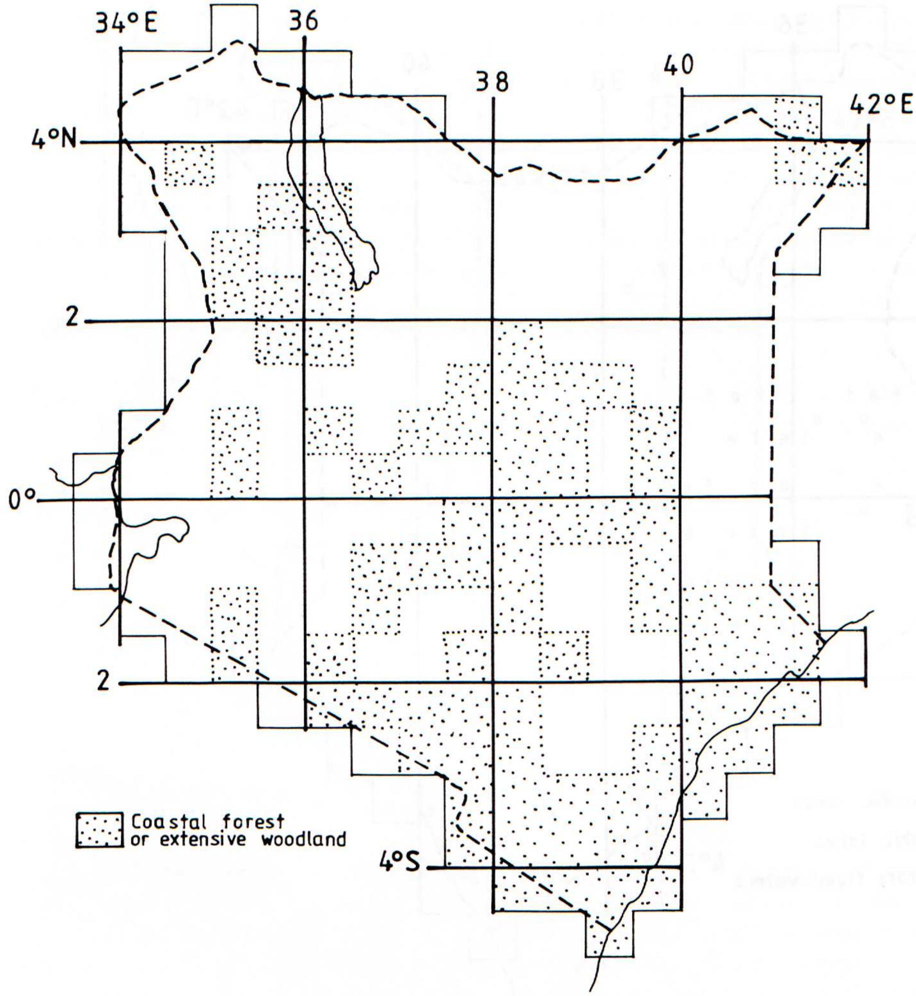

Fig. 9. Distribution of QSDs containing lowland (coastal) forest or extensive woodland.

c) Lowland forests in Kenya are restricted to the coastal strip, and the lower reaches of the Athi and especially Tana rivers. They give way to woodlands on their inland, drier sides. The Sokoke 102B and neighbouring coastal forests were important refuges during the dry glacial periods, and support two endemic species (Britton & Zimmerman 1979).

d) Woodlands. We follow Pratt & Gwynne (1977) in defining a woodland as a place dominated by trees whose canopies cover more than 20% of the land area. The trees are not necessarily tall – some species of *Commiphora* and *Acacia* are only 4-5 m high. Unlike forests, the ground layer of woodlands is typically dominated by grasses. All non-forested squares contain some woodland, particularly along watercourses, but in Figure 8, and the corresponding overlay, we have shown only those QSDs where there is a substantial area. Good examples of extensive woodlands are those along the Turkwell river in northern Kenya 37A 14C, and south of the Athi river in the Kiboko-Voi 88B 101B region. Studies of woodland birds include Lack (1985) and Pomeroy & Muringo (1984).

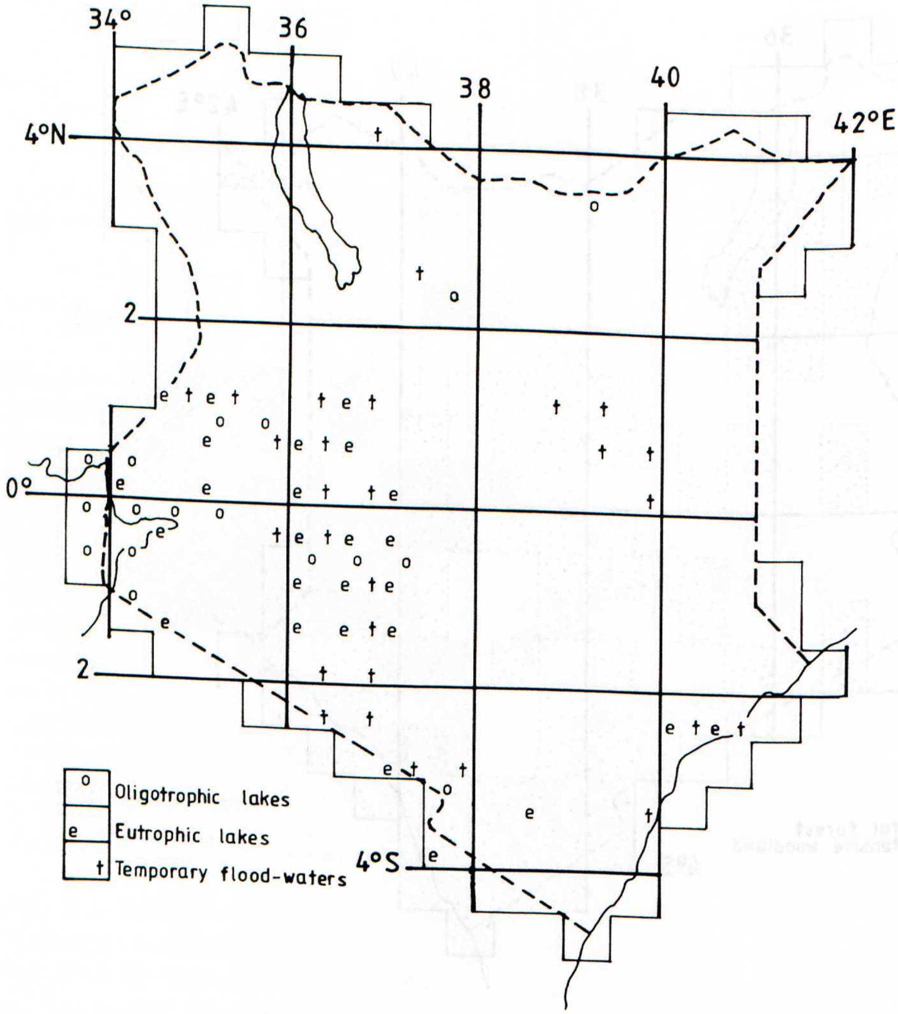

Fig. 10. Distribution of QSDs containing freshwater lakes and temporary flood-waters.

e) Exotic plantations are not distinguished in Figure 8 because all of the larger ones occur in areas where some natural forest remains. So far, only one brief study of these potentially important forests has been made (Carlson 1986a).

Aquatic habitats

Most if not all of the major types of aquatic habitats of tropical Africa are to be found in Kenya: certainly there is a rich diversity, and more than 200 waterbird species have been recorded (Table 1).

a) Marine. The Kenya coast is dominated by two major habitats: sandy beaches and mangrove forests. There is a fringing coral reef along much of the coast, and some offshore rocky islands. Each of these has its characteristic fauna. There are however no breeding sites of pelagic species such as boobies or frigatebirds.

