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Inter-individual distances and interactions among captive giraffes

Master's thesis

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DECLARATION

I Bc. Andrea Šustrová hereby declare that this thesis entitled “Inter-individual distances and interactions among captive giraffes” is my own work under the direction of the supervisor of the thesis and by using literature and other information sources that are cited in the work and listed in the references at the end of work. As the author of the mentioned thesis I further declare that I am in the connection with its creation did not violate copyright of third parties.

In Prague 27.04.2017 Andrea Šustrová

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ABSTRACT

Giraffe (*Giraffa camelopardalis*) social preferences and relationships are very important for understanding complex social structure and social networks of giraffe herds. Giraffe society was described as a loose amalgamation of non-bonded individuals that sometime coalesce into herd. Current studies found out fission-fusion social system creating herd composition based on social bonds among giraffes. Giraffe social behaviour in captivity is depend on giraffe activity budgets and captive female giraffe reliably housed together form social relationships. My study focused on captive giraffe in different zoos in EAZA (Czech Republic, Netherlands, Germany). Aim of my thesis was to describe the differences in social behaviour and preferences among captive giraffes reflected by inter-individual distances and the type of interactions depended on different conditions as inside and inside enclosures and sex-age categories. The final number of measured individuals from all observation zoo consisted 48 adults, 14 subadults, 17 juveniles. The study took place during 3 years from 2013 to 2015. Inside observations were conducted from January to March, outside measured were done from March to October. I was collecting data for interactions and inter-individual distances at the same time, in total have been observed in case of inter-individual distances 58 hours from inside and 60 hours from inside enclosure. The total amount of measured hours in case of interactions was 32 hour from inside and 56 hours from inside. I concluded a longer inter-individual distance in outside enclosure than in inside enclosure. Inside measured value achieved an average distance 6,72 meters. A longest distance was 27 meters and lower distance was 0 meters. Compare to this, an average outside distance was 27,80 meters. A longest distance in outside enclosure was 190 meters and lower measured distance 0 meters. Number of recorded interactions per hour from outside was friendly (n=407), agonistic (n=44), maternal (n=20). Amount of interactions from inside enclosure was agonistic (n=100), friendly (n=2 164), and maternal interactions (n=127). Highest number of interactions was recorded between adult females in both types of enclosure. The study represents the analysis of the influence of different enclosure in captive giraffe and discussed the social behaviour and individual preferences in response to different sex-age categories.

Key words: (*Giraffa camelopardalis)*, zoo, fission-fusion, society, enclosure, sex-age

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1. INTRODUCTION AND LITERATURE REVIEW

Sociality is a strategy that most animals use cope with their environment, allowing them to survive and reproduce in conditions that may not be conductive to survival and reproduction (Dunbar, 1988; Brent, 2015). Sociality implies a numbers of individuals living or interacting together, which can lead to complex social relationships and structure (Krause & Ruxton, 2002; Whitehead, 2009). This strategy evolved a compromise between cooperation and competition with non-random distribution of activity with others (Bercovitch & Berry, 2013). Interactions and inter-individual distances are very important displays in mammalian society and play a key role in the transfer of information within the network where animals live within social system (Pike at al., 2008). Those two displays are very good tool how to measure animal sociality, because animals are may interact in different was such as direct connections or indirectly (Brent, 2015). Social behaviour includes interactions which are defined as a pattern of two individuals or association with others. Interaction occur when animals form simple aggregation or cooperate in sexual or maternal behaviour (Koenig & Dickinson, 2017; Bashaw et al., 2007). Inter-individual distance is based on an animal's ability to represent itself in a distance and distinguish conspecific from the strangers (Mills et al., 2010). Measuring of animal interactions and inter-individual distances is tool to gain organizations structure and create relationships within herd. In generally live in groups has some costs and benefits.

There are many reasons why animals live within group. These are benefits as increasing vigilance, avoidance of predators, foraging efficiency and better offspring survival force individuals. The costs of group living are connected with competition such as mating possibility and resources. (Bercovitch & Berry, 2010 a; Horová et al., 2015). Abundance and widespread sources are typical for most of wild ungulates but not for captive animals. Widespread sources are not expected to establish dominance hierarchy compared to unlimited resources (Wrangham, 1980). In captive conditions an individual is unable to leave the group and avoid to interactions. Individuals are usually limited by food resources such as forage and concentrate. However, the ability of different species to exhibit behavioural flexibility to environment conditions are very important for its

survival (Horová et al., 2015; Jepsen & Topping, 2004).

Patterns of association of wild giraffe (*Giraffa camelopardalis*) are very changeable according to different studies. The older study was considered, that giraffe association is appear random (Dagg & Foster, 1976). Based on other studies was defined, that structure is as loose and constantly shifting fusion of non-bonded individuals because individuals constantly leaving and joining to group. This periodically coalesce into a herd is call as fission-fusion (Dagg & Foster, 1976; Bercovitch & Berry, 2013). Fission-fusion structure in giraffe society seems as an anomality because there are two different perspectives: first is a loose amalgamation of non-bonded individuals that sometimes coalesce into a herd and a structured social system with a fission-fusion process modifying herd composition within a community. Giraffe herd composition is based on upon long-term associations that often reflect kinship. Sex and kindship regulate herd composition (Bercovitch & Berry, 2013). Herds generally consist of familiar individuals, most of whom have weak social bonds, but there are some individuals whom maintain strong social bonds. Giraffe female preferring herd with other females and with relatives as mother/offspring bond. Those association may persist for lengthy periods (Bercovitch & Berry, 2013). Publication of Bashaw et al. (2007) demonstrated complex social structure in captivity. However, other studies found out the only strong bond of captive giraffe is relationships based on preferences mother-daughter and individuals of different age (Bashaw, 2011; Tarous et al.,2000). Other study came up with experimental separation of captive giraffe which provided evidence of complex and long-term relationships between animals (Tarou et al., 2000; Horová et al., 2015).

In the zoo facilities, the individuals are unable to leave the group and avoid the interaction with others. Animals are limited by space and size of stable which play key role on their behaviour. Those factors lead to fact that they have no possibility to select with whom would like to spend a time. Such artificial change of conditions may lead to the expression of behaviour and its flexibility of the individual in different environment conditions. In general animals exhibited behavioural flexibility (plasticity) to face new environment conditions (Horová et al.,2015).

My observations were approved by head zoologists responsible for animals in each zoo and measuring did not affect the animals in any manners. I believe that my thesis help to understand the complex of giraffe social structure which is based on different interactions between sex-age categories and inter-individual distances. In my work I was interest of changes of behaviour in captivity depend on different conditions of enclosures and limitation of space.

2. SOCIAL BEHAVIOUR

2.1. WHAT IS THE SOCIAL BEHAVIOUR?

This relationship between animals can be defined as any number of individuals interconnected by social ties (Brent, 2015). The shape of a group arises through self-organisation, external influence from the physical environment, resource distribution and predator threats. Animal associated with conspecifics varies considerably among species (Ward & Webster, 2016). Each individual within social group is different, in terms of their genes, environmental stimulus and previous experience (Sumpter, 2006). Some of animals are weakly social, highly associated or intrinsically social (Ward & Webster, 2016). In animal groups with high inter-individual variation can provide a continual supply of new solutions to the problems and group aims forward to solve (Sumpter, 2006). The fitness of an individual is entirely dependent on living into a group (Ward & Webster, 2016).

Multilevel society refers two or more hierarchical tiers within the social organization of a species. This means, that each individual is a member of a basic social unit and this unit is part of another, larger tier which may form another tie (Ward & Webster, 2016). There are so many reasons why animal want to live together with the others (Davies et al., 2012). In animal societies, individuals often tolerate the close presence of other members of their species despite the reproductive interference and increased competition for limited resources (Alcock, 2009).

Living in a group is more beneficial because of better detection, acquiring and defending food which are obviously advantages of living in a group. Life in a group is a kind of a strategy which can reduce individual predation in several ways. Here is easier detection and defence against predators because predators may hesitate to attack a large group of animals (Mills et al., 2010), because predators always attack the nearest prey (Morrell & Romey, 2008). A group can be better at surviving (Mills et al., 2010) because the individuals which are more vigilance are less likely to be attacked (Davies et al., 2012). An individual within the group need to simultaneously avoid starvation by foraging and avoid falling as a prey to a predator (Morrell & Romey, 2008). One of the last group behaviour is a complex of emergency movements. The group may move after individuals have voted for their preferred choice (Davies et al., 2012). Each animal within a group is usually strive to gain a maximum advantages for itself and thus it will be more

successful than others (Mills et al., 2010). Here is very intensive link between environment and behaviour (Krause et al., 2014). The wild environment is optimal for good welfare and behaviour. Animal show variable behaviour according to how they respond to novel situations. The resulting behaviour may be adaptive and be maintained by natural selection, rather than reflecting non-adaptive variation around an adaptive mean (Dingemanse et al., 2002).

Disadvantage of life within group may be the spread of illness more rapidly and effectively through the group (Mills et al., 2010; Davies et al., 2012). The cost-benefit also involved dominance and the maintenance of territories. Territorial species tend to be distributed over the landscape which they use randomly. Aggressive behaviour against intruders is typical for territorial animal is typical aggressive behaviour against intruders (Walter & Dickinson, 2017).

Animal within the group have a system of tasks and subtasks requiring the concurrent performance and cooperation of two or more individuals for a successful task completion. The system of performing tasks was found in many animal societies where is no division of labour but each individual performs the same task (Anderson & Franks, 2001).

Changes of social behaviour may occur in isolation, individual manifests a cascade of physiological and behavioural changes. Those changes are often related to stress among species that are strongly social, this may be considerable (Ward & Webster, 2016).

2.2. ANIMAL COOPERATION

Animals live in social system and usually help each other in various ways (Alcock, 2009). Cooperation behaviour is summary of actions adapted to assist others that involves costs to the fitness of participating individuals. This process assumes that an individual competes to survive and breed (Clutton-Brock, 2009). Cooperation is defined as voluntary act in which two or more individuals work together to bring about an end situation with greater benefits that they could have obtained by working individually (Mills et al., 2010). Cooperation may take many different forms in different species. This behaviour occurs in form of mutualism which is common for one or both partners to provide services or resources to the others. Cooperation may be explained in form of direct and indirect benefits. Direct benefit means mutually beneficial cooperation. This type contains by-product benefits, reciprocity and enforcement. Indirect benefit explains altruistic cooperation which contains kin selection (Davies et al., 2012).

2.3. ALTRUISM BEHAVIOUR

Altruism occurs when the first individual performs an action at some fitness cost itself that causes the fitness of a second individual to be increased (Ward & Webster, 2016). Helped individual eventually return the favours they receive (Alcock, 2009). In social system can interactions arise between individuals where within the group the most commonly competition is for access to resources such as food or mates (Mills et al., 2010). Parental care fits the definition of altruisms. (Ridley, 2009). Parental care works because natural selection favours of individuals who maximize their genetic contribution to future generations. We can quantify the probability that a copy of the particular genes in a parent is present in one of its offsprings therefore there is a probability of sharing a copy of gene (Davies et al., 2012). The investment of parental care is time, energy and resources that parents devote to their offspring (Alcock, 2009). This relationship is defined and measured of the coefficient of relatedness often denoted by *r*. Parental care is not based just on an offspring as a kin but there is also helping and mutual aid between animals to feed a younger brother or sister. This relationship is also favoured by selection, it means passing on copies of genes to future generation (Davies et al., 2012). Parental care of mammals is usually where females care for young and males play little or non-part of care. Benefits of parental care is based on correlation between parental expenditure and offspring fitness. Parental care includes preparation of nests and territories, provisioning offspring before and after birth and supporting them till nutritional independence (Gubernick, 1981). In contrast, study showed some cases in which a donor really does permanently lose opportunities to produce offspring by its own, as a result of helping another individual with care (Alcock, 2009).

Other example of altruistic behaviour is allonursing and allomaternal behaviour. that have been favoured as reciprocal altruism (Gloneková et al., 2016c). This type of altruism introduces one solution to the evolutionary paradox of one individual making sacrifices for other unrelated individuals (Walter & Dickinson, 2017). Those behaviours usually occurred in societies with elaborate social structure, where the costs paid by donor are low in comparison with the benefits gained by the recipient (Gloneková et al., 2016c)

Some of those situations may escalate into aggressive behaviour which in turn may compromise the benefits of group living or future cooperation between the opponents.

Social animals have quite strong selection how prevent aggressive escalation. There are still ongoing researches which found out one possible solution which is affiliative behaviour. (Mills et al., 2010).

2.4. MUTUALISMS BEHAVIOUR

This behaviour involves two individuals help one another and make them engaged. Mutualisms may be designated as cooperation when both parties enjoy activity and involve the benefits from cooperation (Alcock, 2009; Mills et al., 2010).

