Comparison of proximity and social behaviors between calves and juveniles in wild giraffe

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ABSTRACT
To date, no study has quantitatively compared the proximity or social interactions between calves and other giraffes except their mothers. In this study, we compared proximity and social behaviors between calves and juveniles to understand developmental changes in giraffe. We observed giraffe in Katavi National Park, Tanzania. We recorded the herd size, the age-sex classes (calf, juveniles, adult female and adult male) of all herd members and proximity conditions. Additionally, we recorded the occurrence, the age-sex class of other individual and direction of muzzling, necking and anogenital examination. Calves showed the lowest rate in proximity with adult males and the highest rate in proximity with same-aged peer. Juveniles spent less time with same-aged peers probably because they are joining herds containing multiple adults. Juvenile can travel for long distances so they have more chances to encounter other age-sex individuals and stay in proximity to them. Calves also received muzzle from many other age-sex classes frequently, whereas juveniles did not receive it frequently. We suggest that the differences between calves and juveniles in proximity duration and social behavior reflects a developmental pathway associated with differences in predator risk, and well as age-related influences on establishing social networks and learning social skills.
KEYWORDS: giraffe, development, proximity, social behavior

INTRODUCTION

In several species, the time spent in proximity to other individuals and the types and rates of the occurrence of social behaviors differ with age. In captivity, the percentage of time the mother and infant spend in proximity is negatively correlated with infant age in western lowland gorillas (*Gorilla gorilla gorilla*) (Maestripieri et al 2002). In voles (*Microtus* sp.), the amount of anogenital nosing and allogrooming increases with age, while nose-to-neck contact decreases with age (Wilson 1982). In chimpanzees (*Pan troglodytes*), young engage in social play more often than adults, while adults engage in grooming more often than young (Bloomsmith et al 1994). These differences may be essential for promoting physiological development, establishing social bonds with strangers, and encouraging young to disperse from their natal group (Wilson 1982; Bloomsmith et al 1994).

Generally, young are more vulnerable than adults (Gunther and Renkin 1990; Lingle et al 2005). In some areas, 50% of giraffe (*Giraffa camelopardali*s) calves fall to predators in the first year of life (Dagg 2014). To reduce the possibility of calf predation, giraffes form a herd called a "nursery group," which consists of several females and calves (Leuthold 1979; Dagg 2014; Saito and Idani 2016). Sometimes calves need to remain hidden until their mothers return from browsing or drinking (Langman 1977; Pratt and Anderson 1979). During the nursery period, regardless of age and sex, other giraffes show strong interest in young calves and perform olfactory-related inspections. Such behavior might help to determine the calf's sex and maternal origin (Pratt and Anderson 1979). Males are independent by 2 years of age and start to join bachelor groups (Langman 1977; Bercovitch and Berry 2010). Males are sexually mature at 7~8 years (Berry and Bercovitch 2012). With age, males spend more time in all-male groups, but ultimately become solitary (Pratt and Anderson 1985). Mature males roam while searching for females in estrous, which the male determines by performing flehmen when the female urinates (Brand 2007; Dagg 2014).

Studies have revealed how giraffes change their group-forming patterns with development and have reported the existence of several social behaviors (Pratt and Anderson 1979; 1985). However, no study has

quantified whether proximity, frequency, and type of social behavior differ with age. Therefore, we compared the rate in proximity and type and rate of occurrence of social behaviors between calf and juvenile giraffes to understand the developmental changes in giraffes more clearly.

We examined the following predictions.

1. *Proximity:* Calves stay in proximity to same-age peers for the highest rate to avoid predation. Juveniles lack this preference because they no longer belong to nursery groups and may have more opportunity to encounter other age-sex classes compared to calves.
2. *Types and rates of social behavior:* As social behaviors, we focused on muzzling, anogenital examination, and necking. We hypothesized that calves are muzzled more often than juveniles because other age-sex class individuals may have interest in new individuals. In comparison, juveniles engage in anogenital examination and necking more often than calves.

MATERIALS AND METHODS

2.1 Study area

Katavi National Park is 4,471 km^2, locates in western Tanzania (Fig.1). The altitude is 800―1,100 m above mean sea level. This national park is the third largest national park in Tanzania. There are two seasonal lakes that support high mammal densities during the dry season (Caro 1999) and Katuma river is the source of water of these two lakes. HQ is located the northern border of this National Park, near the Sitalike village. Field study was conducted mainly around Head Quarters area. Miombo forest mainly covers Katavi National Park.