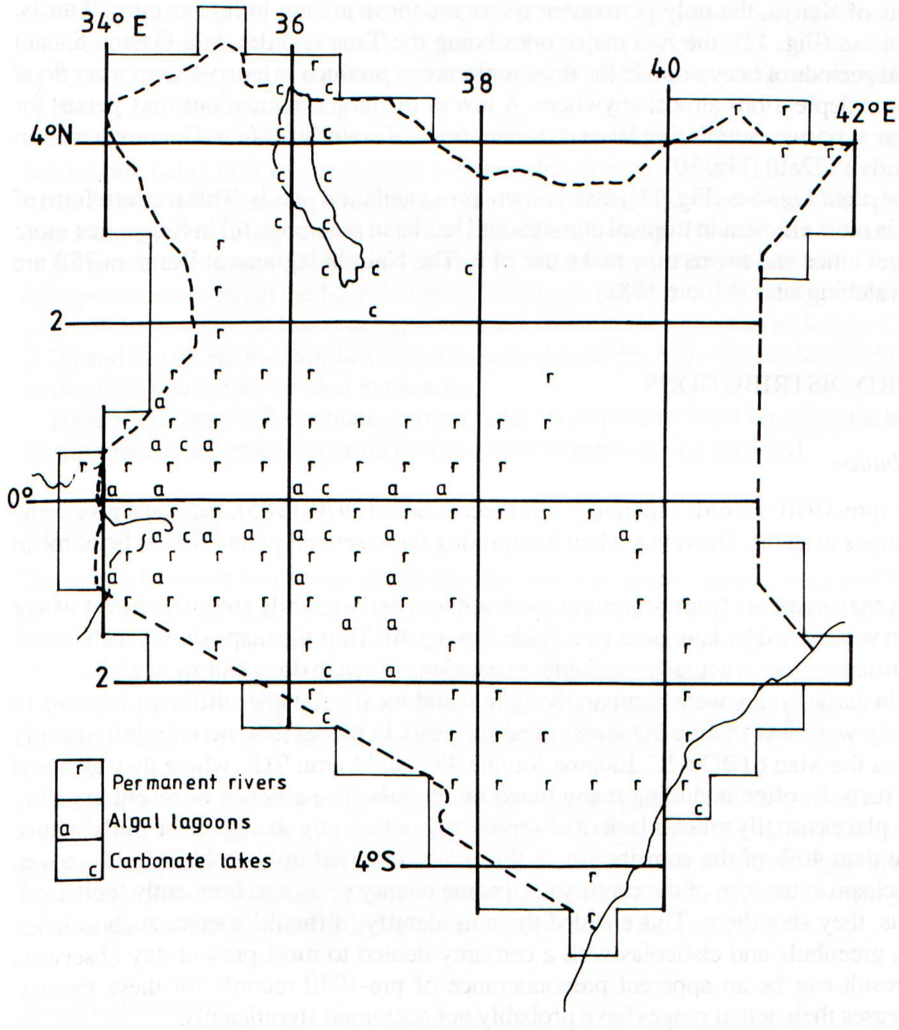

Fig. 11. Distribution of QSDs containing other important water bodies.

The largest concentrations of shorebirds are associated with tidal creeks and estuaries, notably Mida Creek 102B, the Sabaki estuary 103A and the Lamu archipelago 91B 92A, although much of the latter is fringed with mangrove.

b) Inland waters. The numerous *lakes* in Kenya vary greatly in size and composition. Lake Victoria consists largely of water from rain falling directly on to its surface, and consequently it has a low concentration of nutrients. The flora and fauna are correspondingly sparse: it is said to be *oligotrophic* and is one of several such lakes in Kenya (Fig. 10).

Many of the smaller lakes have a higher nutrient status: these *eutrophic* lakes such as Naivasha 62C and Baringo 50A are more productive. A few have very high concentrations indeed of nutrients, especially carbonates, and are generally referred to as 'soda lakes', although the term *carbonate* lake is more appropriate. Well known examples are Turkana, Bogoria 50C, Nakuru 62A and Magadi 75C (Fig. 11). There is an extensive literature on some of these (*e.g.* Vareschi & Jacobs 1985).

In the drier parts of Kenya, the only permanent rivers are those arising in higher rainfall areas. There are few of these (Fig. 11), the two major ones being the Tana and the Athi-Galana-Sabaki system. Occasional periods of heavy rain in the drier regions can produce extensive *temporary flood water* in hollows and depressions almost anywhere. A few of the larger inundations may persist for months or even a year or two, supporting large concentrations of waterbirds (*e.g.* Cunningham-van Someren & Richards 1977ab) (Fig. 10).

Finally we show *algal lagoons* (Fig. 11), also known as oxygenation ponds. This modern form of sewage treatment is most efficient in tropical climates and has been so successful in Kenya that more than 30 of the larger cities and towns now make use of it. The Nairobi lagoons at Dandora 75B are well-known birdwatching sites (Moore 1982).

ANALYSING BIRD DISTRIBUTIONS

Changes of distribution

By showing early (pre-1970) records separately from recent ones (1970-1985), the maps give some indications of changes in status. However, when interpreting these several points should be borne in mind.

i) To prevent map symbols from becoming too complex, early records are only shown where they have not been superseded by later ones (see Table 2 and p. 6). Thus the maps show much less of the pre-1970 information than is actually available; expansions of range do not show at all.

ii) Observers in earlier years were comparatively few and most had rather different interests to those of today. They were less mobile but some lived for years in places that are only infrequently visited now, such as the Mau 61BD 62C, Eldama Ravine 49D and Lamu 91B, where they amassed large numbers of records, often including many breeding records. The absence of recent breeding records from such places usually reflects lack of observers rather than any change in the birds' status. By contrast, more than 40% of the contributors to this atlas are based in Nairobi 75B. Moreover, observers from Jackson at the turn of the century until some twenty years ago frequently 'collected' their birds – that is, they shot them. This enabled them to identify 'difficult' species such as larks, alethes, nightjars, greenbuls and cisticolas with a certainty denied to most present-day observers. Here again, the result can be an apparent preponderance of pre-1970 records for these species, although in most cases their actual ranges have probably not decreased significantly.

iii) Many forest species have obviously declined with the deforestation of large areas of Kenya, most especially the highlands, yet the maps give little indication of this because the QSD is a large unit. Most QSDs in the highlands have much less forest now than a hundred years ago, although they still retain some fragments.

Whilst bearing these facts in mind, we can still discern some probable changes. Despite the large size of a QSD, the maps do suggest losses resulting from agricultural practices.

More detailed studies provide evidence for changes in distribution which, whilst not yet apparent on atlas maps, are likely to be seen in future. Carlson (1986a) found that of 18 species occurring at densities of 1.0 birds ha^{-1} or more in natural forest, only six were found at all in adjacent coniferous plantations, and all at much lower densities. Overall, the natural forest supported about 44 birds ha^{-1}, whilst there were fewer than 11 birds ha^{-1} in the plantations. Interestingly, whilst Palearctic species made up a quarter of the plantation birds, none was found in the natural forest (see p. 28).

Changes taking place in dry woodlands cleared for cultivation were also pronounced, though less drastic than in forests (Pomeroy & Muringo 1984). Of the 15 commonest species in a natural woodland, 14 also occurred in adjacent cultivation, but every one was less common. However, the total densities of birds in the two habitats were similar because some species, notably doves and weavers, were abundant in the cultivation. Lack (1980) described the changes in bird populations in a part of Tsavo East National Park 101B where most of the woody vegetation had been destroyed by elephants *Loxodonta africana*.

But whilst many of the richer terrestrial habitats are declining, some interesting new aquatic habitats are being created, supporting a remarkable diversity of birds. Pomeroy & Tengecho (1982a) studied three of the many small dams east of Nairobi 75B, and found 59 species of waterbirds frequenting them. Oxygenation ponds, such as Dandora near Nairobi, are richer still.

Some well documented changes in bird distributions are hard to explain. No less than 52 of the 618 species recorded in the Nairobi QSD (75B) have not been reported since 1969. It is possible that some of these apparent losses are attributable to habitat change, such as Kenya Crested Guineafowl (178) and Retz's Helmet Shrike (872). But why should the Ashy Flycatcher (785) or Doherty's Bush Shrike (856) no longer be seen in the area?

Habitat changes will continue to occur, and an important function of this atlas is to record bird distributions in a particular period so that future changes can be assessed.

Degree of mobility

The extent to which birds wander outside the breeding season varies considerably. Good examples are to be found amongst the bee-eaters. The White-fronted (441), a highland species, has only once been recorded over 200 km from its breeding range, whereas its congener the White-throated (450), a bird of rather lower and drier areas, is an intra-African migrant.

Evidence for non-dispersion can often be discerned from the maps, even when breeding records are few. Thus the seven breeding squares of the Mountain Greenbul (615) span its total Kenyan range quite well.

