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RESEARCH ARTICLE

ANALYSIS OF THE SOCIAL AND REPRODUCTIVE BEHAVIOUR OF THE WEST AFRICAN GIRAFFE *(GIRAFFA CAMELOPARDALIS PERALTA)* FOR OPTIMAL POPULATION MANAGEMENT

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ABSTRACT

This study aims to understand the biology of the giraffe *(Giraffa camelopardalis peralta)* and its ethological characteristics for optimal management. Little is known about the social and reproductive behaviour of the Niger giraffe. This information enables conservation measures to be adapted for the sustainable management of the giraffe. The present study was conducted in the area between 13°00' and 14°30' north latitude and 2°30' and 3°30' east longitude. Direct daily observations of the giraffe were conducted from 0800 pm to 0700 am for 111 days, from April 2018 to March 2019 on the trays of Kouré, Fakara, Fabidji, Falmey, Northern Dallol Bosso, Fandou, Dingazi-banda and Simiri. It appears from this study that adult females are more numerous; are always accompanied either by a giraffe or by other giraffes of different classes and or sexes. The average herd size is 5.59±3.49 individuals in the cold dry season, 3.96±1.42 individuals in the hot dry season and 7.58±5.20 individuals in the rainy season. All combinations are possible, except groups of young and giraffe only. After 243 observations, only 21 individuals were observed solitary and all of them are adult males, so, no solitary females. There are several types of associations between individuals of the same class and/or different sexes. The average birth rate is 0.13±0.08 individuals and a proportion of 32.93% for breeding females. The rate of increase is 11% and the mortality rate is close to 2% by year. The causes of death are mainly natural. The distance between individuals in a group is about 121.19±80.02 meters. There is an important social connection between the mother and the giraffe baby.

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INTRODUCTION

The giraffe (*Giraffa camelopardalis peralta*) from Niger is the last in West Africa and the only representative of the peralta subspecies in Africa. It frequents several habitats depending on the season; these are the forest trays in the rainy season, the Dallol Bosso in the hot dry season and the intermediate zone in the cold dry season (Ciofolo, 1995; Le Pendu and Ciofolo, 1999; Ambouta, 2006). The giraffe appears on the list of taxa that are fully protected in Niger (Law n°98-07 of 29 April 1998) and is classified as "Vulnerable" on the Red List of the International Union for Conservation of Nature in 2018. This category includes species facing a threat in the wild. For this reason, various conservation operations have been undertaken in the area where the giraffe lives. There is a clear evolution of the giraffe population from 50 individuals en 1996 (Ciofolo, 1998) to 633 individuals in 2018 (DFC/PR report, 2018).

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This can be explained by the relative peace and quiet it enjoys in the study area as a result of awareness-raising efforts and the various actions carried out by development projects, the services in charge of protecting the giraffe and certain associations. The breeding system is polygynous, where only a small number of males seem to have access to reproduction, often the largest and most aggressive (Dagg & Foster, 1976). Female sexual activity is limited to a few days every two weeks (Pratt & Anderson 1985). The male determines whether the female is in estrus by tasting the female's urine (Leuthold 1977). If the female is receptive, the male stays close to the female, attempts to mate with her (Leuthold, 1979; Pratt & Anderson, 1985), and moves away or fights with competing males. During this period, the male decreases his feeding time (Bercovitch, 2006). These fights between males, called "necking", are often ritualised, but sometimes violent: males hit each other on the neck and head. Very rarely in the literature, the death of a male following a fight has been reported (Simmons & Scheepers, 1996). In Niger, cases of deaths following fighting between adult males have been recorded in the last ten years.

Reproduction in giraffes is not seasonal, but birth peaks have been reported in some populations (Scheepers, 1992; Fennessy, 2004). Gestation lasts about 15 months, and when conditions are good, on average a single giraffe is born every 2 years (Dagg & Foster, 1976). This period between births may decrease if the giraffe dies (Dagg & Foster, 1976). The giraffe's social system is described as non-territorial, and extremely flexible. Thus, there is a strong overlap of individual home ranges (Dagg & Foster, 1976; Le Pendu et al. 2000). However, the mechanisms governing changes in herd size are not known. It is still not known whether herds result from random association, or whether they are structured into social networks (Bercovitch & Berry, 2010). These herds can change in number and composition several times a day (fusion/fission system, Berry, 1973). Thus, the giraffe is an ideal model to study how ecological variables contribute to fluctuations in herd size (Bercovitch & Berry, 2010). Little information is known about ethological characteristics (social and reproductive behaviour), interactions between individuals of the same sex or of different classes, rates of growth, birth rate, mortality, links with local populations and the environment in a context of strong degradation of natural resources. This study is part of the knowledge of group composition, birth rate, relations between individuals of the same group and of different groups, relations between mother and giraffe and mortality, all of which will contribute to the sustainable management of the giraffe population in Niger.

Equipment and methods

Study area: The present study was conducted in the giraffe's range between 13°00' and 14°30' north latitude and 2°30' and 3°30' east longitude (Figure 1). The forest formation is an alternating strips of vegetation and bare soil. The processes that determine its evolution have been relatively investigated (Leprun, 1992; Ambouta, 1997; Couteron et al. 1996). It is one of the best structured plant formations in the Sahelian zone (Ambouta, 1999). Rainfall is irregular and poorly distributed in time and space, with an average annual rainfall of 497.15 mm over the last 30 years. The maxima rise from 34.2°C to 30.7°of the rainy season and the minima hover around 23.2°C during the cold dry season and 27.7°C in the middle of the rainy season.