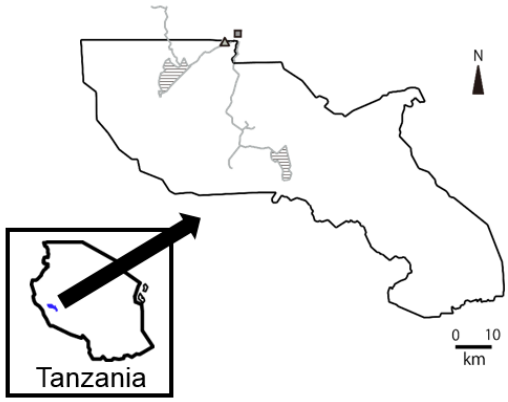

Fig. 1. A map of Katavi National Park in western Tanzania with rivers (gray lines) and lakes (horizontally lined areas). The gray triangle indicates Head Quarters. The filled gray square indicates the nearest village, Sitalike.

2.2. Data collection

Our study was conducted for 63 days during July–October 2010. Data were collected in the daylight hours approximately 07:30 to 18:30. Herd size was recorded at every encounter. We recorded the age-sex classes of all herd members. Age estimates were based on body size, color, and the shapes of the ossicones. Body size was estimated by using laser rangefinder. Sex was determined by checking under side of the giraffe. Individuals were classified into four age-sex classes: calf (estimated height below 2.5 m), juveniles (estimated height between 2.5 m and 3.5 m), adult female and adult male (estimated height of over 3.5 m). After collecting herd information, we conducted focal sampling of calves and juveniles. When we found both calves and juveniles in the same herd, we prioritized following calves over juveniles. Therefore, the Juvenile/Calf cell in Table 1 is blank. We recorded the following items while following the focal animal.

1. *Proximity:* The start and end times of the proximity state. We defined proximity state as "when an individual was within 3 m of the focal animal".

2. *Social behavior:* The occurrence of three types of behavior, age-sex class of the other individual that was engaged in that social behavior, and direction of the behavior (actor/recipient). We focused on the following three social behaviors based on the definitions in Bercovitch et al (2006): 1) muzzling, when two animals make facial contact with one another or sniff each other's muzzles; 2) anogenital examination, when an animal sniffs or licks the anogenital area of another's body; and 3) necking, when an animal rubs its head on a part of another giraffe.

2.3. Definition of association rate and proximity rate

Association rate: this value is calculated as follow; "number of observations of herd which includes specific pair" divided by "number of observations of herd which includes more than one calf/juvenile".

Proximity rate: this value is calculated as follow; "total proximity duration of specific pair" divided by "total focal time of that specific pair".

RESULTS

The total focal duration for calves was 58 h 14 min and that for juveniles was 46 h 9 min. Table 1 summarizes the focal time for each age-sex class combination when we followed juveniles or calves.

Table 1. Summary of the focal time (h) and number of observations of herd for each age-sex class combination when following a calf or juvenile. This duration indicates when these two individuals were in the same herd.

		Focal animal	
		Calf	Juvenile
Combination	Male	27, n = 27	30, n = 47
	Female	57, n = 55	44, n = 76
	Juvenile	45, n = 40	26, n = 40
	Calf	30, n = 29	N/A

We encountered 145 herds and the average herd size was 4.7 (± 3.1) individuals (Fig.2). Regarding the association of calves and juveniles, both classes formed a herd more frequently with females than with other age or sex classes (Fig.3).

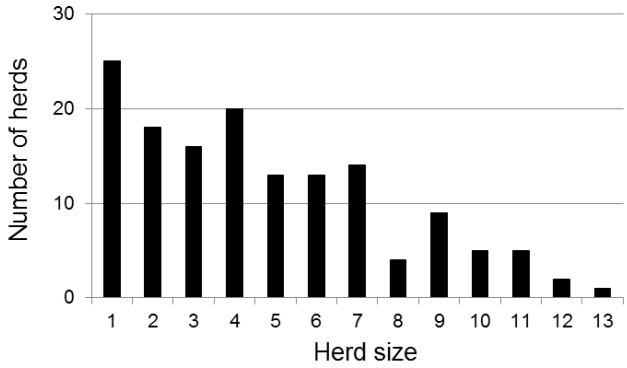

Fig. 2. Frequency distribution of the size of giraffe herds (N = 145).