2.5. KIN SELECTION

Many social animals live in kin group (Ward & Webster, 2016). As I have mentioned above in animal population the social status of individual and their relationship with other group members have an important influence on survive and breeding. Relationships are strongly influenced by effect of kinship (Clutton-Brock & Sheldon 2010). This process occurs when individuals differ in ways that affect their parental care or helping behaviour (Alcock, 2009). Kin selection is cooperation dependent on the relatedness of individuals involved, which means the closer their relatedness, the lower the effort needed to overcome the cost of cooperation (Mills et al., 2010). Such as example when females preferentially nurse more less related than unrelated offspring (Hayes, 2000).

2.6. ANIMAL INTERACTIONS

Social preferences are defined as patterns of interactions or association with others. Measuring of preference is through the proximity, nearest neighbours and interactions (Bashaw et al., 2007). Interactions are influenced by internal and external factors, including individual state, ecological factors and social interactions (Sueur & Mery, 2017). Animal interactions can be characterized as mutualism, altruism, selfishness and spite. First two types have been described above, selfishness means when the actor benefits at the expense of the reciprocity but in opposite case of spite, the actor hurts the recipient and both pay a cost (Walter & Dickinson, 2017). Within social group, each individual can be part of a network of social interactions that are variably in strength, type and dynamic (Sueur & Mery, 2017). Interactions occur between two or more individual

animals, usually of the same species (Walter & Dickinson, 2017). Interaction maintained over time are considered as relationship. Symmetric relationship means that both individuals have similar behaviours toward each other and show mutual attraction (Bashaw et al., 2007). The main goal of animal interactions is to maintain cohesion of the group (Ballerini et al., 2008) but for some interactions it is not necessary to keep the clumping of individuals. In this case use of pheromones is engaged, this work for long-distance (Walter & Dickinson, 2017). Animals are able to communicated in many different ways such as cues and signals (Davies et al., 2012). Another very important behaviour is recognition, Animals need a basic level of recognition especially for species which live in large and highly dynamic social structure such as some ungulates during migration (Ward & Webster, 2016). A cue occurs when the receiver uses some features of the sender to guide their behaviour but this type of communication has not evolved for that purpose (Davies et al., 2012). This type of recognition may be genetically determined, providing an innate ability to recognize, such as in a case of pheromonal communication which was already mentioned. Animals also use visual, acustic and chemical cues which have huge role in animal communication (Ward & Webster, 2016). Visual sense provides the viewer with information about the environment (shape, size, texture and movement of objects) (Kelley & Kelley, 2014). Signals are more typical for mammals and are characterized by acts or structures produced by the sender that alter the behaviour of the receiver (Davies et al., 2012). The attitude is very a common term how to describe a person's subjective opinion. Attitude is very dynamic interaction which is product of cognitive (reasoning), affective (emotional) and behavioural components (Mills et al., 2010).

There is the number of reasons for the spike in interest in the mechanism underlying group. Some study showed that within a group the social interactions can take many forms and may significantly affect and individual's fitness (Sueur & Mery, 2017). Measuring of social structure can affect population growth rate, dispersal and gene flow which are often important factors in management and conservation (Whitehead, 2009). Individuals are usually measured from a focal individual's neighbours who are linked in the network (Wey et al., 2008).

There are many different types of interactions between animals but in general we can characterise some of them as:

2.6.1. Friendly interactions

Friendly interactions involve sex, that means joining gametes in the process of fertilization. Mating interactions are described in terms of how males and females locate one another, how many mate individuals they have and how mating groups occupy space (Walter & Dickinson, 2017).

2.6.2. Maternal interactions

This type of interactions involved parental care, when main benefit is offspring survival. Care can influence an offspring's conditions and future reproductive success. Examples of the parental interaction are lactation and nursing but also feeding and defending offspring, carrying young and building nests (Walter & Dickinson, 2017). Nursing behaviour belong among the most energetically costly part of parental investments (Gloneková et al., 2016c).

2.6.3. Agonistic interactions

Agonistic interactions can be stressful and unfriendly towards subordinate individuals (Horová et al., 2015). Hierarchy formations are overly aggressive such as attacking and biting (Mills et al., 2010). They might also result in serious or fatal injuries. Abundance of food resources are typical for the most of wild ungulates, not for captive animals. In zoo two types of food are provided such as forage and concentrate mix food. Accesses to both of them are limited usually per head so this is the reason why these are generally attractive sources. Water is a very important limited source which is not limited in the captivity therefore there are expected behavioural changes in the captive environment (Horová et al., 2015).

2.7. INTER-INDIVIDUAL DISTANCE

Inter-individual distance is described as the maximum species-specific distance at which conspecifics approach each other. Distance is based on an animal's ability to represent itself in a distance matrix and distinguish conspecific from strangers. The exact distance is different within each life stage or social animals tend to accept a smaller distance than solitary animals. Another factor which influence the distance are open space, sexual activity, environment conditions (e.g. temperature). Term critical distance means a minimum distance at which an animal attacks. Social distance is determined as the maximum distance at which within-species groups feel comfortable (Mills et al., 2010).

Animals are not connected just to the individuals with whom they interact directly, but are also tied indirectly to the partners through their social partners. Indirect connections mean multiple degrees of separation which can ultimately result in everyone in the population being connected to anyone else (Brent, 2015).

2.8. FISSION-FUSION SYSTEM

The main mark of this social system is the regular formation and disintegration of temporary subgroups distinguished by specific social association within a large community that rarely coalesces into a single unit (Bercovitch & Berry, 2013). The process repeats over time and do not characterize a single social system but variation of cohesions and individual memberships known as a fission-fusion system (VanderWaal et al., 2014). This system is produced by two parameters influencing the group dynamic. Fission represents behaviours related to mechanisms of group disintegration, second one (fusion) represents types of behaviours related to mechanism of group formation (Couzin, 2006). This dynamic exhibit frequent coalescing (VanderWaal et al., 2014) and have fluctuating nature of group size and composition (Ward & Webster, 2016; Aureli & Schaffner, 2008) in which group members make spatial adjustment depending on their activity, resource distribution, resulting in splitting and merging of subgroup (Aureli et al., 2012). This dynamic involves carnivores, bats, ungulates, elephants and primates. The structure provides a highly responsive means for social animals to adapt to changes in social and environment conditions (Ward & Webster, 2016). Animal are allowed form larger groups when there are reproductive, foraging or antipredator benefits. There is a

minimum cost of intragroup competition if the benefits of grouping change. Influence of this dynamic has important implications for disease transmission, gene and information flow and mating (VanderWaal et al., 2014).

Social relationships are based on bonding that can be established between individuals. Bonds can be developed between various partners such as mother and young, pair bonding where is the stimulus for mating, brothers and sisters or non-kin individuals. Individuals can be from different species (e.g. human-animal bond) or conspecific (Mills et al., 2010). Mother-offspring relationships are frequently maintained into adulthood. More frequent association is in relationship sister-sister pairs (Bashaw et al., 2007). Individual should be motivated to interact and walk up other individual. They should be able to recognize and select positive interactions. Bonding is influenced by gender, physiological state, previous experiences or emotional context such as stress. The benefits of social bonds are in case of reproduction, survival, reductions of anxiety or provide support during social interaction. The disruption or absence of social bonds can lead to welfare concern (Mills et al., 2010).

3. BACKGROUND OF GIRAFFIDAE SPECIES

The kind ungulates include except giraffe the species like okapi, hippo, oryx, buffalo, cattle. These all species are an even-toed ungulate. Rhino, zebra and horses are odd-toed ungulates. The family ***Giraffidae*** contains only two living species it means ***Giraffa Camelopardalis*** and ***Okapia johnstoni***. Species Giraffe occurs in a patchy distribution in sub-Saharan African savannas although in Namibia. Okapi species occurs in the forest of the Democratic Republic Congo (GCF, 2017).

3.1. BIOLOGY OF GIRAFFE (*GIRAFFA CAMELOPARDALIS*)

Giraffes have been widely distributed across African's continent (Malyjurková et al., 2014). They are distributed across southern and eastern Africa, with small isolated populations in west and central Africa (Muller et al., 2016). They are common in the areas where are typical conditions such as, rainfall, soils, wind, fire, elephants or flooding favour scattered low and medium-height woody growth. This evolution formed the number of geographically distinctive forms classified at subspecies or species level (Malyjurková et al., 2014).

The giraffe as the tallest land living animal and the only extant species of its genus (Kingdon, 2015). The first significant adaptation is the giraffe's neck that has come through natural selection. Its neck contains seven greatly elongated cervical vertebrae which are strung with cables (tendons and muscles) to an anchor point in the shoulder hump (Macdonald, 2006). Role of the neck is very important because giraffes with their necks the centre of gravity ahead during walking. The neck movement is also very intense during galloping, neck move back, forth and at one moment per stride (Dagg, 2014).

Body weight and height are variable in different researches. The height of adult male is from 3,9-6 meters, while female is usually 3,5-4,7 meters tall (Mills et al., 2010). Adult males have body weight from 800-1930 kg, but the average is 1 100kg. Adult females have body weight 550-1180 kg with an average of 700kg (EAZA, 2006; Gloneková et al., 2016b). The general agreement is in terms of body weigh which is connected with sexual dimorphism. The weight of newborn giraffe has been reported between 55-64 kg in captivity (Dagg, 2014; Gloneková et al., 2016b). Data from the wild environment are poor. Weights range from 77 to 101 kg at birth (Dagg, 2014; Kingdon, 2015).

They have horns call ossicones for both sexes in the skin of the forehead (Kingdon, 2015). Males fully-grown horn ends are knobbed and hairless, while females are thin and tufted. On the neck there is visible mane with short erect-standing hair. The end of giraffe legs is formed by large and heavy rounded hooves (EAZA, 2006).

Other good adaptations into African environment are unique digestion and circulatory system. Giraffes are pure browsers (Macdonald, 2006). They browse more different plant species during the wet season than during the dry season. They are mainly associated with the areas where are *Acacia*, *Commiphora* and *Terminalia* trees (Kingdon, 2015; Muller et al., 2016). Wild grazing occurs very rarely, just at time when new, succulent green grass is available after the rains (Macdonald, 2006). Feeding time include rumination takes bout 80% of the daytime activity of wild animals (Mills et al., 2010). They usually do rumination during resting time after feeding (Dagg, 2014). The ecology is characterised by selection of very high-quality foliage, despite of being cud-chewing ruminants rely less on mastication to release nutrients than on digestive efficiency (Kingdon, 2015).

Giraffe's tongue is a specific organ which is very large. Tongue is like papillae in the stomach which provide the largest absorptive surface area known in any ruminant (Kingdon, 2015). When giraffe do browsing usually reaches out with its tongue, wraps a tip around a branch and draws it gently in between extended lips. This is the process how they are ripping the branches from the tree (EAZA, 2006). They can feed at any level up to 5 meters above the ground (Macdonald, 2006). Giraffes do not need to drink on a daily basis (Muller et al., 2016). This is thanks to their diet which contains 70% of water, they drinking often when clean water is available, even daily any hours of the day or night (Macdonald, 2006), (Dagg, 2014). At zoo they drink much more frequently because they do not have any other source of water such as leves or branches. Small calves do not drink water at all, just milk from mother and few nibbled leaves (Dagg, 2014).

Circulation system is characterised by pressure reduction valves. The giraffe has very elastic blood vessels and valves in the venous system of the neck. The jugular veins have valves that prevent a back-flow of blood to the brain when the head is lowered (EAZA, 2006). The heart must pump 2-2,5 meters above its hooves up to the brain and 3 meters below its brain when a giraffe is standing upright and down during drinking (EAZA, 2006; Macdonald, 2006). Another anomality in circulation system is blood pressure which is almost twice that of an average cow (Macdonald, 2006).

Other specific adaptation towards their elongated body shape is adaptation of respiratory system. A long neck requires a long trachea and a long trachea implies an enlarged respiratory dead space volume (Mitchell & Skinner 2011). That space is between lungs and nostrils and it is filled with a mixture of inhaled and exhaled air. Because of this difficulty, giraffe has to breathe more often than would be expected. The respiratory rate of an average adult giraffe in rest is more than 20 breaths a minute (in human it is 12-15) (Macdonald, 2006).

The reproduction is throughout the year and it is not seasonal. Giraffe comes into oestrus for the first time when it is about 3 years and 9 months old. The cycle is repeated every 2 weeks until she becomes pregnant (Dagg, 2014; Bercovitch & Berry, 2010b). After giving birth, a female comes into oestrus again in around 3 weeks. Duration of gestation is 446-457 days but there is difference in captivity where duration is about 470 days. Female after giving birth around 3 weeks comes into oestrus again (Dagg, 2014). In oestrus period females reduce feeding time while engaged in mating activities. In opposite state during the pregnancy they need higher protein and fat food resources (Mills et al., 2010). Cows continue to reproduce for rest of their lives, with an average inter-birth intervals which vary according to different authors (Dagg, 2014).