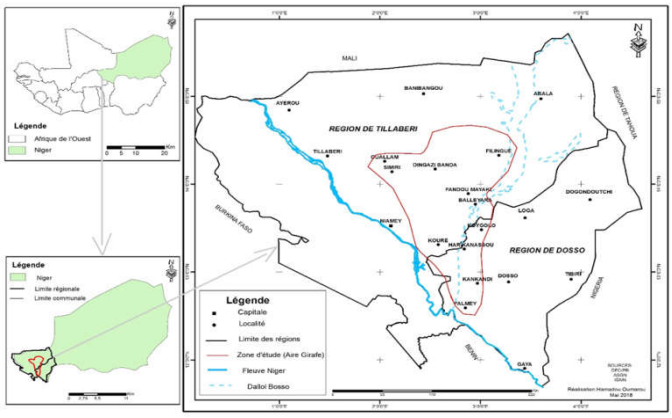

Figure 1: Location of the Study Area

METHODS

Sampling: The choice of our observation sites was made on the basis of the frequency and presence of the giraffe herd in the terroirs according to the different seasons (determined from the bibliography and preliminary surveys). For this reason, three observation sites were selected (the central zone and the outlying areas of Fandou and Dingazi-Simiri) (table 1). We did not take into account the differentiation of habitats and climatic parameters by observation sites (temperature, rainfall, winds, etc.), given the seasonal movements of some individuals on either side of the different sites in the study area. A total of 246 groups, were observed.

Data Collection: The data on giraffe population dynamics are derived from the results of various land counts with photo identification of each individual; it is based on the Capture-Mark-Recapture method. Each giraffe was photographed on the two profiles in order to create individual identity cards. Each giraffe has its own spots that do not vary during the individual's life, similar to human fingerprints.

The giraffe is therefore an ideal model for population studies in large mammals, thanks to individual photo-identification. The advantage of this method is that it makes it possible to determine the age class and sex of each individual encountered and also to count the maximum of the entire population. The age classes were determined in accordance with the work of Ciofolo and Le Pendu (1998);

The distance between individuals in a group: at each observation of a group of giraffes, the distance between the last individual and the rest of the group is estimated using a GPS (Global Positioning System, GARMIN). The same applies to the estimation of the distance between the mother and the giraffe. The other parameters (behaviour of the adult male and the pregnant or lactating female, relationships between individuals in the same group or different groups) are recorded on a form;

Direct observations: the data are recorded on the cards and then analysed. These observations have made it possible to identify in the field the problem of the giraffe's social and reproductive behaviour. The causes of giraffe mortality are noted by personal observations or by information provided by the services in charge of giraffe protection and certain local development associations;

Monitoring was carried out during the three seasons (rainy, cold dry and hot dry season covering (April 2018 to March 2019) and its frequencies are decadal (52 monitoring days in the rainy season) and monthly (59 monitoring days in the dry season). This calendar is explained by the desire to highlight the seasonal variability of the giraffe's social and reproductive behaviour. Indeed, changes in climatic factors and the phenology of the hunted species modify the quantity and quality of the feed, resulting in different associations and seasonal movements of the giraffe herd.

The proportions of the sexes in the various age categories of giraffes are calculated.

Data processing and analysis

For the calculation of the sex ratio, individuals of reproductive age, i.e. adult males and females, were used.

$$\text{Sex} - \text{ratio} = \frac{Number\ of\ adult\ females}{Number\ of\ adult\ males}$$

$$\text{Percentage of males by age group} = \frac{Number\ of\ males}{Total\ number\ of\ individuals} x100$$

$$\text{Mortality rate} = \frac{Number\ of\ dead\ individuals}{Total\ number\ of\ individuals\ in\ the\ population} x100$$

$$\text{Mortality rate by class} = \frac{Number\ of\ deaths\ by\ class}{Total\ number\ of\ dead\ individuals} x100$$

$$\text{Mortality rate by sex} = \frac{Number\ of\ deaths\ by\ sex}{Total\ number\ of\ dead\ individuals} x100$$

Rate of increase (r): $r = \ln \frac{N_t}{N_0}$; where N=number of individuals in the population at time (t); t= number of years or time variation between two counts; N_0= initial number of individuals in the population at time t_0 ; Functional parameters of the population dynamics can be defined from the study of reproduction, namely the birth rate and the proportion of spawners per year and per age class (Gaillard, 1988 in Oumani, 2006) ;

Birth rate $(N_t) = N_0\ e^{rt}$; where N=number of individuals in the population at time (t); t= number of years or time variation between two enumerations; N_0= initial number of individuals in the population at time t_0; r= rate of increase.

$$\text{-Proportion of breeding females} = \frac{Number\ of\ suckling\ females\ observed}{Total\ number\ of\ adult\ females\ observed} x100$$

The ANOVA test was used to compare the growth, mortality and birth rates. The Spearman test was used to correlate the birth rate and the evolution of the giraffe population. These two tests were carried out using SPSS (Statistical Package for the Social Sciences) version 20.

RESULTS

Population dynamics

Periodicity of reproduction: The figure 2 shows that giraffes and pregnant females are observed at all seasons of the year. However, giraffes are more frequently observed during the wet (23 giraffes) and humid (46 giraffes) seasons than during the period from April to May (13), which corresponds to the warm season. Female receptors (in heat) are also observed and followed by adult males throughout the year. Nevertheless, based on our direct observations and on information gathered from tourist guides and foresters, no mating was observed.

