STRUCTURE OF AN ARID TROPICAL BIRD COMMUNITY

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SUMMARY

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The results of monthly censuses in a 500 m square quadrat of *Acacia* thorn-bush in northwestern Senegal during an eight year period are discussed. The climate is strongly seasonal with a short, well defined rainy season. 112 bird species were recorded altogether and this abundance of species was thought to be a function of vegetation heterogeneity. Most of the birds present belonged to a few permanently resident species. Migratory birds did not increase greatly in numbers during the rainy season and they did not consume much of the 'surplus' of food available then. A striking difference in the role of migrants in the Sahel wetlands compared with that in the *Acacia* thorn-bush was observed during the dry season.

INTRODUCTION

The aim of this study is to analyse the structure of an arid tropical bird community in Senegal. It was conducted continuously over a period of eight years and must have encompassed many of the variations of climate and of composition of the bird community experienced by the ecosystem.

The bird community is complex, containing as it does elements of both the ethiopian and palaearctic avifaunas. Most of the ethiopian species are permanently resident. All of the palaearctic and a few of the ethiopian species are migrant.

It is proposed to compare the variation in composition of this community:

1. Throughout a single year, for there are strikingly different wet and dry seasons.
2. Between different years, for there are wide variations in rainfall from year to year and consequently in primary and secondary production.

In this way it is hoped to determine the role of the bird community in the ecosystem and to compare it with that of the nearby Sahel wetland community associated with the Senegal River.

STUDY AREA

The Fété Olé quadrat, latitude N16°13′, longitude W15°06′, is named after a well and lies only 40km south of the Senegal river valley, (Map 1.).

The area studied belongs to the semi-arid thorn-bush belt, sometimes called sub-Sahara which extends without noticeable relief from the Atlantic Ocean to Chad. This vast expanse of scrubland is broken by the Senegal and Niger rivers whose inundation zones are famous winter quarters for wildfowl (Morel & Roux 1966). However, our censuses deal only with the birds of the thorn-bush which is completely devoid of any permanent natural body of water. Water is available in rain ponds from July to December but modern wells and reservoirs supply water to stock and birds throughout the year.

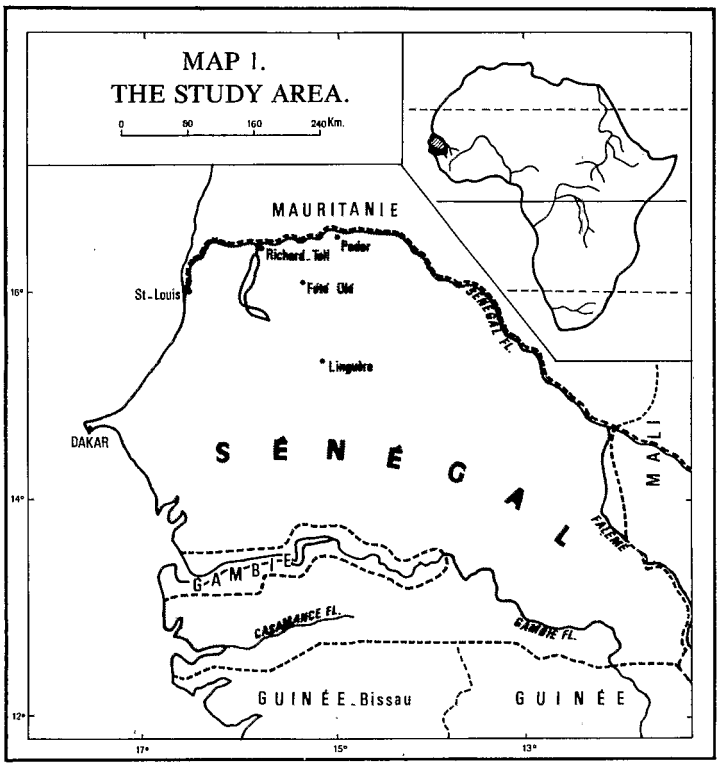
CLIMATE

The climate is tropical and strongly seasonal. The average annual temperature is about 29°C with a marked daily range (22° - 36°). There is one rainy season from June to October, with a low average rainfall: 319±39mm. The rainy season is the most important event in the year and varies greatly in intensity and duration from year to year. 1969 was the only 'normal' year, 1972 was an exceptionally dry one.

