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Reproductive behaviour and non-vocal communication in captive guanacos (*Lama quanicoe*)

(Master thesis)

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Declaration

I hereby declare that I wrote my diploma thesis ‘‘Reproductive behaviour and non-vocal communication in captive guanacos (*Lama quanicoe*)’’ myself and that I have used only sources cited in text and list of references. I agree that my work will be accessible for future studying purposes in the library of CULS.

Prague, 18th April 2014 .....

Bc. Tereza Hartlová

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Abstrakt

Cílem této práce bylo popsat a analyzovat chování související s nevokální komunikací a značkováním a přeznačkováním na záchodcích u lam guanako chovaných v zajetí. Hodnotila jsem vliv příbuznosti, věku, postavení v hierarchii, pohlaví, způsobu značkování (močení, kálení), očichávání před a po značkování, velikosti záchodku, vzdálenosti jedince od stáda na značkování a přeznačkování po jiném jedinci. Data byla získána přímým pozorováním 15 guanak na farmě Školního zemědělského podniku ČZU v Lánech a 6 guanak v Zoologické zahradě hlavního města Praha v celkové délce 134 hodin. Hierarchické uspořádání u obou stád bylo hodnoceno na základě vzájemných agonistických interakcí mezi jedinci pomocí Clutton - Brockova dominančního indexu. Pravděpodobnost, že jedinci budou přeznačkovávat, byla vyšší u jedinců postavených výše v hierarchii, mladších jedinců, kteří přeznačkovali starší jedince a u mláďat přeznačkovávajících po matkách. Zároveň byla potvrzena vyšší pravděpodobnost přeznačkování jedinců na konkrétním záchodku (marking fidelity). To souviselo i s tím, že na větších záchodcích guanaka přeznačkovávali více než na menších a to jak v hierarchii výše, tak i níže postavené. Mladší jedinci však přeznačkovávali více na menších záchodcích. Na pravděpodobnost přeznačkování neměl vliv způsob přeznačkovávání (močení, kálení) ani očichávání místa před přeznačkováním ani místa chovu (farma, zoo). Nebylo potvrzeno, že by dospělý samec přeznačkovával více, než značkoval. Výsledky studie o značkovacím chování mohou sloužit k pochopení sociálního systému lam guanako v souvislosti s teritoriálním chováním a směřováním agresivních interakcí ze strany dospělého samce.

Klíčová slova: guanako, olfaktorická komunikace, značkovací chování

Abstract

The aim of this thesis was to describe and analyse behaviour linking non– vocal communication and scent marking in captive llama guanaco. I investigated influence of kinship, age, position in hierarchy, sex, type of marking (urination, dropping faeces), shiffing before and after, size of latrine, distance from the heard on marking and marking after another animal. Daty were collected by direct observation of 15 guanacos at Czech University of Life Sciences Farm Estate at Lány and 6 guanacos in Prague Zoological Garden in total length 134 hours. Dominance order was evaluated in both herds separately based on agonistic win - loss interactions using Clutton - Brocks index of dominance. Probability of marking after was higher in animals having higher position in hierarchy, younger animals marking after older and calves marking after its mothers. Marking fidelity of individuals on concrete latrine was found which was observed on latrines of bigger diameter without association if animal marks after dominant or submissive individual. No influence of type of marking, sniffing before or place of breeding (farm, zoo) was detected. I have not found any support for male marking with higher probability after another animal from herd in comparison to just marking. Findings of the study may help to understand social system of guanacos in connection of territorial behaviour and direction of aggressive interaction of the male.

Keywords: guanaco, olfactory communication, marking behaviour

Content

List of tables

List of graphs

List of pictures

List of annexes

1. INTRODUCTION

Communication is very important. It is a cooperative interaction between signaller and receiver (Searcy and Nowicki, 2005). For guanacos is very important non – vocal communication (Hoffman, 2005) like ear signalling, spitting, tail signalling, body posture, tactile and scent communication. Scent communication gives information about territorial boundaries, reproductive state or position in hierarchy (Hoffman and Kaehler, 1993). Lama guanaco is very interesting South American camelid. They have very strict hierarchy system and males are very aggressive. It's still a wild species, and therefore is not yet fully adapted and so well explored for farming. Females are induced ovulators. From these reasons is very important study their behaviour for better management of breed. Induced ovulation makes it possible synchronization in breed similarly as in the wild. It is only in case when the males are with females during the period when we want to mate. In breed where is male with the females throughout the year the mating period is relatively long. In this case is mating in this period random, or in the postpartum period. This breeding method is more complicated and more demanding in male aggression against pregnant females and yearlings.

I was interested, how are hierarchically organized quanacos captive herds and the method of non - vocal communication. My interest in this matter raised by the facts that in the Czech Republic are not too much individuals of this species. More frequent are other South American camelids like alpaca, *Lama glama* and in Zoos *Vicugna*. This work could help current and future breeders of this species with a closer understanding of their behavior. In addition, this topic has been described yet in other species, but about guanacos a study is still missing. Therefore, in the following pages I will try to clarify their behavior.

2. LITERATURE REVIEW

2.1. *Lama quanicoe*

2.1.1. History of Camelidae

The fossil record indicates that the right ancestor of the family Camelidae originated in the Great Plains of western North America. It was 9 – 11 million years ago and this ancestor eventually became extinct there during the Ice Age. About 3 million years ago toward the end of the Tertiary period, one branch of this family, *Camelus*, went across land bridges at the Bering Straits into Eurasia, to give rise to the present day camels. The other branch reached South America much later in the Ice Age (Pleistocene Epoch) and gave rise there to the present day Lama species about 2 million years ago (Brown, 2000).

2.1.2. Description of Camelidae

Camelidae belong to the order Artiodactyla (ungulates who having an even number of digits) (Smith *et al.*, 1994). They are separated from ruminants into the suborder Tylopoda (pad or callus on the foot), because they differ in stomach morphology, absence of horns or antlers and the replacement of hooves with callous pads ending in claws (San Martin and Bryant, 1989). Camelidae has long neck, small head and on each foot 2 toes (Smith *et al.*, 1994). Family Camelidae consists of three generas. The Old World Genus or *Camelus* includes the Arabian *Camelus dromedarius* (1 - humped camel) and the *Camelus bactrianus* (2 - humped camel) (Brown, 2000). These camels are indigenous to the arid and semi arid areas extending from Central Asia to Manchuria (Smith *et al.*, 1994). The two New World Generas *Lama* and *Vicugna*, which comprises the domesticated *Vicugna pacos* (Alcock, 2001), raised primarily for wool production in two breeds, Huacaya and Suri for meat production for local people (San Martin and Bryant, 1989), and *Lama glama*, as well as two wild species *Vicugna vicugna* and *Lama guanicoe* (Taylor *et al.*, 1968). All four species have a powder-puff tail, long supple neck, thin legs, oversized doelike eyes and long eyelashes (Hoffman and Kaehler, 1993). The all members of the Camelidae family have same number of chromosomes, 37 pairs. All four species we can interbreed (Smith *et al.*, 1994). The most common hybrid, the huarizo, results from male llama and female alpaca for the fleece, the reverse cross has no economic value. Cross male vicuna and female alpaca produce pacovicuna, it is good for fleece too (Brown, 2000). The resulting hybrids are fertile (Fernández-Baca, 1993).

The one from wild species are Guanacos. They are uniformly marked with brown or cinnamon coats. They have symmetrical white undersides and dark faces (Hoffman and Kaehler, 1993). Guanacos have two kinds of coat, undercoat (crimped fibers) and coat-guard (Martinez *et al.*, 1997). Guanacos stand between 110 and 120 cm at the shoulder. Their weight is about 90 – 130 kg (Eisenberg and Redford, 2000). Males are larger than females and longevity of guanacos is 15 – 20 years in the wild (Zoo San Diego, 2009).

The all llamas are primarily used as very good pack animals but they are also used for their wool and pelts, and their dung for fuel and fertilizer (Brown, 2000). Their skin is used for bed covers, coats and too for shoes (San Martin and Bryant, 1989). They are also used for meat. Useful is its ability to adapt to high altitudes and survive well on poor pastures (Brown, 2000).

Ruminant herbivores, such as guanaco, are unique in their ability to derive nutrients from low quality forages. Camelids are not true ruminants as result of some anatomic and physiologic differences in digestive tract compared to ruminant species. The most important difference is anatomic; camelids have only three distinct compartments of stomach associated with the foregut and stomach as compared to the four compartment ruminant organ as we know for example in cattle (Van Saun, 2006). The upper lip of guanacos is divided by a middle groove and the lower lip is relatively large (San Martin and Bryant, 1989).

Water plays important roles in their body temperature and metabolic reactions. Water consumption is very critical for lactating animals. The water availability depends on the consumption of feed of dry matter. Fresh, clean, high quality water should be available free choice at all times in captivity. Water intake is between 3 and 8 % of body weight, in hot weather between 10 and 15 % (Van Saun, 2006). No specific deficiencies in minerals have been reported (San Martin and Bryant, 1989).