Proportion of breeding females: The number of females swept is 82 between April 2018 and March 2019 (Table 2). During this time interval, the number of adult females observed was 249. The proportion of breeding females is 32.93%.

Birth rate: The females of reproductive or adult age represent 62.99% of the 354 adult individuals (Table 3) of this species in Niger. The numerical evolution of the population since October 1995 is very encouraging. The large number of births observed demonstrates its potential for growth. However, it must be totally protected to avoid all forms of threats that will lead to its extinction. Females are continuously reproducing with an estimated average birth rate of 0.13±0.08 individuals. The figure 3 shows us that the increase in the growth and birth rates is followed by a positive evolution of the global population in number of female and male giraffe individuals. This means a decrease in the mortality rate.

This variation in growth, mortality and birth rates was significant by the ANOVA test (ddl= 71; F= 19,739; p= 0,000). Statistical analysis by the Spearman test showed no correlation (t= 0.56; p= 0.810) between birth rate and the evolution of the giraffe population.

Sex-Ratio: The proportions of the sexes in the various age categories of our giraffe population are as shown in Table 3. The adult female population dominates, which has a positive impact on reproductive capacity, even if only in the short term, in line with the recorded population growth. On the other hand, at birth, the number of males is higher than the number of females (Table 4). Males are always more numerous than females up to subadult age. But from the adult class onward, the rate is reversed. Individuals in the adult class are more numerous than the other classes (53.87%) (Table 4).

Births: According to some previous counts and our collected data, an average of 40 to 80 giraffes have been born each year for the past five years (Table 3). Calving was recorded throughout the year, throughout the range. A total of 46 births (peak) were recorded during the cold dry season.

Mortality: From April 2018 to May 2019, fifteen (15) cases of deaths were recorded. This represents 2.36% of the total population.

Mortality by class: Of the 15 recorded cases of death, adults represent (70.43%), subadults (2.60%), young people (6.95%) and giraffes (20.02%). The mortality rate is higher among adults than in other classes (Figure 4).

Mortality by sex: This rate is much higher in adult males (45.21%) and adult females (25.21%) than in subadult males (2.60%), young females (1.73%), young males (5.21%) and giraffe males (12.17%), giraffe females (7.82%) (Figure 5).

Causes of mortality: The Figure 6, shows us that the main causes of giraffe mortality are: natural death, fighting, poaching and road accidents. 60% of giraffe deaths (April 2018 to March 2019) are natural. As for pathological causes, no information has been collected on the main repair area or off-centre areas of the giraffe and no known pathology in the domestic herd has developed in the giraffe to date. Predation does not exist, as no predators are recorded in the giraffe's range in Niger. As for accidents, they are represented by collisions with vehicles on the asphalt road N°1 that crosses the giraffe's central range. A young male died in April 2018, following a collision with a truck in Tchoudawa (Kouré). Giraffes generally come to drink in natural pools, especially during the dry season. Deaths are generally recorded as a result of muddying. A case of fighting to the death was observed in Dabaga (Birni N'gaouré commune) on 1 March 2019 and cases of poaching were recorded in the outlying area of Fandou in April 2018.

Distances between individuals in a group: The results in Table 5 show that the majority of the individuals observed (88, 05%) are no more than 50 metres apart. Individuals often change partners from one day to the next. The giraffe may be with another adult female, other than its biological mother, in the same group over several tens of meters, up to more than 170 meters in the same group. The young may not be with their biological mothers, unlike the giraffe, for several days. Giraffe individuals belonging to the same social group shall not be separated from each other by an average distance of 121.16±80.02 metres.

Table 1: Distribution of giraffe monitoring observation posts

Observation posts	Location agro-ecological	Seasons of attendance	Communes of membership
Central zone or core	Trays	Rainy season	Kouré, Dantchandou, Fakara, Fabidji
	Intermediate zones (Trays, Dallol)	Beginning of the cold dry season	Kouré, Fakara, Fabidji, N'gonga, Dantchandou, Harikanassou, Hamdallaye, Tagazar
	Dallol	Cold and hot dry seasons	Harikanassou, Kiota, Birni N'gaouré, Fabidji, Koygolo, Falmey, Birni N'gaouré
Fandou	Trays	Rainy season	Tondikandia or Damana
	Agrosystems	Cold and hot dry seasons	
Dingazi -Simiri	Trays	Rainy season	Dingazi, Simiri
	Agrosystems	Cold and hot dry seasons	
Total			16

Table 2: Numbers of adult females and swept females observed from April 2018 to March 2019

Month	Number of suckling female observed	Number of adult females observed
April	5	8
May	4	16
June	4	14
July	4	11
August	5	23
September	10	34
October	4	27
November	9	21
December	12	32
January	8	27
February	11	19
March	6	17
Total	82	249

