

Seasonal movements of giraffes in Niger

YVONNICK LE PENDU* and ISABELLE CIOFOLO†

**Le grand parc, 56190 Lauzach, France. E-mail: yvonnick@france-mail.com*

†*Rue Félicien Delince, 14–1160 Brussels, Belgium*

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ABSTRACT. The last population of giraffes in west Africa lives in Niger in an unprotected Sahelian region inhabited by farmers and herders. The spatial behaviour of each individual of the population ($n = 63$) was studied by direct observation during 15 mo. Two-thirds of the population were resident in the tiger bush in the rainy season and in the nearby area of Harikanassou, a sandy agricultural region, in the dry season. Rainy season and dry season home ranges were mutually exclusive and individual home ranges were overlapping when considering one season (rainy season: 84%; dry season: 67%). The mean size of the seasonal home ranges of these resident giraffes during the dry season (90.7 km^2) was twice the mean size during the rainy season (46.6 km^2). A third of the population moved 80 to 200 km in three directions, and two giraffes from an isolated group from Mali moved 300 km along the Niger River. Long distance movements of such length have never been reported before, and several explanations are proposed: previous distribution, social transmission, hydrographic network and food availability, poaching events. The giraffes in Niger do not avoid rural communities; indeed, they live in densely populated regions. Furthermore, their movements, synchronized with human activities in these regions, are representative of life conditions in the Sahel.

KEY WORDS: *Giraffa camelopardalis*, giraffe, home range, long distance movements, Niger, spatial behaviour, sustainable management

INTRODUCTION

At the end of the 19th century, giraffes (*Giraffa camelopardalis*) were present in Mauritania, Senegal, Gambia, Mali, Niger and Nigeria (Ciofolo 1995, Dagg & Foster 1976). During this century, west African giraffe populations disappeared in all countries except Niger. Hundreds of giraffes lived in Niger at the beginning of the 1970s (Poché 1976). At this time, they were mainly observed between Tillabery and Ayorou, along the Niger River south of the Malian border. Extension of agricultural lands, deforestation, poaching and droughts provoked a dramatic decrease of their number in the following years, resulting in the 63 individuals identified by this study. These 63 giraffes form the whole

population of west African giraffes. In co-operation with local users, a land-use management project was begun in 1996 to provide sustainable natural resources management, which included management of the giraffe population. That project delineated an area, populated with farmers and pastoralists, known as the Man and Biosphere Reserve. The creation of this reserve along with the development of some ecotourism necessitated this study of spatial behaviour of the giraffe population. Individual movements, home range sizes and long distance movements are presented in this paper. Several explanations to long distance movements are discussed: previous distribution, social transmission, hydrographic network and food availability, and poaching events.

STUDY SITE

The giraffe population occurs on the eastern side of the Niger River. Two-thirds of the population is concentrated in the core area, 80 km south-east of Niamey (Figure 1). Giraffes are also found in 'peripheral' regions. The core area and the peripheral regions, except for the Gaya region, are situated in a Sahelian zone receiving an average annual rainfall of 400 mm. The Gaya region is in a Soudanian zone receiving an average annual rainfall of 600 mm.

