

# Numbers, composition and distribution of populations of Anatidae wintering in West Africa

F. ROUX and G. JARRY

## Introduction

Several species of Palearctic migratory Anatidae winter in tropical West Africa, with two species predominating: Garganey *Anas querquedula* and Pintail *Anas acuta*. For Garganey, the Afro-tropical wetlands are of major importance, since, except for a few individuals, the species does not winter in the Palearctic region. For Pintail, these areas represent a permanent alternative to wintering in the temperate zone, although numbers there are extremely variable.

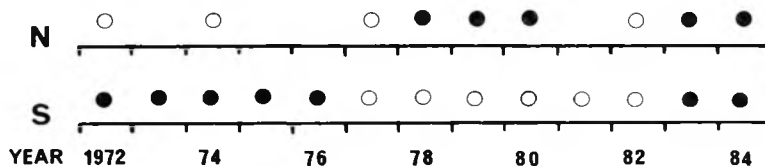
These same areas are collectively exploited by Afro-tropical Anatidae which are dependent on them throughout their annual cycle. Five species are widespread across the western part of the continent, from Sénégal to Chad: Fulvous Whistling Duck *Dendrocygna bicolor*, White-faced Whistling Duck *D. viduata*, Egyptian Goose *Alopochen aegyptiaca*, Comb Duck *Sarkidiornis melanotos* and Spur-winged Goose *Plectropterus gambensis*.

The wintering populations of these major wetlands were recognised as early as 1958 in the Sénégal Delta (Roux 1959). In this area of 4000 km<sup>2</sup>, more or less regular annual counts have been made, generally by aeroplane, each January in the framework of the midwinter census organised by the International Waterfowl Research Bureau (IWRB). Aerial surveys began at the same time, but on an irregular basis, in the Inland Niger Delta, which covers 55,000 km<sup>2</sup>, in Mali; these became regular and comprehensive from 1978, and also covered the Niger valley downstream from the Inland Delta as far as Gao, and the pools south of the Niger Bend (Gourma Region). These regular

counts (Fig. 1), carried out in most cases by the same observers (FR and GJ) using the same techniques, have been complemented by occasional surveys of lakes in southern Mauritania and some areas of lesser importance for Anatidae: the middle Sénégal Valley, the coastal lakes of the Cap Vert peninsula, the Sine Saloum Delta, and Basse Casamance (all in Sénégal); the marshes on the Kolimbiné River and the Sahel Canal system (both in Mali). Thus almost complete coverage of the wetlands of Sahelian Africa from the Atlantic to the Niger Bend has been progressively established. It was then possible to draw up a first inventory as regards their value for water birds, and to define the size and distribution of the populations of Anatidae exploiting them in winter. In addition to censuses, research has been carried out on the structure, origins, movements and dynamics of these populations, and on their ecological requirements, both in Sénégal (Roux 1973, 1976; Roux *et al.* 1976, 1978) and in Mali (Roux & Jarry 1978; Roux *et al.* 1979; Jarry & Lamarche 1980; Jarry 1983).

These wetlands are characterised by a high degree of instability, since their surface area fluctuates with the greatly varying annual rainfall and river flow. This instability is the reason for the considerable fluctuations from one year to another in the number of birds wintering in an area. Such fluctuations were observed from 1972 and 1979 between the Sénégal Delta and the Inland Niger Delta. For Garganey and Pintail, these two great wetlands undoubtedly fulfil a complementary role for the wintering of these two species in West Africa. It even appears that such complementary fluctua-

**Figure 1.** Frequency and completeness of counts of Anatidae in the Sénégal Delta (S) and the Inland Niger Delta (N). Closed circle = full coverage; open circle = partial coverage.



tions are not limited to these two river basins but also extend to the Chad basin (Roux *et al.* 1979).

With this in mind, it was essential to achieve as full a coverage as possible of these three basins in the same winter in order: (i) to establish the numbers, make-up and distribution of populations of Anatidae on a West African scale; (ii) to relate these results to data from the previous 12 years, emphasising the role of habitat factors on the three subjects investigated.

In addition, the exceptionally severe drought of 1983–4 (see below) led us to investigate two other questions: (iii) to what extent and at which sites can the populations studied in Sénégal and Mali hold their own under these extreme conditions? (iv) to what extent can they move southwards out of the Sahelian zone when drought restricts their habitats there?

These were the objectives of the survey undertaken in January 1984. The present paper presents its results.

### Climatic and water conditions

After several years of below-average rainfall and river flow, the Sénégal and Niger Rivers (in the water years of 1982 and 1983) experienced the lowest flows recorded since the beginning of the century (Fig. 2). In

January 1984, Djoudj Lake, the central depression in the Sénégal Delta, was completely dry, while on the Inland Niger Delta, the flooded zone covered only 40% of the available area. No data on levels are available for Lake Chad; however, according to aerial observations in late January, the extent of water in the lake fell short of the area recorded during previous all-time lows in 1908 and from 1972 to 1975 (Sircoulon 1976).

The drought was not restricted to the semi-arid climatic zone known as the 'Sahel' which extends in a belt 300–500 km wide along the southern edge of the Sahara. It was also experienced in the humid tropical climatic zone which extends across the southern part of West Africa, from Guinea to Cameroon. Reservoirs behind the dams built on the River Bandama in Ivory Coast and on the River Volta in Ghana were at their lowest levels.