Extensive movements are apparent in many aquatic species. The Great White Egret (39) has only bred at five sites in Kenya in recent years, and the Woolly-necked Stork (48) is not known to breed in Kenya at all, yet both species have been recorded over a wide area. Scavengers also travel far: thus it is probable that all breeding colonies of the Marabou (50) in Kenya are known, yet the map shows that the species has been recorded in almost every part of the country.

Species abundance

A few European atlas projects have combined records of distribution with estimates of abundance (Udvardy 1981). The PAOC V meeting recommended that species abundance should be recorded as supplementary data where possible (Ash & Pomeroy 1981). No attempt was made to do this in the case of the Kenya atlas however. There are relatively few data on bird populations in Kenya, although attempts at estimating numbers have been made for a few species of particular interest: thus the Sokoke Scops Owl (383) is believed to number from 1300-1500 pairs (Britton & Zimmerman 1979). Brown (1973a) has given estimates for the population of the Lesser Flamingo (60) throughout Africa, and when the Great White Pelican (16) bred at Lake Elmenteita 62A in 1968, he counted about 1150 pairs, which was the total breeding population in Kenya. From 1979 to 1983, the average breeding population of Marabou Storks (50) in Kenya was estimated at about 265 pairs (Pomeroy 1986).

Regular counts of some waterfowl species have been made for a number of years (Meadows 1979, 1980). Apart from various estimates of flamingo populations between 1954 and 1978 (Vareschi 1978 and Vareschi & Jacobs 1985), these are the only counts in Kenya over a sufficient period for trends to be detected.

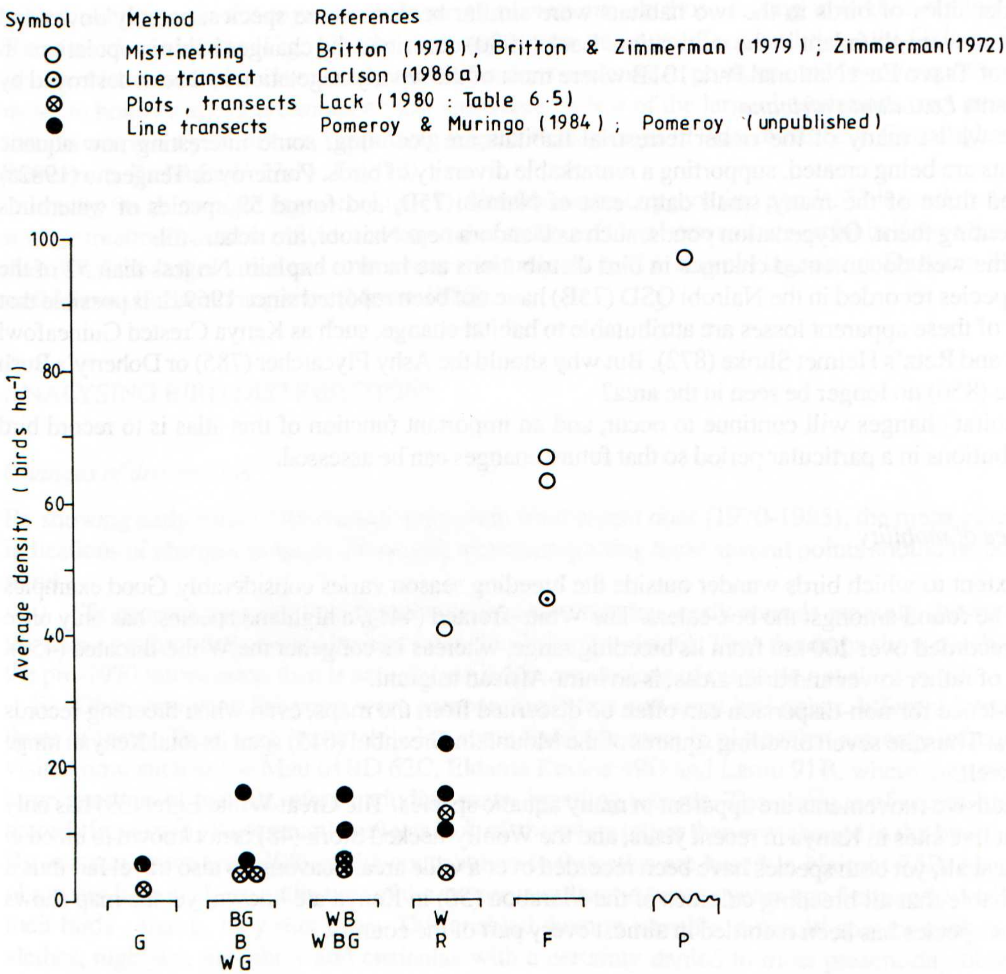

Fig. 12. Estimated densities of bird populations (all species combined) in various natural habitats in Kenya. All are average values, based on series of counts. The habitats are categorised in increasing order of vegetation amount, thus: G (grassland), BG (bushed grassland), B (bushland), WG (wooded grassland), WB (wooded bushland), WBG (wooded bushed grassland), W (woodland), R (riverine forest), F (forest). Exact definitions of these categories are given by Pratt & Gwynne (1977). At the right, P = Papyrus Swamp. As explained in the text, the various data are only rather generally comparable, because of the variety of techniques employed.

Estimates of population density (birds per unit area) have been made for a variety of terrestrial habitats (Fig. 12). The wide range of values probably reflects true differences, despite the fact that several methods were used in deriving them. It is evident that bird populations increase with the amount of woody vegetation (see also Pomeroy & Tengecho 1986). The high figure for papyrus may well be attributed to the high productivity for which this plant is renowned (Jones 1983).

We can safely assume from Figure 12 that, for Kenya as a whole, there must be at least 10 birds ha^{-1}, which would give a population for the whole country of rather more than five hundred million birds.

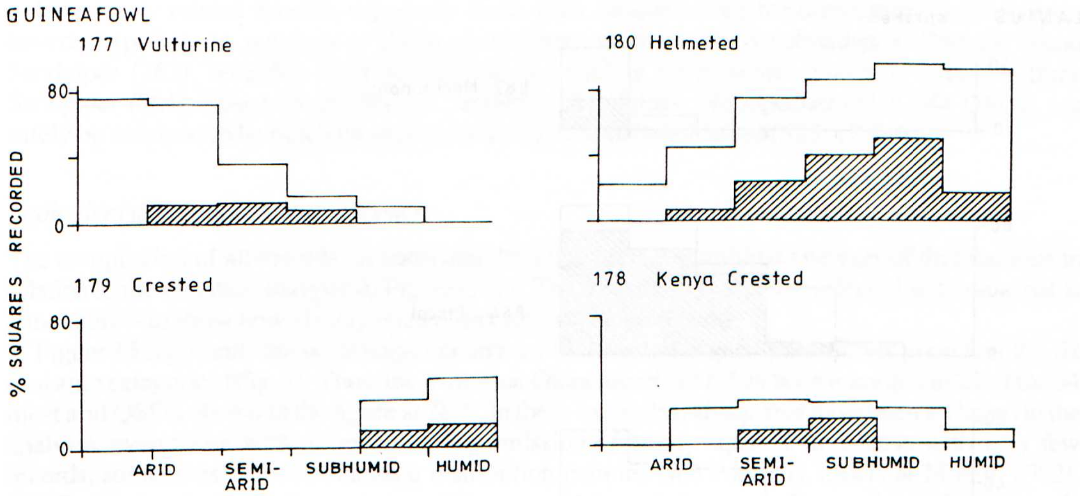

Fig. 13. The proportion of QSDs occupied by all four species of guineafowl in each of the six moisture categories. The shaded areas represent breeding records (including probable breeding). See text for further details.