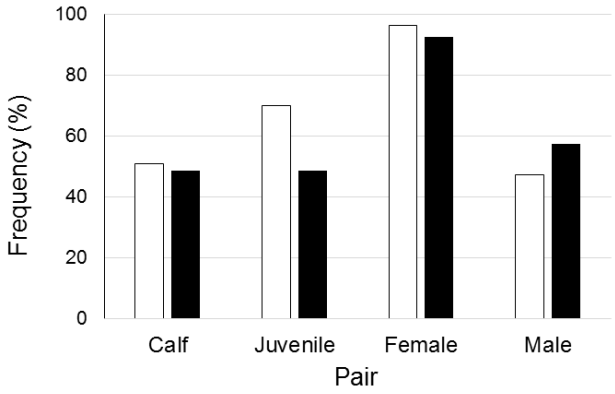

Fig.3. Association rate of calves (the white bar, N = 57, the observation times of herd which included more than one calf) and juveniles (the black bar, N = 82, the observation times of herd which included more than one juvenile).

There were significant differences in the proximity of calves with other same-age class individuals. Calves were in proximity to other calves for the highest rate compared to other age-sex classes (Ryan's method, Fig.4). Table 2 summaries the statistical analysis values for pairs of each age-sex classes combination. Calf-calf pair showed significant difference against all three other pairs (male-calf, female-calf, juvenile-calf). Calf-male pairs were in proximity for the lowest rate. Juveniles did not show any significant difference in proximity to males, females, or same-age peers (Ryan's method) (Fig.5).

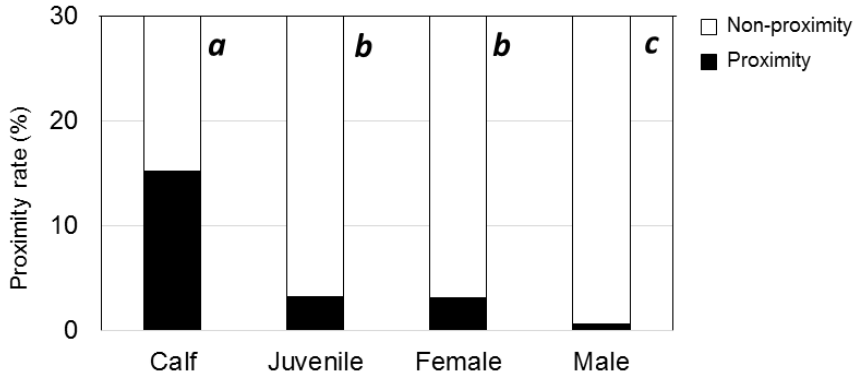

Fig.4. Proximity rate of calves with each age-sex class. The white bar indicates the rate when the calf and age-sex class individuals were not in proximity and the black bar indicates the rate when the calf and age-sex class individuals were in proximity. (calves; N = 29, calf-juvenile; N = 40, calf-female; N = 55, calf-male; N = 27). Each category labeled with different letters differs significantly.

Table 2. Pair of each age-sex classes combination with statistical analysis value

Pair	α value	*P* value	Significance
(Male-Calf) – (Female-Calf)	0.025	< 0.001	Y
(Male-Calf) – (Juvenile-Calf)	0.0125	< 0.001	Y
(Male-Calf) – (Calf-Calf)	0.008	< 0.001	Y
(Female-Calf) – (Calf-Calf)	0.0125	< 0.001	Y
(Juvenile-Calf) – (Calf-Calf)	0.025	< 0.001	Y