### Area covered and itinerary

The survey covered the principal wetlands in each of the major water catchments of West Africa between 5°N and 18°N, and between 16°30'W and 17°20'E, including the great artificial lakes in Ivory Coast and Ghana and some coastal lagoons in the Gulf of Guinea (Fig. 3). We received data on the

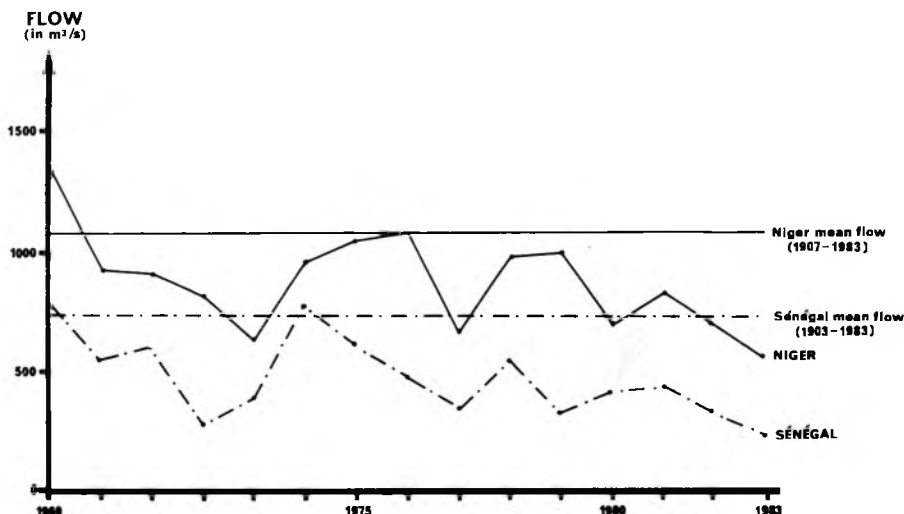


Figure 2. Annual flow of the Sénégal and Niger Rivers in the last 15 years, compared with the mean flow since the beginning of the century.

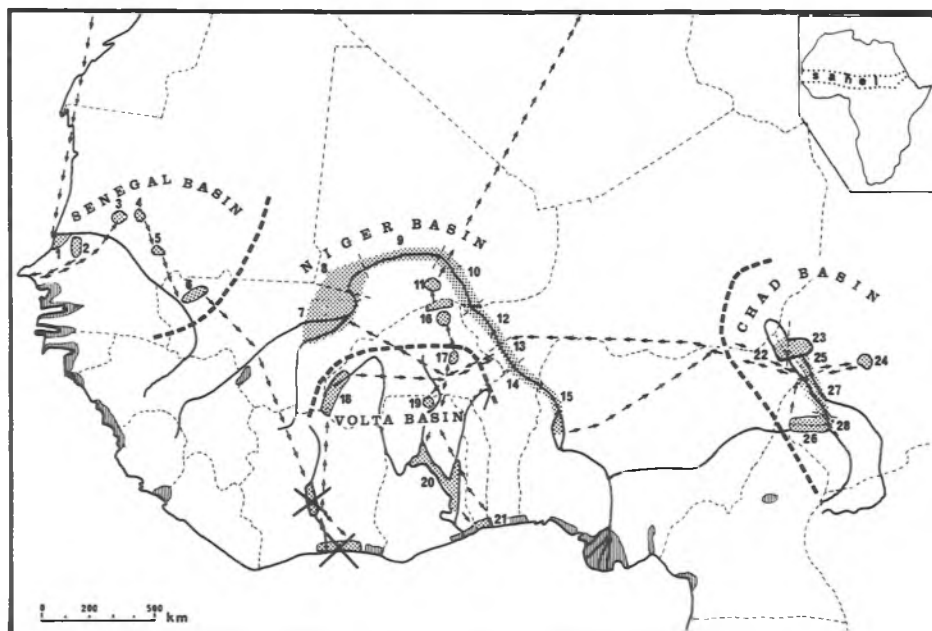


Figure 3. Flight itineraries (arrows) and wetlands surveyed (dotted areas) in West Africa in January 1984. The wetlands not covered are indicated by vertical stripes. The numbers correspond to sites listed in Table 1.

ivers running into the sea in southern S n gambia and Guinea Bissau. The only areas which we did not cover were the lower course of the Niger and Benue Rivers.

The route followed was subject to various constraints – problems of logistics (refuelling and mechanical overhaul), of weather (sandstorm, dust haze) and of politics (some States do not permit their air space to be entered from one direction or another). For these reasons the route does not follow geographical logic. Observations began at St. Louis du S n gal on 7 January and ended at Gao on 7 February after 117 hours flying in 22 flying days.

### Methods

All counts were made from the air. The aircraft used, a high-winged Cessna ‘Skylane’ with eight hours of flight capacity, flew at an average speed of 150 km/hr and an average height of 50 m above the study areas. These were fully covered, either by flying around the edges or by criss-crossing them. Two pilots took turns at the controls. The observers (FR and GJ), one on each side of the

aircraft, noted the numbers of each species of bird using a tape-recorder. The route was marked on a map and the time noted every 15 minutes. The figures for each wetlands or for hourly units of the itinerary, are the sum of numbers recorded on each side of the axis of flight, by counting or by estimate.

The technique of aerial censusing incorporates a high level of inaccuracy, arising from counting proper, e.g. precision and fidelity of the count, and from other forms of bias, e.g. omission, birds escaping notice and species mis-identification (Dervieux *et al.* 1980). Our observations, which refer to large areas and sometimes to huge concentrations of birds (several hundred thousand individuals), are, of course, subject to these forms of bias, which cannot be quantified. However, our experience of these areas and of the size of the concentrations compensates, at least in part, for any shortcomings in the counts. The considerable variations, though not the absolute values for the size of the populations, can therefore be taken as real. The risk of mistaken identification, on the other hand, appears small: only two species of the genus *Anas* are normally recorded, while for the Afro-tropical

Anatidae, field identification marks are very obvious.

However, some species cannot be counted from an aircraft: they escape detection because of their small size, the habitat they use or their behaviour. The African Pygmy Goose *Nettapus auritus* and Hottentot Teal *Anas punctata* are in this position and results relating to them will only be briefly mentioned.