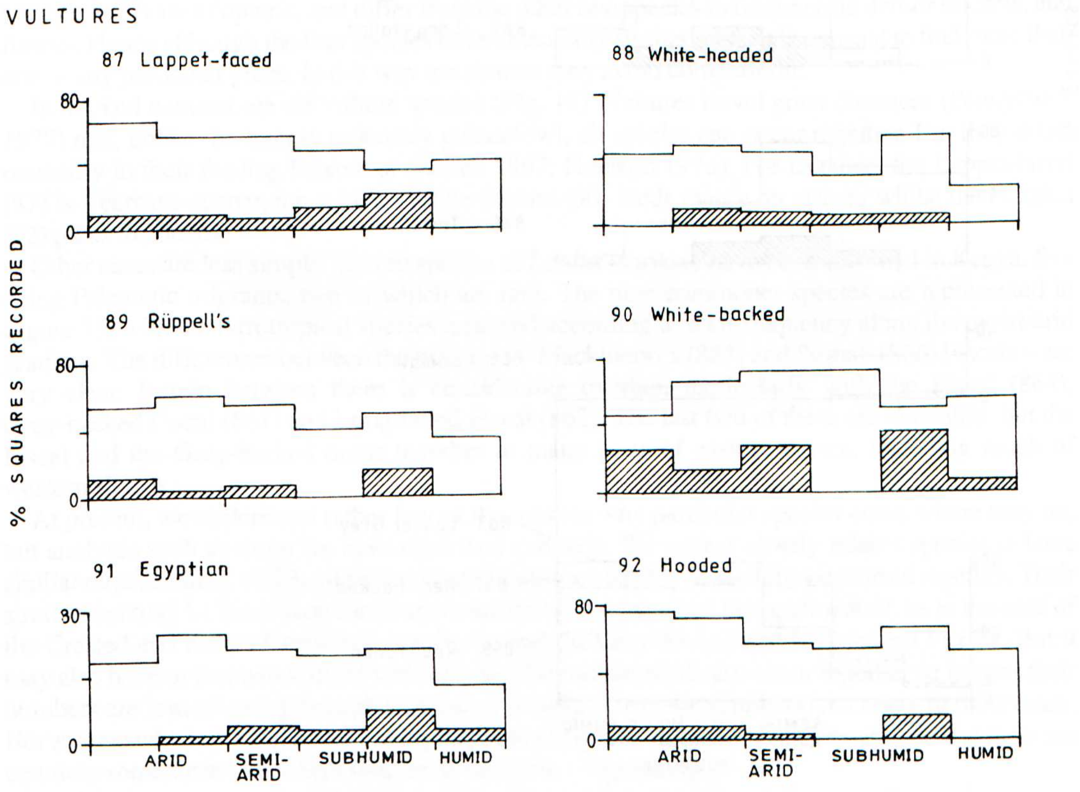

Fig. 14. The proportion of QSDs occupied by six species of vulture occurring in Kenya, in each of the six moisture categories.

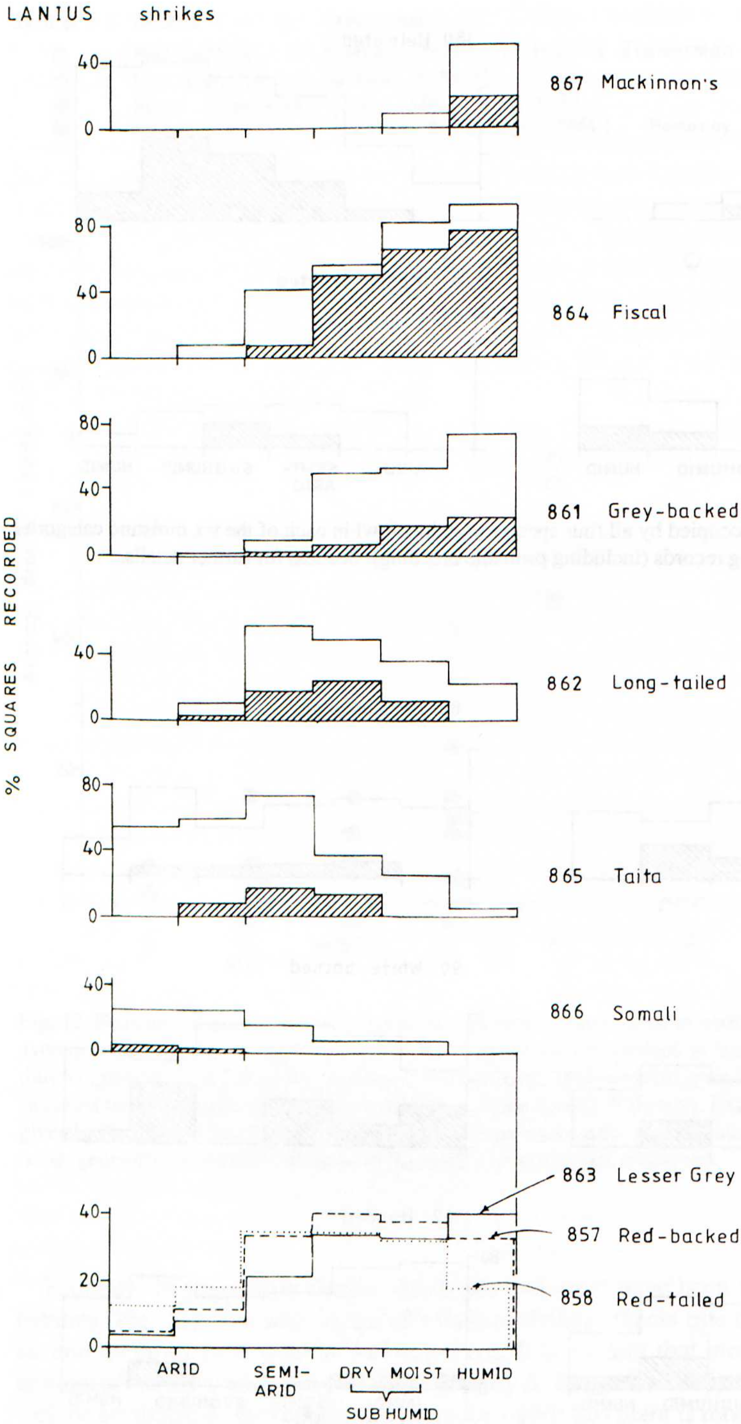

Fig. 15. The proportion of QSDs occupied by shrikes of the genus *Lanius* in Kenya, in each of the six moisture categories. The three Palearctic species, shown at the bottom, are predominantly birds of the moister areas, but they differ ecologically from the resident species.

For closely related species, especially those with similar values for detectability and observer coverage (p. 34), the numbers of QSDs give a rough guide to relative abundance. Thus the Wood Sandpiper (263), recorded from 103 QSDs, is certainly much more numerous than the Terek Sandpiper (264), observed in only 25. Similarly, the Nubian Woodpecker (512: 144 QSDs) can safely be assumed to be much more numerous than the Brown-backed (523: 17 QSDs).

Ecological differences between species

The compilation of all records on computer diskettes greatly simplified analyses of distributions in relation to the variables mapped in Figures 5-11. To illustrate this, we have selected just one variable – moisture – to show how closely related species may be compared.

Figure 13 represents the percentage occurrence of the four Kenyan guineafowls in each of the six moisture categories (Fig. 7). Thus, the Vulturine Guineafowl (177) has been recorded in 27 of the 34 most arid QSDs, shown in the figure at 78%. In these examples, all squares have been included in the analysis, even those with no records. The omission of empty squares, and those with very few records, sometimes helps to elucidate distribution patterns (see Pomeroy, Lewis & Mutere 1982). The figure also shows the percentages of squares with breeding records. Pre- and post-1970 records have been combined.

The four species of guineafowl clearly differ quite markedly in their preferences for moist or arid environments. The contrast between the Vulturine and Helmeted (180) is conspicuous, especially when allowance is made for the scarcity of observers in arid areas. The Kenya Crested (178) and Crested (179) are allopatric, and differ from the other two species in frequenting denser thickets, and forests. Hence although the four species have essentially similar diets, it is unusual to find more than one in any particular place. In this way we assume they avoid competition.

In marked contrast are six vulture species (Fig. 14). Vultures travel great distances (Pennycuick 1972) and, unlike the largely sedentary guineafowl, all species can occur together. But they differ markedly in their feeding behaviour (Kruuk 1967; Houston 1975). For instance, the Lappet-faced (87) is a carcass-opener, the African White-backed (90) feeds manly on viscera whilst the Hooded (92) picks the bones.

Other cases are less simple. Eleven species of *Lanius* (shrikes) have been recorded in Kenya, five being Palearctic migrants, two of which are rare. The nine commoner species are represented in Figure 15, with the Afrotropical species arranged according to their frequency along the moist-arid gradient. The differences between the extremes – Mackinnon's (867) and Somali (866) Fiscals – are very clear. But in between there is considerable overlap, particularly with the Fiscal (864), Grey-backed Fiscal (861) and Long-tailed Fiscal (862). The last two of these are allopatric, but the Fiscal and the Grey-backed occur together in many parts of eastern Africa, including much of western Kenya.