Giraffe offspring are defined as “hidders” and “followers” as well. They are ranked in an “intermediate cluster”. This term means, that they are able to react to changing environmental conditions (Gloneková et al., 2016c).

Vocalization is necessary type of communication to maintain contact over long distance (Mills et al., 2010). Giraffes can make vocal noises, but they seldom do. Giraffes ocassionally moan, bleat, moo, low, sneeze or grunt, snort, growl (Dagg, 2014)

3.2. GIRAFFE'S DAILY ACTIVITIES

Locomotion is a voluntary activity of movements that displace the whole body. It usually occurs in case of walking and galloping (Seeber et al., 2012). Movement towards the ground is always difficult for them because of blood pressure on the brain. They need to do this for daily activities such as licking at salt, picking up branches or drinking (Dagg, 2014). Their movement is motivated by demand for food, water, companionship, safety, grooming, sexual partner and other sources (Seeber et al., 2012).

Walk is in case when animal moves in a four-beat locomotion which is distinct from the three-beat *cantering* also due to its lack of a phase of suspension. In walk, there is a tendency to pacing, as both legs on one side might swing forward almost contemporary (own observation). The giraffe spends a considerable proportion of the day walking (e.g. 5 hours according to and travels roughly 3 to 5 km per day on average (Seeber et al., 2012). Adult giraffe frequently range over several hundred km, around 50-300 km (Brown et al., 2007).

Gallop is the fastest gait which involves an asymmetrical step pattern, a lengthened and free-gliding phase. There are leading front limbs, followed by the other front limb, then a pause after which is followed by placing the two hind limbs on the ground, one fractionally before the other (Seeber et al., 2012). Gallop can be slow and fast, average speed is 56km/h (Dagg, 2014).

Feeding is a big activity, which the giraffe spend approximately half of the 24 h per day feeding (Gloneková et al., 2016b; Mills et al., 2010). The giraffe ingests food other than browse, such as concentrates or hay; captive animals are often fed on hay and concentrates from cribs or elevated feed buckets. On the contrary to browsing, giraffe spend considerably less time feeding on concentrates due to a higher nutrient content and easier accessibility; while giraffe in the wild spends up to 16 hours browsing, captive individuals only feed as little as 4-6 hours (Seeber et al.,2012).

Resting time is usually at midday and after the morning. Usually the giraffe observed standing or laying in the resting position 20 m apart from each other in the nature. This activity is the most common for young giraffe, because it is great and hard deal for old individuals (Dagg, 2014). Adults usually resting rather short periods of time, presumably to *sleep*, with the head resting on the body (Seeber et al., 2012). The typical laying position is sternal position when legs are tucked in or folder up under the body, the

body touches the ground (Seeber et al., 2012; Shorrock, 2016). The head is curried with an erected or slightly bent neck (Seeber et al., 2012).

The best sleeping time for ungulates and giraffes as well is at the night. They have very small amount of deep phase of sleep. They may do it when standing as well as laying, when lying position is the same as during resting. The reason for very short time of sleeping is alert for predators, foraging and rumination (Dagg, 2014). As in other ungulate species, juvenile giraffes seem to spend more time sleeping than adult ones (Shorrock, 2016). During real deep sleep each animal is completely relaxed with its neck head stretched back along its side. Within this phase they do not ruminate (Dagg, 2014). Captive giraffes usually have sleep around 4,5 hours out of 24 hours. Scientists also looked at deep sleep and found out the average is only 27 minutes at night (Seeber et al., 2012).

The giraffe rubs its body / neck / head against an object. Rubbing against objects is presumably done to get rid of an itch, as the giraffe‘s rather unstable balance does not allow to scratch an itch with its own legs, as seen in other ungulates. Giraffes can also walk and stand over shrubs that are somewhat higher than animal’s trunk to rub their bellies on it by moving back and forth (Seeber et al., 2012). In this case, we can observe self-grooming by biting its own body or legs. Licking of foreign objects or different soils can be identified as stereotypical behaviour or missing some supplements in the feed stuff (Shorrock, 2016). The animal uses its tongue on an object that is neither food nor a mineral donator, repeatedly and persistently over a lengthy period of time (Seeber et al., 2012). The giraffe can use its tail to brush off flies from almost whole trunk. Tail swishing might be also sign of irritation in an alert situation (Shorrock, 2016).

Scanning is individual activity when animal observes its surroundings. Vigilance behaviour is traditionally considered as function primarily for antipredator protection. But this is not just only function within the group. The purpose of vigilance is also protection against competitors, which are usually conspecific. In generally vigilance decrease with increasing group size and it is considered as an advantage of group living (Cameron & Toit, 2005). Vigilance is most obvious when the animal is standing still with an erect neck and appears to be actively watching, but scanning is apparently done synchronously with many other behaviours (e.g. while ruminating, walking, or between feeding bouts). The giraffe’s visual abilities are assumed to be its most important feature of predator defence. According to (Backhaus, 1959) has proved high developed visual

abilities in giraffes (Seeber et al., 2012). Predator defence is based on kicking. This is very common in case of cows and their new-born calf (Shorrock, 2016). The effect of vigilance in case of giraffe species may be a social element. Lions are the main predators of giraffes which may be a seasonal shift in prey preference. This type of behaviour is playing very important role in giraffe behaviour, potentially contributing to the maintenance of sexual segregation in foraging heights (Cameron & Toit, 2005).

Giraffes have peculiar tendency to chew on old bones or parts of carcass and to eat soil that is call scavenging (Seeber et al., 2012; Macdonald, 2006). Giraffe in captivity and in the wild were observed to scavenge on carcasses of different herbivore species, including giraffes. Comparably to osteophagy and geophagy, scavenging in the giraffe is presumably an indicator of nutritional stress, as e.g. lacking minerals. Giraffe cows have also been reported to eat the afterbirth (Seeber et al., 2012). Giraffe can sometimes die from choking or botulism poisoning as a result of the chewing and swallowing bones (Macdonald, 2006).

3.3. SYSTEMATIC CLASSIFICATION

Giraffe as a single species (*Giraffa Camelopardalis*) include several sub-species. This is very variable and still being investigated and changing. Classification of different subspecies is based on pelage patterns, characteristic of ossicones and geographical distribution across the African continent (Bock et al., 2014). The colour patterns are variable between individuals and subpopulation. Coloration of giraffe's coat mimic is combination of light and shade that is found in savanna woodlands (Macdonald, 2006). Essential color is dark reddish to chestnut brown blotches of various shapes and sizes. Under parts of body are of a light and buff ground colour and are usually unspotted. The coat patterns of young do not change with age (GCF, 2017).

It is widely accepted that there are nine subspecies: *G. c. angolensis, G. c. giraffa, G. c. peralta, G. c. reticulata, G. c. rothschildi, G. c. tippelskirchi, G. c. antiquorum, G. c. reticulata and G. c. tippelskirchi* (Dagg & Foster, 1976; Brown et al., 2007). There are more different classifications according different authors that have used data which correspond with different natural habitats or topographic obstacles to dispersal into environment (Brown et al., 2007).

New study (Fennessy et al., 2016) that used a genetic analysis which is based on

DNA mitochondry sequence found out four giraffe species instead of one**.** Study investigate genetic variation among giraffe matrilines by increased sampling. Sampling was focused in key southern Africa (Bock et al., 2014). Genetic analysis showed, that there are four highly distinct groups of giraffe, which apparently do not mate with each other in the wild (GCF, 2017).

Recognition includes:

Northern giraffe (*Giraffa camelopardalis*)

- **Kordofan** (*G. c. antiquorum*),
- **Nubian** (*G. c. camelopardalis*)
- **West African giraffe** (*G. c. peralta*)

Southern giraffe (*Giraffa giraffa*)

- **Angolan** (*G. g. angolensis*)
- **South African giraffe** (*G. g. giraffa*)

Reticulated giraffe (*Giraffa reticulata*)

Masai giraffe (*Giraffa tippelskirchi*) (GCF, 2017).

Difference is in the exact classification. The southern giraffe, **Masai giraffe** and **Reticulated giraffe** are not exactly new. They already existed but until now they were classified as subspecies of the **Northern giraffe, Giraffe Camelopardalis**. The result from this study is the change in the definition of this animal group. Classic definition was a group of animals which can reproduce with one another and whose offspring are fertile. Animal within a species, but of different subspecies can reproduce from a purely genetic standpoint. Distribution of all giraffe species currently occur in 21 countries, forming a wide arc throughout sub-Sahar Africa, Niger, Central and East Africa to down to southern Africa.

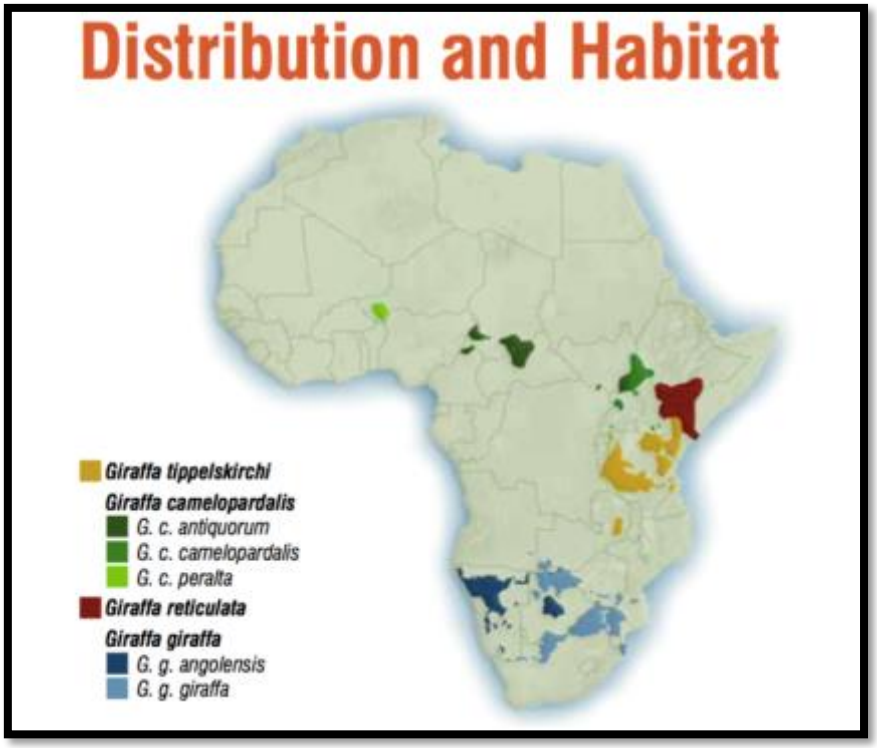

Figure 1. Distribution and habitats of giraffes. The four species of giraffe currently occur in 21 countries, forming a wide arc throughout sub-Saharan Africa from Niger to Central and East Africa, down to southern Africa (GCF, 2017).

3.4. DESCRIPTION OF SPECIES

3.4.1. Masai giraffe (*Giraffa tippelskirchi*)

This species range across central and southern Kenya throughout Tanzania. The Masai giraffe is often noticeably darker than other species. Its patches are large, dark brown and distinctively vine leaf-shaped with jagger edges. The patches are surrounded by a creamy-brown colour, which continues down their lower legs (GCF, 2017).

3.4.2. Northern giraffe (*Giraffa Camelopardalis*)

Three subspecies of the northern giraffe occur across Eastern and Central Africa.

Subspecies:

- Kordofan giraffe (*G. c. antiquorum)*

  Giraffes range includes southern Chad, Central African Republic, northern Cameroon, northern DRC and western south Sudan. This subspecies patches are pale and irregular. Similar to other northern giraffe subspecies, they have no markings on their lower legs (GCF, 2017).

- Nubian giraffe (*G.c. Camelopardalis*)

  The range area is in western Etiopia, eastern South Sudan, Kenya and in Uganda. The estimated number of Numibian giraffe is 2, 645 individuals which include the genetically identical Rothschild's giraffe (GCF, 2017).

- West African giraffe (*G.c. peralta*)

  The wild range of this subspecies is in the Niger. The west African giraffe is noticeably light appearance. Their patches are rectangular and tan coloured and are broadly surrounded by a creamy color. There are no markings of their legs (GCF, 2017).