## Results

The results are collected under 28 sites or groups of sites, listed by country within the major catchments of the Sénégal, Niger and Volta, and Lake Chad (Table 1). Sites where absolutely no ducks were recorded do not figure in Table 1. In this respect, the most remarkable sites are the Kossou Reservoir and the coastal lagoons, both in Ivory Coast (marked with an X on Fig. 3). The sites listed are either well demarcated geographical units, or groups of sites making up a coherent whole. Thus sites 7 and 8, which are made up between them of 33 count points, constitute the whole of the Inland Niger Delta. The divisions correspond to the divisions in the overall grid covering this zone which we have used in calculating count values since 1978.

### Sénégal Basin

Traditionally, the most important site in the Sénégal Basin in January is the river delta, where the Djoudj National Park normally holds the vast majority of Anatidae. With the drying out of the Djoudj, the birds abandoned the area almost completely, and the level of the Lac de Guier, filled artificially by pumping from the River Sénégal, was too high to suit Anatidae. About 90% of the Anatidae counted (essentially 85,000 Garganey) were on the lakes of southern Mauritania (Aleg and Mal), which held water because of local rainfall. In the upper part of the basin, the Kolimbiné, a tributary flowing into the River Sénégal from its right bank in Mali, was almost entirely dry.

### Niger Basin

Despite a considerable reduction in their surface area, the flood plains and lakes of the Inland Niger Delta (the groups of sites numbers 7 and 8) remained the most impor-

tant stations for Palearctic Anatidae (126,000 Pintail, 150,000 Garganey) and for Afro-tropical species – 31,000 Fulvous Whistling Ducks and 5000 Spur-winged Geese in the flood plains. The Ferruginous Duck *Aythya nyroca* was recorded only on the Northern Lakes (Lake Horo); these 3000 individuals represented the total number seen for all sites.

In the remaining parts of the Niger Valley, downstream from the Inland Delta, three sections of the river each held more than 40,000 Anatidae: the Niger Bend from Bourem to the frontier with Niger (site 10), the river valley below Niamey (site 13) and the River Niger in Nigeria (site 15). For the two latter sites, these are the first counts made. The most striking observation is the number of White-faced Whistling Ducks (27,000) in the southern part of the Niger Valley. A site on the edge of the catchment, Lake Gossi in the Gourma Region, held 21,000 Garganey.

### Volta Basin

The basin, in its upper sections, is made up of a large number of pools and small reservoirs; its lower reaches, in Ghana, form an immense reservoir covering several thousand square kilometres. The very low potential capacity for Anatidae, compared with that of other basins, is surprising. Half of the birds counted came from a small reservoir for irrigation in northern Ghana (site 19).

### Chad Basin

Lake Chad, where the area under water was reduced from 20,000 km<sup>2</sup> to at most 8000 km<sup>2</sup> in the southern part of the basin, held 750,000 Palearctic ducks (220,000 Pintail and 520,000 Garganey) in a massive concentration on a few square kilometres of shallow water on the northern edge, for the most part in the territory of Nigeria. Previous data (Vielliard 1972) gave no indication of the occurrence of such numbers on Lake Chad. In comparison with these large figures, the numbers of Afro-tropical Anatidae, represented almost exclusively by White-faced Whistling Ducks (15,000), appear low in the extreme.

Lake Fitri, 270 km to the east of Lake Chad, is a vestige of the Paleochadian Sea, totally separate from the present-day Lake Chad. It proved to be a major area both for

**Table 1.** The numbers of Anatidae counted during an aerial survey of tropical West Africa in January 1984. Figures are in thousands. Species with a total count below 1000 are omitted. Counts of less than 100 (given in brackets) are omitted from the totals. Sites marked \*\* have been surveyed three or more times since 1972. Sites marked \* have been surveyed in only one or two previous midwinter counts. Subtotals (given in italics) are not included in totals.

(a) Palearctic species

COUNTRY	No. on map (Fig. 1)	Site or grouped sites	No. of sites in group	Pintail	Garganey	Shoveler	Ferruginous Duck	Total Palearctic Ducks
<i>Basin</i>								
SENEGAL								
<i>Senegal basin</i>	1**	Sénégal delta <sup>1</sup>	4	0.6	2.5	3.6	0	6.7
	2**	Lac de Guier	1	0.1	0.3	0.2	0	0.6
MAURETANIA								
	3*	Lac d'Aleg	1	3.3	70	0	0	73.3
	4*	Lac de Mal	1	16	15	(10)	0	31
	5*	Foum Gleita	1	0.1	0.1	0	0	0.2
MALI								
	6*	Kolinbiné	1	(25)	0.2	0	0	0.2
<i>Total Sénégal basin</i>				20.1	88.1	3.8	0	112
<i>Niger basin</i>	7**	Niger flood plain	24	61	90	0	0	151
	8**	Northern lakes	9	65	58	0.2	2.9	126.1
	9**	Niger bend above Bourem	2	3.3	9.6	0	0	12.9
	10**	Niger bend below Bourem	2	20	12	0	(2)	32
	11**	Mare de Gossi	1	4	21	0	0	25
NIGER								
	12*	Niger above Niamey	1	3	4.2	0	0	7.2
	13	Niger below Niamey	1	10	33	0	0	43
BENIN								
	14	Niger right bank	1	1	6.6	0	(2)	7.6
NIGERIA (WEST)								
	15	Niger above Kainji	1	0.1	17	0	0	17.1
UPPER VOLTA								
	16*	Sahelian lakes	2	2.4	0.7	0	0	3.1
<i>Total Niger basin</i>				169.8	252.1	0.2	2.9	425.3
<i>Volta basin</i>	17	Bam reservoir	1	0	1	0	0	1
	18	Upper basin ponds	5	0	1.1	0	0	1.1
GHANA								
	19	Navrongo réservoir	1	0	2.5	0	0	2.5
	20	Lake Volta	1	0	0.1	0	0	1.1
<i>Total Volta basin</i>				0	4.7	0	0	4.7
TOGO								
	21	Lake Togo	1	0	0	0	0	0
NIGERIA (EAST)								
<i>Chad basin</i>	22*	Western L. Chad	1	220	470	2.7	0	692.7
CHAD								
	23*	Eastern L. Chad	1	0.6	60	0	0	60.6
	24	Lake Fitri	1	32	17	0.1	(40)	49.1
	25	Lake Chari	1	0	0	0	0	0
	26	Mayo Kebi	5	0	0.8	0	0	0.8
CAMEROON								
	27	Lower Logone <sup>2</sup>	2	0	0.2	0	0	0.2
	28	Lake Fanga	1	0	0	0	0	0
<i>Total Chad basin</i>				252.6	548	2.8	(40)	803.4
GRAND TOTAL			74	442.5	892.9	6.8	2.9	1345.1