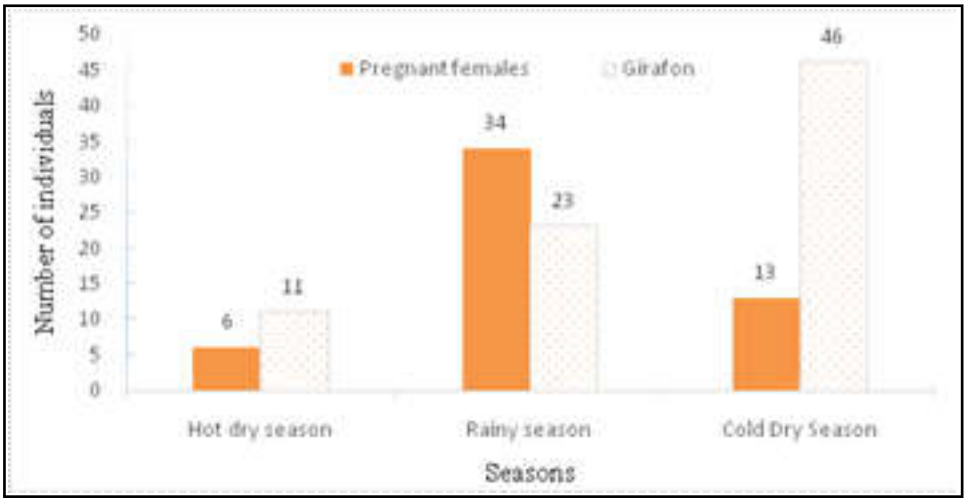

Figure 2. Variation in the number of pregnant females and giraffes during the year

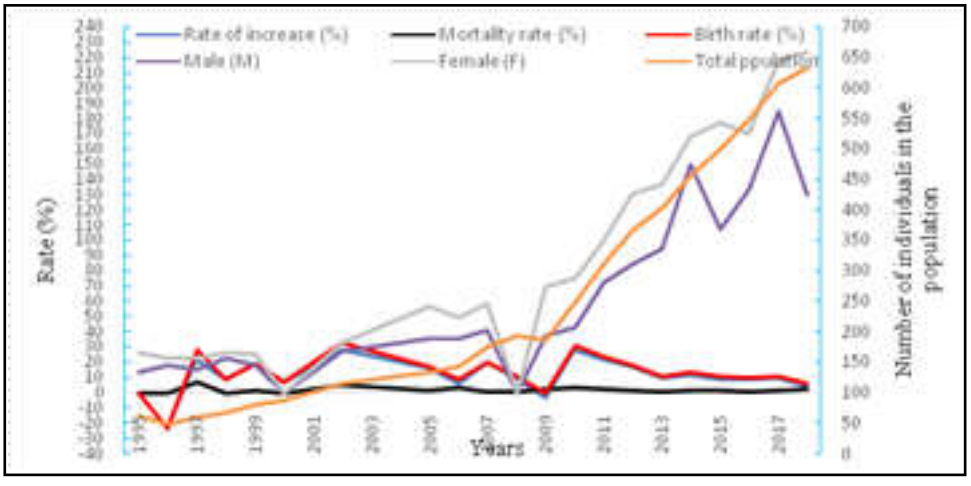

Figure 3. Changes in growth, mortality and birth rates as a function of changes in the giraffe population

Table 3. Population status of the giraffe from 1995 to 2018

Class / sex		Years of counts																				
		1995	1996	1997	1998	1999	2000	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Adult	Male (M)	14	18	16	23	18	-	28	36	36	41	-	38	43	73	85	95	150	108	133	185	131
	Female (F)	27	23	23	27	26	-	33	57	50	59	-	70	75	100	130	137	168	177	170	218	223
Subadult	Male	8	5	5	-	18	-	11	5	11	13	-	19	17	16	36	20	19	35	73	35	73
	Female	4	3	3	-	10	-	14	11	10	16	-	14	19	18	15	25	24	21	24	43	45
Youg	Male	5	0	8	10	7	-	16	8	11	4	-	17	17	41	18	36	15	54	69	50	62
	Female	4	0	6	7	4	-	5	9	12	9	-	13	19	33	27	39	36	38	45	39	58
Girafon	Male	-	0	-	-	5	-	8	7	9	15	-	6	7	16	35	27	23	48	14	17	29
	Female	-	0	-	-	3	-	0	2	5	3	-	8	3	13	22	15	20	27	22	25	26
	Not identified	0	0		14	13	3	0	0	0	4		3	3	-	-	-	-	-	-	-	-
Birth		-	0	-	14	21	3	8	9	14	22	-	17	13	29	57	42	43	75	36	42	55
Mortality		-	-	4	-	1	-	6	2	5	1	2	5	8	7	5	4	9	9	6	9	15
Sex-ratio (F/M)		1,92	1,27	1,43	1,17	1,44	-	1,17	1,58	1,38	1,43	-	1,84	1,74	1,36	1,52	1,44	1,12	1,63	1,27	1,17	1,7
Rate of increase			-24	21,51	8,61	18,23	6,76	27,76	15,7	5,82	19,06	9,53	-3	27,8	21,5	16,6	9,53	11,33	8,61	8,61	9,53	3,92
Mortality rate		0	0	6,55	0	1,23	0	5,21	1,48	3,47	0,57	1,03	2,65	3,2	2,25	1,36	0,99	1,97	1,8	1,09	1,48	2,36
Birth rate		0	-24	28,06	8,61	19,46	6,76	32,98	17,2	9,29	19,63	10,56	-0,4	31	23,8	17,9	10,5	13,31	10,4	9,71	11	6,29
Total		62	49	61	67	81	87	115	135	144	175	193	188	250	310	366	403	455	499	547	607	633