ANNUAL PRODUCTION

The annual plants germinate with the first rains and the whole seed crop is available at the end of the rainy season. Simultaneously, there is a flush of invertebrates (Gillon & Gillon 1974) which quickly disappears within 1-2 months. Water is everywhere and the trees are in full foliage.

The seeds remain available on the ground during the dry season until the next year's showers. In January, most of the rain ponds have dried up. Fruit production is not markedly seasonal.



METHODS

The methods were those of Morel (1968a) and essentially consisted of a monthly bird census conducted over a 500 x 500m quadrat (25ha) divided in 10 strips 50m wide. Odd numbered strips were censussed the first morning and even numbered strips the following morning; the count was made by three observers. A careful search was made for nests twice a month.

In addition this quadrat has been intensively studied by botanists, a termite specialist and a mammalogist from 1968 to 1972 under the International Biological Programme (Bourliere ed. 1972, 1974). Detailed studies of the diets of the Columbidae (Morel & Morel 1972, Morel 1980, and in prep.), Pteroclididae and Alaudidae were also made.

RESULTS

SPECIES COMPOSITION

Table I gives the composition of the bird fauna studied on our quadrat from July 1969 to June 1976. This population includes all the breeding and non-breeding species. A species is termed 'resident' if it reproduces in our region even though it is not recorded on our quadrat every month. Thus far, 112 species have been found, Accipitridae and Falconidae not included. This total consists of 83 ethiopian and 29 palearctic species (the palearctic species do not breed in the tropics). Ethiopian birds include 67 resident and 16 migrant species (7 migrants breed while they stay in our area).

It can be seen that 44% of the species are non-passerines and 56% passerines, but contributions to these two categories by the ethiopian and palearctic avifaunas are very unequal. Amongst the ethiopian species non-passerines and passerines are nearly equal in numbers, whereas non-passerines constitute only 20% of the palearctic species compared with the 80% contributed by passerines.

TABLE I
Composition of the bird fauna of Féte-Olé quadrat (25 ha) from July 1969 to June 1976.

		ETHIOPIAN				PALEARCTIC		
		Resident		Migrant		Migrant		
		N.P	P.	N.P	P.	N.P	P.	TOTAL
Number of species		33	34	11	5	6	23	112
Percentage in each category		29	30	10	5	5	21	100
SIZE	small (<25g)	2	21	4	3	1	19	50
	medium (25-75g)	12	7	3	2	2	2	28
	large (>75g)	15	2	3	0	2	0	22
FOOD	seeds	5	4	1	0	2	0	12
	invertebrates	12	11	8	1	3	18	53
	fruit	3	0	0	0	0	0	3
	invertebrates + seeds	3	9	1	3	0	0	16
	invertebrates + fruit	3	4	0	1	0	3	11
	invertebrates + flowers	0	2	0	0	0	0	2
	invertebrates + vertebrates	3	0	0	0	0	0	3
FEEDING SITE	ground	17	15	4	3	3	8	50
	trees	8	7	2	1	0	9	27
	trees + ground	2	6	0	0	0	0	8
	air	2	0	4	1	2	4	13
	trees, ground + air	0	2	0	0	0	0	2
PREFERRED MICROHABITAT	ground	7	6	4	0	2	4	23
	trees	9	8	3	3	1	13	37
	trees + ground	13	16	3	1	1	2	36
	air	0	0	0	1	1	2	4

N.P. = non-passerines P. = passerines

SIZE

Half the species weigh less than 25g, including 33 of the 83 ethiopian species (40%) and 22 of the 29 palearctic species (76%). 22% weigh more than 75g, including 21 ethiopian species and 2 palearctic species.

DIET

Invertebrates are widely consumed since 53% of the species feed on them exclusively and they form part of the diet of a further 32%.