At present, we understand rather few of the reasons why particular species occur where they do, but analyses such as those we have described can help. We expect closely related species to have similar requirements, which might lead to competition between them if they occurred together. Their similarities may be the reason for many members of superspecies being allopatric, as in the case of the Crested and Kenya Crested Guineafowls, and the Grey-backed and Long-tailed Fiscals. But it may also happen that two species with very similar requirements can occur together so long as their numbers are low, allowing enough resources for both. As yet we simply do not know in most cases. But anyone who has watched a vulture party at the height of its frenzied activity can see that there are certainly some instances where species do compete – vigorously.

Further examples are given in Pomeroy, Lewis & Mutere (1982) and Pomeroy (in press, c).

Restricted distributions: endemic species

Whilst most of Kenya's species occur in other countries too, a few are confined to Kenya, and are known as Kenya *endemics*. In addition, a good number of species have races restricted to some part of Kenya. Clearly endemic species and races have limited distributions, a situation which can arise in one of two ways. They may be the surviving relicts of a formerly widespread species, or they may have evolved where we find them today and never spread far from their origin.

There are several reasons why the range of a species may expand or contract – but the biggest cause today is man. Until the recent past, however, changing climate was probably the primary cause. During the past million years or so, the global climate has undergone a series of cold 'glacial' periods, which were comparatively dry, and alternated with milder, wetter periods – the interglacials. Many authorities believe that we are at present living in an interglacial period, rather than that the 'ice ages' are over.

During the past few years, evidence has been accumulating to show that tropical Africa was profoundly affected by these climatic changes. The greatest impact was probably on forests, which shrank in the glacial periods, and expanded in the interglacials. Until recently, when man began the process of deforestation, Africa's forests were probably as extensive as they have been at any time in the past million years, and were certainly much more widespread than 10 000 years ago (Diamond & Hamilton 1980). During the last glacial, there was almost no forest in most of the areas of Kenya where, in 1850, forests were extensive: the highlands, Aberdares 62BD, Mts Elgon 36D and Kenya 63A, and the west, including Kakamega 48D, Nandi 49C and much of the Lake Victoria basin. The only significant area of forest in Kenya that did survive this cold, dry period was at the coast; other forest islands survived in western Uganda, and on several of the lower mountains in Tanzania, most notably the Usambaras.

Those isolated forest refuges which survived the glaciations all contain endemic species – ones that have not subsequently spread as the forests have spread in the past 10 000 years. (See Stuart (1981) for a detailed review of this subject.) There are six endemic species of birds in the Usambaras, and four in the coastal forests of East Africa (two of them endemic to Kenya: the Sokoke Scops Owl (383) and Clarke's Weaver (959)). But as the climate warmed, the refuges acted as centres of recolonisation. The forests of western Kenya were largely recolonised from Uganda and Zaire. About 35 species reach their eastern limit in the Kakamega-Nandi 48D 49C Forests.

There are five other endemic species in Kenya, namely the Violet Wood Hoopoe (460), Williams' Bush Lark (535), Hinde's Pied Babbler (600), the Aberdare Cisticola (723) and the Tana River Cisticola (726). Whether these arose in the interior and failed to spread, or are the last survivors of once widespread species, is a matter for speculation.

Migrants

Nearly 80% of Kenya's bird species breed in Kenya, or are thought to do so (Table 1). Most of the remainder are species that breed in the Palearctic Region during the northern summers but spend their winters in the Afrotropical. To do so, they either cross or skirt the Sahara and other deserts on their annual migrations. Others, the intra-African migrants, come to Kenya as non-breeding visitors from within the Afrotropical Region. Amongst the species that breed in Kenya, many, perhaps half, make regular movements away from their breeding sites for part of the year.

Palearctic migrants from western Europe mostly fly south or south-west to West Africa; few cross the equatorial forests. In contrast, most Palearctic migrants in eastern Africa have come from eastern Europe or from western, central or northern Asia, many from as far east as Siberia. A few originate in the Indian sub-continent, part of the Oriental Region. Many cross the equator and some continue

Table 5A. Percentages of Palearctic migrants in various habitats. Britton (1947f) considered that in SW Kenya, southern passage was mainly in Oct and Nov; birds present in Dec-Jan were presumed to be overwintering. Data were collected in various ways and many sample sites are atypical or unrepresentative. Hence only rather general conclusions can be drawn.

	Locality	QSD	Oct-Nov	Dec-Jan	Feb-Apr	Reference
Areas not extensively affected by man						
Evergreen forest	Kinale	62D	-	-	0	Carlson 1986a
Evergreen forest	Kakamega	48D	-	1	-	Britton 1974f
Evergreen forest edge	Mt Elgon	36D	-	9	-	Britton 1974f
Riverine woodland	Tsavo E NP	101B	-	10	-	Ulfstrand 1973
Moist acacia woodland	Naivasha	62C	-	6	-	Ulfstrand 1973
Dry mixed woodland	Masalani	89A	(0)	12	5	Pomeroy (unpubl.)
Dry acacia woodland	Olturot	27A	5	4	3	Pomeroy (in press, b)
Moist	Kisumu	60B	(22)	(13)	10	Britton 1974f*
Dry	Nairobi NP	75B	-	5	-	Ulfstrand 1973
Dry	Amboseli NP	88C	-	4	-	Ulfstrand 1973
Dry Various wooded	Tsavo E NP	101B	10	4	15	Lack 1980, 1983
Dry and bushed areas	Tsavo E NP	101B	-	12	-	Ulfstrand 1973
Dry	Magadi	74D	-	12	-	Ulfstrand 1973
Dry	Olorgesaille	75C	-	14	-	Ulfstrand 1973
Arid	Olturot	27A	5	4	3	Pomeroy (in press, b)
Lakeshore	Nakuru NP	62A	-	60	-	Britton 1974f
Papyrus swamp edge	Kisumu	60B	2	5	1	Britton 1974f*
Areas extensively affected by man						
Coniferous forest plantation	Kinale	62D	-	-	(23)	Carlson 1986a
Lantana-dominated thicket	Kisumu	60B	(53)	(24)	(16)	Britton 1974f*
Arable farm	Naivasha	62C	-	10	-	Ulfstrand 1973
Moist	Nairobi	75B	-	9	-	Ulfstrand 1973
Moist	Kisumu	60B	6	7	4	Britton 1974f*
Dry Cultivations	Masalani	89A	(0)	10	2	Pomeroy (unpubl.)
Dry	Voi	101B	-	4	-	Ulfstrand 1973

Figures in parentheses are based upon counts of less than 50 birds.
*based upon netted species (his Table 1); other references to this paper are from his Tables 4 and 5.

Table 5B. Summary of data in Table 5A. Data on forests and aquatic habitats (papyrus, lakeshore) have been omitted, as have those based upon small samples. These figures can be criticised on various grounds but they give a first approximation: all are percentages.

	Oct-Nov	Dec-Jan	Feb-Apr
Areas not extensively affected by man	7*	10	7
Areas extensively affected by man	6*	8	3*

* based upon rather few data (*cf.* Table 5A).