2.1.3. Distribution

Guanaco is the best adapted of all South American camelids, found in the greatest diversity of habitats with an ability to survive where other camelids would perish. On the world are four subspecies of *Lama quanicoe* (Hoffman, 2005). The first, *Lama guaunicoe guanicoe* in Patagonia, Tierra del Fuego and Argentina, the second, *L.g. huanacus* on the western slope of the Chilean Andes, the third, *L.g. cacsilensis* found from the Pacific coast

to high altitude along the western slope of the Andes in Peru and northern Chile and the fourth, *L.g. voglii* on the eastern slope of the Argentine Andes, in southeastern Bolivia and northwestern Paraguay (Wheeler, 2012). These subspecies are distribution in South America. There are an estimated 550,000 animals. The subspecies from Peru is considered endangered consisting of about 3,000 animals (Hoffman, 2005). Although guanaco numbers have diminished significantly during last century because of overhunting and grazing conflicts with a sheep-based society (Franklin and Johnson, 1994). The guanaco inhabits environments where are characterized by highly seasonal weather, with snow cover, dry winters, cold to freezing temperatures, moderate to high winds and precipitation which combine to produce high evapo - transpiration and dry conditions and lead to low primary productivity. The altitude, which guanacos occupy, is within the range from sea level to over 4,000 m (Eisenberg and Redford, 2000). Historically it was the dominant, wild mammalian herbivore throughout most of the arid lands of the southern cone of the South American continent (Franklin and Johnson, 1994). They live mostly in high altitude environments of the Andean highlands in treeless pastoral zones called antiplano (Brown, 2000). There are Bunchgrasses of the genera *Stipa*, *Festuca* and *Calamagrostis* the dominant vegetations (San Martin and Bryant, 1989).

2.2. Reproduction of camelids

2.2.1. Puberty

Male will begin to show sexual interest in females at 1 year of age or less (Smith *et al.*, 1994), but are incapable of mating, because the penis adheres to the prepuce from the birth. Penis is not completely liberated until puberty is reached. At 3 years, males are without penile adhesions (Brown, 2000).

Females, after reaching puberty at about 1 year age, do not show a definite pattern of estrous cycles. Common practice on farms is postponement pregnancy after two years of age in females (Fernández-Baca, 1993).

2.2.2. Reproductive season

There are conflicting reports on this theme (Brown, 2000). In their natural habitat in the highlands of southern Peru they are reproduce from December to March, the warmest months of the year, when rainfall is sufficient and green forage abundant. Same it is in farms in their original region (South America), where males and females are together all

year, on farms around the world, where are together all year is reproduction in different part of the year (Sumar, 1996).

Unlike most domestic species, female camelids are not polyestrous. They may have very long oestrus, but ovulation comes after copulation (Brown, 2000). Guanaco, such as all genus *Lama sp.*, is an induced ovulator, similar to the rabbit or cat (Wilson and Chapman, 1985). Follicles mature throughout the year and are capable of ovulation. Thus lamoids are considered to be nonseasonal, have ovarian activity throughout the year and may breed and give birth at any time of year (Smith *et al.*, 1994). Ovulation occurs about 26 h after copulation (Fernández-Baca, 1993). Females are uniparous (Parraguez *et al.*, 1997). Only one egg is shed at each ovulation (Brown, 2000) and the development of a *corpus luteum* in a further 1-4 days (Pollard *et al.*, 1994)**.** Breeding season they show continuous oestrus interrupted by short periods of non-receptivity. Copulation takes place in a recumbent position and may last from 10 to 50 min (Fernández-Baca, 1993). To recumbent position (prone position) go receptive females. It is position for copulation, after a period of pursuit by a male, or may approach a male that is copulating with another female and adopt the prone position (Sumar, 1996).

2.2.3. Mating behaviour

Guanacos exhibit a resource-defense-polygyny mating system (Sarno *et al.*, 2003). The male shows active and sometimes aggressive attitude during mating in contrast to the passive and submissive behaviour of the female (Fernández-Baca, 1993). In captivity, from male is expected to detect and copulate with receptive females only (Lichtenwalner *et al.*, 1998). Non-receptive females strongly reject the male by spitting, screaming, kicking and running away. Mating behaviour in camelids can be divided into two phases, courting and copulatory phase. In courting phase, the male chases the female with various repertoires (Fernández-Baca, 1993). Male may choose between receptive and nonreceptive females by indirect way, visual means, because receptive females lie down in the mating position after few minutes in the presence of a male. Direct way, means olfactory way, is when males appear to smell the female perineal region and perform the flehmen response (Lichtenwalner *et al.*, 1998). Flehmen and sniffing of dung piles and urine is important for males to recognize female reproductive status (Hoffman and Kaehler, 1993). When the females are in oestrus they adopt a mating prone position in the presence of a male, pregnant females don’t adopt this position (Alarcon *et al.*, 1990). Some receptive females

may display mounting behaviour with other females of the herd (Sumar, 1996). Length of courtship and pursuit of a female may be influenced by the level of libido of individual males. When males have high libido may last pursuit female for up to 10 min before the males give up (Brown, 2000). Once the female is in the recumbent position the male enters a half-sitting mounting position at her rear and adjusts his pelvis to facilitate intromission. During intromission the male moves his pelvis forwards and backwards (Bogle, 2009). In this position, the head of the male is above and slightly behind that of the female, his elbows hold her at the shoulders and his forefeet are on the ground. Camelidae are the only ungulates to mate in this interesting recumbent position (Brown, 2000). Ejaculation apparently begins early in copulation (Lichtenwalner *et al.*, 1996). During copulation, the male constantly vocalises, making a ‘‘guttural’’ sound called ‘‘orgling’’ whilst the female remains relatively quiet. It has been suggested that the ‘‘orgling’’ sounds of the male contribute to the neural response in the hypothalamus of the female to release gonadotrophin releasing hormone (Brown, 2000). It is described that stimulation by the penis during copulation initiates the preovulatory cascade by activating sensory nerves in the vagina and cervix (Bogle, 2009). Other receptive females may lie down beside the mating pair and females in oestrus can also adopt mounting behaviour, though the latter does not provide sufficient stimulus to induce ovulation (Brown, 2000). Trigger for eliciting the preovulatory luteinizing hormone surge in camelids has been attributed primarily to a neuroendocrine response to the physical stimulation of genitalia during copulation or the physical stimulation, such as olfactory, auditory or visual factors (Tanco *et al.*, 2011). When males and females are run together, it has been observed that some females can be mated several times in 1 day for several days, while another may only be mated once (Brown, 2000). In most cases has female head faced away from the male, ears were half forward or back and tail and head tended to be held down (Pollard *et al.*, 1994).

Picture 1: Mating of guanacos

(http://www.piersallison.co.uk/images/patagonia/mating.jpg, 2014)

2.2.4. Pregnancy

The length of gestation in llamas ranges from 345 - 360 days (Ojasti, 1996). It is approximately 11.5 months (Filipczyková, 2009). Implantation is thought to take place about 20 - 22 days after breeding (Fernández-Baca, 1993). Embryos originating in the right side of uterus but later migrate to the left horn for attachment. The reason for this migration, which is unique for Camelidae, is unknown. This is maybe for reduction of twin pregnancies to singles, as differential luteolytic effect of uteral horns (Sumar, 1996). Multiple ovulations occur in about 10 % of cases. As indicator of pregnancy are using behavioural response of the females in the presence of males (Fernández-Baca, 1993), rectal palpation reliable after 45 - 50 days, intra-rectal ultrasound scanning successfully between 19 and 28 days after mating (Brown, 2000), circulating progesterone levels (Fernández-Baca, 1993) and trans-abdominal scanning can be a reliable method when used later in pregnancy, after 75 - 80 days (Brown, 2000). The use of ultrasonography techniques will help to improve the reproductive efficiency of camelid livestock (Parraguez *et al.*, 1997). Early embryo mortality appears to be one of the main factors leading to low reproductive efficiency (Fernández-Baca, 1993). In captivity are minimal birthing problems (Hoffman, 2005).

2.2.5. Parturition

Females close to giving birth have some physical and behavioral characteristics. Near-term pregnant females have enlarged abdomen. Several days before birth, the lower hindquarter of the abdomen became more distended, the fetus dropped in. Few days before birth vulva change shape and exactly before birth the female go away from the herd (Franklin and Johnson, 1994). Parturition is generally quick and easy. Usually occurs between 07:00 and 13:00 (Sumar, 1996), the warmest time of the day in the natural habitat (Fernández-Baca, 1993), when even in the summer, freezing temperatures are common at altitude. Camelids are being able to delay birth for hours to days to avoid giving birth during night or cold days (Sumar, 1996). Female reproductive success depends on the survival of their calves, which is related with birth weight and growth (Vila and Cassini, 1994). New World camelids generally give birth in the standing position, the whole process of parturition takes about 2 h; distocia and placental retention are uncommon (Fernández-Baca, 1993). Parturition has three stages. Stage one includes segregation from the herd, restleness, increased humming, increased frequency of urination and decreasing of appetite. During second stage female lies down and stand up frequently. Fetus is delivering. The young are on their own to dry off, stand up and seek out the mother to nuzzle, when it guides by female. Maternal care is spitting and protection young against strangers. Mothers make also a low volume humming at newborn lama, young make the same noise. Last stage is expulsing of placenta (Smith *et al.*, 1994). The placenta of camelids is simple diffuse epitheliochorial (Fernández-Baca, 1993) in that it does not have raised points of attachments like domestic ruminants, for example cattle. Camelids are unique in that there is an extra membrane which is derived from the epidermis of the fetus that covers the entire fetal body and is attached at the mucocutaneous junctions, function is not precisely known, but it may play a role in facilitating delivery of the conceptus by lubricating the fetus (Brown, 2000). Guanaco neonates, called chulengos, are born in open habitat and are classic followers, attaining mobility soon after birth and rarely separating from their mother during the postpartum period (Franklin and Johnson, 1994). Mating of females is described within 15 - 20 days after giving birth to obtain good fertility and one offspring per year (Sumar, 1996). The young stay with mothers for one year (Franklin, 1983).