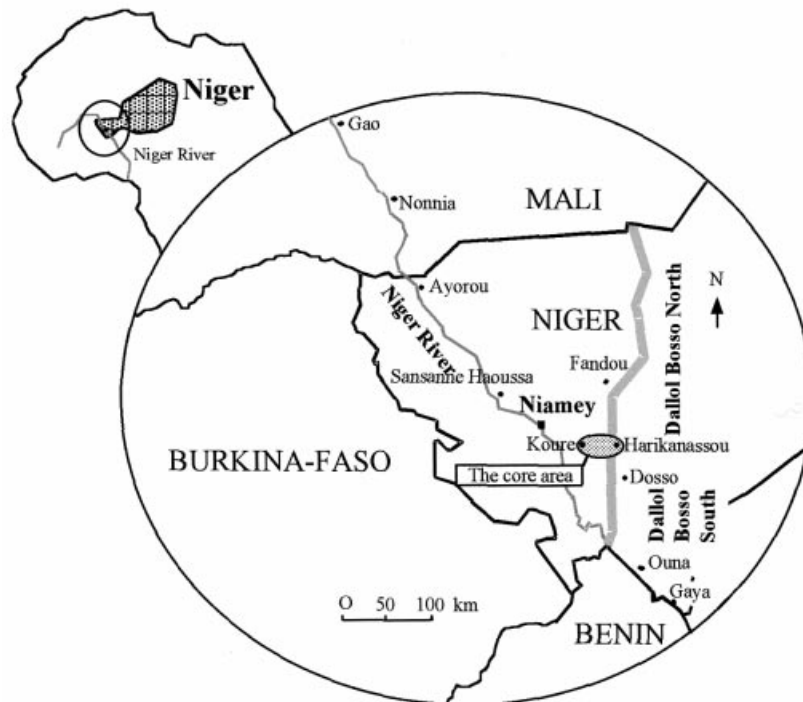


Figure 1. Location of the study area in Niger: the core area and the peripheral regions (Nonnia, Fandou and Gaya).

The core area

This area is composed of the Koure plateau and the area of Harikanassou (Figure 1). The Koure area is a lateritic plateau covered by tiger bush, a specific shrubby vegetation type with dark wooded strips of land alternating with light barren ones (Ciofolo 1995). Eighty per cent of the vegetation is composed of Combretaceous species (*Guiera senegalensis*, *Combretum micranthum* and *Combretum nigricans*). The rest is composed of 10% of Cappariaceae species (*Boscia angustifolia* and *Boscia senegalensis*), 5% of Mimosaceae species (*Acacia macrostachya*, *A. pennata* and *A. ataxacantha*) and 5% other species (Karimou 1984). This region is populated by people from three predominant ethnic groups. Farmers from the Dzarma ethnic group practise extensive subsistence farming of cereal crops (millet, sorghum, beans, corn) in the rainy season. Herders from the Peul and Tuareg ethnic groups live in isolated encampments and move across the plateaux with their herds (cows, oxen, goats, sheep, camels). Both of these rural communities threaten the tiger bush with deforestation (Ciofolo 1995).

The area of Harikanassou, east of the Koure plateau is located in the northern part of the Dallol Bosso which is considered as the bed of an ancient river. It is a sandy region with permanent water in numerous hollows. *Combretum glutinosum*, *Acacia albida*, *Balanites aegyptiaca* and *Prosopis africana* each represent 15–20% of the trees. *Guiera senegalensis*, *Annona senegalensis* and *Piliostigma reticulatum* are the most common shrub species. Grass species are also frequent (*Andropogon gayanus*, *Eragrostis tremula*). The Dzarma people cultivate millet in most of the region during the rainy season. They also cultivate fruits and vegetables during the dry season in the hollows and near permanent ponds. Peul and Tuareg herders are also present in the Dallol Bosso during the dry season.

The peripheral regions

The Fandou region is situated 100 km east of Niamey, in the northern part of the Dallol Bosso. This region is also composed of tiger bush and cultivated land where Dzarma farmers practise extensive subsistence farming of cereal crops (millet, sorghum, beans) during the rainy season. Desertification does not allow gardens or fruit orchards during the dry season.

The Gaya region is situated 225 km south of Niamey. It is composed of the fertile region along the Niger River, with a typical soudanian forest classified since 1935 (the Gorou-Bassounga Forest) and the cultivated region of Ouna. This region is fertile because of the proximity of the Niger River. Cereals, gardens and fruit orchards are cultivated year-round. Fishing is also an important economic income for the region. The proximity of the Benin and Nigeria borders enhance the economic activity; Haoussa and Dendi merchants are numerous in this region.