Seeds are the exclusive food of 12% of the species and, supplemented with invertebrates, are the food of a further 16% of the species.

FEEDING SITE

The ground is the most important site since 50% of the species forage exclusively on the ground for seeds or insects and sometimes both. Trees are second in importance and 27% of the insectivorous and insectivorous/frugivorous species feed exclusively there. 13% of the species are exclusively aerial feeders and most of these are migrants.

PREFERRED MICROHABITAT

This is not to be equated with feeding site. For example, doves carry out all activities except

feeding in trees. Indeed trees are the most important microhabitat for 73% of the species, 37% of which live there exclusively even though the ground is the most important feeding site.

WITHIN- AND BETWEEN-YEAR POPULATION VARIATIONS

Figure 1 shows the monthly variations in the number of species, the density per hectare and the biomass (g/ha) for three years: a very dry year (1972/73) and two more 'normal' years, 1969/70 and 1975/76.

During the rainy season, the avifauna consists of both resident and migratory species, the migratory species coming from both the north (palaearctic) and the south (tropical). During May, the avifauna is reduced to a few resident species, well adapted to the high temperatures and the remoteness of the watering points (Morel 1968a).

Between-year variations in population are apparent. For example in 1972/73 population levels were appreciably lower than in the other years. This is not unexpected in view of the poor rainfall that year but it is interesting to note that the number of species present fell little if at all.

Ethiopian passerines were particularly abundant in 1975/76: *Passer luteus* in July 1975 and June 1976; *Eremopterix nigriceps* from November to June; and *E.leucotis* from July to October. *E.leucotis* was in fact responsible in part for the population peaks which occurred from November to January each year.

Between-year variations in biomass were not necessarily directly linked to population levels. For example, the avifaunal biomass of 1969/70 appears high when compared with the population level but this is a result of the abundance of the heavy (140g) dove *Streptopelia roseogrisea* then. Average biomass present is lower in the other years but shows greater monthly variation than in 1969/70, a function of the reduction in the number of doves and the sporadic presence of the large numbers of small passerines already noted.

DISCUSSION AND CONCLUSION

Moreau (1964) wrote: '*Acacia* steppe has an abundance of bird species that is surprising in view of the simplicity of the habitat and small biomass of the vegetation'. We agree that there is an abundance of species, but Moreau underestimated the complexity of the habitat: there are eight vegetation groups in our small quadrat (Bille & Poupon 1972, Bille 1977) and 48 for the whole region (Valenza & Diallo 1972). Therefore there are a mosaic of niches, some of them very narrow, and a correspondingly high number of species, most of which are uncommon. This savanna exhibits an ambiguous appearance: poor for a casual observer who is impressed by the stunted vegetation and the long dry season and very rich for the more careful bird-watcher.

Resident species dominate both in terms of numbers and biomass (Fig. 1). Though primary and secondary production (grass layer and insects) are variable, a function of irregular precipitation, the overall pattern of the bird population remains strikingly constant. Resident birds make up 86% of the total number of individuals present and their biomass 93%. 67% of the total biomass is made up by non-passerine residents except during 1975/76 when an outbreak of Golden Sparrows brought down the figure to 56%. The importance of non-passerines is due to the large size of many species: bustards, guineafowls, francolins, doves and sandgrouse. Most of the frugivorous species are also non-passerines (parrots, colies).

In high latitudes the spring flush of insects is used by migrants coming from the south to breed. We might expect a similar situation in the tropics with either ethiopian or palearctic migrants exploiting the tropical wet season insect flush. However only the ethiopian migrants are present during the wet season and they constitute no more than 3% of the total numbers of birds and only seven species breed in our area. Moreover the palearctic migrants, which are scarce until November (the end of the rainy season) are present mostly during the dry season (December-May) when the insect flush is over. However the number of species, biomass and number of individuals does increase during the rains. Most of the newcomers are coming from the riverine (Senegal) forests or other refuges not far away, where they have spent the dry months.