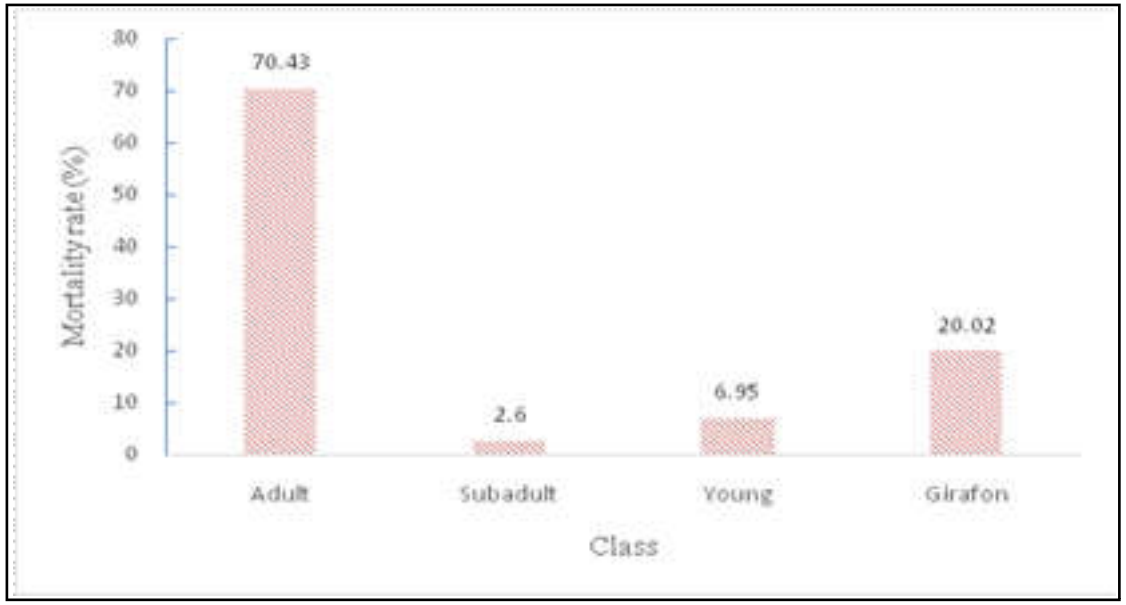

Figure 4. Mortality rate by class

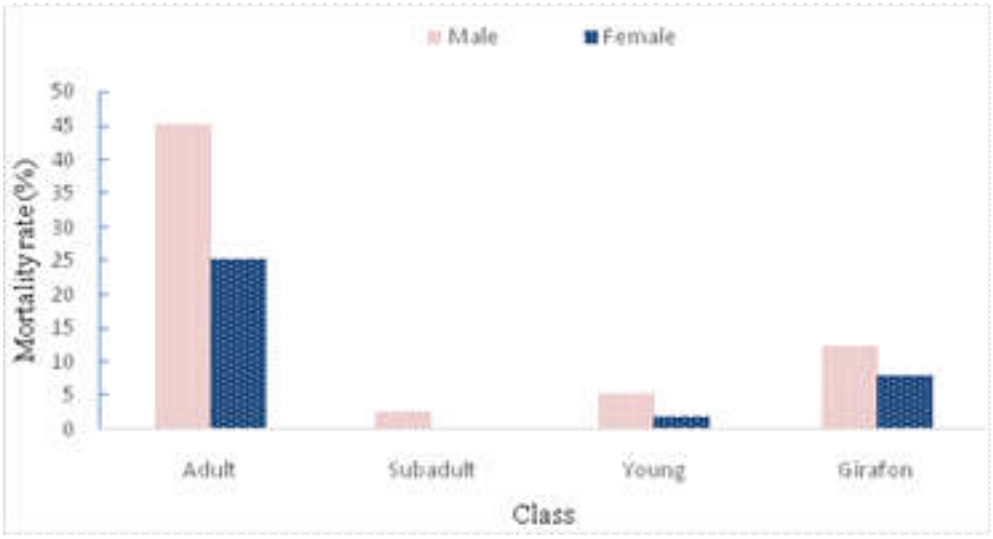

Figure 5: Mortality rate by gender

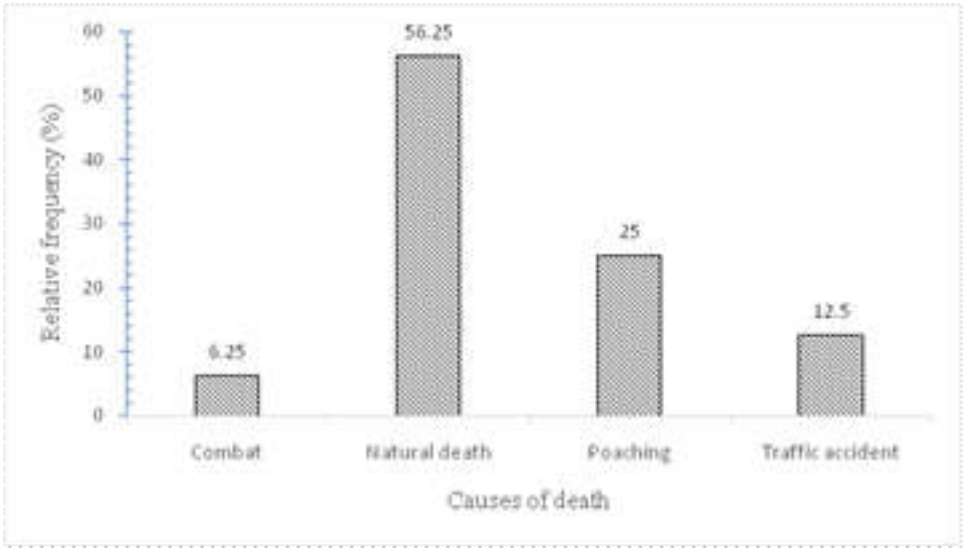

Figure 6: The main causes of giraffe mortality

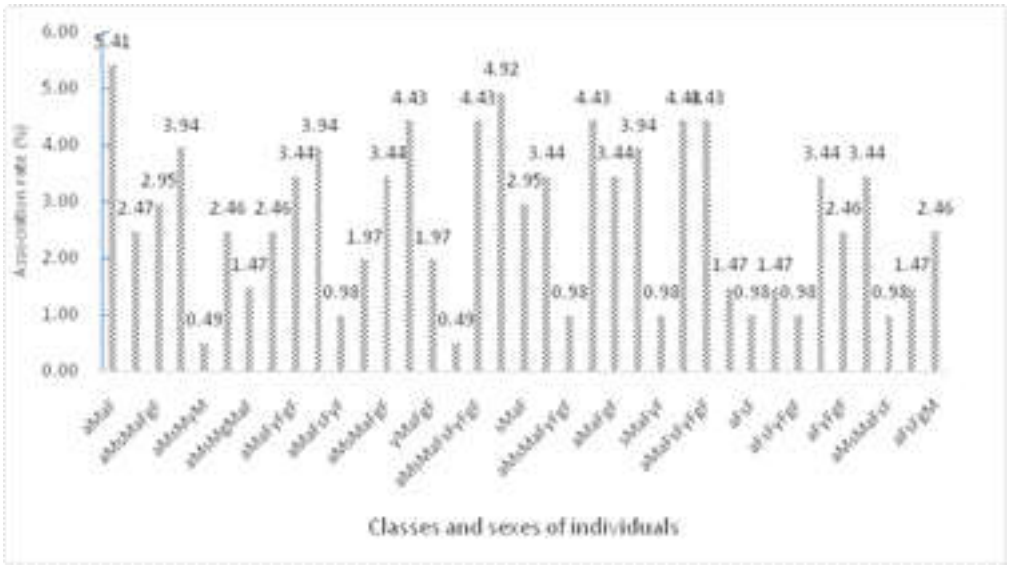

Figure 7: Rate of association between age and sex classs (aM= adult Male ; aF= adult Female; sM= subadult Male ; sF= subadul Female ; yM= young Male ; yF= young Female ; gM= girafon Male ; gF= girafon Female)

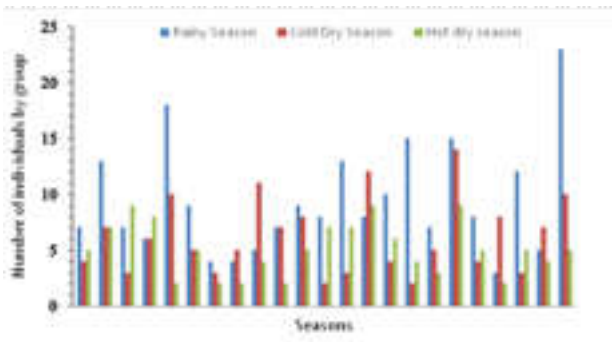

Figure 8. Distribution of giraffe groups according to seasons

When it is necessary to move towards the group, the giraffe moves towards its mother, or sometimes it is the mother that moves towards the giraffe. By moving less than 50 metres closer, giraffes tended to flee in different directions and form small groups.

Social structure: 113 groups are observed in the rainy season, 103 in the cold dry season and 27 groups in the hot dry season. In the rainy season (June, July, August, September, October), giraffe groups of more than 20 individuals are often observed. Also, during this period, small gatherings are observed, with an average of 7.85±5.20 individuals. Furthermore, the disparity between group sizes is greater during the rainy season. The largest group, observed on 27 August 2018 at Dingazi-banda, was composed of 23 individuals. In the hot dry season (April, May), herds are smaller, with an average of 3.96± 1.42 individuals. In the cold dry season (November, December, January, February, March), on the other hand, group size is relatively stable, averaging 5.59±3.49 individuals per group (Figure 8). Although group size changes over the seasons, their composition does not vary significantly. The most