2.2.6. Suckling

Lactation is the most energetically expensive behaviour of mammals and lactating females may pay a fitness cost in terms of subsequent survival and reproductive success (Zapata *et al.*, 2009). Milk production will normally increase over the first few days after birth and chulengo must obtain passive immunity through ingesting colostrum in the milk (Brown, 2000). Suckling frequency decreased with age. Also the young spent more time grazing and less time suckling as it grew older. *Lama sp.* was performed in the reverse parallel suckling posture commonly seen in ungulates. Even if most of suckles were directed toward the mother, suckling was occasionally tolerated by other lactating females (Prescott, 1981). Weaning usually takes place when young are about 7 - 9 months of age (Brown, 2000).

2.3. Social organisation of guanacos

Social structure is important for cooperation in attaining resources or defending either resources against conspecifics or themselves against predators. Another or care for one another. The social structure is often a key determinant of population biology, influencing fitness, gene flows and spatial pattern and scale (Whitehead, 2008).

Guanaco herds are usually well-defined units (Hoffman and Kaehler, 1993). During breeding season, three basic social units can be found: territorial family harems (Correa *et al.*, 2013) which are very stable in time and space (Vila and Roig, 1992). These are consist of one male, females and offspring to one year, non-reproductive male or fiale groups, and solitary males (Correa *et al.*, 2013). Last group is band of adult females with young, move between male territories from middle to late mating season and big herds during particularly snowy winters with a drastic reduction of food availability (González *et al.*, 2006).

Guanaco is territorial animal and it is connected with its area. Availability of resources, size or location of the territory in this area often reflects strength of the individual (Filipczyková, 2009). Guanacos have less defined territorial boundaries. Territories are crossing over (Hoffman and Kaehler, 1993). Dams and offspring are subjected to enforced separation when the juveniles are aged 6 - 8 months. As adult females are capable of becoming pregnant within 2 weeks of parturition and gestation lasts about 11 months, enforced weaning relieves the pregnant female of not only the nutritional

drain of suckling but also competition for pasture from young grazing animals, against inbreeding (Pollard *et al.*, 1993), competition for mates, competition for resources (Sarno *et al.*, 2003). Territorial male expels yearlings once a year, before time of mating (Hoffman and Kaehler, 1993). Aggression from territorial males is overt, intense, and potentially injurious to juveniles, and includes spitting, biting, chasing and attempting to suffocate juveniles (Sarno *et al.*, 2003).

2.4. Communication - evolution and function in guanacos

Communication is defined as the transfer of information from a signaller to a receiver (Dugatkin, 2008). Guanacos communicate by body language as visual communication and locomotion display, by vocalization, tactile and scent communication. These types of communication are important for example for territorial males acting as a gatekeeper to predator and lesser males, for females to create their own internal linear hierarchies too (Hoffman, 2005). Understanding of the evolution of communication systems requires information about origins of the signal and the pattern of changes that took place in signallers and receivers and information about the causal processes that made these change occur (Alcock, 2001).

Communications serve for example for to maintain and protect the family group and safeguard territory (Hoffman and Kaehler, 1993). Guanacos mark their territory with latrines. This behaviour has been described scientifically partly in free-ranging camelids but not sufficiently in captive animals at all (Filipczyková, 2009).

2.5. Visual display of reproductive behaviour and communication

2.5.1. Visual display of communication

Communication for these South American camelids includes ear signalling, spitting, chest ramming, tail pointing, submissive crouching, body posturing and locomotion displays. For spitting is used regurgitated food from its stomach. Spitting can be mild (mouth of grass spit) or severe (content of stomach) (Hoffman and Kaehler, 1993). When female threatened to spit, she orientated and elevated her head towards the male, with ears held back (Pollard *et al.*, 1995).

Ear positions - Changes in ear positions by only a few degrees can telegraph alertness, contentment or displeasure (Hoffman and Kaehler, 1993). An aroused animal, showing an “alert stance”, rotates its ears forward toward whatever has piqued curiosity (Hoffman, 2005). A relaxed animal often holds its ears straight up or slightly back (Hoffman and Kaehler, 1993). Ears forward means alarm signal and in horizontal position is mark of aggression plus lift of chin (Zoo San Diego, 2009). The individual with lower ear position was invariably the dominant individual of an interacting pair (Cavalcanti and Knowlton, 1998). A threatening animal uses a continuum of ear position for example for keep overanxious males under control and warn a chulengo to take its playfulness elsewhere (Hoffman and Kaehler, 1993).

Tail positions - Normal position is indicated by straightening down the tail (Zoo San Diego, 2009). Mild aggression or alertness is indicated by the tail being slightly elevated, but below horizontal. As the degree of agitation escalates, the tail may be carried horizontal, curled above horizontal or vertical. Basically, the higher the tail is the higher the level of aggression. Submissiveness in the guanaco is indicated by curving the tail forward over the back (Fowler, 2010).

Neck and body positions – Whole body posture is especially important to mature males that spend much of their time advertising the boundaries of their territory. Yearlings are often using ‘‘submissive crouch’’. This posture consists of lowering the head, curving the neck toward the ground, flipping the tail onto the back and crouching slightly. It is also used within the family group when yearlings pass by the territorial male, who may soon expel them (Hoffman and Kaehler, 1993).

For each situation is combination of positions of ears, tail, neck, head, body posture and vocalizing. These all steer the herd´s progress through the day. When strange male approaches the territorial male stands rigidly. His tail is held high, neck bent in “s” shape, ears pinned back and nose tilted skyward, in what is termed a “broadside display” (Hoffman, 2005). When territorial male attack other male, the most common response is chase, but a tenacious challenger can expect to be spit upon, chestrammed, bitten by canine teeth and subjected to exhausting neck wrestling which may result in its being pinned to the ground (Hoffman and Kaehler, 1993). Threatening behaviour is defined by specific movements and positions of head and ears and spitting (Cavalcanti and Knowlton, 1998). If one guanaco lift it head, thrusts its ears straight back and tilts its chin upward, the other

guanaco curls its tail onto its back and slinks away (Hoffman and Kaehler, 1993). Stotting is an expression of play, practiced by a chulengos at dusk. All four legs leave the ground simultaneously. The stotting animal holds its head high as it bounds around its family group. Young males play fight in a ritual that will prepare them to send a more biting message later when they spar for real as compelling adult (Hoffman and Kaehler, 1993).

2.5.2. Vocalization

Guanacos use vocalization very often. The most common kind of vocalization is humming, which occurs frequently among members of a family group. There are many kinds of this communication. During mating, males make a grunting sound called orgling, one of many guanaco vocalizations (Hoffman and Kaehler, 1993).

Humming is constant noise heard in the family groups and its meanings depend upon the context in which is used. Low contact hums make two individuals to stay in touch as between mother and young. Other hum is interrogative hum with a high pitched ending makes by chulengos, when they want suckling or when they are separated.

From as far as a mile away, the territorial male can give the warning that violence awaits any intruding guanaco. The family groups stay close together and territorial male is patrolling his herd against predator. When male find predator he sound the ‘‘alarm call’’ (Hoffman, 2005).

2.5.3. Scent communication

Scent marking, as a means of territorial defence, is a common behaviour in ungulates (Sun *et al.*, 1994). It lasts longer than other communication and it is working also in the absent of the animal (Filipczyková, 2009). Males mark their territorial boundaries with dung piles that are recognizable to other guanacos. The dung piles serve information, that this territory is occupied (Hoffman and Kaehler, 1993). A male on a latrine introduces his action with sniffing, turning and tail wagging. Females and males show less ceremonious behavior when they eliminate away from a latrine (Filipczyková, 2009). There is higher frequency of marking near borders where territorial neighbours are known to occur. Some dung piles, called ‘‘latrines” too, are use by both males. These territorial males make special trips to go a dung pile (Walther *et al.*, 1983). Guanaco females do not use the latrines because they have less permanence with the territorial group. In addition, the females are not as dependent as males on being oriented to a territory (Filipczyková,

2009). Another form of scent communication is flehmen. These way males inhale and sniff dung or urine of females to determine their reproductive status. The male sniff a pile, when tilts his head to a vertical position and inhales (Hoffman and Kaehler, 1993).

3. AIMS

To analyze factors influencing non - vocal communication linking to scent marking behaviour in captive bred llama guanaco.

3.1. Hypothesis

1) Scent marking behaviour of animals will differ between herds due to its size and structure.
2) Scent marking fidelity of individual will be more probable than marking at different places.
3) Distance of the animal from the herd during marking and marking after will be different.
4) Sniffing will be more probable before marking after another animal than before marking.
5) The adult male will mark after other animals with higher probability than just marking (dropping his faeces or urinate).
6) Young will mark after their mothers with higher probability than *vice versa*.
7) Younger individuals will mark after older individuals with higher probability.
8) Individuals who are higher in hierarchy will mark after submissive individuals on the latrines with higher probability.
9) The latrines of bigger diameter will be used more frequently for marking after another animal than only for marking.
10) Animals higher in hierarchy will mark after another animal at bigger latrines.
11) For marking after another animal the urination will be used more frequently.