3.4.3. Reticulated giraffe (*Giraffa reticulate*)

The reticulated giraffe has a relatively limited distribution across northern and north-eastern Kenya, and small restricted populations most likely persist in southern Somalia and southern Ethiopia. The species rich orange-brown patches are clearly defined by a network of striking white lines, which continue entire length of their legs (GCF, 2017).

3.4.4. Southern giraffe (*Giraffa giraffe*)

Two subspecies of the southern giraffe occur across Southern Africa and, together, they make up more than 50% of the continent's total giraffe numbers.

Subspecies:

- Angolan giraffe (*G.g. angolensis*)

  Despite their name, Angolan giraffe were extirpated (*locally extinct*) in Angola until recent translocations. The Angolan giraffe's range includes central Botswana and most parts of Namibia. This subspecies is relatively light in colour. They have large, uneven and irregular notched light brown patches. The patches are surrounded by a pale cream color and lower legs are randomly speckled with uneven spots (GCF, 2017).

- South African giraffe (*G.g. giraffe*)

  The South African giraffe ranges from west to east across southern eastern Angola; northern Botswana; southern Mozambique; northern South Africa; south- western Zambia; and eastern and southern Zimbabwe. Giraffe has star-shaped patches in various shades of brown, surrounded by a light tan colour. Their lower legs are randomly speckled with uneven spots (GCF, 2017).

3.5. GIRAFFE CONSERVATION, STATUS AND NUMBERS

Giraffes population counts from 97, 000 to 100,000 individuals in total (Gloneková, 2016d; Fennessy & Brown, 2010; Carrington, 2016). Declining of population over the past three years have been assessed by Vulnerable and Endangered respectively in the **IUCN Red** List 35- 50%. Currently some species are Critically Endangered (Fennessy et al., 2016). There are two subspecies, *G.c.peralta* which is genetically unique and *G.c.rothschildi* changed into new classification as Nubian giraffe (Suraud et al.,2012). Northern giraffe number less than 4,750 individuals in the wild and reticulated giraffe number less than 8,000 individuals as distinct species. The treat for giraffe iconic status comes from wide public affection, cultural and economic importance and role of functioning of African ecosystem. Alarmed sight is severe range reduction, population declines and increasing fragmentation, due to habitat loss and degradation which means agricultural expansion, timber and fuelwood collection and development of infrastructure. The big threat is also from human side such as illegal poaching, war and civil unrest (Fennessy et al., 2016).

4. GIRAFFE SOCIAL BEHAVIOUR

Giraffes live in uncomplicated, extensive social groups. They live in social system call fission-fusion which was described above. Group may include two or more than 20 animals of different ages (Macdonald, 2006) but on average they are 3-5 individuals (VanderWaal et al., 2014). There was seen group around 100 individuals (Dagg, 2014). Within the group there are adult cows, subadult males and juveniles (Macdonald, 2006), (Horová et al., 2015; VanderWaal et al., 2014). The ratio of males to females in herds varies a lot deal and herd rarely consist of the same individuals for more than a short time (Wilson & Mittermeier, 2009). Some study concluded that association patterns are random. Giraffe groups perpetually shifting grouping patterns when group daily or hourly coalesce into larger groups or break apart into smaller groups (VanderWaal et al., 2014). According to some studies the definition of giraffe group could be quite problematic because of the potential disparity between giraffe and human perceptual fields (Mills et al., 2010). Giraffe lives in a complex society characterized with about 25% of the variance in herd composition owing the kinship and sex (Bercovitch & Berry, 2013). Some of the individuals may associated because they have similar or the same habitat preferences (Malyjurková et al., 2014). As was already mentioned the description of social structure of wild giraffes are very subtle. Relationships are constructed by the interaction mother-offspring contact and the agonistic encounters of males. Groups size depends on the season. Groups have a dynamic structure in the nature. This is because of some effects like animals are leaving or joining a group but also there are mortalities and births (Horová et al., 2015).

Only strong bonds are between a cow and her dependent young. There is some experimental separation of captive animals because study support the fact that captive giraffes maintain social relationships (Tarou et at., 2000). Different conditions in the wild and in the captivity are limited factor such as enclosure or stable but also the access to preferred food (pellets, vegetable, concentrates) (Horová et al., 2015). Giraffe has as in many ungulates, sociality dependent on sex and age. At 5 years old, a cows and bulls are considered on to be an adult. At this age female can give a birth but males do not become sexually matured and stop growing for several more years (Dagg, 2014). Females with young calves live in a nursery group which is fairly stable. Young bulls creating bachelor groups where they stand parallel and swing their heads towards each other (Mills et al., 2010).

The system evolved in response to the exploitation of food availability that animals can effectively use by broadcasting long-distance information to their kin. This communication and cooperation is the combination with short-distance bonding (Malyjurková et al., 2014). Patterns of association of wild giraffe however appear random (Bashaw, 2011) and giraffe live in loosely constructed social groups with large home range sizes, ranging from 5 km- 20 km (Brown et al., 2007).

4.1. LONG TERM BONDS

Some study has shown that giraffes loose social bonds and frequent changes in social partnership are typical (Mills et al., 2010). Giraffes form only loose social bonds, that are temporary and occur mainly between young animals. Study prevalents that only strong bond among giraffes is between a mother and dependent young (Malyjurková et al., 2014). There could be bonds for mother and calf which could disappear early, it may become broken after 12-16 months postpartum a new sibling is born (Bercovitch & Berry, 2013). There are some differences between scientists, some of them said, cow-calf bond may also persist until 19-22 months or one year (Dagg, 2014; Bercovitch & Berry, 2013; Mills et al., 2010). Social bonds among giraffes have been also described in a nursery groups which consists of memberships composed of females and offspring. There are mainly interactions between calves which associate frequently with other calves and form peer bonds (Bashaw et al., 2007). Young males exhibit a lot of types of interactions with peer more frequently than the other classes (Le Pendu et al., 2000). Some observations recorded young females when reached adulthood, they associated with increasing number of females, thus increasing their social network (Dagg, 2014). The female giraffes have shown significant preference for avoidance of other giraffes. Inter-individual distances are quite often long in giraffe herd. The basic distance may be 1 km apart (Malyjurková et al., 2014). Study from captive environment resulted increasing stereotypic and contact behaviour when animals were in social separation (Tarou et al., 2000).

4.2. BULLS BEHAVIOUR

Old bulls are frequently solitary (Le Pendu et al., 2000) but in the close distance from another males group, females and young giraffes. The aim of bulls is to mate with female in oestrus and spend a lot of time by searching (Dagg, 2014). Mature bulls walk around widely, typically 20 km in a day and search for cows in oestrus (Macdonald, 2006). Usually young males spend a lot of time just by mixing and creating new groups with males, females, young or adult individuals. Giraffes have roaming strategy which has three major costs. First is that they need high metabolic expenditures for travelling on great distances. Second is, males are travelling along and there is higher risk of predators. The last one is, if they are staying and guarding one female in oestrus, a male can miss opportunity to mate with other female (Dagg, 2014). In juvenile male is confirmed higher frequency of agonistic behaviour (Le Pendu et al., 2000). If they become older they get stronger and heavier neck and horns longer and thicker. This is reason why they are start sparring and necking which is common activity of young adult bulls around 5 years old (Dagg, 2014; Le Pendu et al., 2000). Subadult and adult males initiate sexual interactions with subadult female more frequently than with adult females. Sexual interactions such as testing of urine is more often with young adult females (Le Pendu et al., 2000). Dominant hierarchy in this case means that largest dominant bulls monopolize mating (Macdonald, 2006).

4.3. COWS HERD

Bonding between parents and offspring is mostly just in case of female parent. Bonding develops soon after birth and given opportunity, will persist as a matriarchal family group. Natural creation of bond is by suckling motivation. The bonds are preserved by grooming after suckling. Other form of communication is vocalization which is also very important. Main advantage of this mother- filial bond is to teach the offspring how to survive but another reward is protection, nutrition and also stable position in the group structure dependent partly on their mother position (Mills et al., 2010).

Groups of giraffe cows are seldom alone. They live in groups which can contain several females and young mothers with calves. In social system of cows was described fighting between cows when one cow nosing or rubbing against another with her head. Bumping or hitting by head may also occur within herd. Giraffes usually do not have a leader of the group but it has observed in the few cases. If there is any leader in the group it is almost always a middle-age or old cow also usually with a calf (Dagg, 2014). The female dyad shown non-random preference to spend time with specific individuals in the same group and partners for variable association. There is an option that long-lived females experience social preferences and avoidances based on previous experience. The relationship between mother-daughter or sisters may persist through the time. Stronger bonds among giraffe females may have adaptive function due to reciprocity and allomaternal care. Allomaternal care support association with calf of familiar female which defined as friend. In the Malyjuvkova. et. al., 2014 study has been reported the relationship of female and calf of other friend such as medium to strong, since the relationship with calf of non-friend was weak to medium. Calves from friend relationships associated together and form nursery groups more than calves from non-friend relationships (Malyjurková et al., 2014).

4.4. COW AND CALF RELATIONSHIP

Relationship between cow and a new-borne calf develop special strategy how to let calf survive. Giraffes are very hard-working mothers, even if they are pregnant again, while tending and nursing their current youngster (Dagg, 2014). The relationship is based on the protection when mother can and protects her young in important situations (Ralls et al., 1986). In case of ungulates has been suggested that followers cope with predators by fight, hider by concealment and defenders through defence (Ralls et al., 1986).

In the wild giraffe cow prefers to give birth alone and few days after join up with other giraffes (Dagg, 2014). There is an interesting behaviour after the birth when mother introduces her new-borne calf to the herd. The juvenile is led towards to herd with mother. Juvenile members of group are usually playfully and adult giraffes approach the newborne and sniff it (Fennessy, 2004). This is similar in captivity where cow and calf are keep separate for a few days from the rest of group (Dagg, 2014). Young of giraffe showed a unique pattern because they are intermediate between followers and hiders. Study showed that they spend less time lying than the young of any other species except zebra (Ralls et al., 1986). According to Langman (1977) study, new-borne giraffe stayed hidden in thickets or tall grass for their first 3 weeks. Mother comes back three or four times a day to nurse them for few minutes. After this time the pair joins one or more mothers and they create a group. Higher number of mothers with new-born calves may create nursery *crepe* group (Dagg, 2014). Giraffe form nursery group, while others search for food. Giraffes know well purpose of this group in the wildlife and they use it in the captive living as well (Malyjurková et al., 2014). The group usually stayed in an open area on high ground with tall grass during the day. During the night one or two females stand watch near to nursery group, alert for the approach of predators. Females change shifts during the night, so that not only one female stay on duty all night. The young are usually weaned at 6-8 month of age but staying with mother until at least 14 months. The rumination does not work until 4-6 month of age (Dagg, 2014).

In capture the social organization of herds allows mother to leave calf in the safe environment of a *crèche* group. This bonds between juveniles and older females may persist through the time (Malyjurková et al., 2014). According to (Bashaw el.al., 2007) publication the captive giraffe female formed complex social structure with quite strong relationships. In capture social structure reflects to a continuation of mother-calf attachment. This behaviour leads to the promotion of allomaternal care, including

allonursing. Relatedness and stable composition of the herd in the captivity could support increasing number of allomathering activities (Malyjurková et al., 2014).

4.5. CALF AND CALF RELATIONSHIP

The association between calves is surely influenced by the association between their mothers (Pratt & Anderson, 1982). Juvenile giraffe also has physical contact and playful behaviour with other giraffes of all age categories, particularly juveniles (Fennessy, 2004). The behaviour of calves is particularly dependent on a mutual attraction and attachment is quite aside from their mother's affiliations. In case of physical contact and play may occurre different types of behaviour like nosing, rubbing, sniffing, licking, kicking, gambolling and noso-frontal greeting. The frequency of these activities is not significantly different between male and female calves. According to (Pratt & Anderson, 1982) study calves spent a higher percentage of the time with calves than with their mothers and were closer to one another with much physical contact between them.

5. GIRAFFE‘S INTERACTIONS

5.1. FRIENDLY INTERACTIONS

Affiliative, contact and play interactions appeared to decline in frequency with an increase in age (Fennessy, 2004).

5.1.1. SNNIFING

Sniffing behaviour occurred when one giraffe touched another briefly and lightly with its nose. There is a specific description when individual used the upper end of its rostrum, it is probably smelling the other giraffe rather than touching it. Typical and very significant is nosing of the trunk, neck or head of the other (Dagg, 1970).

Figure 2. Giraffes sniffing behaviour of neighbour (Masterfile, 1981).

5.1.2. LICKING

Licking usually lasted longer than nosing, but rarely more than 1 minute. Licking is typical for different part of body such as trunk, neck, horns or mane of the second giraffe. There was also observed licking of each other’s eyes (Dagg, 1970).