frequently observed associations are adults of both sexes (5.41%), adult males+young males+adult females + girafon females (4.92%), adult males+young males+adult females+subadult females+girafon males (4, 43%), adult males + subadult males + adult females + subadult females + young females + girafon females (4.43%) and adult males + subadult males + adult females + girafon females (4.43%) (Figure 7). The latter composition is even more frequent during the rainy season (23 individuals) (Figure 8).

Only 21 individuals are solitary and are all adult males, no solitary females.All combinations are possible, except groups of giraffes or juveniles only (figure 7). One case of 8 individuals (one adult male, 3 subadults and 4 juveniles), all males, was observed on 1 October 2018 in Fandou. There are non-aggressive interactions, between two unrelated individuals, except in adult males (neck rubbing). Interactions exist in all age and sex classes. Out of 79 contacts, the most frequent (38 contacts) take place between adult males and subadult males (48.10%), then to a lesser extent, between subadult males and adult females (25 contacts, 31.64%) and between subadult males and young males (16 contacts, 20.25%). The other age and sex classes interacted weakly. Also, sexual interactions exist in all age groups. Behaviours relating to this type of interaction are essentially "flehmen" and trial runs. Sexual interactions between adult males and adult females are the most numerous (71.28% of 101 observed cases). Frequent sexual relationships between adult females and subadult males (17.82%) and between subadult females and adult males (10.89%), which are generally short attempts, are also observed. In the other age and sex classes, they are less frequent.