4. MATERIALS AND METHODS

4.1. Animals

My research was based on data, which I collected in two herds. The total number of individuals was variable, so the numbers of animals in herds are listed in the Tables 1 and 2. In these tables are also listed other data about individuals in both herds, such as gender, identification of the individuals, date of birth and in table with individuals from Lány period, when I observed animals were there.

The first herd was located at farm at Lány near city Kladno. Number of guanacos in this herd was changing during my observation. Adult males were present during all of observations. I observed this herd from September 2012 to September 2013. Guanacos in this herd were recognized by ear marks with different colours and numbers. Calves have same colour of ear mark as their mother.

Table 1: List of guanacos in Lány

Number	Colour of eartag	Sex	Birthdate	From	To
1	Blue	F	14.6.1991	4.10.2012	25.9.2013
2	Orange	F	17.10.2000	4.10.2012	25.9.2013
3	Green	F	25.9.2000	4.10.2012	29.1.2013
4	Yellow	F	1.9.2007	4.10.2012	25.9.2013
5	Red	M	2008	4.10.2012	25.9.2013
7	Yellow	F	16.10.2011	4.10.2012	25.9.2013
8	Blue	M	18.5.2012	4.10.2012	25.9.2013
9	Green	F	28.5.2012	4.10.2012	25.9.2013
10	Orange	F	17.9.2012	4.10.2012	25.9.2013
11	Yellow	M	13.10.2012	24.10.2012	25.9.2013
13	Red	F	13.7.2009	28.3.2013	25.9.2013
14	Red	F	10.2.2010	28.3.2013	25.9.2013
15	Pink	F	16.7.2010	8.11.2012	25.9.2013
16	Blue	F	31.5.2013	20.6.2013	25.9.2013
17	Yellow	M	22.6.2013	9.7.2013	25.9.2013
18	Orange	M	10.9.2013	11.9.2013	25.9.2013
19	Yellow	M	25.9.2013	25.9.2013	25.9.2013

Female number 1 is the mother of the animals 8 and 16, the animal number 2 is the mother of individuals with numbers 10 and 18, female number 3 is mother of 9, female number 4 is mother of 7, 11 and 19 and female 7 is mother of 17.

Second herd what I observed was in Prague Zoological garden. I observed this herd from September 2013 to February 2014. There were six animals, one adult male and five females. Some animals were marked by ear notches, but no all individuals. I recognised them by different body signs, such as colour of limbs, scars and holes in the ears, size and the like. List of these animals is in the Table 2.

Table 2: List of guanacos in Prague Zoo

Number	Sign	Sex	Date of birth
1	Veins under the eyes	F	3.4.2000
2	Bent ears	F	13.9.1992
3	Holes in the ears	F	15.1.1992
4	Young, darker	F	5.11.2010
5	Young, lighter	F	17.2.2011
6	Male	M	30.11.2006

Female number 1 is the mother of the animal 5 and the animal number 2 is the mother of an individual number 4.

4.2. Study places and management

Both places were observed in outdoor enclosures and had similar management. Feeding was carried out in both herds by similar way, manner pasture and hay ad libitum. All year round was a mineral lick and water available to free access. All study places were in temperate climate, where the mean annual temperature around 8 ° C is and mean annual precipitation around 480 mm.

The first study place was at Czech University of Life Sciences Farm Estate at Lány near Kladno in the Czech Republic. This place was 421 meters above sea level. The paddock for guanacos was established in 2009 in abandoned apple orchard. This paddock was from two sides surrounded by road and from two sides by meadow. Fenced area was approximately 1.3 ha. Whole area was divided in smaller yard with shelter, drunkard and a place for hay and in second bigger paddock with grass and trees. Fencing was made of wood two and a half meters high from sides where roads and rest of fencing was from iron wire mesh of two meters high. Hay was placed in hayloft in shelter and non eaten hay from ground was cleaned daily.

Picture 2: Place for guanacos in Lány

Picture 3: Shelter with hay in Lány

Second study place was in Prague Zoological Garden. This place was 186 meters above sea level. Guanacos were placed in the exhibition, which has approximately 0.4 ha. This place was aslope. In the lower part there was a vantage point for visitors. Around the middle there was a hayloft. The shelter was located in the upper corner of the exposure, as well as drunkard. Hay was replenished every day, as well as all excrements from the exposure. Therefore, also in this herd had not addressed the question of the size of the latrines. Mineral licks and water were also available.

Picture 4: Place for guanacos in Prague Zoo

Picture 5: Hayloft in guanaco exhibition in Prague Zoo

4.3. Data collection

Data were collected in 2012 in the period from October to December, throughout 2013 and 2014 in the period from January to February on selected days for two to six hours. Observations were carried out for practical reasons only throw day, especially from 9:00 a.m. to 4:00 p.m. Method of data collection was ad libitum scan sampling (Altmann, 1973).

In my observations were recorded direct interactions between animals, including aggression, nursing, contacts, playing, urinating, defecation, training of mating, mating and

indirect interactions. I observe indirect interactions between animals such as ear and tail positions, neck and leg movements and vocalizations. About urination and defecation I observe whether the individual was remarking and after which animal, and how the animal behaved before and after defecation or urination. I also kept a record of the submissive and aggressive behavior of animals. After that on the basis of these interactions I determined position of animals in the hierarchy of a herd.

Tables for data collection are in appendixes.

4.4. Data analysis

To assess dominance relationship among animals the dyadic encounters were directly observed and recorded and every time winner and loser was determined. I recorded any occurrence of an approach of one animal to another, any attack, threat gesture (position of ears, head and tale), or escape and fighting, which caused an apparent displacement or yielding of the approached individual. During each observation session I counted the number of attacks of each animal and noted identity of attacked and attacking animal. Afterwards the dominance index was calculated based on win–loss scores using rating according to Clutton- Brock et al. (1979). Order in rank was based on value of dominance index, i.e. the animal with higher dominance index has higher position in hierarchy.

All the statistical procedures were d0ne in SAS System V 9.2 (SAS Inst. Inc., Cary, NC). The probability of marking after another animal was tested using the logistic regression model (LR, GENMOD procedure). Tested class factors were the position in hierarchy (yes, no) ‘higher in hierarchy’, marking of younger animal after older (yes, no) ‘younger after older’, marking repeatedly at the same place (yes, no) ‘marking fidelity’, sniffing before at the toilet (yes, no) ‘behaviour before’, sniffing after (yes, no) ‘behaviour after’, marking of male after another animal (yes, no) ‘male after’, marking of calves after its mothers (yes, no) ‘calves after mother’, type of excretion (urination, faeces, both) ‘excretion’ and place where observed (farm, zoo) ‘place’. To account for repeated measures, the identity of the guanaco was included as a random factor in the repeated statement.

The associations between the ‘size of the toilet’ or ‘distance of marking animal from the herd’ treated as predicted values and the fixed effects of class variables the position in hierarchy (yes, no) ‘higher in hierarchy’, marking or marking after another animal ‘marking behaviour’, marking of younger animal after older (yes, no) ‘younger

after older', marking repeatedly at the same place (yes, no) 'marking fidelity', sniffing before at the toilet (yes, no) 'behaviour before', sniffing after (yes, no) 'behaviour after', marking of male after another animal (yes, no) 'male after', marking of calves after its mothers (yes, no) 'calves after mother', type of excretion (urination, faeces, both) 'excretion' and its interactions were tested using a Generalized Linear Mixed Model (GLMM) with MIXED procedure. The full model with all the factors and interactions was iterated until with excluding not significant factors until to get best fitting model. The 'size of the toilet' or 'distance of marking animal from the herd' were included as a dependent variable. The significance of each fixed factor in the GLMM was assessed using an F-test. The least-squares-means (LSMEANs) were used to find differences between the tested fixed effects. The animal identity was used to treat for repeated measures. For multiple comparisons we used the Tukey-Kramer adjustment. The normality of data distribution was tested by 'UNIVARIATE' statement.

5. RESULTS

My studied sample contained in different time different number of individuals. Numbers were from fifteen to twenty - three individuals. These animals were different age, sex and from two different places. Type of observing was ad libitum recording. I observed in total 134 hours long in 35 observing days. During this period I recorded 242 agonistic interactions, 497 cases of excretion (from this number 178 cases produce direct and immediate response in another animal- marking after), 101 cases of direct contact between two individuals and 194 cases of nursing. I watched a total of 299 cases of scent marking after another individual. From this number were 204 cases of marking after by defecating and urinating together, 65 cases by defecating and 30 cases by urinating. Regarding the observation of reproductive behaviour, males were not during my observation sexually active.

5.1. Hierarchy

To determine the hierarchy in herds I observed aggression between pairs and record who the winner was and who was the loser. The following figures show the position of the ears, which helped me to understand the communication between individuals in the herd, and therefore I also helped to recognize the placement of individuals in the hierarchy. Aggressive individuals gave ears in a position BACK and attacked, while submissive individual fled, gave the tail to position FRONT and ears to the MIDDLE position.