We may wonder why birds — and particularly palearctic species — are unable to use more of the rainy season production. We suggest tentatively that this rainy season is too short and its timing too unreliable to support a large influx of migrants on a regular basis. It is also well establi-

Figure 1a. Monthly variation in the number of species present in the study area.

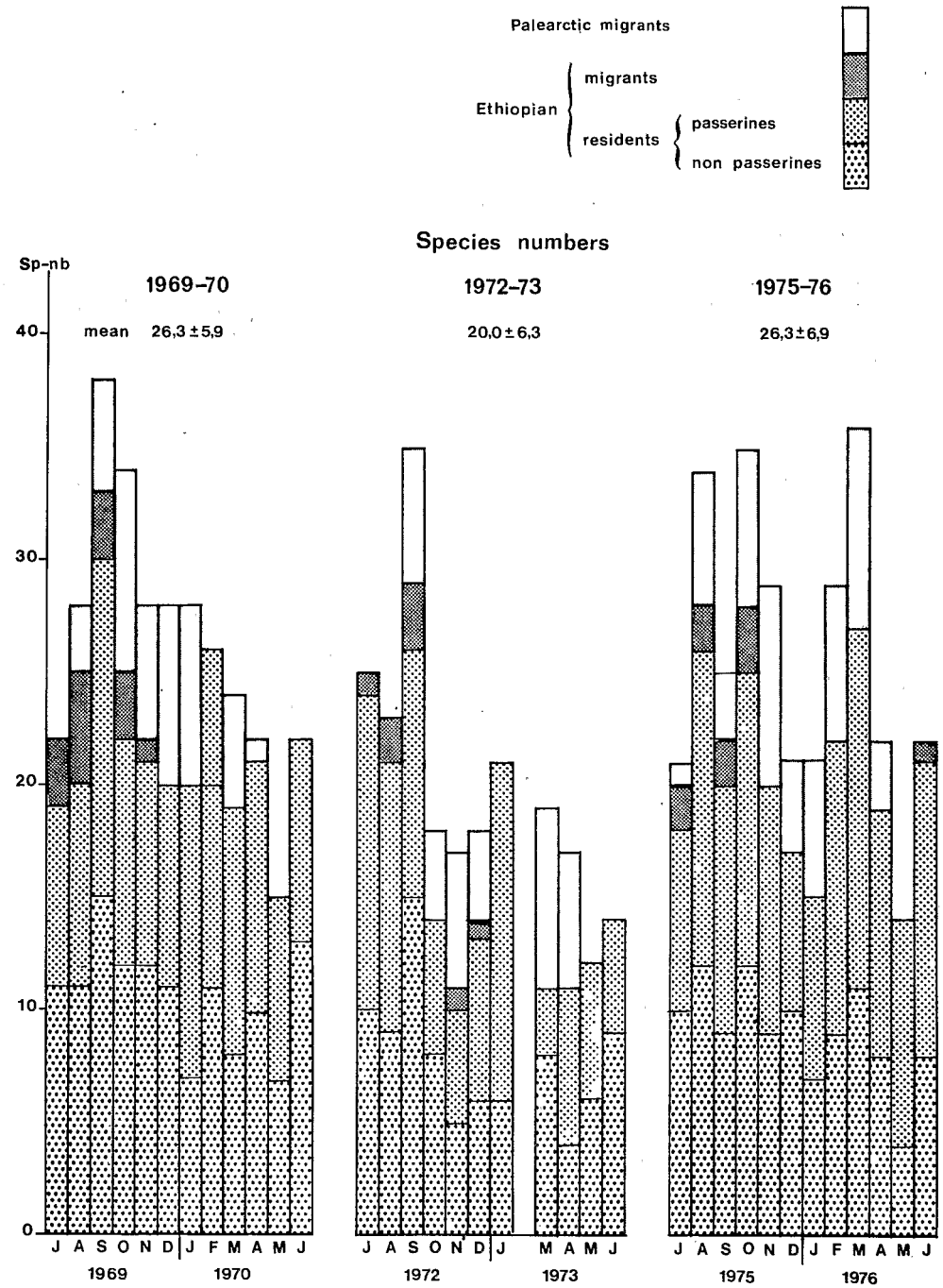


Figure 1b. Monthly variation in the density of birds in the study area (Individuals/ha).