Figure 3. Licking behaviour applied on the calf (Masterfile, 1981).

5.1.3. SHARRING BRANCHES

There could be any cooperation between individuals during feeding time especially. When they get new branches, one giraffe held branches in its mouth while pulling off the leaves with its tongue. Another giraffe joined and while holding another part of the branch she consumed leaves too. This kind of sharing or cooperation occurs more between young female but sometimes has been observed how the individual left with branch away and no one could join (Dagg, 1970).

5.1.4. APPROACH

One animal moves towards conspecifics, obviously not in the order to threat, but to become closer. Approaching appears considerably frequent when bulls join groups and attempt to investigate each individual; these approaches might be followed by *investigation* or *nuzzling.*

5.1.5 GROOMING

Grooming is type of behaviour which is call altruistic behaviour, that means when one animal grooms another's body or crest by licking or biting. The purpose of this behaviour is cleaning of the outer surface of the body, include removal of parasites. Biting or chewing the mane of a conspecific for more than few seconds, repeatedly, and not in a grooming context (Shorrock, 2016; Mills et al., 2010). It seems to be as social tolerance,

so that a low-ranking animal grooming a higher-ranking animal. Within this relationship are animals able to maintain proximity and thereby some level of protection or sharing sources (Mills et al., 2010). Grooming tends to be heavily biased towards kin selection. Allogrooming is term for grooming between mother and young that is necessary for cleaning of juvenile animal. This interaction is also between non-kin animals but is often meant to be maintained through grooming reciprocity. Grooming interaction between familiar and non-familiar animals can be seen to vary greatly (Mills et al., 2010). Grooming in case of giraffes was observed relatively frequently. There was a following behaviour such as shaking, biting, scratching the neck or head. Allogrooming was observed just very rarely (Fennessy, 2004).

Figure 4. Grooming behaviour between mother-young (Masterfile, 1981).

5.1.6. NUZZLING

A tactile encounter with conspecifics by animals nose or muzzle to conspecifics nose or any other area then flanks or genital area. This greeting ritual seems to be more frequent between cows and calves then among adult giraffes. Study of Pratt and Anderson (1982) referred as naso-frontal greeting and (Bashaw et al., 2007) study as nuzzle. Nuzzling seems to strengthen the social bonds between animals, as it is seen very often by cows, directed to calves before suckling.

5.1.7. INVESTIGATION OF GENITALIA

The animal licks or sniffs a conspecific genital area or flanks. Investigating is most common with bulls directed towards adult and subadult cows. By investigating the bull intends to stimulate the cow to urinate, and subsequently might perform *urine testing*. The behaviour can be conducted by bulls or cows, and in both cases directed to either sex.

Figure 5. Investigation of genitalia between cow-male (Masterfile, 1981).

5.1.8. LICK OF URINE

The giraffe licks another giraffe‘s urine from the ground. Licking urine from the ground is not to confuse with urine testing, which is performed by adult and sometimes by subadult bulls after stimulating a cow to urinate. Licking urine by bulls is sometimes followed by a flehmen response. Adult cows were also seen to lick urine of other giraffes from the ground (own observation). Classified as an *interaction* due to its presumed character of communication (Seeber et al., 2012).

Figure 6. Licking and testing of urine by male (Masterfile, 1981).

5.1.9 FLEHMEN

Flehmen behaviour is performed by ungulates and animals of many other taxonomy in response to pheromones from other animals, usually conspecifics, but also other species. Pheromone is chemical that transmits messages between animals. This behaviour has a characteristic posture (Mills et al., 2010). Males always check the reproductive status of cows when they encounter them. Identification of cows they do by sampling and testing of urine such as sniffing or nuzzling at each cow's genitalia. After that cow delivers a short stream of urine that bull caught in his mouth (Macdonald, 2006), (Dagg, 2014). The giraffe raises its head up, sometimes with the nose line tilted above the horizontal, and curls up the upper lip, inhaling deeply. The flehming is frequently performed by bulls after urine testing in the process of investigating, showing long saliva threads hanging from the mouth. By inhaling deeply, the giraffe presumably uses its Jacobson's organ to assess the cow's cyclic state (Seeber et al., 2012).

Figure 7. The male has just collected urine from the urinating female and is flehmening to determine if she is in oestrus (Dagg, 2014).

5.2. AGONISTIC INTERACTIONS

Number of agonistic interactions increase with maturity. Dominant behaviour in giraffe is more often for bulls because of their social hierarchy. Only occasional observations of some cow agonistic interactions, such as neck rubbing, sparring or chesting have been observed. Exhibition of aggressive behaviour was mainly by stamping their front hooves, snorting or growling (Fennessy, 2004).

5.2.1. CHASING, FOLLOW

One animal stays close to other and follows its movements in walking. Following is common with bulls, sometimes prior to the establishment of a mate guarding courtship, or when cows do not approve of the bull's affiliation. Also, calves have a tendency follow each other. Mature cows were described to follow the movement of their calves (Seeber et al., 2012). This behaviour seems to be like a strong mother-young bond but it is also the part of antipredator strategy. The mobility of the young followers combined with birth synchrony leads to the large number of young animals being present at the same time (Mills et al., 2010).

Figure 8. Following behaviour of female who is likely in oestrus by male group (Dagg, 2014).

5.2.2. AVOINDANCE

This type of behaviour is described as a sequence of actions involving retreat from, or lack of approach to or a perceived threat stimulus. Avoidance behaviour can be sub-divided into two main categories. The first is unconditioned can be called like unlearned and second one is conditioned call like learned. Unconditioned behaviour is assumed to be entirely instinctive. Those interactions are released by triggers or cues. Conditioned avoidance behaviour consists of learning something aversive about a stimulus that is either intrinsically threatening to the species or due to an association with an intrinsically threatening objects or processes. An aversion is a reaction of avoidance. There is aversion towards conditions, individuals or behaviour (Mills et al., 2010). Aversion occurs very often in captivity where animal do not have possibilities to go away.

5.2.3. NECKING, SPARRING

When it is necessary to face to other male and fight, the dominant male stands tall with his neck held vertically and strut with legs stiffened towards his opponent. The winner sometime chases the loser for a short distance and then stands in tall display posture (Macdonald, 2006). Sparring seems to be like a dance between two animals standing side by side, head to head or head to tail. They are taking turns to gently hit each other's bodies with their horns. They can make a small break between hits or others male could join them (Dagg, 2014).

Figure 9. Sparring behaviour between young subadult males (Dagg,2014).

5.2.4. HITTING

Hitting and necking matches are less common in captivity. This is activity for wild male mostly. Have observed that often necking may lead to homosexual activity with one bull mounting the other. Necking matches never involved calf and mostly no females as well (Dagg, 1970).

5.3. MATERNAL INTERACTIONS

5.3.1. NEONATE CLEANING

In this case age of calf is less then 1 month old. Behaviour is defined such as mother's licking of the new-borne calf dry and eat the foetal membrane (Shorrock, 2016).

5.3.2. SUCKLE

Juvenile animal sucks milk from cow's udders. It was reported that the nursing relationship in giraffe is exclusively limited to one cow and her calf (Pratt & Anderson, 1982). They also suggest that nursing serves as a strengthening of the mother-calf bond, and not only for nutrition. the suckling act can be initiated by either the calf of the mother (Seeber et al., 2012). The time of duration is different some study says 66 seconds another 56 seconds. Suckling is usually initiated as frequently by the mother as by the calf.

5.3.3. NURSING

Nursing communication involved all sensory channels (acoustic, tactile, olfactory). Acoustic signals used by mother, informs about her identity, location and timing. Tactile stimuli prolonged teat nuzzling or butting. Olfactory communication primary serves to identify the progeny to the mother (Mills et al., 2010). Nursing is initiated either by the calf or its mother who may at intervals approach and stare her own calves. The session is more likely initiated by mother than by calf (Dagg, 2014).

One animal attempts to suckle on a cow‘s udders. The unsuccessful nursing attempts are mostly seen in calves, which approach a cow that is already nursing another calf. Sometimes subadult or adult animals also approach the nursing act, and try to suckle themselves; cows are reported not to allow any other calve then their own to nurse (Seeber et al., 2012).

Figure 10. Maternal behaviour-suckling (Masterfile, 1981).

Allonursing may occur in many cases. Lactation is the mostly parental investment for mammalian females, therefore allonursing can be an extreme case of communal care (Gloneková et al., 2016a). The physiological state is when a lactating female would only nurse her own offspring. But there are some other influences which can change mother behaviour. Mother can make a misdirected attachment "miss mothering" to an alien young during the postpartum period. Mother may tolerate the sucking by alien offspring even though she recognized them correctly. Another example is when mother aggressively repel alien young and the last example is when calf steals the milk from the alien young and suckling together with biological offspring (Mills et al., 2010). Allonursing is adaptive behaviour for females, or as an adaptive behaviour for young which may be nonadaptive for female (Gloneková et al., 2016a).

Figure 11. Allomaternal care – allosuckling (Masterfile, 1981).

6. GIRAFFES IN THE CAPTIVITY

6.1. ZOO

Giraffes are popular animals and are distributed in zoos facilities around the world (Casares et al., 2012). Husbandry of this species is regarded as demanding which means repeatedly occurring in captive giraffe such as locomotion system problems like overgrown hooves, joint issues and nutrition problems (Hummel et al.,2006). There is the set of minimum space per one animal is 25 m^2 per animals so this is not abided in the case. The minimum high in the stable should be 5,5 meters, here is 8 meters so it is enough (Miller & Fowler, 2014). Very big influence to those problems come from the environment and conditions in the stable. There is the focus on nutrition, parturition, floor characteristic like hardness, abrasiveness and humidity. All those factors influence hooves growing and health state in case of large animals confronted with the husbandry practice (Hummel et al.,2006). General fact is that giraffes have a shorter lifespan in zoo than in the protect wild. The reason probably is poor nutritional status and low energy intake. Furthermore, many captive giraffes show oral stereotypic behaviour such as well licking. Besides those problems, they also have reproductive problems such as high infant mortality and abnormal oestrus cycling. Sub-abnormal captive environment induces abnormal, repetitive stereotypic behaviour caused by disrupting normal brain development.

6.2. STEREOTYPICAL BEHAVIOUR

Overall captive animals perform stereotypic behaviour for no-mutually exclusive reasons. There are many reasons which include environmental sources, stress, exposure to loud or arousing odors (Morgan & Tromborg, 2006). The internal states are induced by the captive environment or cues external to the animal. Both of persistently trigger or motivate a specific behaviour response. Second one is just environment which creates a state of sustained stress resulting in abnormal perseveration. Last reason for stereotypic behaviour is influence of a past or early rearing environment which has affected CNS development. This behaviour in captive animals is typically most time consuming and prevalent in conditions known or believed to be aversive, for example physical confinement or low stimulation (Mason et al., 2007).

Stereotypical problems among captive giraffe occur in form as oral stereotype, in particularly a tongue playing, licking of objects or vacuum chewing. All those problems are linked with food and feeding problems. The typical diet consists mostly concentrate food which is consumed rapidly and do not provide stimulation for their long tongue (Baxter & Plowman, 2001). There is a timetable, because in the wild they are not limited by time and can move constantly to find food. Occur stereotype behaviour could be find licking of non-food objects such as inside fences and paving. There were described stereotypes of self-injury, head tossing and tongue playing. Natural behaviour in the wild is that giraffe spend most of the time by browsing. Consuming leaves from acacia thorn tree. In the zoo we could avoid this stereotype behaviour by changing diet and involve new, diet enrichment and motivated behaviour patterns. Stereotypes correlate with stress so perhaps a reduction of stress can reduce these aberrant behaviours (Dagg, 1970). Occur of stereotypical behaviour was detected when the resident male was removed from the group. In this case, just female's individuals exhibited significantly increased level of activity, stereotypical behaviour and contact behaviour after separation (Tarou et al., 2000). The results from the studies are that 79% of the giraffe individuals performed at least one type of stereotypic behaviour. Non-food or licking of object is the most common form of stereotypic behaviour. Over 29% paced and 3% performed other forms of stereotypic behaviour (Bashaw et al., 2001; Mills et al., 2010). Stereotype behaviour is generally accepted to be an indicator of sub-optimal welfare which can be reduced by the simple additions for example by coarse fibre to the diet (Baxter & Plowman, 2001).

7. AIMS OF STUDY

The master thesis goals to assess the differences in social behaviour and preferences among captive giraffes reflected by inter-individual distances and the type of interactions depended on different conditions as inside and inside enclosures and sex-age categories. Those two displays of giraffe social structure are key to compared differences of social behaviour in inside and in outside enclosure in the zoo.

8. STUDY HYPOTHESIS

H1: The individuals in the outside enclosure have longer inter-individual distances and fewer of interactions than in inside enclosure.