DISCUSSION

The ethological characteristics of the Niger giraffe, has growth rates of 11%; mortality rates of 2% and a birth rate of 13%. The distance between the last individual and the rest of the group averages 121.19±80.02 meters. Associations, the most frequently observed are between adult male+adult female, adult male+young male+adult female+girafon female, adult females + adult males + subadult males + subadult females+young females+ girafon males or of different sexes. But, the affiliation between the mother and the giraffe is more numerous than the others. Noaggressive interactions, the most observed are adult male-subadult male and between subadult male-adult female and sexual interactions are adult male- adult female. All combinations are possible, except one group consisting of giraffes only. The composition of the groups varies according to the season. Thus, the giraffe has a variable social organization and reproductive behavior during the year. Young giraffes are frequently observed in groups other than their biological mothers. This may be justified by the absence of predators. In the presence of predators, the mother-youth bond persists longer (Aziliz, 2015). This decrease in the bond can also be explained by the approach of the birth of a new giraffe. The distance between mother and child is gradually changing, certainly in relation to the preparation and implementation of weaning. Some young leave their biologicals for several days.

But the giraffes are always with their biological mothers. This distancing varies according to the size of the group and the individuals. The mother and the giraffe show a different spatial proximity, more marked than in other individuals of the herd. The giraffe is closer to the mother in small groups (3 to 5 individuals) than in other groups (10 to 23 individuals). This is related to a more marked monitoring behaviour in the small groups. These observations are similar to those made in red deer (Cervus elaphus) for which the proximity between mother and pup declines with increasing population density (Albon et al. 1992). This may be related to the fact that in a small group the vulnerability of the young depends more on maternal defence and less on protection due to the group effect (Green, 1992). However, in Canadian sheep, it was observed that in a situation of high population density, the association between mother and yearling daughter was significant. This behaviour occurred as food became more scarce and the reproductive success of females decreased (L'Heureux et al. 1995). Thus, in some ungulates, prolongation of the mother-child bond is more frequent when the population is High density. Giraffes live in groups in a fusion-fission system. For example, they group together to sleep and separate to find food. It is sometimes reported that contact between giraffes in the wild is limited to the mother-girafon pair and interactions between males. However, females are often gathered in small groups and it has been shown that in captivity and in the wild, adult females establish strong links between themselves with preferential relationships with certain individuals. Often both females and males have special relationships with other males. Thus, an adult male is often associated with at least three other males (Wolf et al. 2015). As far as giraffes are concerned, they too establish strong links with each other. This is certainly explained by the fact that in their environment, they are raised in 'nursery' systems with a mother who stays with the giraffes

while the others go to feed. Thus, Rose suggests that it is preferable to keep larger groups in captivity, allowing for more than one young at a time and thus fulfilling the behavioural need to be in the presence of other youngsters (Rose, 2011). Among social interactions (excluding sexual behaviour), the following stand out: rubbing necks (48.10%), feeling each other's nose (31.64%) and eating on the same branch (20.25%). The use of kicking is much rarer and is more generally used to chase away an opponent (Jolly, 2003). Adult males sniff the genitalia of adult females, collect and smell their urine every month of the year. Individuals involved in "flehmen" occasionally stood apart from the rest of the group and the operation could be repeated and prolonged for several minutes, especially if the female showed some refusal. The female giraffe enters "in heat" every two weeks (Ngoe, 1981). Therelatively short duration of estrus may explain the greater or lesser intensity of yard driving (Ngoe, 1981). Many females are pregnant between August and December and giraffes are also observed throughout the range. At this time the palatable species still bear enough leaves and are at their peak flowering. Observations made in Niger on birth peaks during the dry and cool period thus confirm the results of the other authors (Foster and Dagg, 1,972; Hall-Martin, Skinner and VanDyk, 1,975). Many observations have already been made and confirm the fact that births take place throughout the year, even if more births can be observed at certain periods. In terms of the total number of individuals, giraffes will account for 8.68 per cent of the population in 2018. This figure is different from the 14% indicated by Dagg and Foster (1976) for Nairobi Park.

The extent of the range and the difficulties associated with counting could explain this phenomenon. At birth, the sex ratio is balanced and it is probably only after sexual maturity that the rate of disappearance of males exceeds that of females. This is probably due to the fact that adult males tend to isolate themselves in the most closed environments, as has been observed in Nairobi Park (Dagg and Foster, 1976). It is also due to the great ability of adults to travel great distances and to be driven into dangerous or hostile environments. Historical data on population structure show that the sex ratio has varied significantly over the past decade with a varying dominance of females in adulthood. At birth, it is very much in favour of males, noted by Bourlière (1961) in 117 giraffes born in captivity, is probably attributable to the artificial conditions of the latter. Out of 31 births observed in Nairobi Park, there were in fact only 16 males (Dagg & Foster, 1 976). However, Leuthold (1,978) observed in Tsavo East a sex ratio of 120 males per 100 females in adult and subadult giraffes, and 159 males per 100 females in juveniles less than 12-18 months old. The problem of an unbalanced sex ratio at birth in favour of males thus remains unresolved and may be dependent on habitat characteristics. Adult females always outnumber males and this is consistent with the observations of Foster and Dagg (1,972) and Leuthold (1,979). Adults dominate the population. The low percentage of "subadults" recorded may be due to under- or over-estimation of ages during the various counts at the "<18 months ≥3 years" class level. And this could explain the low rate of adult males, if it is subadult males that were underestimated in the latest counts. There were no or almost no giraffes in the mid-1990s, especially when compared with the high proportion in the years 2015 and 2018. This phenomenon is undoubtedly the consequence of the 1996 capture/translocation attempts that targeted young giraffes (Sadou, 1996). This endangered the population by removing many young or giraffes (PURNKO, 1998).