**Notes:**

<sup>1</sup> Including Djoudji National Park. Data provided by P. J. Dugan.

<sup>2</sup> Including Pouss reservoir

Table 1. (Continued).

## (b) Afro-tropical species

COUNTRY <i>Basin</i>	No. on map (Fig. 3)	Site or grouped sites	No. of sites in group	Fulvous Whistling Duck	White-faced Whistling Duck	Egyptian Goose	Comb Duck	Spur-winged Goose	Total afro-tropical	Total Palearctic and Afro-tropical
SENEGAL										
<i>Sénégal basin</i>	1** 2**	Sénégal delta <sup>1</sup> Lac de Guier	4 1	0 0.1	2 0.1	(10) 0.2	0 (30)	0 0.2	2 0.6	8.7 1.2
MAURETANIA										
	3*	Lac d'Aleg	1	1.5	4	0.3	0.3	0.4	6.5	79.8
	4*	Lac de Mal	1	0.5	0.8	(10)	0	(35)	1.3	32.3
	5*	Foum Gleita	1	0	0	0	0	0	0	0.2
MALI										
	6*	Kolimbinié	1	0	(10)	0	0	0	(10)	0.2
<i>Total Sénégal basin</i>				2.1	6.9	0.5	0.3	0.6	10.4	122.4
<i>Niger basin</i>										
	7**	Niger flood plain	24	0.4	31	(40)	1.1	4.9	37.4	188.4
	8**	Northern lakes	9	31	0.9	0.7	0.4	0.3	33.3	159.4
	9**	Niger Bend above Bourem	2	(20)	0.9	0.2	0.2	(20)	1.3	14.2
	10**	Niger Bend below Bourem	2	(40)	15	(3)	1.6	(3)	16.6	48.6
	11**	Mare de Gossi	1	0	0	(20)	(12)	0.8	0.8	25.8
NIGER										
	12*	Niger above Niamey	1	0	0.1	0	0.1	(3)	0.2	7.4
	13	Niger below Niamey	1	0	0.2	0	0.6	(4)	0.8	43.8
BENIN										
	14	Niger right bank	1	0	1.3	0	0.6	(8)	1.9	9.5
NIGERIA (WEST)										
	15	Niger above Kainji	1	0	27	(10)	(10)	0.2	27.2	44.3
UPPER VOLTA										
	16*	Sahelian lakes	2	0	0	0.2	0.3	0.1	0.6	3.7
<i>Total Niger basin</i>				31.4	76.4	1.1	4.9	6.3	120.1	545.1
<i>Volta basin</i>										
	17	Bam reservoir	1	0	(12)	0	0	0	(12)	1
	18	Upper basin ponds	5	0	0.7	0	(1)	(40)	0.7	1.8
GHANA										
	19	Navrongo réservoir	1	0	0.7	0	(1)	0.3	1	3.5
	20	Lake Volta	1	0	0.1	0	0	(6)	0.1	0.2
<i>Total Volta basin</i>			3	0	1.5	0	0	0.3	1.8	6.5
TOGO										
	21	Lake Togo	1	0	(30)	0	0	0	(30)	—
NIGERIA (EAST)										
<i>Chad basin</i>	22*	Western L. Chad	1	13.2	0.4	(40)	0.1	(23)	13.7	706.4
CHAD										
	23*	Eastern L. Chad	1	1.2	0.1	(5)	(20)	(11)	1.3	61.9
	24*	Lake Fitri	1	21	18	0.1	3.5	1.8	44.4	93.5
	25	Lower Chari	1	0	0.1	(1)	0	(26)	0.1	0.1
	26	Mayo Kébi	5	0	1.9	0	0.1	0.3	2.3	3.1
CAMEROON										
	27	Lower Iogone <sup>2</sup>	2	0	2.8	0	0.4	0.4	3.6	3.8
	28	Lake Fianga	1	0	0.1	0	(20)	(50)	0.1	0.1
<i>Total Chad basin</i>				35.4	23.4	0.1	4.1	2.5	65.5	868.9
GRAND TOTAL			74	68.9	108.2	1.7	9.3	9.7	197.8	1542.9

## Notes

<sup>1</sup> Including Djoudj National Park. Data provided by P. J. Dugan.<sup>2</sup> Including Pouss reservoir.

Paleartic (32,000 Pintail and 17,000 Garganey) and Afro-tropical Anatidae, 44,000 individuals, the biggest concentration in the Chad Basin, and a quarter of total for West Africa. Most of the Spur-winged Geese and Comb Ducks were moulting their flight feathers.

On the lower reaches of the River Logone, the Pouss reservoir in Cameroon holds back the water of this river flowing into Lake Chad, without providing any benefits for water birds. To the west, the River Komadougou – Yobe on the borders of Niger and Nigeria, which also flows into Lake Chad, had dried out.