Picture 6: Ears in UP position

Picture 7: Ears in BACK position

Picture 8: Ears in MIDDLE position

Picture 9: Ears in FRONT position

Table 3: Hierarchy of herd in Lány

Obs	Names_identity	Cluttonbrock index	Hierarchical order
1	yellowfour	34	15
2	blueone	32	14
3	greenthree	14	12.5
4	orangetwo	14	12.5
5	redfive	11.5	11
6	yellowseven	2.875	10
7	redfourteen	1	9
8	blueeight	0.6923	8
9	redthirteen	0.5	7
10	pinkfifteen	0.1786	6
11	bluesixteen	0.1667	5
12	greennine	0.1154	4
13	orangeeight	0.0909	3
14	orangeten	0.0357	2
15	yelloweleve	0.0256	1

Table 3 shows that four the oldest females were in hierarchy higher than adult male. It might happen because adult females interact together and were present within herd and male look after the herd from outside and from bigger distance. Animal which I marked as yellowseven was in hierarchy between resident adult animals and offspring to one year and animals which arrived during the time of my observation.

Table 4: Hierarchy of herd in Prague Zoological garden

Obs	Names-identity	Cluttonbrock index	Hierarchical order
1	male	11	6
2	faceone	2.5	5
3	lightfive	0.8333	4
4	earstwo	0.6	3
5	darkfour	0.5	2
6	holesthree	0.3333	1

This Table 4 shows that in Zoo, where were not offspring during the time of my observation, was on the top of the hierarchy the male. The female on the second position was the biggest female and on the third was her daughter.

If we compare the herd at the Zoo with herd in Lany it is certainly a difference in their hierarchy. It could be due to herd size, number of offspring, or even old age individuals. In the Zoo was on top of the male and females were similar to the lower level, while at Lany it was somewhat different. The male was younger, must guard the bigger herd and bigger territory (fenced area). The situation that occurred in Lany was more close to natural condition concerning herd structure and number of individuals and bigger size of territory.

5.2. Expelling yearlings

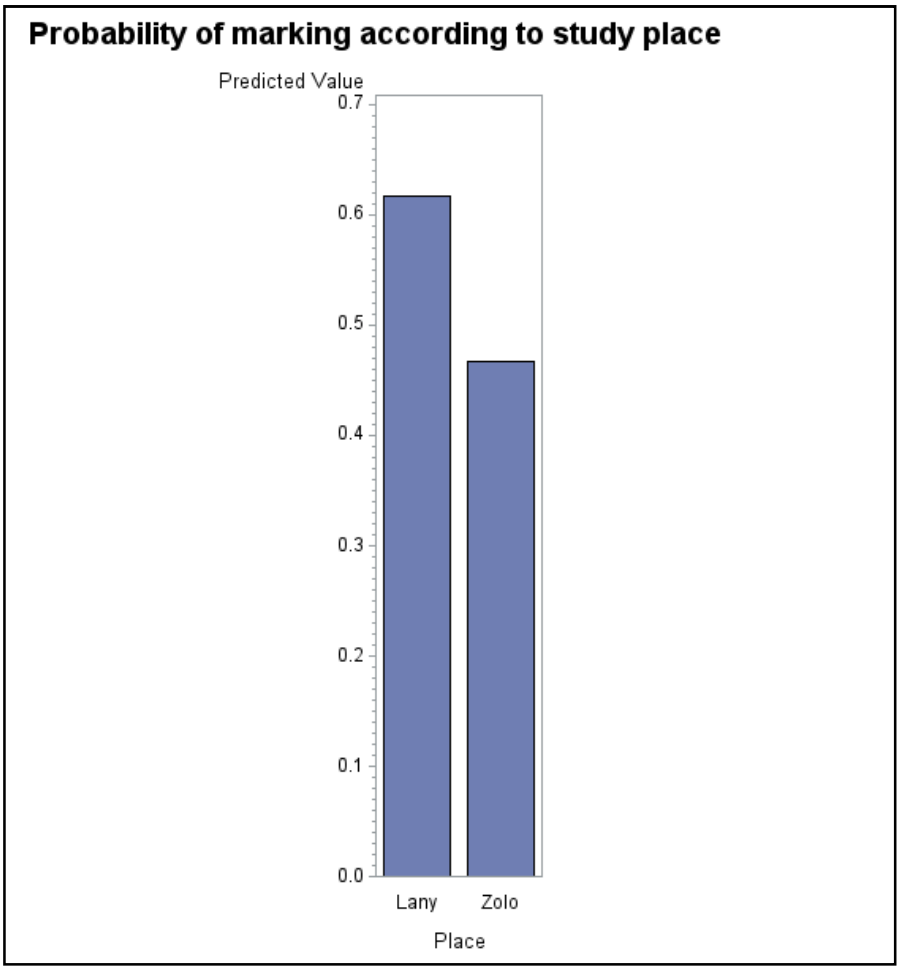
During the observation, I saw an aggressive male behavior towards young who reached the age of one year. Firstly was aggression against yearlings of male gender and approximately two weeks after against yearlings of female gender. This was seen but cannot confirm by the test due to a short observed period and not demonstrable data and only two observed herds.

5.3. Marking of all individuals

5.3.1. Scent marking according to study place

Data processed to the following Graph 1 shows that there was no difference between both herds in marking behaviour on latrines. Therefore, hypothesis that the herds will differ was not confirmed. Probability of marking after in Lány was 62 % and in Zoo 47 %. ($\chi^2 = 1.37$; DF = 1; p = 0.2411)

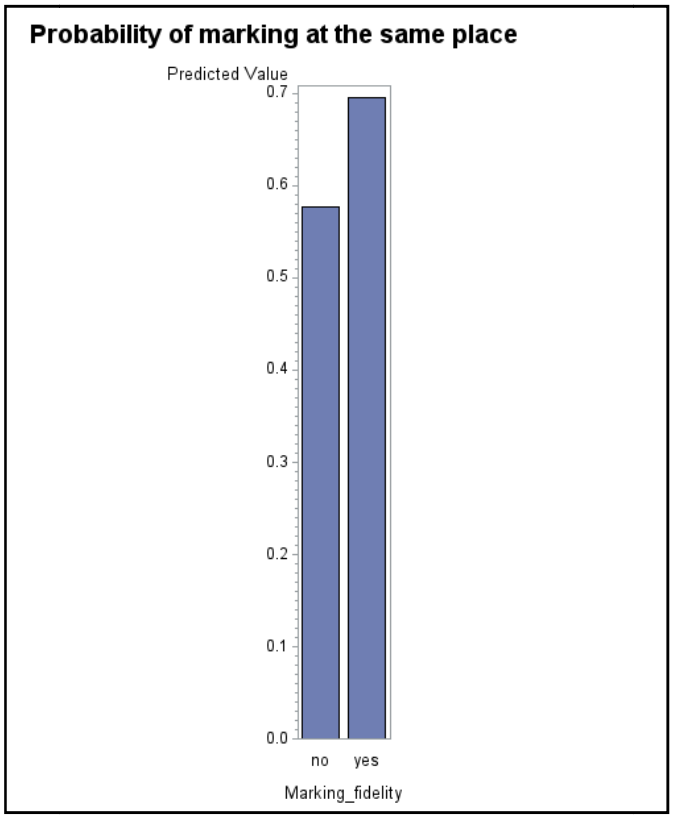
Graph 1: Probability of marking after according to study place.



5.3.2. Scent marking fidelity - marking at the same place

In the Graph 2 results show that marking fidelity of individual will be more probable than marking at different places. This was supported and probability of the marking on the same place was 69 % and probability that animal didn't mark at the same place in same observation was 58 %. (χ^2 = 4.28; DF = 1; p = 0.0387)

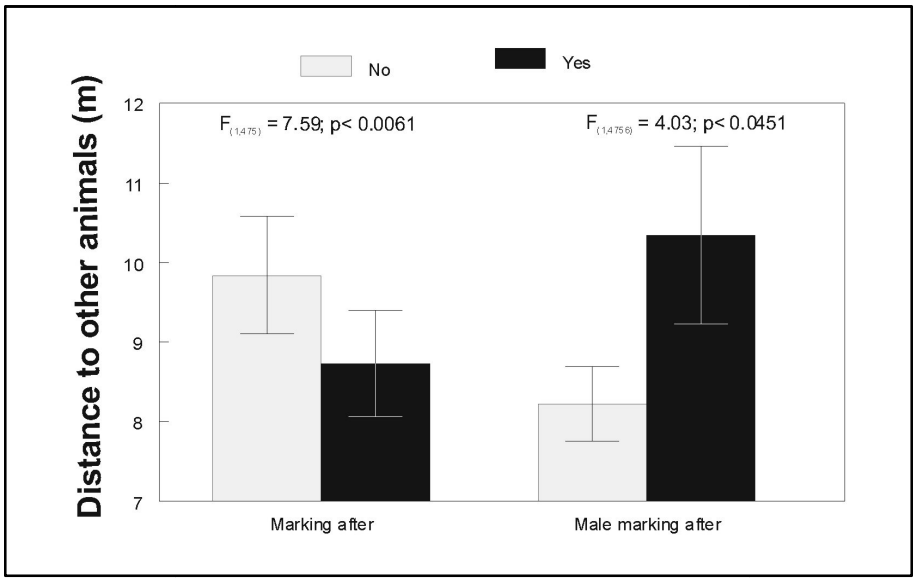
Graph 2: Probability of marking at the same place by certain animal during same day of observation.



5.3.3. Distance from the herd during scent marking behaviour

Graph 3 shows that male who did not marked after was closer to herd in comparison to situation when he was scent marking after another animal. This was just an opposite pattern in rest of the herd.