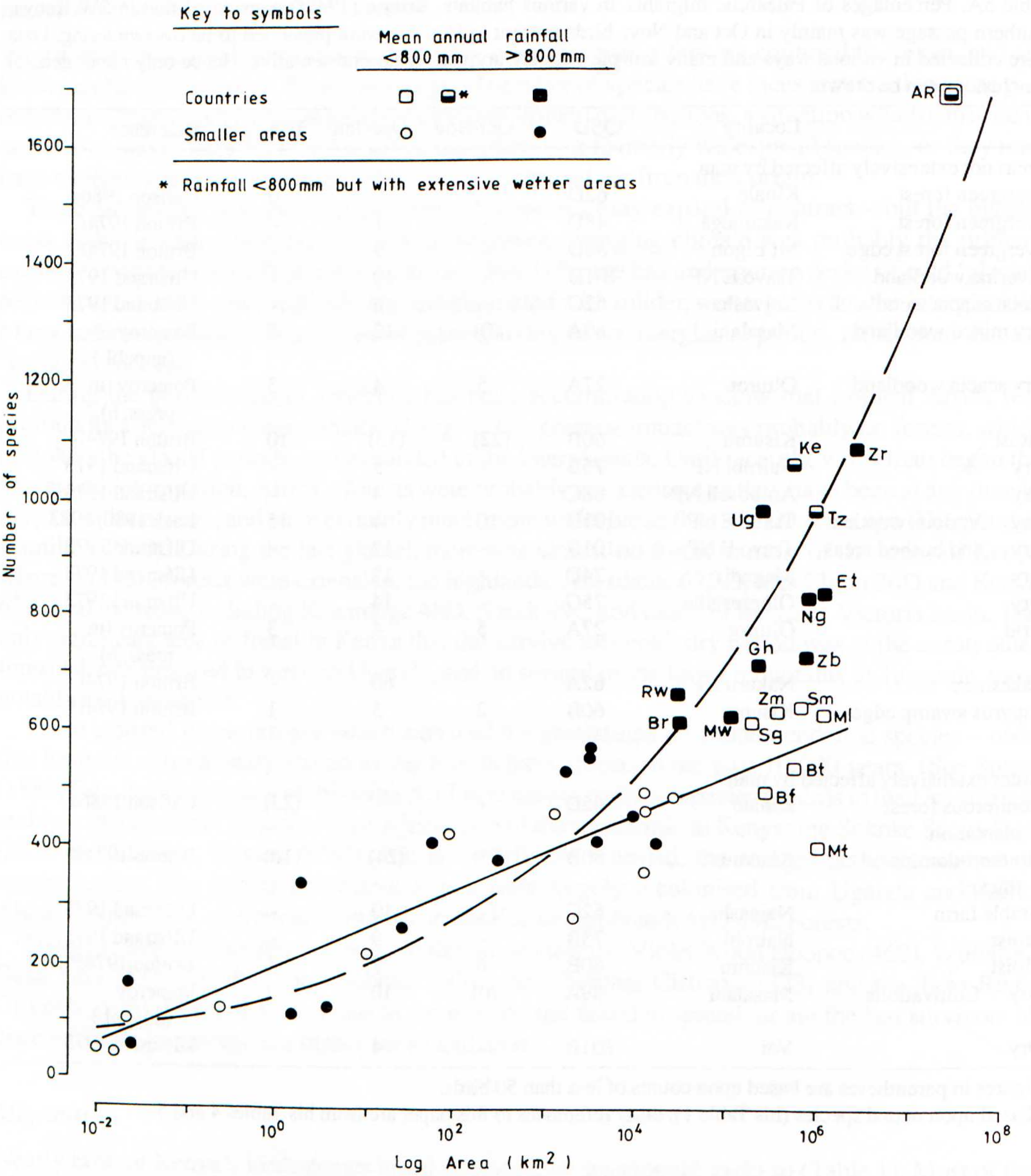

Fig. 16. The relationship between species number and area in the Afrotropical Region. The number of species increases with area: the curve is for moist areas and the straight line for dry ones. All data are for tropical Africa, except 'AR' (see below). The equations of the regression lines, which can be used to predict values expected for any area, are as follows (A = area, S = numbers of species):

moist areas : $\log_{10}S = 0.125 \log_{10}A + 2.231$

dry areas : $S = 65.4 \log_{10}A + 187.1$

For further details, see Pomeroy & Lewis (1987). The countries are indicated by their initials, thus Botswana (Bt), Burkino Faso (BF), Burundi (Br), Ethiopia (Et), Ghana (Gh), Kenya (Ke), Malawi (Mw), Mali (Ml), Mauritania (Mt), Nigeria (Ng), Rwanda (Rw), Senegambia (Sg), Somalia (Sm), Tanzania (Tz), Uganda (Ug), Zaire (Zr), Zambia (Zb) and Zimbabwe (Zm). AR indicates the total Afrotropical Region. (Redrawn, with permission, from Pomeroy & Lewis (1987)).

southwards as far as Mozambique, Zimbabwe and South Africa. Taxonomically, the Palearctic migrants are very diverse. Amongst the longest distance migrants are some of the swallows, terns and waders. The swallows and warblers probably make up the greatest numbers of individual birds. In some habitats, these migrants outnumber their Afrotropical relatives. This is strikingly so in the case of waders and swallows, and also of falcons, where most of the resident species are quite rare; some Palearctic falcons, such as the Hobby (152) and Lesser Kestrel (160), occur in flocks of hundreds or even thousands (see, for example, Smalley (1983)).

In terms of habitats, the Palearctic species frequently dominate shorelines, both marine and inland, and they can at times make up a large proportion of the birds in bushland habitats, especially in eastern Kenya, including Tsavo 89C 101 (Lack 1983). Elsewhere they are usually less significant and they scarcely penetrate forests at all (see Table 5A, with a summary in Table 5B). 'Oversummering' by Palearctic birds – that is, staying in Africa during the northern summer, rather than migrating north to breed – is common in immatures of most species of terns and waders (*e.g.* Pearson & Britton 1980), but oversummering by passerines such as the Northern Wheatear (639) in Tsavo is exceptional.

Whilst the movements of Palearctic species in Africa have been extensively studied and reviewed by Moreau (1972) and Curry-Lindahl (1981), far less is known about intra-African migrants. To take just two examples, the Spotted Ground Thrush (681) is apparently a non-breeding migrant to Kenya's coastal lowlands but the location of its breeding range is unknown; and the Grey-rumped Swallow (561) disappears completely from some areas for several months at a time and is believed to migrate extensively: but nobody knows where it goes.

There is almost no knowledge of the movements of the many dry country species which leave their breeding areas after the young are fledged; they are often referred to as 'wanderers'. The only significant exception is the Red-billed Quelea (986) (Ward 1971; Allan 1983), which has been shown to make predominantly north-south movements from southern Somalia, through eastern Kenya (where it often breeds) and into eastern Tanzania.

Peter Lack (pers. comm.) points out that Palearctic species can be considered as Afrotropical species which move out to breed. This is almost certainly how they came to colonise the northern Palearctic regions after the ice ages. There are also a number of Kenyan species which move out to breed but stay within the Afrotropical Region. Examples include several bee-eaters and nightjars, and a number of aquatic birds like the Great White Pelican (16). Whilst some of these species have been recorded breeding in Kenya, most of the population seen here are migrants.

KENYA IN AN AFRICAN CONTEXT

Comparison of avifauna

Kenya is well known for the numbers of bird species that have been recorded here. Only one African country, Zaire, has more species recorded, but clearly this is partly because Zaire is much larger – some four times – than Kenya. Similarly, one would not expect so many species in a small country, such as Burundi, about one twentieth the size of Kenya.

Figure 16 shows the numbers of species in various countries of tropical Africa, related to their sizes. In order to present a clearer perspective, some smaller areas such as National Parks are included too. The countries as well as the smaller areas are divided into two categories, moist and dry, on the basis of their annual rainfall, those with a modal rainfall averaging more than 800 mm yr^{-1} being designated moist. Two generally 'dry' countries, Kenya and Tanzania, are nevertheless included with the moist category because they have extensive moist areas, unlike the other dry countries.

For dry areas, species numbers rise progressively with size. The same is true for moist areas except that for the largest areas – whole countries – the slope is much steeper. These relationships can be described mathematically, as shown by the two lines in Figure 16. The upper, curved line which is for moist areas, has two countries well above it – Kenya and Uganda. On this basis we can say that Kenya and Uganda have the richest avifaunas in tropical Africa, relative to their size.

Species richness is strongly related to latitude (Pomeroy & Lewis 1987) and this is one reason for Kenya's having so many species. Another reason is that Kenya lies at the conjunction of several sub-regions which have been important centres of speciation within the Afrotropical Region (Crowe & Crowe 1982; Diamond & Hamilton 1980). One distinct avifauna originated in the arid area of Somalia, southern Ethiopia and northern Kenya. A second sub-region is centred on the equatorial forests of the Congo basin, and a third stretches across the Sahel, reaching north-western Kenya (*cf.* Fig. 4).

Other African atlases

We return finally to the opening paragraph of this introduction, where we mentioned other atlases and, in Figure 1, showed the position for the whole continent in 1987. Planned or existing atlases by then covered just over half of the area of Africa. Ultimately, perhaps, there will be an atlas for the whole of Africa. For such an idea to become a reality, there is clearly a need for some degree of uniformity. This is why PAOC V suggested that the unit of mapping should be a square of half-degree side, the quarter square degree (QSD). Some atlases, including Natal (Cyrus & Robson 1980), use squares of quarter-degree side (16 to a degree square), but this of course is compatible with the QSD.