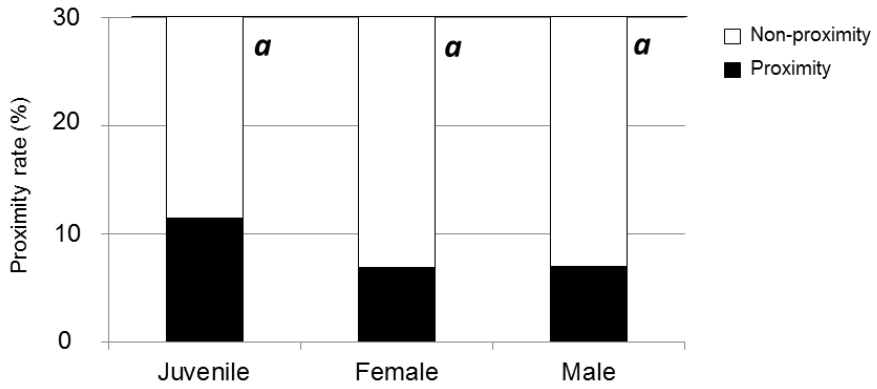

Fig.5. Proximity rate of juveniles with each age-sex classes. The white bar indicates the rate when juvenile and age-sex class individuals were not in proximity and the black bar indicates the rate when juvenile and age-sex class individuals were in proximity. (juveniles; N = 40, juvenile-female; N = 76, juvenile-male; N = 47). Each category labeled with different letters differs significantly.

Calves were muzzled by juveniles and females more frequently than were juveniles (Calf-Juvenile vs Juvenile-Juvenile: G-test: *P < 0.05, Calf-Female vs Juvenile-Female: G-test: ***P < 0.001, Fig.6 (a)). However, calves initiated muzzling frequently with same-age peer, they seldom initiated muzzling with males or females or juveniles (Calf-Calf vs Calf-Juvenile: G-test: ***P < 0.001, Calf-Calf vs Calf-Female: G-test: ***P < 0.001, Calf-Calf vs Calf-Male: G-test: ***P < 0.001, Fig.6 (b)). On the other hand, juveniles initiated muzzling with males and females (Juvenile-Juvenile vs Juvenile-Female: G-test: P = 0.767, Juvenile-Juvenile vs Juvenile-Male: G-test: P = 0.44, Fig.6 (b)). Anogenital examinations were frequently observed between males and juveniles and males initiated this behavior only to juveniles, and not to calves (Calf-Male vs Juvenile-Male: G-test: *P < 0.05, Fig.7 (a)). It seemed juveniles initiated and received anogenital examinations more often than calves did and calves did not perform this behavior. However, there was no significant difference when calves or juveniles were initiated anogenital examination with other age sex classes (Calf-Juvenile vs Juvenile-Juvenile: G-test: P = 0.079, Calf-Female vs Juvenile-Female: G-test: P = 0.106, Calf-Male vs Juvenile-Male: G-test: P = 0.075, Fig.7 (b)). Males did not initiate necking with juveniles (Fig.8 (a)), but juveniles initiated necking with males and same-age individuals (Fig.8 (b)). Necking was observed only for juveniles, and not for calves. However, we did not find any significant differences between calves and juveniles both when they were recipient or actor (Calf [recipient]-Juvenile vs Juvenile [recipient]-Juvenile: G-test: P = 0.257, Fig. 8 (a)) (Calf [actor]-Juvenile vs Juvenile [actor]-Juvenile: G-test: P = 0.257, Calf [actor]-Male vs Juvenile [actor]-Male: G-test: P = 0.358, Fig. 8 (b)).

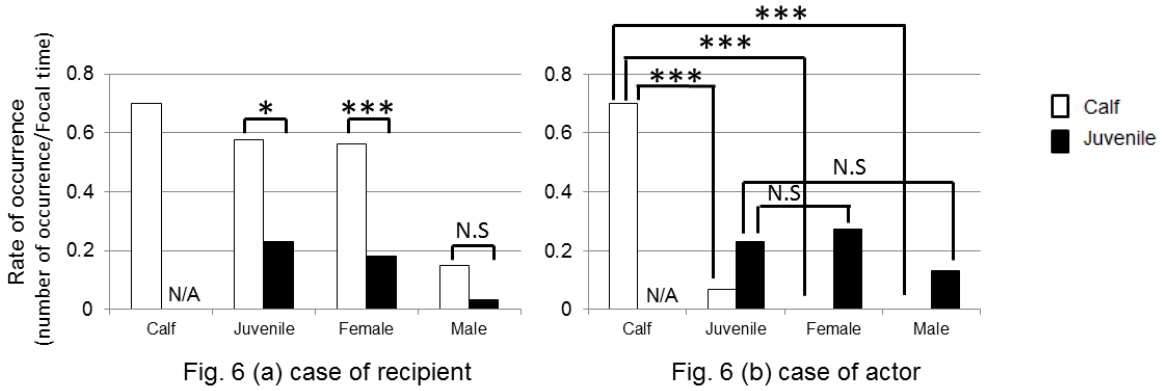

Fig.6. Rate of occurrence of muzzling. The data of juvenile-calf when juvenile was focal animal is not available. * indicates $P < 0.05$. *** indicates $P < 0.001$.