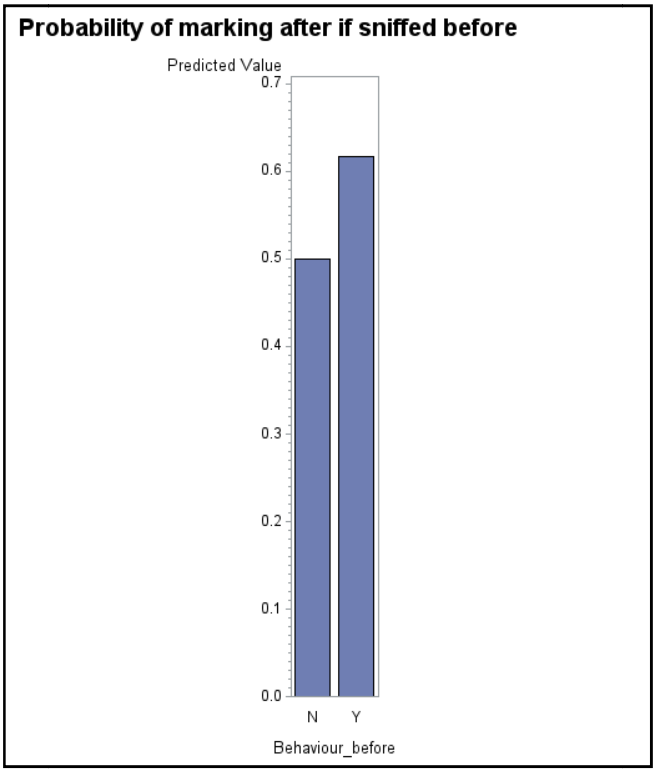
Graph 3: Distance from the herd of male and herd during marking.



5.3.4. Sniffing before marking

The hypothesis that animals will sniff at latrines with higher probability before marking after anther animal has not been confirmed (Graph 4). The probability that the animal will sniff was 62 % and probability that not was 50 %. (χ^2 = 1.86; DF = 1; p = 0.1726)

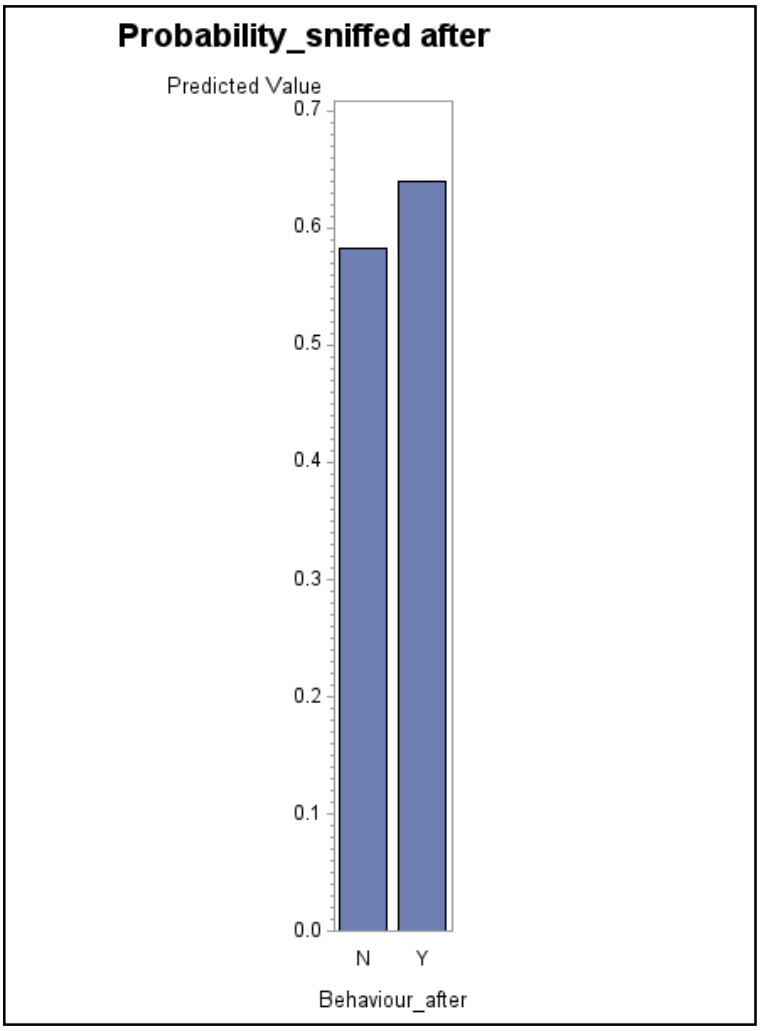
Graph 4: Probability of sniffing to latrine before marking.



5.3.5. Sniffing after marking

The hypothesis which is similar to the previous one that animals will sniff after marking after at latrines with higher probability has not been confirmed too. The probability that the animal will sniff was 64 % and probability that not was 58 % (χ^2 = 1.16; DF = 1; p = 0.2807).

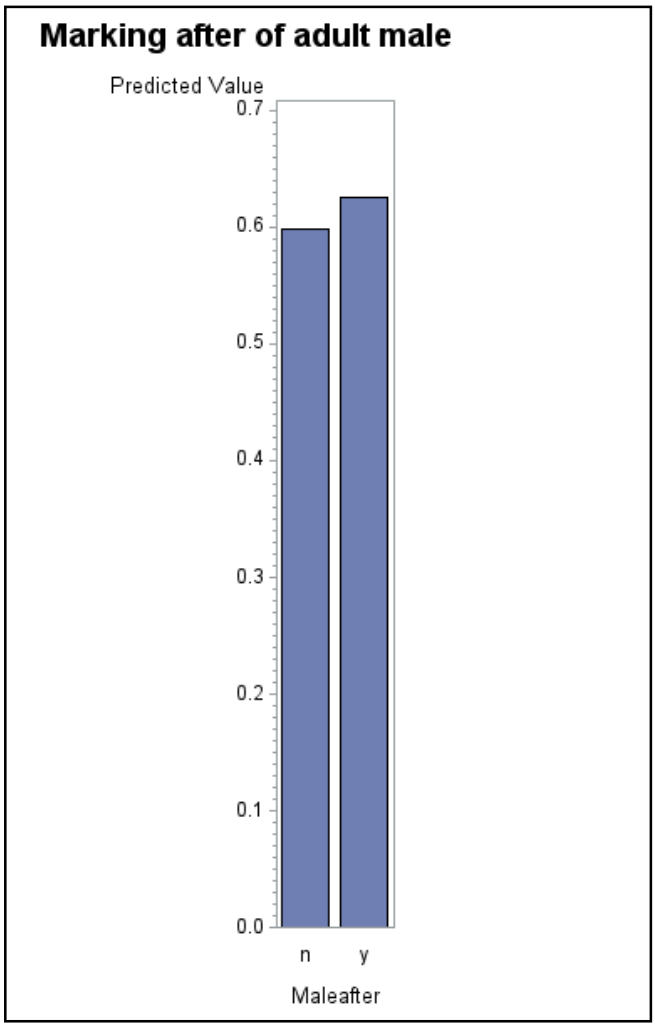
Graph 5: Probability of sniffing after marking after another animal.



5.4. Marking after of an adult male

Graph 6 shows that assumption that adult male will mark after other animals with higher probability than just drop his faeces was not confirmed. The probability of the male only defecate or urinate was 60 % and probability that male mark after another individual was 63 %. (χ^2 = 0.11; DF = 1; p = 0.7407)

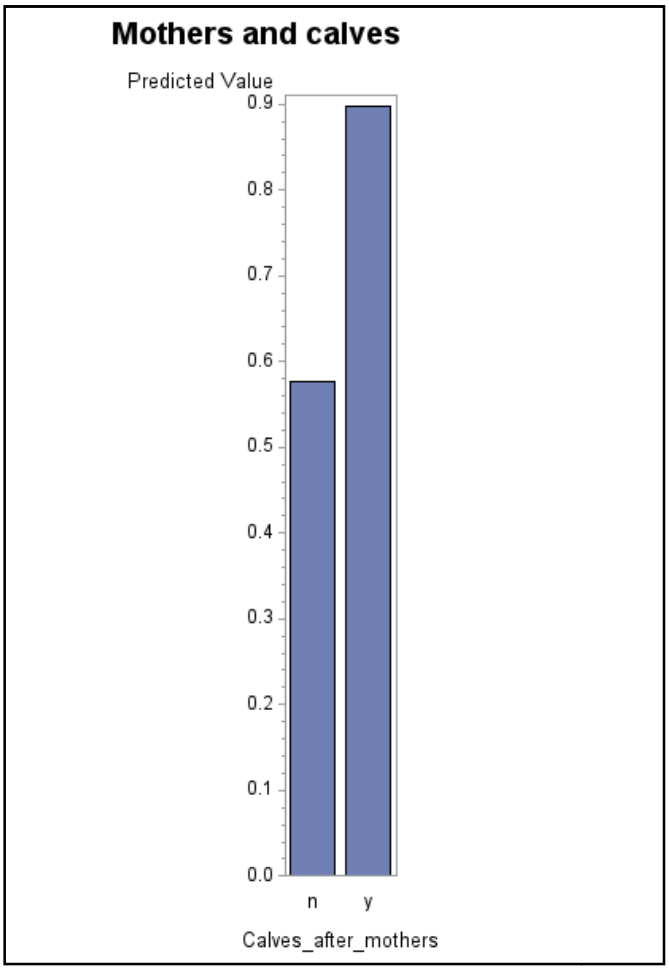
Graph 6: Probability of marking after by adult male.