#### Total survey area

Overall, the major part of the total numbers observed, estimated at 1.5 million Anatidae, is made up of 440,000 Pintail and 900,000 Garganey. Of the other Palearctic ducks less than 10,000 Shoveler *Anas clypeata* were observed, mostly in the Sénégal Delta and the western part of Lake Chad; Ferruginous Ducks were confined to a group of 3000 on Lake Horo in the Inland Niger Delta; only a few Teal *Anas crecca* and Pochard *Aythya ferina* were recorded, on the Niger.

Among the Afro-tropical species, the White-faced (110,000) and Fulvous (70,000) Whistling Ducks made up the greatest part (92%). Numbers of Comb Ducks and Spur-winged Geese were low at 9500 each, with, respectively, a half and two-thirds in the Niger Basin. Less than 2000 Egyptian Geese were recorded, mostly scattered through the Sénégal and Niger Basins. About 100 African Pygmy Geese were counted (Niger Valley, ponds in Upper Volta and Chad) and probably a few Hottentot Teal (Lake Fitri).

Afro-tropical species represented 15% of the total number counted. Our earlier observations show that this percentage is remarkably constant over the years and areas studied: the only major variations were recorded at Lake Fitri in 1984 (47% of a total of 95,000 birds) and on the Niger Bend in 1979 and 1980 (80% of 25,000 birds). It is, however, known in the latter case that the differences arise from a decrease in Palearctic ducks. Lake Chad on the other hand is notable for the very low proportion of Afro-tropical Anatidae (2%). As far as general distribution is concerned,

it is notable that almost all the sites or groups of sites where Palearctic ducks occurred also held Afro-tropical Anatidae. It is also notable that these sites are extremely few in number since 18 of them held 95% of the total counted (Fig. 4). They are all situated between the 200 and 1000 mm isohyets (lines of equal rainfall). Lake Fitri is a separate case, perhaps because of its role as a moulting area.

These results, taken as a whole, make it possible to gauge the relative size of bird populations in each of the three great Sahelian catchment areas (Fig. 5). The Chad Basin held the majority of Palearctic ducks (60%), although it represents only 27% of the total area of the wetlands under consideration. Its carrying capacity thus appears to be four times greater than that of the Niger Basin which in January held only 32% of the ducks in an area twice as large. The share of the Sénégal Basin, where wetlands which could be exploited by Anatidae were reduced by 90%, was essentially made up of the birds which took refuge on the lakes of southern Mauritania. For Afro-tropical species the carrying capacity of the three basins appears to be of equivalent level.

#### Effects of the drought on the size and distribution of populations

The effect of the drought can be measured by comparing the results on three groups of sites – the Sénégal Delta, the Inland Niger Delta and the Niger Bend – where winter counts were made at three distinct periods: (i) a 'reference period': 1972 to 1976 for the Sénégal Delta (Roux *et al.* 1976); 1978 to 1980 for the Inland Niger Delta and Niger Bend (Roux *et al.* 1978, 1979; Jarry & Lamarche 1980). (ii) January 1983 (Jarry 1983). (iii) January 1984 (our present data).

In each of these periods, the annual flood, in almost all cases below average, became poorer and poorer (Fig. 2). The 'reference periods' are thus not average periods in climatic and hydrological terms, but in themselves periods with a small deficit; the differences in size and distribution of populations of Anatidae illustrating the effect of the drought are therefore less marked than might have been expected.

Overall, and in relation to the average figures, the numbers recorded in 1984 represent a general decrease in the three groups

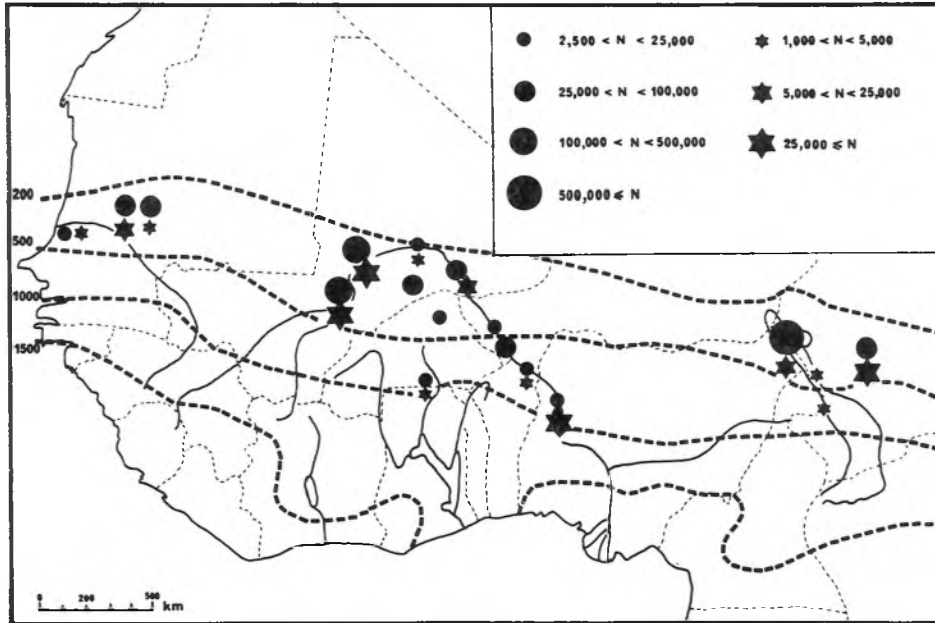


Figure 4. Numbers and distribution of Anatidae counted in West Africa in January 1984, and their relation to bioclimatic zones. 95% of the 1.3 million Palearctic (filled circles) and the 200,000 Afro-tropical Anatidae (stars) are concentrated on 18 sites, situated essentially in the Sahelian zone (between the 200 mm and 500 mm isohyets).