Other recommendations of the PAOC V meeting were that breeding records should be noted, and that records prior to 01 January 1970 should be kept separately, as in this atlas. Optimal additional features might be data on seasonality (some atlases show or are planned to show monthly occurrence), and on abundance.

Atlassing in southern Africa is well advanced and there is a high degree of coordination between the 12 schemes (Hockey & Ferrar 1985). Now, with the publication of this atlas, and others planned, eastern Africa will be the next part of the continent to be covered. We hope this will stimulate those in the west and north to initiate schemes in these important areas, which are largely blank on Figure 1.

A GUIDE TO THE SPECIES ACCOUNTS IN THIS BOOK

1. *Bird names and sequence*

Scientific and English nomenclature in this atlas, and the sequence in which the families are presented, are exactly as in Britton (1980a). We gave considerable thought to the question of the systematic order within families, particularly in view of the thorough research which went into Britton (1980a). The overriding consideration in our choice of an order has been the juxtaposition of closely related species, to facilitate comparisons.

Britton's (1980a) adoption of the alphabetical arrangement of genera within families, and species within genera – following Lack (1968) – leads to an unsatisfactory sequence. In the larger genera, such as *Ploceus* and *Cisticola*, species which are clearly close relatives become widely separated, whilst more distantly related species come together. This is particularly unsatisfactory for an atlas, where one wants to compare the distributions of members of superspecies, *e.g.* Scarlet-chested and Hunter's Sunbirds (930, 931), or the Wailing, Ashy and Tana River Cisticolas (724-726).

This comparison of closely related forms was a prime objective of Hall & Moreau (1970) and Snow (1978) in their Afrotropical atlases, and we use their sequences here. Sequences for Palearctic species, which were not covered by these works, have been taken from Voous (1977) and, for the few marine species which he did not cover, from Harrison (1983).

Thus we have introduced our own series of species numbers, but the Britton numbers and Mackworth-Praed & Grant numbers for each species are given too (see p. 34), to facilitate cross-reference.

This atlas is primarily concerned with distributions at species level, but subspecies are sometimes mentioned (see p. 36).

2. *Geographical abbreviations*

Geographical terms are abbreviated thus:

central	C
east (-ern)	E
north (-ern)	N
south (-ern)	S
west (-ern)	W
Lake	L
River(s)	R
Mount(s)	Mt(s)
National Park	NP
Game Reserve	GR
Quarter Square Degree	QSD

3. *Abbreviation of standard references*

Frequently cited references are abbreviated as follows:

AGH	Andrews, Groves & Horne 1975
AM	Ash & Miskell 1983
Ba	Backhurst, Britton & Mann 1973
Be	Betts 1966
Br	Britton 1980a
BUN	Brown, Urban & Newman 1982
EABR	East African Bird Report, *Scopus*. Years are given if three or less issues are quoted.
HM	Hall & Moreau 1970
HH	Hopson & Hopson 1975
Ja	Jackson 1938
La	Lack, Leuthold & Smeenk 1980
MPG	Mackworth-Praed & Grant 1957, 1960
Se	Sessions 1966
Sn	Snow 1978
St	Stevenson 1980

4. *Localities*

Localities are followed by their QSD number (see Fig. 2 and the overlay), *e.g.* Nairobi 75B, Kakamega Forest 48D. Precise localities are given in the gazetteer to Britton (1980a), and in the United States Board on Geographic Names (1964).

5. *Family accounts*

Each family is introduced by summarising its representation in Kenya, related to the Afrotropical Region and the world. The numbers of species quoted for each family are approximate, since authorities sometimes disagree. Afrotropical numbers exclude Madagascar and oceanic islands such as the Seychelles.

Certain general characteristics of each family may be noted, particularly where these affect the interpretation of the maps *e.g.* whether the species are easily observed or skulking, and whether they are easily identified (see *detectability* and *coverage*, below). These factors are in turn used to discuss the significance of features on the maps such as (a) clusters of pre-1970 squares, which may signify a contraction of range, and (b) absence or paucity of breeding squares, which may indicate migratory behaviour.

6. *The titles of the species accounts*

The following example can be used:

609 COMMON BULBUL *Pycnonotus barbatus*
B732 / MPG741-744 / D3C3

The top line consists of the sequence number for this atlas (609), and the English (capitals) and scientific (italics) names: full details of taxonomic status, including authority and races, are given by Britton (1980a).

The second line consists of the sequence numbers from Britton 1980a (given as B) and Mackworth-Praed & Grant 1957, 1960 (given as MPG), and the Detectability (D) and Coverage (C) numbers for the species.

These DC numbers require some elucidation here. Each is accorded a rating on a four point scale (Table 6). These ratings are intended to aid interpretation of the maps and should also be considered when comparing species. Ease of detection clearly influences the completeness of a species' map: nocturnal species, notably owls and nightjars, are harder to detect than birds like plovers and woodpeckers, although the nocturnal species might be just as numerous. By detectability we also imply that one not only has to see the species but also to identify it, so that pygmy crakes (185-189) and the smaller honeyguides (504-506) generally have low detectability – and nightjars (except such as the Pennant-winged (410)) are given low ratings.

Coverage refers to observers: obviously even a rare bird has a good chance of being spotted in Nairobi National Park 75B, but it is virtually certain to be missed if it lives at Fudua 90B, which is north-west of Garsen in a very poorly known area. In general, the remarks made earlier (p. 10) on dry country species apply here – mostly they live in poorly covered areas.

The difference in meaning of detectability and coverage should become clear from the following examples. The Nubian Shrike (859) is a distinctive species (D3), but it is a migrant which only rarely reaches Kenya: there are reports of only four birds so far, and it is quite possible that others have gone undetected in Kenya's poorly known northern areas *i.e.* our map's coverage of the bird's occurrence may be poor (C0). The same applies to the Swallow-tailed Bee-eater (445), for which there is only a single, old record. On the other hand, the Little Grey Greenbul (611), whilst obscure and difficult to identify (D1), is apparently restricted to the Kakamega and Malaba Forests of 48D, so that its range is known very well (C3).

Maps are not given for species with very restricted distributions in Kenya. Instead, their square numbers are listed, together with the classes of record (see p. 6) which occur in them *e.g.*:

Table 6. Categories of detectability and coverage

	Detectability		Coverage
D3	Very well recorded: conspicuous and easily identified, active and/or vocal throughout day e.g. Black Kite (135), Hoopoe (458), Common Bulbul (609)	C3	Good: very well known and at least fairly common species e.g. Marabou Stork (50), Fish Eagle (134), Eurasian Swallow (553)
D2	Well recorded: species which require reasonably good views for identification or are often identified by their calls; fairly easily seen e.g. larger falcons, most waders and swifts, the Red-chested Cuckoo (365), tchagras	C2	Fair: fairly common but frequently overlooked, or uncommon but fairly distinctive e.g.Grasshopper Buzzard (120), Spotted Thicknee (275), Tree Pipit (817), Retz's Helmet Shrike (872); or fairly common but in rather restricted habitats such as dams, ponds, e.g. Jacana (211), Green Pigeon (340)
D1	Poorly recorded: hard to identify and/or skulking and/or nocturnal e.g. many nightjars, crakes, cisticolas, the African Finfoot (202)	C1	Inadequate: many of these species are relatively uncommon, or the less conspicuous dry country birds; may also be difficult to identify; e.g. Blue Quail (175), Barred Owlet (390), Gambaga Flycatcher (781)
DO	Seriously under-recorded: secretive and often very difficult to identify, including some crepuscular/nocturnal species, e.g. Pintail Snipe (252), small members of *Indicator*, Friedmann's Bush Lark (536), Rock-loving Cisticola (733)	CO	Poor: either low detectability and/or in remote areas (see coverage map) or very rare e.g. *Sarothrura* crakes, small *Indicator* species, Friedmann's Bush Lark (536), Collared Lark (530), Pygmy Sunbird (903)

491 GREEN TINKERBIRD *Pogoniulus simplex*
B554 / MPG591 / D2C3
NO MAP: post presence 102BD 114ABC;
post confirmed 103A

Species whose presence in Kenya has been mentioned in reputable publications, but later doubted or withdrawn, do not have a sequence number on this atlas. They are clearly labelled *e.g.*:

– DWARF HONEYGUIDE *Indicator pumilio*
B568 / MPG- / DOCO
RECORDS DELETED

7. *The maps*

The maps are the central feature of the atlas: and are provided for 871 of the 1065 species that constitute the Kenyan avifauna. The mapping symbols are shown in Table 2 (see also p. 6).