5.5. Marking of calves

The following results have shown that the hypothesis that young will mark after their mothers with higher probability was confirmed. The Graph 7 shows that the probability that young will mark after their mothers was 90 % while probability that they not mark after their mothers was 58 %. (χ^2 = 6.73; DF = 1; p = 0.0095)

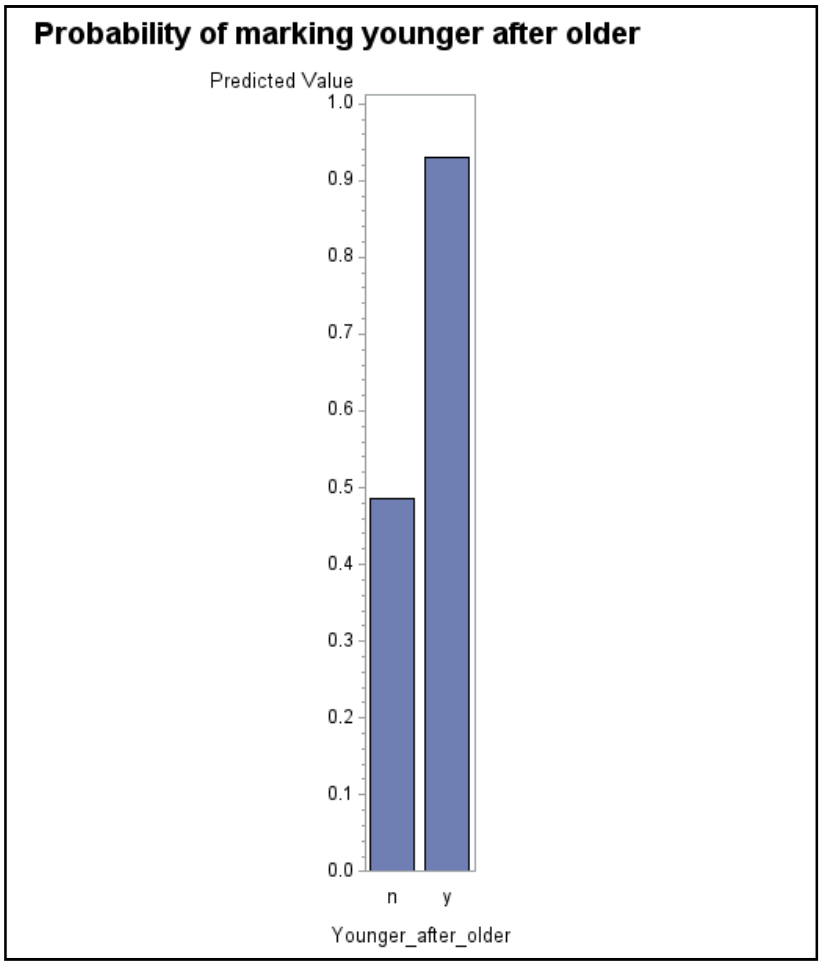
Graph 7: Probability that young will mark after their mothers.



5.6. Marking after and age

The Graph 8 which is listed below shows that the hypothesis about the younger animal marks after older individual with higher probability was confirmed. The probability that younger animal will mark after older one was 93 % while probability that they not mark after older individuals was 48 % (χ^2 = 11.00; DF = 1; p = 0.0009).

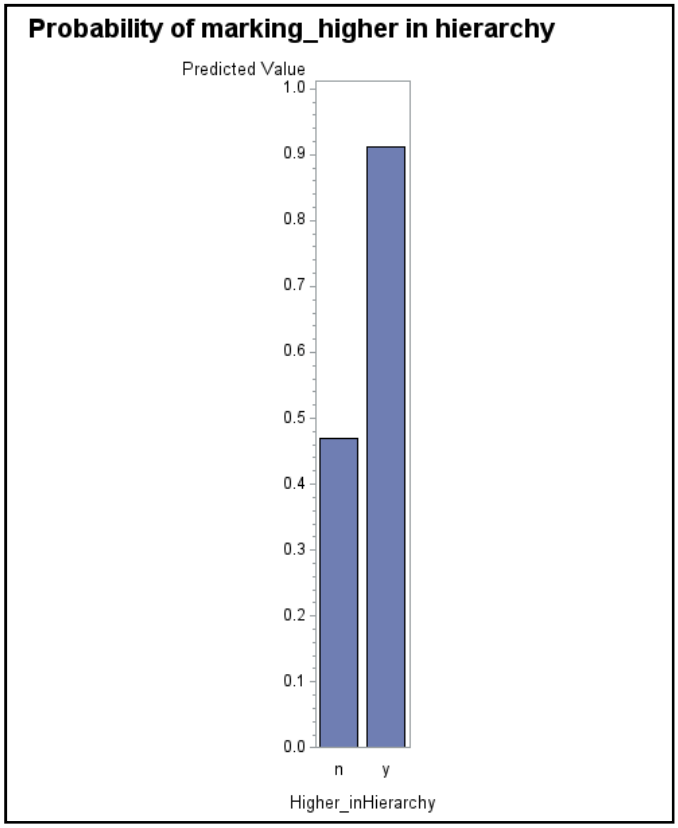
Graph 8: Probability that younger individual will mark after older individual.



5.7. Marking after and position in hierarchy

The hypothesis that individuals who were higher in hierarchy will mark after individuals who were lower in hierarchy with higher probability was confirmed. As shown in the Graph 9 the dominant individual will mark after submissive with probability 91 % and probability that dominant individual will not mark after submissive individual was only 47 % ($\chi^2 = 11.63$; DF = 1; p = 0.0007).

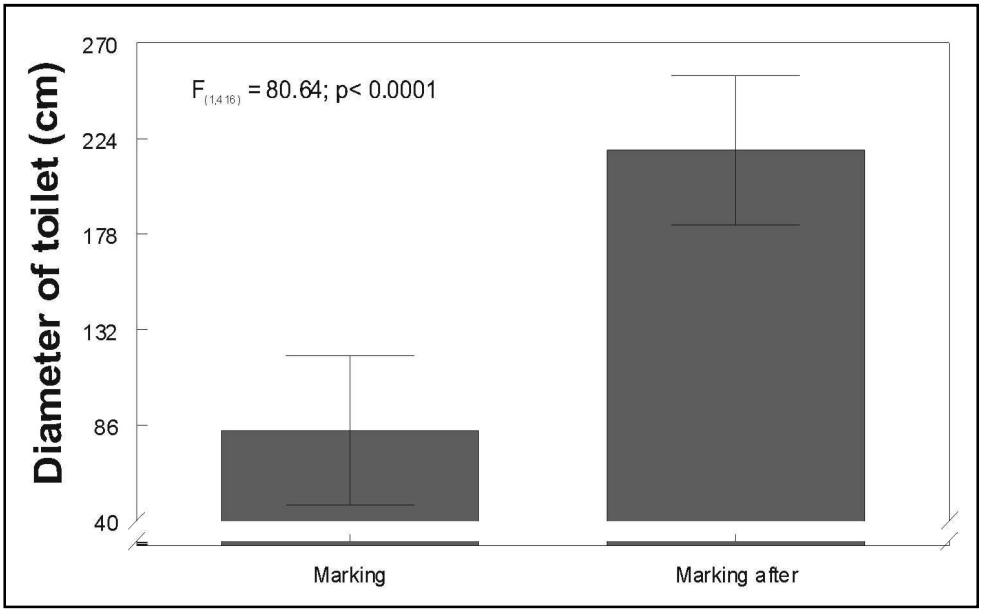
Graph 9: Probability that individual who was higher in the hierarchy will mark after submissive individual.



5.8. Diameter of latrines and scent marking behaviour

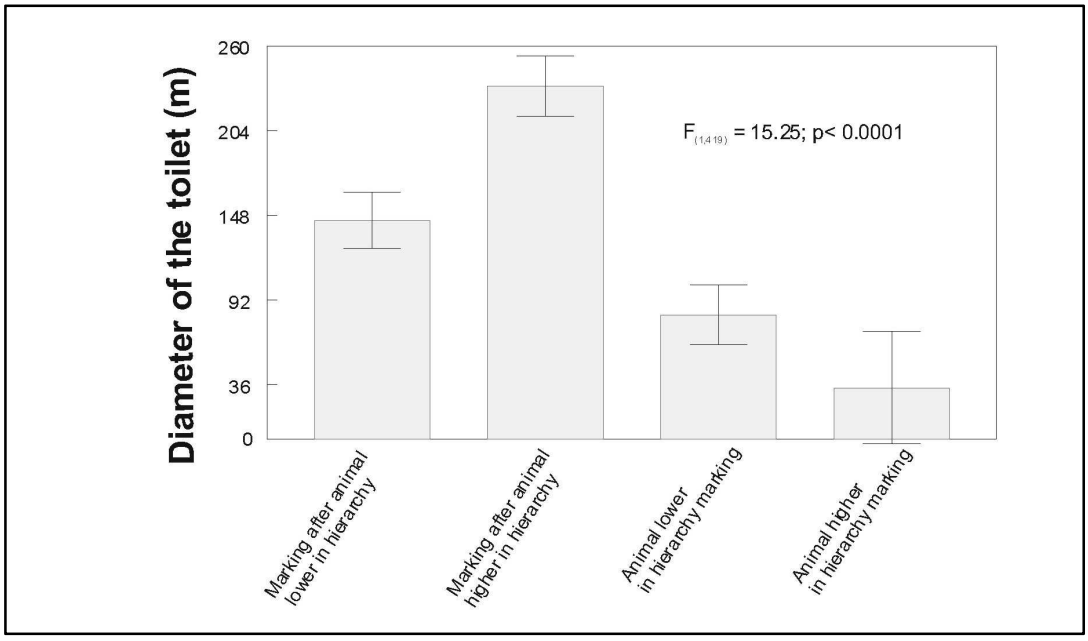
According to the following Graph 10, the latrines of bigger diameter were used more for marking after another animal than only for marking. This may be due to the fact that the latrines of bigger diameter are used to transfer information, and therefore to olfactory communication.