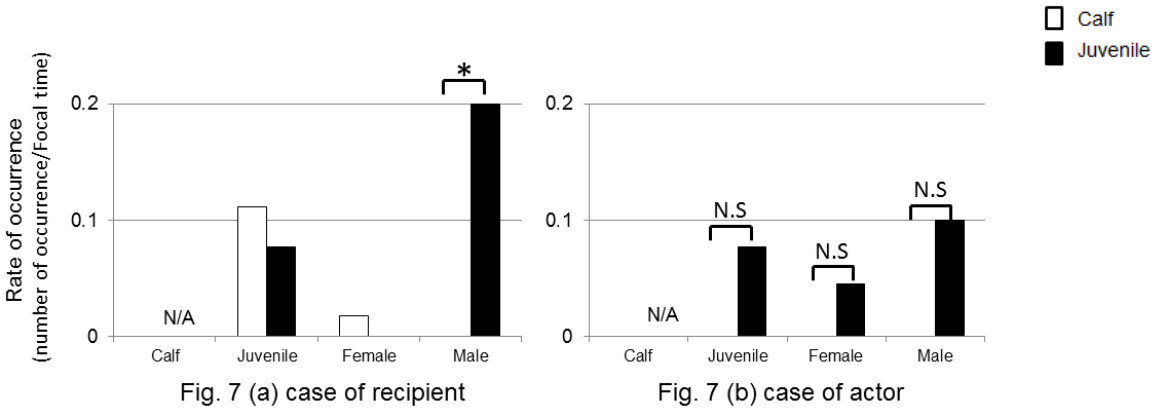

Fig.7. Rate of occurrence of anogenital examination. The data of juvenile-calf when juvenile was focal animal is not available. * indicates $P < 0.05$.

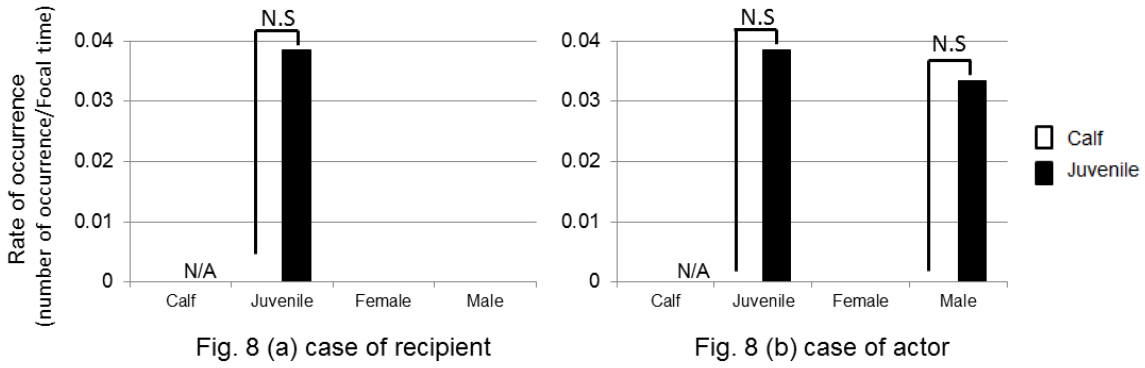

Fig.8. Rate of occurrence of necking. The data of juvenile-calf when juvenile was focal animal is not available.