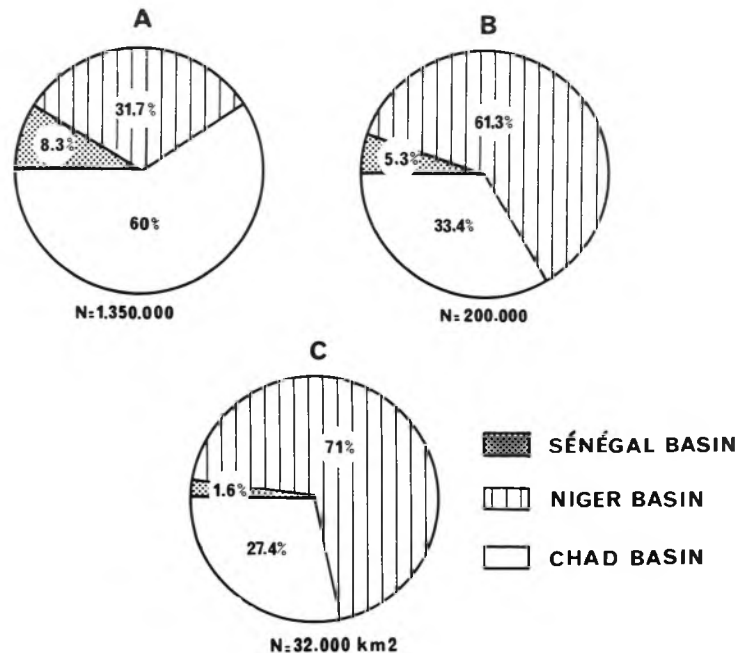


Figure 5. Relative abundance in 1984 of Anatidae counted in the major catchment areas of West Africa (A = Palearctic species; B = Afro-tropical species), compared to the relative size of the areas surveyed in each basin (C).



of sites, with the exception of Afro-tropical species in the Inland Niger Delta (Fig. 6). The shortfall is greatest in the Sénégal Delta where scarcely 5% of the Palearctic ducks and 10% of the Afro-tropical Anatidae remain. On the Niger, more especially in the Inland Delta, numbers are 25% below average for Pintail and 65% down for Garganey, i.e. a loss of 370,000 birds; Afro-tropical species dropped by 28%. The total deficit for the Niger Basin is of the order of half-a-million Anatidae.

In detail, a combined analysis of the varying hydrological situations and of the distribution of Anatidae over the different sites makes it possible to understand the process as a whole. In the Sénégal Delta, the shortfall in water supplies led in 1983 and 1984 to the drying-up of the Djoudj National Park which normally holds practically all the Anatidae wintering in the delta. A drying-out of this kind had previously been observed in January 1973, and then again 1977, 1978 and 1980 and thus assumes a chronic character. As a result, birds desert Djoudj, probably in favour of the two endoreic lakes (with no outlet) in southern Mauritania (Aleg & Mal), as long as they contain some water. These two lakes in fact held as many or more Garganey and almost as many Whistling Ducks in January 1983 and 1984 as the Sénégal Delta in an average period.

In the Niger Delta, the shortfall in water supplies did not have a marked effect on numbers until January 1984. As early as January 1983, however, the distribution of Anatidae was extremely unusual, with almost half the total (and 75% of the Palearctic species) on Lake Faguibine alone. This site on average holds only 2500 birds, with a maximum of 8000 since 1972. Such concentrations, which are definitely exceptional, correspond to the abandoning of the flood plains of the Inland Delta, which can no longer be exploited because they have dried out. The drop in lake level also makes such concentrations possible; vast areas of shallows become accessible to the Anatidae and provide optimal conditions for them to loaf in an area where they can touch the bottom and to feed on the spot thanks of the development of grasses and water-lilies.

These conditions only arise when waters are very low, and can only last for one season. If subsequently the Niger flood returns to normal levels, the lake will fill, the Anatidae can only obtain their requirements on the narrow band of shallow water

round the edge of the lake, while the preferred habitat conditions are reconstituted over immense areas of the flood plain. This was the situation in the reference period.

If, on the other hand, the river flood is insufficient to refill the lake, the bottom is no longer covered by water, aquatic vegetation chokes the remaining pools, and the birds are obliged to abandon the lake for another refuge. This was what happened in 1984.

The case of Lake Faguibine should be emphasised: it is a perfect illustration of the complex interaction of physical parameters affecting the distribution of water birds in West Africa. It also bears witness to the extremely wide variations which may affect populations at a single site from one year to another. The case is probably also valid for Lake Chad, whose hydrological system is altogether comparable and which, because of the drought, has undergone a similar evolution in the last twenty years.

It thus appears that the drought has been characterised by an overall drop in numbers (at 500,000 in 1984) and by a partial and short-term switch to particular sites (Mauritanian lakes, Lake Faguibine in 1983) which played the role of a climatic refuge. The outstanding question concerns the role played in this context by Lake Chad in 1984.

## Discussion

This first practically complete survey of the wetlands of West Africa makes it possible to give a better idea of their relative importance for wintering of total West Palearctic duck populations. The compilations of data made by Atkinson-Willes (1976) and Scott (1982) show that the region holds 10% of the total of these populations. As for species, it holds almost all the Garganey counted hitherto and more than half the Pintail. Given the current dry state of the habitats and the considerable mobility of Pintail, it can be assumed that West Africa's contribution to the wintering area of this species is even higher in average climatic conditions.