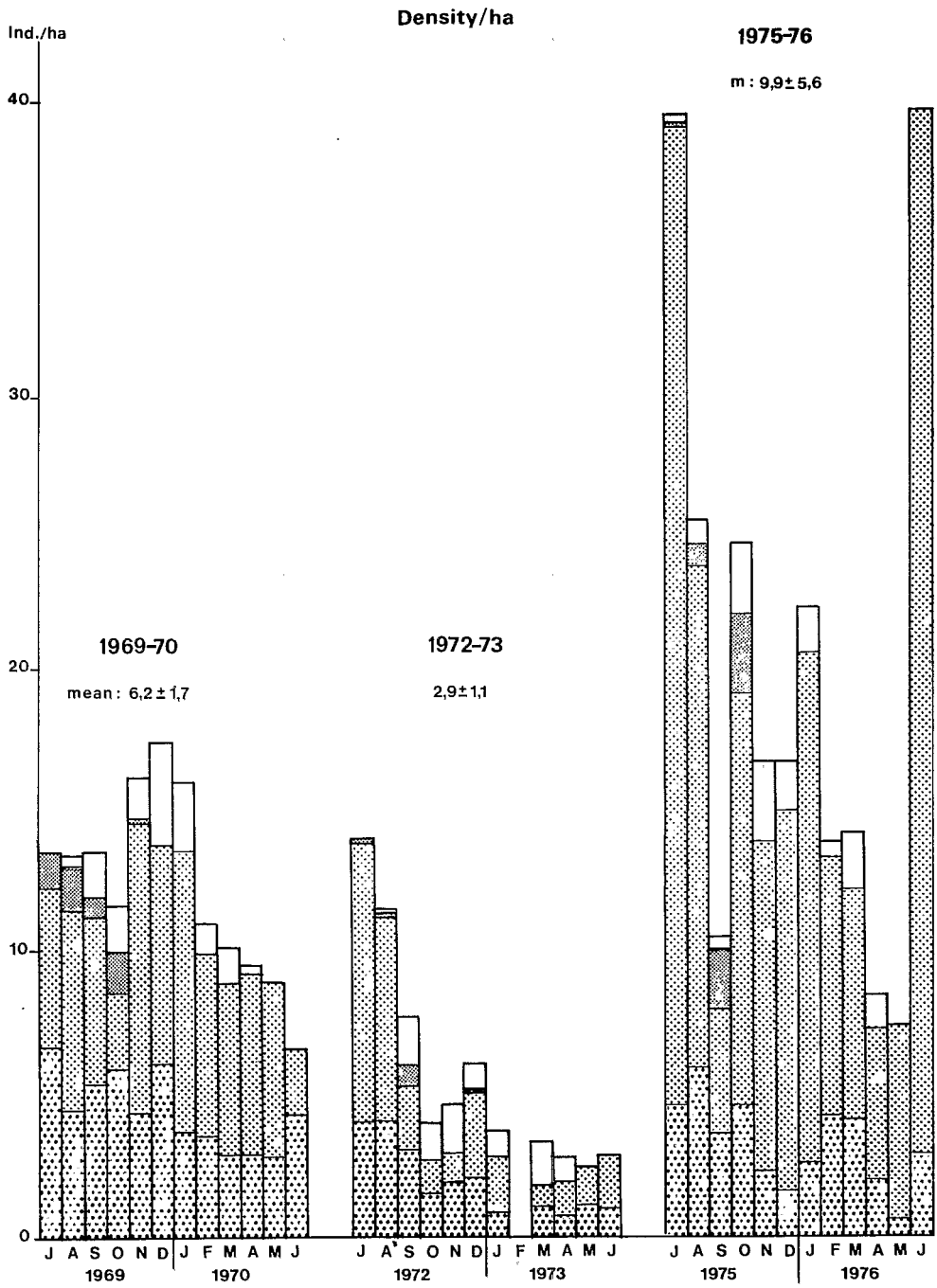