DISCUSSION

Proximity

As predicted, our findings demonstrate that calves maintained proximity to the same-age peers more often than did juvenile-juvenile pair. Herd formation is an anti-predator strategy based on the early detection of predators (Lent 1974; Borner et al 1987; Gunther and Renkin 1990; Lingle et al 2005). Mother giraffes often travel for a few hours to browse and drink (Langman 1977; Pratt and Anderson 1979). While the mother is away, the risk of being preyed on might increase. Therefore, it might be better for calves to stay close to same-age peers to decrease the risk of being preyed on. Additionally, we found calves were in proximity with male in the lowest rate. Male giraffes are known to travel several kilometers per day (4.52 km in northern Botswana [McQualter 2015] and 5.64 km in Namib desert [Fennessy 2009]) and to roam freely in search of females in estrus (Brand 2007). Therefore, males may join herds of females and calves to check whether the females in that herd are in estrus. If they are not, the males may soon leave the herd to find another female elsewhere. Males also do not take responsibility for the care of calves, in contrast to females, who nurse them, so they might not often be in the proximity of calves. Hence, it is possible that calves are less often close to adult males than to members of other age classes. Juvenile spent fewer times with same-age peers probably because they are joining herds containing multiple adults. Juvenile can travel for long distances so they have more chances to encounter other age-sex individuals and stay in proximity to them.

Types and rates of social behavior

The results significantly supported our hypothesis for muzzling, part of anogenital examination, but not for necking. We found that calves were muzzled by other age-sex classes often. Perhaps other individuals, regardless age or sex, tried to determine the calf's sex and maternal origin (Pratt and Anderson 1979). Juveniles were muzzled less often than calves. Other individuals might already know juveniles and do not need to initiate muzzling.

Juveniles had more anogenital examinations with males compared to calves. An anogenital examination is thought to be sexual behavior (Bercovitch et al 2006). Adult males may be interested in juvenile females as mating partners, even though they are not sexually mature. Unfortunately, we did not record the sex of the juveniles in this study and it is necessary to investigate whether adult males really perform anogenital examinations more frequently with female juveniles than with male juveniles. Even though juvenile showed a tendency that they involved into this behavior more often than calf, there was no significant difference. We assume because juveniles are still immature and they might not show strong sexual interest to others, it was rare for them to be an actor of anogenital examination. It might be better to define sub-adult between juvenile and adult male/female to reveal if the rate of occurrence of anogenital examination change along with age.

For necking, we did not find any significant difference of the rate of occurrence among calf and juvenile with each age-sex class. Necking behavior sometimes trigger injury and in the worst case, individual may die (Brand 2007). Since juvenile's body is still in the process of growing, juvenile may not involve this activity frequently as mature males do to avoid needless injury. Additionally, necking is mainly used among males for defining a rank for mating (Berry and Bercovitch 2012). As juveniles are not sexually matured, they might not need to define it in such an early phase. Because of these reasons, the rate of occurrence of necking in juveniles might not high. However, we observed few occurrence of necking for juvenile but not for calf. After dispersion from the natal area, young males join all-male herds (Brand 2007). Therefore, juvenile males may try to establish a social bond with males as preparation for dispersion by performing necking. This might help them to join an all-male herd smoothly after dispersion from the natal area. A long term research is needed to collect enough data to reveal if juvenile is engaged in this behavior more than calf. Moreover, it would be interesting to see if the value of the social relationship becomes stronger with the increment in the rate of necking in the long-term.

No other study on giraffes has quantified the difference in proximity and the development of social behavior between calves and juveniles. We found several differences with age. These differences may play important roles in preventing young giraffes from being preyed on, in learning social skills, and for establishing social bonds with other individuals at the appropriate developmental stage.

Comparisons with other species

In cattle (*Bos Taurus*), calves prefer to have other calves of the same age as social partners and to be in their proximity (Bøe and Færevik 2003). Additionally, the bonds between cow peers established early in life are stronger than those established later in these domesticated herbivores. It has also been suggested that, in Japanese macaques (*Macaca fuscata*), close relationships form through behaviors such as foraging, traveling, and resting in proximity (Nakamichi 1989). Therefore, being in proximity while young may contribute to the formation of strong social relationships among same-age peers that last for a long time. It would thus be interesting to study whether individuals who are in proximity to each other when young maintain close relationships into adulthood.

In chimpanzees, after the juvenile period, sexual and aggressive behaviors are frequently observed, but the time spent alone also increases (Kraemer 1982). Therefore, as part of our results showed, the occurrence of sexual behavior in chimpanzees also differs among age groups. By revealing the rate of occurrence of these behaviors, we might be able to estimate each individual's developmental stage.

However, in wild ungulates, few studies have focused on proximity or on differences in the type and frequency of social behaviors among different age groups. Such studies should be performed on ungulates to determine whether there are differences among various ungulates.

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