The region north of Niamey is composed of the eastern side of the Niger River from Gao (Mali), 300 km north-west of Niamey, to Sansanne Haoussa, 50 km

north of Niamey. It is a degraded region due to desertification that does not allow agriculture, except along the river.

METHODS

Observations were conducted between October 1996 and December 1997. The rainy season occurred from June to October and the dry season from December to April. May and November were called transition periods corresponding to the giraffes' movements (see Results). Giraffes were individually recognized by photo-identification. The ages of the giraffes born during our observation period were precisely known, each individual being observed, on average, twice each month (Ciofalo & Le Pendu 1998). The other giraffes were assigned an age class according to dated photos taken during previous years and to some morphological criteria (size, bony concretions on the old males' head). Four age classes were defined: newborn (< 6 mo), young (6–18 mo), subadult (18 mo to 4 y), adult (> 4 y). We visited the core area 3 d per week and the peripheral regions 3 d per month. Using a GPS, 1754 locations of giraffes were recorded, and the local environments were defined as tiger bush, field, fallow land, other. We analysed separately resident and non-resident giraffes. We considered as a non-resident, a giraffe observed in two successive locations distant by 50 km or more. Movements inside the core area were not considered as long distance movements.

The seasonal area of home ranges and the degree of overlap of individual home ranges were calculated for each resident individual, using the convex polygon method (Kenward 1990). An ANOVA was applied to home range size of resident giraffes, after a square-root transformation for variance homogeneity. Mothers were excluded from this analysis and identity number of each individual included in order to ensure independence of the data.

RESULTS

Population size

The population increased between September 1996 and December 1997 from 51 to 63 individuals (Table 1). The low proportion of giraffes less than 18 mo

Table 1. Composition of the whole population of giraffes in Niger in September 1996 and December 1997. The 10 extra-young were born during the first months of the study period.

	September 1996		December 1997	
	Male	Female	Male	Female
Age class				
Newborn	0	0	0	2
Young	1	1	8	4
Subadult	6	3	7	3
Adult	18	22	16	23
Total	25	26	31	32

old in September 1996 is attributed to the abundant poaching between April and August 1996 in which villagers were not involved (Ciofolo & Le Pendu 1998, Sadou 1996). No more poaching events occurred during our study period. The population of giraffes of Niger reached in December 1997 the population size of the year 1995 (Peterson 1995).

Spatial behaviour in the core area

Two-thirds of the population spent the entire study period in the core area. All other giraffes, except an adult male and a young male, spent at least a part of the study period in this zone. During the dry season, giraffes were observed in the area of Harikanassou (Figure 2). The first movements to the tiger bush of Koure occurred the day after the first rain. Most of the giraffes were present in the tiger bush of Koure at the beginning of June. Ninety per cent of the giraffes were observed in the tiger bush during the rainy season. They moved back to the area of Harikanassou in November, being observed mainly in fields and fallow lands during the dry season.

Seasonal home range sizes

The mean size of the seasonal home ranges of all resident giraffes during the dry season were twice the size than that during the rainy season (90.7 km^2 vs 46.6 km^2 ; $F = 6.774$, $df = 1,10$, $P = 0.03$).