The survey confirms the striking numerical inferiority of Afro-tropical Anatidae (15% of the total), represented essentially by Fulvous (70,000) and White-faced Whistling Ducks (110,000). However, it is certainly more difficult than for Palearctic ducks to work out absolute population size, because

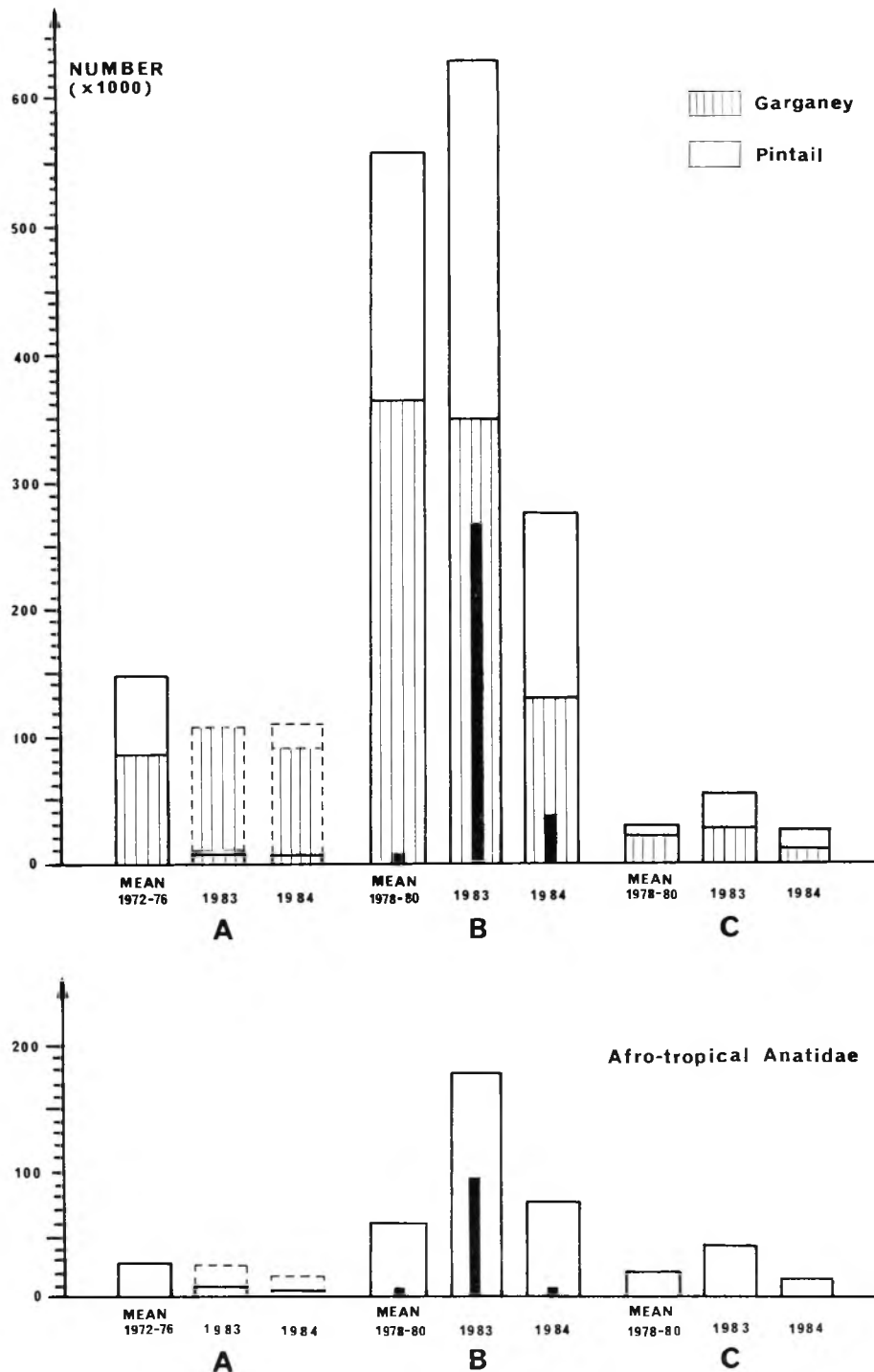


Figure 6. Comparison between the number of Anatidae observed during three periods on the Sénégal Delta (A), the Inland Niger Delta (B) and the Niger Bend (C). The dotted lines above the columns in section A illustrate numbers observed on the Mauritanian lakes; the black lines inside the columns in section B illustrate numbers observed at Lake Faguibine (see text).

of their distribution (less restricted to the Sahelian zone), the more loose dispersal of some species and the possibility of movements across the Equator (for Comb Duck see Douthwaite 1974).

The survey also reveals the carrying capacity of Lake Chad (700,000 *Anas* sp.) which seems to be an entirely new observation. It furthermore consolidates a notion partially formulated for Palearctic species (Moreau 1972; Roux 1976): even in the worst drought conditions, wintering of Palearctic and Afro-tropical Anatidae does not occur south of the Sahelian zone, although wetlands (mainly coastal lagoons, cf. Fig. 3) exist there. All the areas visited to the south of this zone in Guinea Bissau (Poorter & Zwarts 1984; W. Altenburg & J. van der Kamp, pers. com.) in Ivory Coast, Upper Volta, Ghana and Togo do not hold 10,000 Anatidae between them. The explanation of this situation may be found at three levels: (i) the habitats to the south of the Sahel are unsuitable because of their physical conditions (habitats too heavily overgrown or wooded, too deep, or individually too small); (ii) their low productivity, associated with constant habitat factors during the annual cycle (temperatures, water levels) is to be contrasted with the sudden burst of very high productivity in Sahelian habitats when they are flooded; (iii) for Palearctic migrants, the position of the majority of these habitats, on average more than 1000 kilometres south of the Sahelian belt, would lengthen the spring migration flight to the first stopping points on the shores of the Mediterranean by a considerable amount. The birds would therefore have to increase their energy reserves at the end of the winter.

Given the need for large numbers of birds to have abundant resources available for collective exploitation, the argument based on reasons of energy (low available resources and high cost of reaching them), seems sufficiently strong to explain the devotion to the Sahelian zone of both Palearctic and the majority of Afro-tropical populations.