8. *The Afrotropical section of each species' text*

This paragraph briefly describes the species' distribution within the Afrotropical Region. Many of Kenya's birds are at or near the limits of their range (see p. 11), so that their distribution within sub-Saharan Africa aids in the interpretation of their distribution in Kenya. A final sentence in this section stresses if Kenya lies at the limit of the range, *e.g.* Honey Buzzard (137).

We have taken the Afrotropical Region to be the area south of the Palearctic as defined by Cramp & Simmons (1977): this is shown in Figure 1. In these range descriptions, E Africa refers to the eastern side of the continent, while East Africa means Kenya, Uganda and Tanzania.

In this section, the data for Afrotropical species have been extracted from Hall & Moreau (1970) and Snow (1978), with additional data for Somalia from Ash & Miskell (1983), while material on marine and other aquatic species has been taken from Harrison (1983). There is, however, no text of comparable accuracy on the distribution of Palearctic migrants within the Afrotropical Region during the northern winter. David Pearson (pers. comm.) provided these data, together with notes on each Palearctic species' overall distribution and seasonality in Kenya.

9. *The Kenyan section of each species' text*

Here we provide a summary of the species' occurrence in Kenya, including comments upon its map. The summary consists of data derived from the map, the literature, and personal experience. Map interpretation included extensive use of the various overlays, and environmental data from this source are often quoted as percentages *e.g.* 'Range is 94% within 500+ mm rainfall areas', which means that 94% of the squares in which the species is recorded have a modal rainfall of at least 500 mm per year. In the case of very localised species, these environmental data are presented in terms of actual numbers of squares *e.g.* 'four of five squares are in 500+ mm rainfall areas'. Data from the altitude overlay are quoted only if they amplify or contradict altitudinal ranges given in the literature (*e.g.* Red-winged Starling (885)).

Important records for which the exact QSD is uncertain (*e.g.* Palm Nut Vulture (86) in 37C) are mentioned in the text with an indication about plotting. Records that are too imprecisely located to plot at all are also mentioned (*e.g.* Yellow-billed Shrike (868) in 25-13D), as are potentially important but unconfirmed reports (*e.g.* Broad-billed Prion (7) off Shimoni 114C).

Apparent expansions (*e.g.* Somali Bee-eater (451)) or contractions (*e.g.* Marsh Tchagra (843)) of range are discussed, often with reference to factors such as the possible effects of observer frequency in remote areas or the relative absence of specimen collecting in recent years (*e.g.* Bristle-crowned Starling (884)).

Closely related species are discussed in some detail, since their inter-relationships often amplify the distributions seen on the maps, for example in the case of allopatric members of superspecies, where various birds occupy mutually exclusive ranges (*e.g.* the East Coast and Chin-spot Batis (797, 799), and the Black-backed, Northern and Pringle's Puffbacks (836-838)). Races are mentioned if they amplify the map's features (*e.g.* Speckled Mousebird (425) and Black-headed Batis (798)), or if they are readily identifiable in the field (*e.g.* Lilac-breasted Roller (455) and Black and White Mannikin (1042)). Easily identifiable morphs are also referred to (*e.g.* Little Egret (35) and Augur Buzzard (119)).

We make frequent references to Ash & Miskell's (1983) *Birds of Somalia: their habitat, status and distribution*, because areas to the east of 40°E are amongst the most poorly known ornithologically in Kenya. Hence, despite low observer frequencies in these areas of both countries, any analogy that can be drawn between a bird's range in the far east of Kenya and adjacent areas of south Somalia helps to demonstrate the validity of the distributions shown on our maps (*e.g.* Red-chested Cuckoo (365) and Black-breasted Glossy Starling (877)).

Although we did not collect seasonal data for this atlas (see p. 1), we have tried to summarise those existing in the literature, and in the unpublished notes of ourselves and others. Seasonality of most Palearctic species is reasonably well known, whereas that of most Afrotropical birds is not.

We have mentioned even the slightest evidence of movements or wandering in Afrotropical species, sometimes including examples from outside Kenya, as this topic is so little known here and, indeed, in Africa in general. Any mentions of residential status are included, unless the bird's family is known to be essentially sedentary, *e.g.* the Turacos Musophagidae, Babblers Timaliidae and Bush Shrikes Malaconotidae.

If not in chronological order, references are listed in their order of importance to the point being made. In most cases, the criterion for the use of a reference from the literature has been its mention of aspects of a species in Kenya. In addition to the sources quoted in the text, the bibliography also contains references to writings on the birds of Kenya that are not sufficiently specific to be included in any species or family account.

10. *Opportunities for further observations on birds in Kenya*

This atlas attempts to provide an explanatory overview of the birds of Kenya. We hope that it will enable interested observers to derive greater satisfaction from their birdwatching by seeing the significance of their observations in a broader context.

But we have only just begun the fascinating study that is ornithology in Kenya. There are a multitude of ways in which relatively simple observations can add substantially to what is known.

Here are some suggestions:

a) Studies of single species. This atlas provides a broad summary of what is known about each species in Kenya, directly via the text and indirectly via the references cited. How little that is known about many birds, especially common ones, may come as a surprise: J.P.Dittami's (1983) studies of the Blue-eared Glossy Starling (879) at Nakuru 62A are a classic case. Such topics provide almost unlimited opportunity for constructive observations, ranging from the activities of the Common Bulbuls (609) in your garden, to those of the Shovelers (78) wintering on Lake Turkana. Published examples of this type of study include: Bennun 1985, Brown 1972a, Candy 1984, Lewis 1982d, Meadows 1977a, Pearson 1981a and Sessions 1972.

b) Studies of single areas. Rather than concentrating on one species, you may prefer to look at some or all of the birds in a defined area, *e.g.* your garden, a stretch of lakeshore, a section of forest edge *etc*. Bearing in mind the very little that is known about the movements of birds, particularly African species, within Kenya, simple periodic counts of individuals can easily produce valuable data *e.g.* J.P.Dittami's study already referred to, Stevenson's (1980) at Lake Baringo 50A, and D.E.P.'s data (presented in this atlas) from the Ruaraka-Kahawa-Ruiru area of 75B. Records of rainfall and the state of the vegetation (*i.e.* lush, in flower, dessicated etc.) are useful here, and the study site should be visited regularly. Other examples of this type of study are: Britton 1978, Britton & Zimmerman 1979, Carlson 1986a, Dittami 1981, Lack 1985, Pearson 1984d and Pomeroy 1982.

c) Testing specific statements in this atlas. Many points in this atlas can be tested by simple observations. Is the apparent paucity of breeding of the Hamerkop (44) in the coastal lowlands real? And what of that of the Silvery-cheeked Hornbill (465) in Kenya as a whole? Do both the Yellow and Montane White-eyes (937, 938) occur on Mt Nyiru 26D and , if they do, are they alongside each other or in some way segregated? Can anyone find a Shoebill (-) in the Winam Gulf 60AB, or a truly wild Mallard (-) anywhere? Does the White-winged Apalis (752) still exist along the lower Tana River?

d) Adding to this atlas. Whereas the total number of records needed to complete this atlas may be as high as 135 000 (see p. 9), we have amassed less than 43 000 : there is plenty of opportunity for further atlassing work, whether as expeditions to poorly covered, remote areas, or as general birdwatching on better known ground. When recording a 'new' bird for an atlas square, the following questions should be borne in mind. Is the species in an area where it is to be expected, both in terms of its habitat (and seasonality, if known), and of nearby QSDs with other records? If not, then see the points made in the next section.

e) Recording of rarities and vagrants. This atlas will tell you whether any bird that you see is rare in a local or national context. When faced with an apparent rarity, remember that *details* are essential. Firstly, accuracy of identification: what features distinguished your bird with certainty from other, similar species? Photographs are invaluable, as is the corroboration of other observers. Where did you see the bird, and what was the date? How good were the lighting conditions, for how long was the bird in view, and approximately how far were you from it? Was the area uncharacteristically lush or arid, and were there harsh weather conditions elsewhere that might have caused the bird to wander? Details of rare birds should be sent to the East African Bird Report, an annual publication of the journal *Scopus*, c/o D.A. Turner, P.O.Box 48019, Nairobi, Kenya.

Species accounts