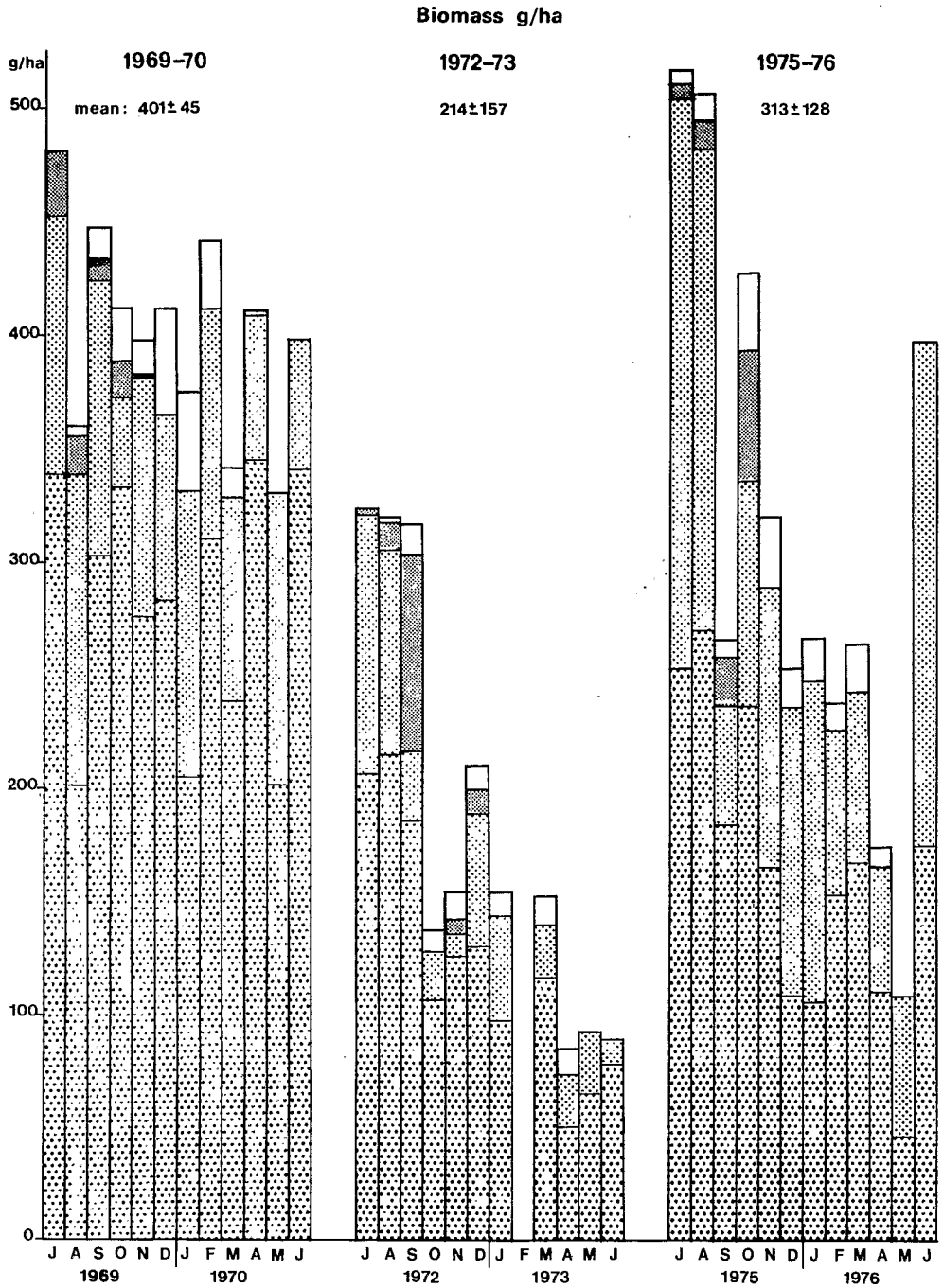