If they use only the resources of Sahel habitats, the alternative for water birds in times of drought is to make lateral movements between basins (Sénégal, Niger or Chad), to exploit the remaining resources. This would explain the massive concentrations observed at times at some sites (Lac d'Aleg, Lac de Mal, Lake Faguibine) and this year on Lake Chad. With this in mind, it

is astonishing that the total number observed in 1984 on all three basins is only 25% higher than the maximum recorded only on the Sénégal and the Niger in earlier years. Two hypotheses, which are not mutually exclusive, can be envisaged to explain this: either there has been a decrease in the numbers of the population as a whole; or there has been a change in their distribution. Since it is known that migrants do not return to areas north of the Sahara in mid-January (counts in Algeria and Tunisia in January 1984 confirmed this yet again: M. Smart pers. com.), the assumption must be either that some of the birds moved to the east (Nile basin) or that the Chad Basin served as a refuge for birds unable to exploit the Niger Basin. This would suggest that, at normal water levels, Lake Chad holds only 300,000 to 400,000 Anatidae and that the drop in water levels in 1984 made massive exploitation possible, as happened at Lake Faguibine in 1983.

The only definite answer that can be given relates to certain Afro-tropical species (Whistling Ducks) for which it appears indisputable that a decrease has taken place: the Chad Basin does not hold a half of the birds which have disappeared from the Niger. These species are restricted to the same bioclimatic zone throughout their annual cycle and thus cannot at any time escape the problems of the habitat. How can these populations maintain their numbers when an intense and generalised drought affects the normal course of reproduction and moulting? Earlier data have already shown that, in Sénégal, the 1972–3 drought led to a sharp drop in numbers of all Afro-tropical species, which only reached their initial numbers again in 1975 (Roux *et al.* 1976).

It was also shown that 95% of the total numbers are concentrated in 18 sites. All of these are thus of fundamental importance for the survival of populations of Anatidae in extreme climatic conditions. Experience from the Sénégal and Niger Basins indicates that these latter remain extremely important whatever water conditions may be. These conclusions demonstrate the type of survey which will have to be carried out in future and which must include the Nile Basin in Sudan, if the situation as a whole is to be understood. The costs in energy and money are not exaggerated in comparison with the value of the results which will certainly be obtained, as long as the biologists

carrying out the operation are already experienced in the techniques of aerial censusing and familiar with working conditions in Africa.

Finally the distribution in time and space of the populations in 1984 clearly illustrates the wetlands at which conservation measures and scientific monitoring must be carried out, if the survival of the water bird populations which depend on them is to be guaranteed.

#### Acknowledgements

We offer our warmest thanks to Messrs C. Alanic and P. Chene, our volunteer pilots during the forty days of our aerial odyssey.

We also offer thanks, for their warm welcome and their assistance, to Mr and Mrs S. Darroux in Sénégal; Messrs P. Chouret (ORSTOM) and N. Diallo (Ministry of Transport) in Mali; Mr and Mrs L. Bortoli in Upper Volta; Messrs K. Vouna and G. Daboulay (Water and Forestry Service), Rev. P. Faure (SECADEP – Catholic Aid for Development) and Lt N. Tombor (Ministry of Defence) in Chad.

Mr J. C. Klein (ORSTOM) made the hydrological data available. Messrs W. Altenburg, P. J. Dugan and J. van der Kamp gave us details of their complementary observations. Our sincere thanks go to them and to Mr A. Tamisier (CNRS – National Council for Scientific Research) for his contribution in the writing of this article and Mr M. Smart (IWRB) for translating it into English.

The survey, carried out as a research mission of CRBPO (the Centre for Research on the Biology of Bird Populations), had the benefit of support from the Paris MNHN (National Museum of Natural History), CNRS, ONC (the National Hunting Office) and the French Ministry of the Environment. It was financed by the Mission for Study and Research of this Ministry, and could not have taken place without the enthusiastic support of Mr J-P Grillet.

#### Summary

Following 12 years of regular winter observations in the delta of the Sénégal and the Niger flood zone in Mali, the first practically complete aerial survey of the wetlands of West Africa (Sénégal, Niger, Volta and Chad Basins) was carried out in January 1984 during a period of exceptional drought.

It revealed the hitherto unsuspected potential of Lake Chad (700,000 *Anas* sp.). It shows the overall size of the Anatidae populations of West Palearctic (essentially 440,000 Pintail *Anas acuta* and 900,000 Garganey *A. querquedula*) and Afro-tropical origin (70,000 Fulvous Whistling Ducks *Dendrocygna bicolor*, 110,000 White-faced Whistling Ducks *D. viduata*, 10,000 Comb Ducks *Sarkidiornis melanotos* and 10,000 Spur-winged Geese *Plectropterus gambensis*), which winter in this part of the African continent and their concentration (95%) on only 18 sites or groups of sites. A comparison with earlier data shows that the same sites are always occupied, whatever the water conditions.

The effect of the drought is illustrated by a very notable decrease in numbers of both faunal groups in the Sénégal delta (in favour of the lakes in southern Mauritania) and in the Niger Basin where a decrease of 500,000 individuals was recorded. The two hypotheses to be retained are: firstly, a decrease in overall population size (which is certain for the Afro-tropical species, and considerable for some of them); and secondly a movement to the east by Palearctic species, particularly towards the Chad Basin (which alone held more than half of the numbers counted) but perhaps also towards the Nile Valley in Sudan.

It can be seen that even in these conditions of extreme drought, Palearctic and Afro-tropical Anatidae do not extend southwards beyond the Sahelian wetlands. These habitats, and among them the 18 sites traditionally exploited by Anatidae, therefore assume major importance for the survival of these populations and must be given priority in conservation measures and ecological research.

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- F. Roux and G. Jarry**, Centre de Recherches sur la Biologie des Populations d'Oiseaux, Museum National d'Histoire Naturelle. 55 rue de Buffon, 75005 Paris, France.