The home ranges of females and newborn calves are not the same in Table

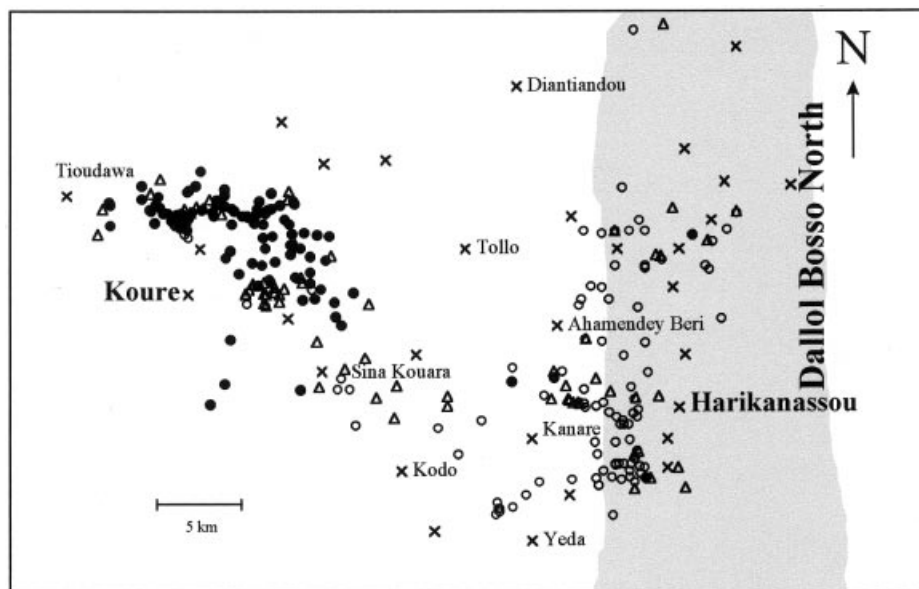


Figure 2. Locations of 265 groups of giraffes ($n = 1888$) in the core area between October 1996 and December 1997 during the rainy season (●), the transition periods (△) and the dry season (○). × villages, ■ Dallol Bosso.

Table 2. Mean seasonal home range sizes (km²) of resident giraffes.

	Male			Female		
	mean	SD	(n)	mean	SD	(n)
Rainy season						
Age class:						
Newborn+young	50.7	±19.3	8	52.3	±9.4	3
Subadult	38.7	±5.3	3	66.4	±39.9	3
Adult	31.7	±12.5	10	50	±17.5	18
Average	39.9	±16.8	21	52.4	±20	24
Average, males+females	46.6	±19.4	45			
Dry season						
Age class:						
Newborn+young	56.3	±40	3	72	±43.2	2
Subadult	96.9	±39.2	3	44.9	±27.6	3
Adult	133.9	±42	2	102.5	±72.4	15
Average	90.9	±47	8	90.6	±67.2	20
Average, males+females	90.7	±61.2	28			

2 because some females did not have a newborn during our study period. Mothers and their newborn shared the same home range at least during the first 6 mo of life of the newborn (Laboureau 1997) and generally until 18 mo old (Le Pendu & Ciofolo; unpubl. data).

Seasonal home ranges of resident giraffes were overlapping during both seasons: the mean degree of overlap was 84% during the rainy season and 67% during the dry season. The only difference between males and females occurred during the dry season (male/male: 61%; female/female: 72%). There was no spatial segregation between the sexes.

Long distance movements to peripheral regions

Movements to the Fandou region. Nineteen giraffes moved to the Fandou region during our study period (Figure 3, Table 3). These movements were mostly from the tiger bush of Koure to the Fandou region and from the Fandou region to the area of Harikanassou. Giraffes were found in the tiger bush of the Fandou region during the rainy season and in cultivated areas during the dry season. They moved between these two types of environment similarly as they did in the core area.

Non-resident giraffes comprised all sex and age classes but adult males were the largest class (n = 9). Movements from the tiger bush of Koure to the Fandou region occurred between June and the first two weeks of December, and giraffes moved back to the core area between November and February. Four giraffes were observed both years in Fandou. Long distance movements periods were probably much shorter than the lapse of time between the last observation in the departure region and the first one in the arrival region. On two occasions, giraffes are known to have travelled the 80 km separating Fandou and the core area in 5 d.