Figure 1c. Monthly variation in biomass (gm/ha) of birds in the study area.



shed that both the quantity of insects produced and the families of insects present are extremely variable (Morel & Morel unp. data). Migrant birds would have to adapt to these difficult and unreliable conditions and in evolutionary terms this is a poor proposition when better areas occur nearby. Therefore, the bulk of the rainy season resource 'surplus' is consumed in different ways:

1. By insects, which respond quickly to vegetation growth and do not survive the rainy season. They are well adapted to exploit a rapid increase in food resources.
2. By amphibians, which though poorly known and studied, are teeming during the rains and only feed then, remaining inactive during the dry season.
3. By two species of birds, though locally and not every year: *Quelea quelea* and *Passer luteus*. *Quelea* show a remarkable adaptation since they can delay their reproduction until the food (fresh seeds and insects) they want for their huge colonies has reached a sufficient level. When the season is over they wander in search of an area with enough seeds (a non-perishable crop) to sustain their numerous flocks. *Passer luteus* also breeds in colonies during the rainy season but feeds primarily on insects (Morel & Morel 1976). After breeding they also turn their attention to dry seeds. Both these species therefore rely on a similar strategy which is essentially a change of diet, and both can be termed 'major consumers' when and where they happen to nest (Morel 1968b).
4. Finally a major part of this production probably goes to the soil decomposers (such as soil bacteria and fungi), although the lack of data in this field is almost total. But circumstantial evidence strongly suggests that this is the case.

It is possible, knowing the annual mean number of birds and nests per hectare, to estimate the quantitative participation of birds in the ecosystem energy flow (Karr 1971, Holmes & Sturges 1973, Wiens & Nussbaum 1975). Though we have most of the necessary data, a synthesis is still to be undertaken. It will however certainly be difficult because of the nomadism of many species and of the instability of the habitat. Our censuses produced a monthly mean of 5,8± 2,3 individuals per hectare and an annual mean of 1,5 to 3,2 nests per hectare. In comparison Weiner & Gzowacinski (1975) found in a Polish deciduous forest, a rich northern temperate habitat, a mean monthly density of 11 birds per ha and 8 breeding pairs per ha during the breeding season, only twice as many as in our quadrat. They conclude that the birds, as consumers in this ecosystem are 'quite important'. In contrast, the role of birds as consumers does not look really important in our dry tropical savanna, since during the rainy season they do not increase in proportion with the sudden burst of productivity in their habitat.

Although this study deals only with the dry thorn-bush it is relevant to mention the Senegal river wetlands and inundation zones, whose bird population is strikingly different. While in the dry savanna the migrants, particularly the palearctics, appear little more than insignificant visitors, in the inundation zone they are certainly of considerable importance (Morel & Roux 1966). No less than 5 000 While Pelicans (food: fish) stay and feed for several months in the river delta. Amongst the other palearctic visitors are ducks, such as the Garganey and Pintail which feed mainly on seeds and may number 100 000; Ruffs, also seed-eaters and which may number half a million; other species of Charadriidae and Laridae which eat invertebrates and fish; and up to half a million Sand Martins which eat flying insects. All of these birds depend upon aquatic habitats.

This paper is certainly not the place to analyze and discuss all the parameters involved in the river wetlands. However, we do know that while in the dry savanna the rains stop in October, marshes retain water much longer, until February. The period of primary production thus lasts longer and undoubtedly gives more stability to the system and has promoted a better utilization of the resources by higher vertebrates. But the point we would like to make is that in the same region two different systems occur. However, these systems are not completely independent. One important link between the two is the riverine forest which is part of the wetlands in the rainy season. In the dry season, it forms a refuge for many resident species from the dry savanna.

ACKNOWLEDGMENT

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This paper is only a preliminary version of a more comprehensive article: Gérard J. Morel and Marie-Yvonne Morel, 1978. Recherches écologiques sur une savane sahélienne du Ferlo septentrional, Sénégal. Etude d'une communauté avienne *Cah. O.R.S.T.O.M.*, sér. Biol., *13*: 3-34.

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