H2: I test whether the higher number of interactions per hour will be observed in the inside enclosure than in outside enclosure. Furthermore, I aim to describe the differences in type of interactions between different sex-age categories.

H3: The individuals of different sex-age categories have significant difference in number of interactions per hour between two different enclosures.

9. METHODOLOGY

9.1. STUDY SITE AND SUBJECTS

All observed individuals belong into species Northern giraffe, subspecies Nubian (*G. c. camelopardalis*). This species has been reported as Rothchild's giraffe until September 2016. All of individuals were born in captivity as well as their parents. In all observing groups were different sex-age categories which I determined according literature. Juveniles age (from birth to 1,5 years). Subadults (1,5 years to 4 years), no longer consistently accompany with their mothers but still smaller than adults. Adult (>4 years), onset of sexual maturity and adult size (Fennessy, 2004). At the conclusions of the study period, the finale number of measured individuals from all observation Zoo consisted 48 adults, 14 subadults, 17 juveniles. Before the behavioural observation was necessary study of each individual in the zoos. Giraffes were recognized by using individually unique spot patterns along their necks, anatomical abnormalities, age, sex, body size, shape of the horns, shape of the hooves (Gloneková et al., 2016a).

The study took place during 3 years from 2013 to 2015. Inside observations were conducted from January to March, outside measured were done from March to October. Observations were approved by head zoologists responsible for animals in each zoo. Data collection occurred daytime hours. The observation was doing in time range from 8 am to 5 pm. The best time is in range from 10 am to 4 pm because of a good activity of animals and they are not really disturbed by keepers. The time table was kept more leas in time. Most of the observations were made from visitor's area and from keeper's area when was necessary. Any observation did not influence the behaviour of the studied animals and observers did not alter the daily schedule of husbandry in the zoos. Data was collected by more observers. In case of my study I cooperated with one other student, who collected interactions mostly, I was focused just to inter-individual distances because of more accurate data. We were collecting data for interactions and inter-individual distances at the same time and date because of data analysis. My own observation took place in three zoos and the total number of observed hours by myself was 92 hours.. Rest of the data from other zoos I got from the other observer.

Before the study, we made a study plan and schedule with the exact number of hours on each sex-age category as female-female (FF), male-female (MF) and male-male (MM). Combination of all age categories create different combinations. Age classes were

recognized as adult-adult (AD/AD), adult-juvenile (AD/JUV), adult-subadult (AD/SUB), juvenile-adult (JUV/AD), juvenile-juvenile (JUV/JUV), juvenile-subadult (JUV/SUB), subadult-adult (SUB/AD), subadult-juvenile (SUB/JUV) and subadult-subadult (SUB/SUB). This distribution was used for inter-individual observation. For interactions we made 6 basic sex-age categories as adult female (ADF), adult male (ADM), subadult female (SUBF), subadult male (SUBM), juvenile female (JUF), juvenile male (JUM).

Study plan was 12 hours on each sex-age category that counts 72 hours in total from inside and 72 hours in total from outside enclosure. During the observation period became some changes in management such as change of place of some individual and move it out into different ZOO or change of timetable of daily activities. Therefor we had to modify our plan during data collecting and observed not exactly 12 hours on each category.

9.2. STUDY AREAS

The observations have been doing in the different zoos in EAZA around Czech Republic (Prague, Olomouc, Ostrava, Liberec, Dvur Kralove), Germany (Gelsenkirchen, Leiptzig, Berlin Tierpark) and Netherland (Arnhem). I described a management in zoos where I have done observations (Prague, Olomouc, Ostrava).

The animals in Olomouc zoo occupied a stable which was for most of the winter heated. Giraffes had possibility go into outside enclosure. During the summer time, they are in large grassy enclosure (Gloneková, 2016c). They were fed by forage *ad libitum* structured from hay or grass accompanied by branches for browsing. Concentrated feed stuff was provided such as grain fodder, fresh fruit, vegetables. Daily timetable of feeding was twice per day and consumed immediately. Access to water was *ad libitum* (Horová et al., 2015). Size of enclosure (150 m^2 inside, 360 m^2 outdore) (Gloneková, 2016d). The composition of herd in Olomouc zoo was 7 adult females, 1 juvenile male and female, 2 subadult female and 1 subadult male. List of individuals see the *Appendices 2*.

Prague zoo has at the time of observation in total 10 individuals. There were 6 adult females, one adult male, one juvenile male, one subadult male and female. All informations about individuals see the *Appendices 1*. Animals are breed in the high quality stable, enclosures and equipment. During the winter season the animals are keep in the temperate stable. In the warmer part of the year they spent most of the day in the

inside enclosure (Gloneková et al., 2016b). The feeding program in Prague ZOO is *ad libitum* with hay and branches. The limited part of feed stuff are supplements like granulated food, fruit and vegetable. During the main season from April-October fresh branches were provided and pasture allowed with green alfalfa feed. Size of enclosure is 400 m^2 inside; 2,2 ha inside (Gloneková, 2016d).

In Ostrava zoo are 5 individuals. Individuals within herd were one adult male, 3 adult females and 1 subadult female. List of individuals see the *Appendices 3*. Inside enclosure is divided in three parts. There are two small separate rooms for veterinary interventions and one for male during the night and common big room for all animals during the day. The size of the stable is 110 m^2 which means 22 m^2 per each. Diet in every season is complexly different. In the winter is main part of diet hey which is serving *ad libitum*. In the summer season is green forage, branches and pasture provided. Branches are very important part of diet but in case zoo is impossible to provide adequate amount as a main part of diet so there are some supplements of diet like granule mixture served in the morning and mash in the noon. In the evening keepers putting in the stable 2 kg of vegetable and 1 kg of fruit per each. In the later evening around 7 pm is putting last part of diet which is granule mixture. Another supplements are vitamins and minerals. Daily schedule is in fact same in every season. During the winter season is limited insides activities which means around 2 pm are animals putting inside. The emphasis is also to weather and outside temperature. According those conditions are activities scheduling.

Managements of zoos is not much different in timetable or in diet structure. All giraffes were kept in a stable during winter time, while they spent most of the summer warm days in the outside enclosure. They were fed ad libitum by hey and branches with limited supplements as granulated food, vegetable and fruit.

9.3. DATA COLLECTION

9.3.1. Interaction

For recording of interactions, we used the focal sampling method. We recorded all the interactions of the focal animal during the one observation hour. Collection was based on an action between animals, following recognition of activity and recording of involved animals. If there were more participated animals in one interaction we have recorded all of them. We made worksheet with columns and rows where we have put all necessary information for observation. For the data collection, we made a worksheet that involved date, place, observer, name of focal animal, name of measured animal and additionally in case of interactions contained time of start and end of observation, name of action and reaction of animals and determination of final interaction.

Analyse of interactions was classified by description of actions and reactions between animals, as a final value was defined final interaction. For the analysed were compared sex-age categories and type of interaction. Types of interactions was defined before the observation. There are three main categories of observed interactions (friendly, agonistic, maternal) see in *Appendices 4,5,6*. Based on the results during the data collection, which showed higher number of friendly interactions we have decided to create four more subcategories just in case of friendly interactions for better determination and orientation in the following analysis. Friendly interactions where subdivided into four categories 1,2,3,4 see in *Appendices 7*. For the objective results was necessary gain number of interactions per one hour. I used a simple calculation when I calculated the number of recorded interactions in total divided by total number of observed hours. There was necessary count observing hours per each sex-age category.

9.3.2. Inter-individual distances

Recording of inter-individual distances took place in 10 minute intervals within an hour. We measured the distance between the observer and the focal animal, after that the distance between the observer and all other individuals within the group one by one. We used the compass to get the angle between the measured animals. Inter-individual distance worksheet included, date and time of observation, name of observer, zoo, name of focal and measured animals, values of distances on focal animal and measured animal and angle between animals.

For data analysis, we used the trigonometric functions to count the final distance between animals [$a = \sqrt{b^2 + c^2 - 2bc.\cos\alpha}$]. First I calculated the final distance between animals by trigonometric function, when I used **cosine** of an angle is the ratio of the length of the adjacent side to the length of the hypotenuse. As a variable value for statistical analysis, we used average distances on each sex-age category.

9.4. DATA ANALYSIS

All data were performed in software STATISTICA 12. As the first step of my analysis, I used pivot tables to gain average values of inter-individual distances and interactions per each sex-age category. As statistical analysis was chosen nonparametric tests because data did not have a normal layout. At first, we used Kruskal-Wallis test to compare more independent variable samples (categories). For another analysis, we used pivot tables and Chi-Kvadrat which were applied to compared two set of categorical data and verify a calculation from pivot tables. As for last statistical analysis, we used General linear model (GLM) to test the influences on inter-individual distances. We tested the influence of sex-age category and different enclosures.

9.5. RESULTS

9.5.1. Inter-individual distances

In total I have recorded 5 608 different inter-individual distances between animals. The total amount measured hours was 58 hours from outside and 60 hours from inside enclosures. Inside measured value achieved an average distance 6,72 meters. A longest final distance was 29 meters between adult male-subadult female, lower final distance was 0 meters between more sex-age categories. Compare to this, an average outside distance was 27,80 meters. A longest distance in outside enclosure was 190 meters between adult male-subadult female and lower measured distance 0 meters between more categories as well.

The longest average inside distance was 8,44 meters between adult females, the shortest average distance was 4,12 meters between juvenile females. The longest average outside distance was 39 meters between adult male- subadult female, the shortest average distance was 5 meters between adult female-subadult female. There were different combinations between sex-age categories and final distance. All the results are in (Table 1., 2., 3).

Table 1. Data of number recorded distances from INSIDE and OUTSIDE, results in sex category female-female (FF)

Category FF	Number of final distances		Average of final distance (meter)		Minimal distance		Maximal distance	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
AD/AD	425	461	8,44	35,05	-	1	27	168
AD/SUB	85	1	7,72	5	-	5	25	5
SUB/AD	416	182	7,28	25,31	-	-	27	144
JUV/AD	325	209	5,44	31,76	-	1	15	88
SUB/SUB	42	-	5,26	-	1	-	10	-
SUB/JUV	28	20	4,60	10,3	1	-	12	21
AD/JUV	42	42	4,38	23,01	-	2	12	62
JUV/SUB	42	21	4,26	21,35	-	5	14	45
JUV/JUV	55	-	4,12	-	0,5	-	13	-

Table 2. Data from INSIDE and OUTSIDE results in sex category male-female (MF)

Category MF	Number of final distances		Average of final distance (meter)		Minimal distance		Maximal distance	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
AD/JUV	113	183	8,15	36,50	0	2	22	137
SUB/AD	313	231	7,52	39,09	1	1	29	190
AD/AD	106	140	6,98	7,01	0	1	18	29
SUB/JUV	63	111	6,96	25,06	0	1	25	158
AD/SUB	82	120	6,79	29,14	0	1,5	21	105
JUV/AD	289	231	6,71	29,52	0	1	26	102
JUV/SUB	75	70	6,00	17,58	0	2	23	85
SUB/SUB	161	21	5,49	12,66	0	1	19	28
JUV/JUV	138	154	4,28	20,48	1	1	10	102

Table 3. Data from INSIDE and OUTSIDE results in sex category male-male (MM)

Category MM	Number of final distances		Average of final distance (meter)		Minimal distance		Maximal distance	
	IN	OUT	IN	OUT	IN	OUT	IN	OUT
JUV/JUV	14	28	8,85	25,36	5	6	19	59
SUB/AD	14	37	7,5	20,05	1	1	16	54
JUV/AD	20	28	6,85	36,40	0	4	11	60
JUV/SUB	20	42	5,9	25,19	0	2	12	80
SUB/JUV	35	102	5,08	24,06	0	2	13	90
AD/AD	-	47	-	35,80	-	0	-	120
AD/JUV	-	148	-	22,40	-	1	-	145
AD/SUB	-	76	-	9,90	-	1	-	110
SUB/SUB	-	-	-	-	-	-	-	-

According my statistical analysis I reported a significant influence of variable values of final inter-individual distance. There was significant influence of sex-age category (F=25,03; N=15; p=0,000; Fig. 12.) and significant influence of variable value as different type of enclosures (F=4,99; N=8; p=0,000; Fig. 13).