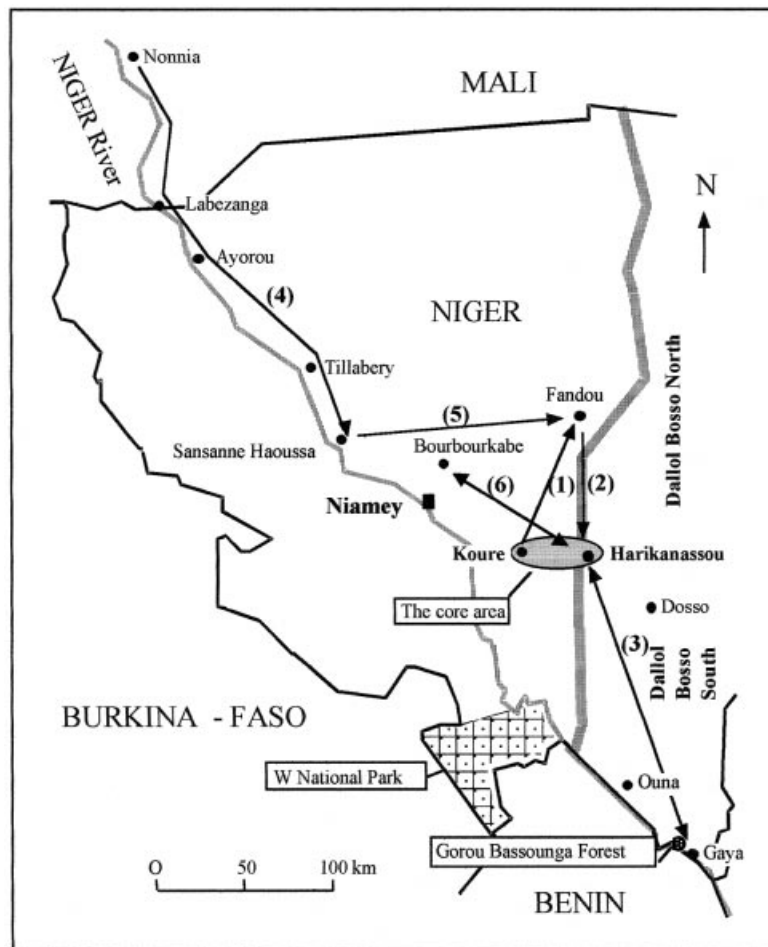





Figure 3. Long distance movements of giraffes in Niger between October 1996 and December 1997. Movements from the tiger bush of Koure to the Fandou region (1), from the Fandou region to the area of Harikanassou (2), between the core area and the Gaya region (3), from Mali to Sansanne Haoussa (4), from Sansanne Haoussa to the Fandou region (5), between the core area and Bourbourkabe (6).

Movements to the Gaya region. Two giraffes moved to the Gorou-Bassounga Forest in the Gaya region during our study period (Figure 3). An adult female, well known in the core area for years did the 160 km trip between May and August 1997. An old male moved to the Gorou-Bassounga Forest between October and December 1997. It probably returned in May 1997, being observed at this time in the core area for the first time. Another old male observed in the Gorou-Bassounga Forest in January 1998 was photographed in the core area in January 1994. On the other hand, herders observed regularly up to five giraffes together in the Gorou-Bassounga Forest, indicating the presence of other giraffes there during the entire year. Giraffes are also observed regularly by farmers and herders every year during the dry season 50 km west of the Gorou-Bassounga Forest near Ouna.

Table 3. Periods of long distance movements observed in giraffes from October 1996 to December 1997 between the tiger bush of Koure, the Fandou region and the area of Harikanassou. Individuals in bold moved both in 1996 and 1997. f, female; m, male. Age at first long distance movement during this period: n, newborn; y, young; s, subadult; a, adult. Periods of long distance movements include the lapse of time between the last observation in the departure area and the first observation in the arrival area.