According to Ciofolo and le Pendu (1998), there are four (4) age classes in this population: the adult class: comprising giraffes 4 years and older and with a height of 4 metres or more; the subadult class: giraffes from 18 months to 4 years and with a height of approximately 3 to 4 metres; the juvenile class: giraffes from 6 months to 18 months and with a height of 2 to 3 metres; and the giraffe class: giraffes from zero (0) to 6 months with a height of approximately 2 metres. The duration between two (2) giraffe counts in Niger is estimated at one year (12 months). During this time interval, only the giraffe (0 to 6 months) changes class. However, this assessment remains underestimated, as there are giraffe individuals, which are only observed in juvenile, subadult or adult classes. This, moreover, underestimates the birth rate. The available data on rates and/or number of births are too disparate to constitute definitive results, given the lack of regular monitoring in recent years. The birth rate (13%) number shows the good reproductive capacity of the population, despite the historical and present risks and threats. However, this rate is different from that found by (Ngoe, 1981) in Waza National Park (23%) where the number of reproductive-age females is 74% of adult individuals. In areas outside of the Waza National Park, the number of breeding females was 74% of the adult individuals. In the areas outside the central range of the Niger giraffe, there are many male and female individuals of breeding age. It is important to be able to cover as many of the giraffe's preferred areas as possible and to facilitate a better understanding of the true population dynamics.

It appears that most of the mating took place either in the middle of the rainy season or during the cold dry season, but it is difficult to give a reliable conclusion on this point. Poaching was an important factor in the 1990s, when most mortalities were observed (Ciofolo, 1990; 1992). Today, poaching is limited thanks to the efforts of the actors involved in the protection of the giraffe in Niger (NGOs and wildlife protection authorities), except in outlying areas where poaching cases are recorded, despite the prohibition on hunting the species in Niger (Law n°98-07 of 29 April 1998). This is certainly due to a lack of knowledge of the hunting law and to the lack of conduct of awareness activities in the areas indicated. Accidents involving buses or large vehicles on the main road (RN1) of Niamey cause an average of two (2) deaths each year. Despite the presence of traffic signs and speed limits, cases of giraffe deaths due to road accidents continue to be recorded, due to the recklessness of some motorists. It appears that nursing females shelter their young or move to remote, damp locations to protect them from the high heat. Females in advanced gestation are hiding as they approach parturition. This may explain the low rate of giraffe sightings at this time. Solitary individuals are only adult males in the giraffe population in Niger. A male associates with several females and vice versa. An adult male more often associates with several females than an adult female with several males. The results in Table 1 are not close to those obtained in Eastern and Southern Africa (Dagg and Foster (1 976)) where solitarious individuals are most numerous everywhere: 23% in Nairobi, and 44% in the Eastern Transvaal. Foster (1,966) did not observe anything similar in Nairobi Park. Consistent with what Foster and Dagg (1,972) and Leuthold (1,979) found, adult females outnumber males in our population. The predominance of adult females among solitary giraffes is not confirmed in Niger. Only males are solitary in Niger. They are "good indicators" in determining the movement of the herd.

They may be looking for a recipient female or hunting by another male. Several adult males can be in the same group. The less dominant males are always behind the group and "do not get very close to the receiving females, risking being hunted to other areas. Larger groups include 7; 8; 4; 2 individuals and groups with many individuals (up to 23) are the rarest. The average group size has varied seasonally. It averaged 5.59±3.49 individuals in the cold dry season (November, December, January, February and March), 3.96±1.42 individuals in the hot dry season (April, May) and an average of 7.58±5.20 individuals in the rainy season (July, August, September, October). This decrease in the number of individuals in the hot dry season is certainly due to the high heat during this period. During this period, the temperature is very high (37°C), and individuals in groups of giraffes are separated a lot in search of shade to avoid the strong heat. This is in line with the results found by Oumani (2006) who states that Barbary deer (Cervus elaphus barbarus) were observed more during the low temperature period than during the period when the temperature is relatively high. The proportion of breeding females is 34.59%. This shows that it is difficult to accurately assess the number of females swept by direct observation. Certainly, some females hide their giraffes during the calving months, which will decrease the proportion of breeding females by direct observation.

Conclusion

This study has made it possible to understand the ethological characteristics and dynamics of the giraffe population in Niger, which continues to grow rapidly. Knowledge of the giraffe's biology is important in the choice of actions or measures to be taken for its conservation. It has made it possible to identify the main cause of mortality of the giraffe and to note an important social link that links the giraffe to the mother, also of other adult females of the same group. The distance between the mother and the giraffe is a characteristic element of this relationship. This relationship is bidirectional, with both the mother and the giraffe playing a role in the distance established. The mother's share of responsibility in the distancing seems to be the most important. However, no giraffe has been observed suckling on another female other than its biological mother. The combination of individuals by different classes and sexes is confirmed. Thus, the control of the giraffe's social and reproductive parameters is essential for the sustainable management of the giraffe in Niger.

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Authors' contributions

HO is the principal author; AOA; MB and MA corrected the research protocol and followed the work.

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