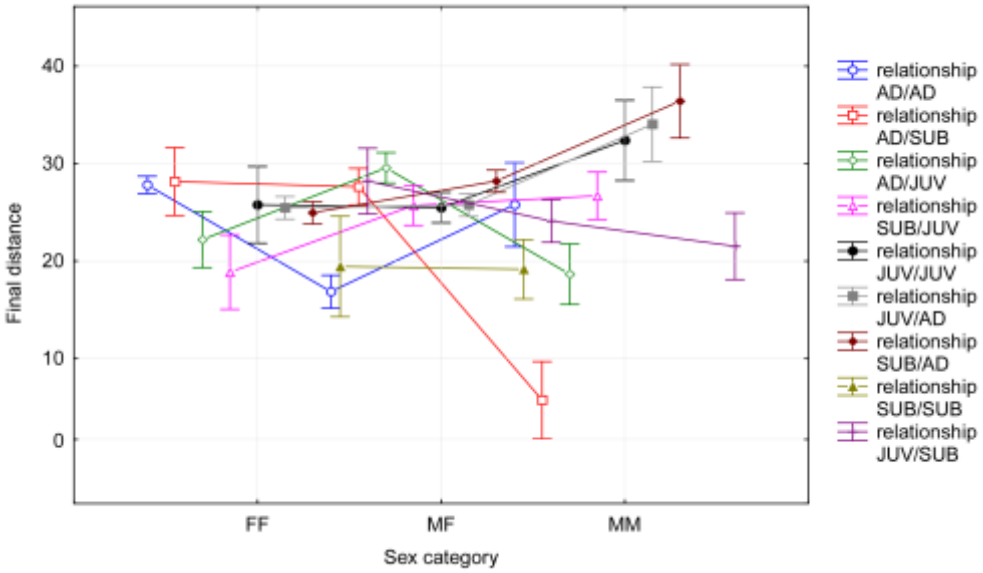

Figure 12. Influence on final distance by sex-age category

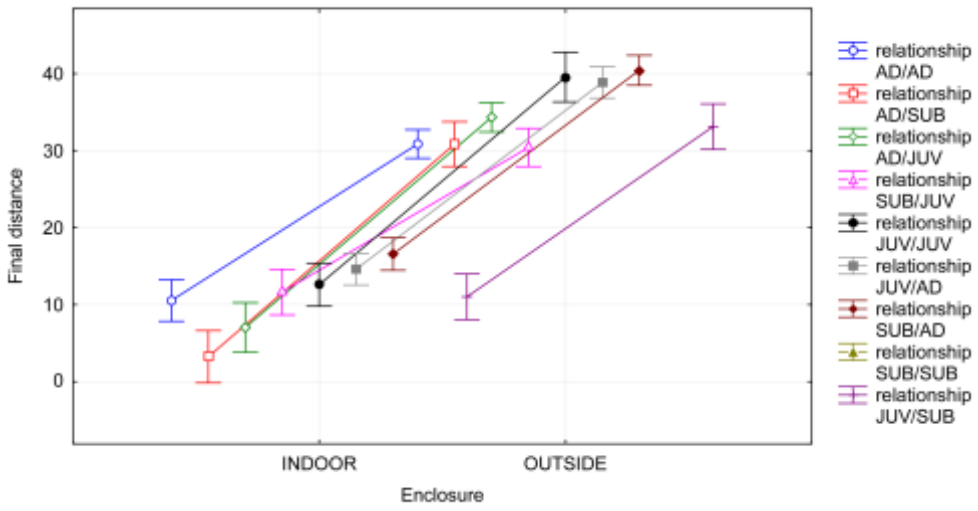

Figure 13. Significant influence on final-distance by different enclosures

9.5.2. Interaction

In total was measured 2 867 interactions among animals from inside and outside enclosures. I recorded 32 hours from outside enclosure and 59 hours from inside enclosure. The total amount from INSIDE enclosure of recorded interactions was 2 391, from that the number of agonistic interactions was 100, friendly interactions was 2 164, and maternal interactions was 127.

Number from OUTSIDE enclosure in total was 476 interactions, from that the amount of agonistic interactions was 44, friendly interactions was 407 and maternal was 20.

For the objective analysis, we calculated number of interaction per hour. As the most common interactions in inside were friendly interactions in number 22 per hour. Those interactions were between category adult female - adult female (ADF/ADF). Less common were friendly interactions within category adult male - adult male (ADM/ADM). In outside enclosure were also most common friendly interactions between adult female - subadult female (ADF/SUBF) in number 15 interaction per hour. A lowest number of interactions was same for two categories, adult male-adult male (ADM/ADM) and adult male - subadult female (SDM/SUBF). All the results for each created combination of sex-age category and type of interactions are in (Tables 5.,6.) in both enclosures.

Friendly interactions as most common had differences in each sub-category 1,2,3,4) in both enclosures. In (Table 4.) is overview with highest value of interactions per hours from each sub-category and name of sex-age category.

Table 4. Highest number of interactions per hour in each friendly sub-category

	Inside		*Outside*	
Sub-Category	Number per hour	Sex-age category	Number per hour	Sex-age category
1	20	ADF/ADF	12	ADF/SUBF
2	2	ADF/SUBF	2	ADF/SUBF
3	0,79	ADF/ADF	0,36	ADF/SUBF
4	0,57	ADF/SUBM	1,4	ADF/ADM

Table 5. Inside number of different interaction within each category per hour

INSIDE –number of interactions per hour

CATEGORY	AGONISTIC	FRIENDLY	MATERNAL	IN TOTAL
ADF/ADF	0,3	21,7	0,0	22,0
ADF/SUBF	0,3	15,1	1,2	16,5
ADF/SUBM	0,3	13,3	1,2	14,9
ADF/JUM	0,2	11,9	1,0	13,1
ADF/JUF	1,7	8,8	1,3	11,8
SUBF/SUBM	0,2	4,5	0,3	5,1
ADF/ADM	0,1	4,3	0,0	4,4
JUM/SUBM	0,6	3,2	0,3	4,2
JUF/JUM	0,2	2,8	0,0	3,0
JUM/SUBF	0,1	2,7	0,4	3,2
JUF/SUBM	0,0	2,2	0,0	2,3
SUBF/SUBF	0,2	1,9	0,0	2,1
ADM/SUBF	0,0	1,8	0,0	1,8
SUBM/SUBM	0,1	1,8	0,0	1,9
ADM/JUM	0,0	0,9	0,0	0,9
JUF/JUF	0,1	0,9	0,0	1,0
ADM/SUBM	0,2	0,7	0,0	0,9
SUBF/JUF	0,0	0,5	0,0	0,5
ADM/ADM	0,0	0,1	0,0	0,1

Table 6. Values of number of interaction per each category per hour in outside enclosure

OUTSIDE-number of interactions per hour

CATEGORY	AGONISTIC	FRIENDLY	MATERNAL	IN TOTAL
ADF/SUBF	0,1	14,5	0,8	15,4
ADF/ADF	0,1	8,7	0,0	8,9
JUF/JUM	0,3	8,6	0,0	9,0
SUBF/SUBM	0,9	5,6	0,3	6,8
ADF/JUM	0,1	5,5	1,3	6,8
ADF/ADM	0,9	4,9	0,0	6,1
JUM/SUBM	0,3	4,8	0,0	5,3
SUBM/SUBM	0,2	4,3	0,0	4,7
ADF/JUF	0,1	3,9	0,7	4,8
ADF/SUBM	0,2	3,3	0,6	4,3
JUM/JUM	0,2	3,2	0,0	3,4
SUBF/JUF	0,8	2,8	0,1	3,6
JUF/SUBM	0,0	2,5	0,0	2,5
ADM/SUBM	1,7	2,4	0,0	4,1
JUM/SUBF	0,1	2,4	0,3	2,8
SUBF/SUBF	0,0	1,0	0,0	1,0
ADM/JUF	0,0	0,5	0,0	0,5
ADM/JUM	0,1	0,5	0,0	0,6
ADM/SUBF	0,0	0,3	0,0	0,3
ADM/ADM	0,1	0,2	0,0	0,3

According to statistical analysis I reported nonsignificant influence of different enclosure on number of interactions per hour. There was a significant influence of sex-age categories on number of interactions (U= 32,99; N=20; p=0,0338; Fig 14.). As another variable value was tested an influence of sex-age category on number of different interactions per hour. Categories had nonsignificant influence on number of agonistic interactions. Only significant influence of sex-age categories was on friendly interactions (U=35; N=20; p=0,0201) and on maternal interactions (U=33; N=32,66; p=0,0367).

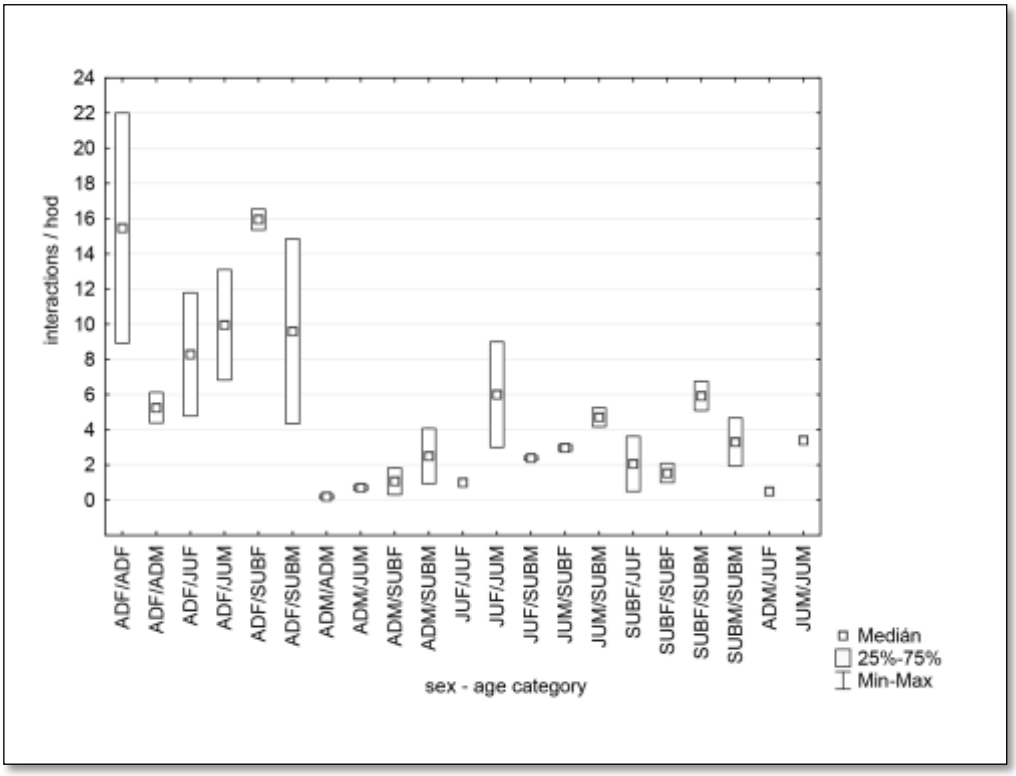

Figure 14. Significant influence of sex-age category on number of interactions per hour

10. DISCUSSION

This study investigated the social preferences among captive giraffe (*Giraffa camelopardalis*) based on inter-individual distances and interactions. Aim of my thesis was to describe the differences in social behaviour and preferences among captive giraffes reflected by inter-individual distances and the type of interactions depended on different conditions as inside and inside enclosures and sex-age categories. I have tested three hypothesis explaining giraffe social structure dependent on the differences between sex-age categories and environment. Measuring of data was done in two different enclosures, inside and outside and through different sex-age categories as juvenile, subadult and adult individuals.

I discuss my first hypothesis when I assume longer inter-individual distances in outside enclosure than in outside enclosure. In general, giraffe society and association patterns are characterized as loose and constantly shifting cohesion of non-bonded individuals that periodically coalesce into a herd as well as a structured community network that is presented as fission-fusion system (Bercovitch & Berry, 2013). The hypothesis was verified in my study by significant difference between inside and outside enclosures in final distance. This fact, of course depends on the conditions in captivity where animals prefer to keep inter-individual distance similar to those in the wild but they are influenced by space limitation and size of enclosure. In this case, the number of social encounters increases in inside (Horová et al., 2015). In the wild the members of a herd may be spread out as much as a kilometre between individuals. Animals usually move together and are engaged in the same activity at any one time but because of a long distance between individual they may not seem to belong together (EAZA, 2016).

Results from my study showed a shorter distance inside than in outside and highest number of recorded inter-individual distances between adult females in both types of enclosure. In the wild giraffe members within a group are usually closer when browsing the same tree, when a predator approaches or also when they occur in large members in open tree grassland. The recorded distance for rest of the activities such as stay, inter-individual distance is over 20 meters from each other (EAZA, 2016). Minimum dimension of size of enclosure according to EAZA (2016), should measure not less than 1500m^2, when shorter side should be a minimum of 25 meters in length.