Ind.	Sex	Age	Period of observation (fortnights)											
			Rainy season						Dry season					
			June	July	August	September	October	November	December	January	February	March	April	May
7	m	y												
8	m	a												
9	m	s												
11	m	a												
11	m	a												
12	m	a												
13	m	a												
14	m	a												
15	m	a												
18	f	a												
32	m	s												
37	m	a												
40	m	a												
40	m	a												
41	f	a												
41	f	a												
42	f	a												
42	f	a												
46	m	a												
48	f	a												
57	f	a												
58	f	y												
69	f	n												

 Period of long distance movements from the tiger bush of Koure to the Fandou region.
 Period of long distance movements from the Fandou region to the area of Harikanassou.
 Period of long distance movements from the area of Harikanassou to the Fandou region.

Movements from Mali. In September 1997, two subadult males coming from Nonnia (Mali) passed through the Malian border and travelled along the Niger River to Sansanne Haoussa, 50 km north of Niamey and *c.* 300 km from Nonnia (Figure 3). These two males probably come from a relic group of five individuals living in the Natural Reserve of Monzonga. In December 1997, five unidentified giraffes went from Sansanne Houssa to Fandou. The group could have been composed of giraffes from Mali and/or giraffes from Niger. In January 1997, one adult female went from the area of Harikanassou to the north-east of Niamey.

DISCUSSION

Movements in the core area

The regular journeys between the tiger bush of Koure and the area of Harikanassou have been known for years (Ciofolo 1990, Ciofolo & Le Pendu 1998). These movements are clearly linked with the phenological status of the vegetation. For instance, during the dry season, *Acacia albida* and *Combretum glutinosum* represent 42% of the feeding time of the giraffes (Ciofolo & Le Pendu 1998). In May, the *Acacia albida* of the area of Harikanassou lose their leaves and the old leaves of *Combretum glutinosum* are full of tannins (Achard 1990). The phenological status of these two species, as well as other species, favours the departure of the giraffes at that time to the tiger bush. As a matter of fact, the tiger bush is highly productive during the rainy season, from June to October (Achard 1990). In November, the return to the area of Harikanassou can be associated with the withering of tiger bush vegetation and the renewal of the foliage in the Dallol Bosso (Ciofolo & Le Pendu; unpubl. data).

Home ranges

Home range sizes of giraffes differ among studies (Table 4). These differences are due to environmental characteristics (topography, structure of the vegetation, fenced/free area), animal density and methods used for estimation (duration of the study, number of observations).

Our population presents the largest home ranges ever measured for giraffes, not only for non-residents, but the mean annual home range size of resident giraffes is also larger than those found in previous studies. This larger size of home ranges is due to the fact that they include two distinct areas (the tiger bush of Koure and the area of Harikanassou), making annual home range measures irrelevant.

Seasonal movements exist in other populations (Hall-Martin 1974, Leuthold & Leuthold 1978). In the Serengeti, 75% of the sightings occurred in the central 30% of the home range (Pellew 1984). Converse to this study, Leuthold & Leuthold (1978) note smaller dry season home ranges with the animals concentrating along a river with green vegetation. When such topographic elements produce irregularly shaped home ranges, the minimum convex polygon method is not appropriate (Scheepers 1992).

Table 4. Mean annual home-range size in different populations of giraffes. Residence status: N.Res, non-resident; Res, resident. n, Number of individual. ?, information lacking. Methods employed: a, convex polygon; b, dot grid method; c, unknown.

Sex and age	Residence status	Home range (km ²)		n	Observation period (mo)	Source
		Mean	Range			
Adult males	Res	641 ^a	127–1559	6	7–15	Ciofolo & Le Pendu (1998)
	N.Res	992 ^a	202–1564	8		
Adult females	Res	324 ^a	151–1378	14		
	N.Res	487 ^a	200–1307	5		
Subadult and adult males		164 ^a	5–654	60	12–28	Leuthold & Leuthold (1978)
females		162 ^a	9–484	50		
Adult males		82 ^a	up to 145	14	54	Berry (1978)
females		68 ^a	up to 82	4		
Adult males		62 ^b	?	10	?	Foster & Dagg (1972)
females		85 ^b		10		
Adult females		282 ^a	?	1	27	Du Toit (1990)
Adult females		41 ^a	?	1	20	Langman (1977)
Males		37 ^a	?	4	?	Langman (1973)
Females		23 ^a		9		Leuthold & Leuthold (1978)
Adult females		120 ^c	?		?	Pellew (1984)

The greater home range sizes of resident adult females during the rainy season is not in accordance with Berry (1978) and Scheepers (1992) who found that males used a greater area than females throughout the year. In the Tsavo National Park, young adult males have larger home ranges than females while old males have smaller home ranges than females (Leuthold & Leuthold 1978).

Home ranges were overlapping, especially during the rainy season. The high degree of overlap between males' and females' home ranges and the frequent mixed associations among sex and age classes (Le Pendu & Ciofolo; unpubl. data) confirm the absence of socio-spatial segregation (Backhaus 1961, Berry 1978, Foster & Dagg 1972, Leuthold 1979).

Long distance movements

Long distance movements concerned three main peripheral areas: Nonnia (Mali), Fandou and Gaya area.

The 300 km movement between Nonnia and Sansanne Haoussa represents the longest movement ever recorded. The longest linear movements measured in other populations are less: 86 km (Berry 1978), 50 km (Leuthold & Leuthold 1978); 50 km (Dagg & Foster 1976) and Berry (1978) found a giraffe killed 140 km from her nearest herd members. Migrations from Nairobi National Park are supposed to be frequent but they were not measured (Dagg & Foster 1976).

Several hypotheses could explain long distance movements of giraffes in Niger:

(i) The previous distribution of giraffes in Niger: In the 1960s, a flourishing population of giraffes lived from Gaya to Mali with the highest population density near Ayorou at the Malian border (Happold 1978, Poché 1976). The frequent poaching events of the 1970s (Pfeffer 1981) and the 1984 drought have caused a general migration from the Ayorou region to the Dallol Bosso since 1982 (Ciofolo 1990, 1991). During the same time, the intensive deforestation in the Gaya region caused a migration to the area of Harikanassou (Ciofolo 1990, 1995).

(ii) The social transmission. Four giraffes moved to Fandou in 1996 and 1997 (Table 3). One can suggest a possible social transmission from these individuals to the other giraffes. Furthermore, two adult females moved with their young to Fandou (Table 3) and Gaya (Le Pendu & Ciofolo, unpubl. data). Further research could confirm filial transmission.

(iii) The hydrographic network and food availability. Long distance movements occur near permanent sources of water i.e., the Niger river valley and the Dallol Bosso, the bed of an ancient river. These sources of water favour the growth of plant species consumed by giraffes (*Acacia* sp., *Combretum* sp., *Boscia* sp.).

(iv) Poaching events. Long distance movements of giraffes to the Fandou region have been known for years, but previously the animals did not stay there during the rainy season. The disturbance caused by poaching events during the 1996 rainy season (Sadou 1996) could have contributed to enhance these movements the following year.

There is no simple explanation to the long distance movements observed in the population of giraffes of Niger. They cannot be only associated with food or water scarcity. They do not involve specific sex and age classes.

In Niger, giraffes are in an unprotected and densely populated region (37 inhabitants km², Yahaya 1992). They do not live in parks or reserves in which human activities are controlled. They do not damage crops, and they live peacefully with domestic cattle which can be found in the entire area.

The movements of the giraffes in the core area are synchronized with human activities and movements of domestic cattle. The production of millet, which covers most of the Dallol Bosso during the rainy season begins after the departure of the giraffes. At the same time, domestic animals are brought to the tiger bush to avoid damage to crops.

Therefore, giraffes, human communities and domestic cattle move at the same time according to environmental constraints. All these movements are

representative of life conditions in the Sahel, where the lack of resources does not allow a sedentary way of life. Survival implies mobility.

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