Similar study of adult female behaviour in different captive conditions with activity budgets and social relationships showed that giraffe behaved similarly insides and insides (Bashaw, 2011). This case, when animals face to new environment and changes is called behavioural plasticity. The term plasticity may be referred to an ability of an individual to vary its response according to circumstances (Mills et al., 2010). Another study showed no significant differences in behaviour between males and females. There was detected significant differences in locomotor stereotypies between adult and sub adult giraffes. This result gave suggestion that this stereotype behaviour develop as an animal matures (Mason, 1991, Veasey et al., 1996)

My assumption about (ii) higher number of interactions in inside enclosure than in outside was confirmed. In total I recorded higher number of interactions in inside compared to outside enclosure. Giraffes social structure can be considered to association patterns that are not random in case of female giraffes who excise some social preferences, which are determined by shared space use and genetic relatedness (Fennessy, 2004; Shorrocks & Croft 2009; Bercovitch & Berry, 2010a; Bercovitch & Berry, 2013). There is a question about social hierarchy and agonistic interactions in inside enclosure with limited space. Study about aggression among female ungulates in captivity showed that in inside enclosure are limitations by size of stable, body size of animals, density of animals and food resources availability. Individuals in this study showed escalating aggression as the value of the resources increases. In case of body size, the correlation between size differences mean that the rate of aggression was not significant (Popp & Bunkfeldt-Popp, 1986). Other study on adult giraffe females researched forming of dominant hierarchy within the captive herd. However, giraffe have a significant linear hierarchy and confirmed a significant affect by age but not significant affect by sex. CBI was positively affected by time sped within herd but this factor influence females only not males (Horová et al., 2015). Giraffes in the wild show no obvious signs of territorial behaviour and bulls make no attempt to occupy and hold a piece of ground. The only position of the hierarchy has largely a function contents in the bachelor herd and among bulls during the mating peak (EAZA, 2016). Giraffes in captivity corresponds to different limited spaces such as stable or outside enclosure. Hierarchy formation might help captive giraffes to prevent the risk injury and save energy during frequent interactions (Horová et al.,2015; Wirtu et al., 2004; Kaufman, 1983).

As I have done in another part of my study I focused on the life how the social structure usually leads to (iii) different social preferences in sex-age categories. In the study, I have verified my hypothesis that there is the significant influence of sex-age categories on number of interactions. As the highest number and most frequent interactions were between adult females in both types of enclosure. This result leads me toward to hypothesis about very close relationships between adult females which was also confirmed by another study. Suggestions of different studies saying that bonds between cows and similar individuals are stronger than among other sex-age categories (Fennessy, 2004). Study of Bercovitch and Berry (2013) showed a result from the observed population where female–female dyads were significantly more likely to associate in a herd than were other sex combinations. As it was referred by Dagg (2014), that association pattern is probably caused by fact, that female usually stay within the group with another female's young without leaving for the long time. Study showed that on average an adult female met with another adult female in frequency 3 times during the long time (Dagg, 2014). Suggested study of Bercovitch and Berry (2013) said that females do not randomly associate with other females within their own home ranges. There were sister-sister pairs which were more likely to associate the same, as mothers with their daughters (Bercovitch & Berry, 2013). Giraffes were observed with up to 3 generation of maternal kin in wild (Bercovitch & Berry, 2010b). There is also another possible reason for giraffe female association which is allomaternal behaviour. This behaviour means when mother leaves calf in the safe environment of a *crèche* (nursery) group under protection of another adult female (Nakamichi et al., 2015). This behaviour is also known in case of other species, such as African elephants (*Laxodonta africana*) or lions (*Panthera leo*). Allomathering care involves allonursing which is also described in case of giraffe behaviour as an extreme case of communal care (Gloneková et al., 2016c). Nursery groups usually exist in case of strong social bonds between mothers. The conclusions of Nakamichi et al. (2015) study said, that captive giraffe mothers are very likely control the nursing-related interactions with their calves. As new scientific researchers concluded, giraffe (*Giraffa camelopardalis*) population have more complex structure which means that herd size varies in response to probable predator risk, food distribution and mating (Fennessy, 2004; Shorrocks & Croft 2009; Bercovitch & Berry, 2010a; Bercovitch & Berry, 2013).

Compared to those facts, I recorded higher number of interactions between an adult a male and adult female in outside enclosure because of in inside enclosure male is usually kept separated from the others because of reproductive management in zoo. I observed some types of friendly interactions which involved flehming or sniffing of genital. Those behaviour might show opportunity for mating or bull interest around peak rut. According to study Body et al., (2015) who has done study on reindeer (*Rangifer tarandus*), the possible reason for the variable group structure is according to the peak rut. There is an increase of average group size before the peak rut and decrease after the peak rut. The reason for mating opportunity to associate is also in case of the giraffe social structure. Usually a male and female are considered to occupy a separate social network. Male social cliques are called a bachelor herd that is described in other ungulates as well. Young males tend to be observed in larger groups of other males, in opposite to older males, they tend to be alone (VanderWaall et al., 2014). In general, it is well known that old giraffe bulls join the female group just during the mate peak (Dagg, 2014; Le Pendu et al, 2000).

The result from the study showed nonsignificant influence of the sex-age category on number of agonistic interactions. There was recorded an agonistic interaction between an adult female and juvenile female, subadult females-subadult male and adult female-adult male. Other observed categories with occur agonistic behaviour in this study were juvenile male-subadult males, adult male-subadult male. Dominant hierarchy was reported only in bulls in the wild (Horová et al., 2015). Young bulls are frequently seen in the company of other bulls and they often engaged in sparring. Older bulls are more solitary (Pratt & Anderson, 1982). Neck sparing has been reported in the wild but it is not excluded between females but in lower numbers. Juvenile were also observed neck sparring with all age categories (Fennessy, 2004). In case of juvenile, play behaviour is most likely. Agonistic behaviour in Fennessy (2004) study was rare, but significant stimuli for animals are people (tourist, communal farmers and researcher), other giraffes, predators.

I recorded also other sex-age preferences between adult female and juvenile or subadult individuals. This relationship has been occurred in my study mostly in inside enclosure than in outside enclosure. This relationship usually occured in case mother-offspring relationship. This bond mother-offspring usually disappear early when a new sibling is born but there is different time of duration from different authors (Fennessy,

2004). Study of captive giraffes exhibited associations when of adult females were most affiliative with their subadult daughter (Bashaw et al., 2007) and a protest of adult female response to the social separation (Tarou et al., 2000). This type of relationship leads to different group association which seems to be as weak compared to bovid followers or hiders as it was already described (Ralls et al., 1986). I recorded also frequently friendly interactions per hour and close inter-individual distance between juveniles and subadults. In case of young individuals there could be reason for association because of creating of nursery groups where animals sped a most of the time together.

This study should present the distribution of interactions between different sex-age categories and confirm those social preferences in different captive enclosures. Differences in number of inter-individual distances and interactions should refer about variable values which can influence frequency of manners. Those two displays are important in animal society and behaviour.

I believed that my study help to understand social behaviour and structure of giraffes and support other future projects and studies to gain deeper knowledges about this problematic. I would like to suggest some topic for other study such as….

11. CONCLUSIONS

In the thesis, I summarized the information from available scientific literature which were focused on giraffe social structure and behaviour. Based on my aim when I described the differences in social behaviour and preferences among captive giraffes reflected by inter-individual distances and the type of interactions depended on different conditions as inside and inside enclosures and sex-age categories I found out, different distances between inside and outside enclosure and significant differences between sex-age category and its preferences. Rates of social interactions were affected by sex-age category with significant associations. Although the relationship among giraffes are described as loose and subtle. I concluded frequent social preferences between adult females which were reflected by friendly interactions. There were less frequent preferences between different peers as adult female and young individuals as juveniles or subadults which were reflected by friendly or maternal interactions. Social preferences between adult female and adult male were also reflected by friendly interactions which involved some types of sexual behaviour such as flehming or sniffing of genitalia. The rank of an individuals was stable during observation time. I concluded differences between inside and outside enclosures which show a certain behavioural plasticity of giraffe. They keep the long inter-individual distances from each other in the wild so this leads to fact if they have same possibility in captivity they behave similarly. In my study, I registered differences between sex-age categories which corresponding with the social system in the wild.

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13. LIST OF APPENDICES

The Appendices 1: The list of observed animals in Prague zoo

The Appendices 2: The list of observed animals in Olomouc zoo

The Appendices 3: The list of observed animals in Ostrava zoo

The Appendices 4: The list of the friendly interactions

The Appendices 5: The list of the agonistic interactions

The Appendices 6: The list of the maternal interactions

The Appendices 7: The list of the sub-categories of friendly interactions

The Appendices 1: The list of observed animals from Prague zoo

Date of birth *Place of birth*	*Name*	*Sex*	*Category*
06.10.1995	Eliska	F	AD
30.10.2007	Faara	F	AD
06.01.2003	Diana	F	AD
08.03.2009	Gabina	F	AD
02.02.2014	Hynek	M	JUV
09.10.2013	Justyna	F	SUB
13.01.1993	Kleopatra	F	AD
27.06.1997	Nora	F	AD
09.10.2014	Roman	M	JUV

The Appendices 2: The list of observed animals from Olomouc zoo

Date of birth *Place of birth*	*Name*	*Sex*	*Category*
14.05.2000	Zaira	F	AD
26.02.2010	Zainabu	F	AD
19.05.2008	Natasha	F	AD
17.01.2010	Kayla	F	AD
15.12.2013	Zwena	F	SUB
22.03.2014	Zuri	M	SUB
11.04.2014	Nuru	M	JUV
11.04.2014	Kamilly	F	JUV
01.02.2011	Abena	F	AD
06.04.2009	Paula	F	AD
02.05.2008	Suzi	F	AD

The Appendices 3: The list of observed animals from Ostrava zoo

Date of birth *Place of birth*	*Name*	*Sex*	*Category*
21.09.1991	Kabu	M	AD
16.05.2003	Orionka	F	AD
01.05.2012	Radost	F	SUB
25.07.1992	Crantina	F	AD
09.03.1991	Bentina	F	AD

The Appendices 4: The list of the friendly interactions

Action	*Definition*	*Reaction*
Eating together	Two or more giraffes are eating from the same tree. One giraffe join to other	Negative reaction towards other giraffe, no leaving, continue with feeding
Walking together	Two or more giraffes walk side by side. One of them walk away.	Next giraffe join and following
Standing together	Two or more giraffes stay side by side (rumination and watching) Stop at the same time or one come closer to other	Negative reaction, do not leave
Unrequited Nosing	One giraffe nossing second	The nosing giraffe does not have a negative reaction, do not leave. Do not nosing return back.
Unrequited Licking	One giraffe licks second	The licking giraffe does not have a negative reaction, do not leave. Do not licking return back.
Unrequited Rubbing	One giraffe rubbing second	The rubbing giraffe does not have a negative reaction, do not leave. Do not rubbing return back.
Reciprocated Nosing	Two giraffes nosing each other	Giraffe returns contact back
Reciprocated Licking	Two giraffes licking each other	Giraffe returns contact back
Reciprocated Rubbing	Two giraffes rubbing each other	Giraffe returns contact back

Sniffing genitalia	Sniffing of genitalia (male to female, female to male, male to male, female to female)	It is not clear (urinating, leaving, standing)
Flehmening	Testing of urine (usually male to female)	It is not clear

The Appendices 5: The list of agonistic interactions

Action	*Definition*	*Reaction*
Avoidance	One giraffe avoids other (giraffe come close to other)	Second giraffe leave
Hitting	One giraffe hit other	Second giraffe does not react
		Second giraffe does not leave
Pocking	One giraffe pock other	Second giraffe does not leave
		Second giraffe does not react
Kicking	One giraffe kick other	Second giraffe does not leave
		Second giraffe does not react
Chasing	One giraffe chasing other	Second giraffe does not leave
		Second giraffe does not react
Threat	This is different type of behaviour which is not	Second giraffe does not leave

	described in the previous category. Posture or….	Second giraffe does not react
Necking matches	Fighting with necks. Just in case of males	

The Appendices 6: The list of maternal interactions

Action	*Definition*	*Reaction*
Nursing bout	Nursing more than 5 seconds	This is nursing
Nursing attempt	Trying to nurse or nursing shorter time than 5 seconds	Female usually rejected calf
Following	Calf follow female, female leaving	Calf has detected leaving mother and follow her
Other contact	Non-defined interactions	Female does not react

The Appendices 7: The list of sub-categories of friendly interactions

CATEGORY	*TYPES OF BEHAVIOUR*
1. neutral actions/interactions	Eating together, rumination, resting, standing together, arrival, lying, drinking, without any reaction, walking
2. unrequited interactions	Rubbing, licking, sniffing
3. reciprocated interactions	Licking, sniffing, rubbing
4. sexual interactions	Sniffing of genitalia, flehming