Graph 10: Association between a diameter of latrines and scent marking or marking after another individual



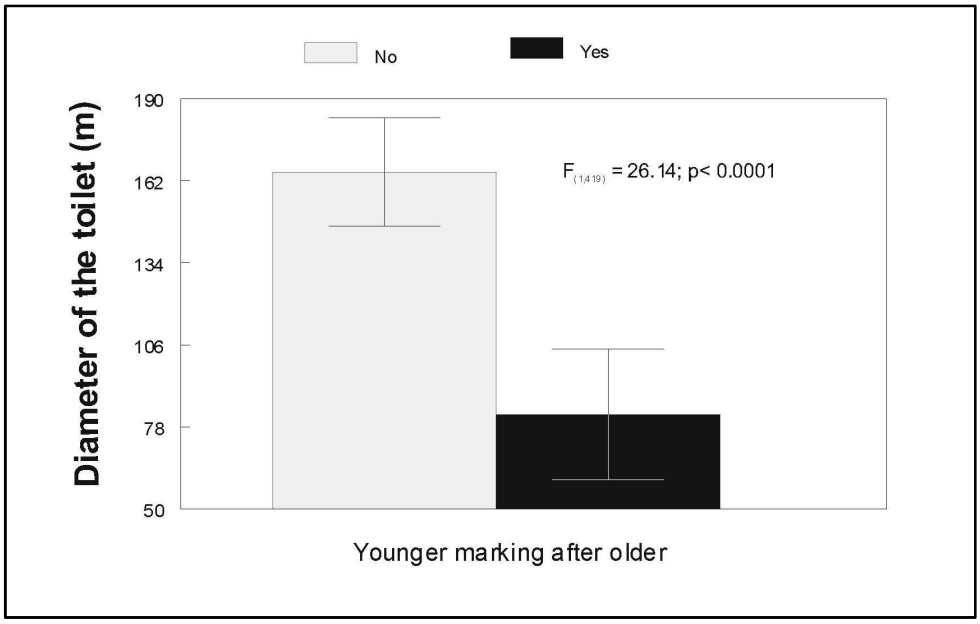
The following Graph 11 shows that animals used for marking after animals higher in hierarchy latrines of the biggest diameter (235.5 cm). On the other hand, if these animals only marked they choose latrines of the smallest diameter (34 cm). Animals that were in the hierarchy on lower position mainly used latrines of the average diameter and when marked after someone they choose the slightly larger latrines than if only marked.

Graph 11: Association between diameter of latrines and the interaction of marking or marking after animal higher or lower positioned in hierarchy.



In the following Graph 12 we can see that if the younger individual scent marked after the older individual they used latrines which were of a smaller diameter (82 cm) than if not mark after the older individual (165 cm).

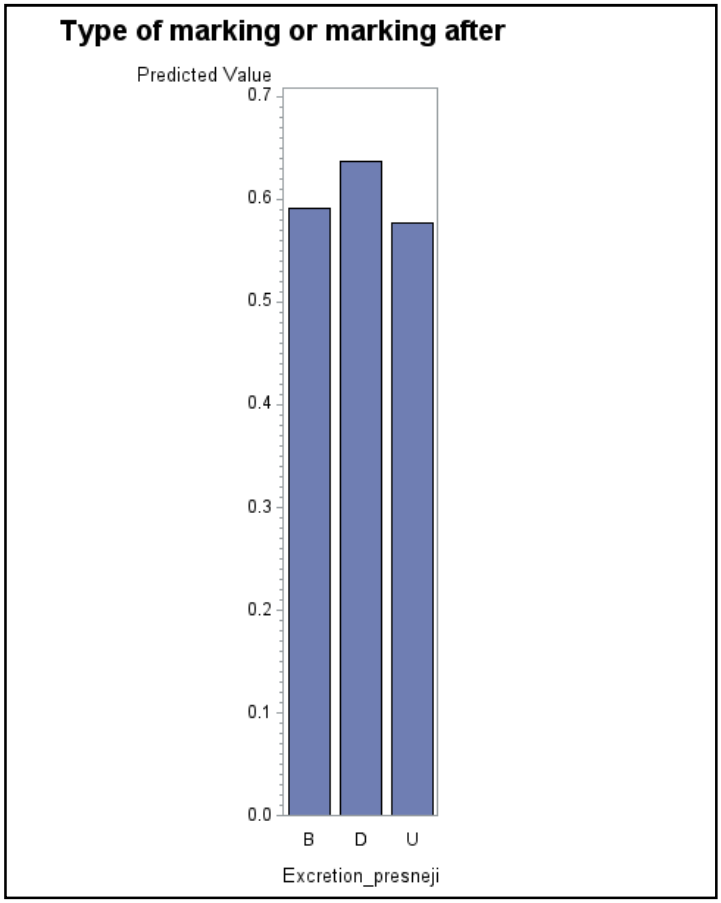
Graph 12: Dependence of the diameter of latrines on whether younger marks after the older individual or not.



5.9. Scent marking after according type of marking

Assumption that for marking after another animal will be more frequently use urination was not supported according Kimura (2001). The Graph shows that probability of the animal use defecation for marking after was 64 %, use urination was 58 % and use both was 59 %. Thus, between the ways of marking after were no significant difference, and certainly urination was not dominant way (χ^2 = 1.47; DF = 2; p = 0.4804).

Graph 13: Probability of using different types of marking (D-degecation, U-urination and B-both of types)



6. DISCUSSION

6.1. Hierarchy-dominance order

Correa *et al.* (2013) described that hierarchy can be also understood as a product of the social rank formation process, given the differences in age, sex, body size, external ornaments, reproductive state and dominance interaction.

Some studies on ungulates indicate that the social hierarchy is affected particular by age - older animals are on the social order higher than others as was presented on zebras (Pluháček *et al.*, 2009). This is found also in this study on guanacos. On the other hand the same study from Pluháček *et al.* (2009) shows that this may not to be the case for guanacos as detect any significant effect of age, body size or body condition on hierarchical position (Correa *et al.*, 2013). In my research were on the top hierarchy the biggest and the oldest animals. As Hoffman (2005) wrote about guanaco females having their own internal linear hierarchies out of male. Dominance relationships among female guanacos were well resolved and highly linear (Correa *et al.*, 2013).

The breeding units, i.e., family groups, would show the highest rate of inter-group agonistic interactions. In family groups the adult male dominates over all group members and adult females dominate over juveniles (Filipczyková, 2009).

In this case, this statement is not applicable for guanacos in observed herd in Lány, where adult females were higher in hierarchy than male. The guanaco's social system (territoriality, group size, and composition) and social hierarchies are more fluctuating, has less fixed family membership, and is characterized by frequent changes in territorial boundaries (Filipczyková, 2009).

6.2. Expelling yearlings

During spring, territorial males become increasingly aggressive toward all juveniles born the previous year and begin expelling them from family groups in nature. This I observed in herd in Lány (unfortunately due to not enough recordings were not statistically evaluated). As Sarno *et al.* (2013) published it may be because of competition for mates, competition for resources and avoidance of inbreeding. In an apparent effort to reduce aggression, juveniles display submissive crouches when being observed, approached, or

attacked by the territorial male. More - submissive animals generally dispersed later than less - submissive animals (Filipczyková, 2009). Juvenile males were approximately 2 weeks younger than juvenile females when they were force dispersed from family groups (Sarno *et al.*, 2003). In this study I observed that male expelled young female later than young males. One year old males were expelled by adult male with a bigger aggression than one year old females. Aggression from territorial males is overt, intense, and potentially injurious to juveniles, and includes spitting, biting, chasing, and attempting to suffocate juveniles (Sarno *et al.*, 2003).

6.3. Marking of all individuals

Marking and marking after as a kind of communication is recorded, for example, for all equine. Most of works about marking were concerned about males. Not much mentioned functions of marking of juveniles and females (Tučková, 2012). Other studies showing that marking can be interspecific differential mainly on the basis of different social organizations (Kimura, 2000). Some studies describe that females are not marking by dung piles or urine or marking less (Tučková, 2012).

6.4. Marking of adult male

In one study Tučková (2012) about marking of equids was documented that male marked on the urine/dung of all individuals, regardless of their age and sex. It might mean that male marking was to create family smell or keep herd together. Males of equids more often marked after the urine of other individual (Tučková, 2012). But males which I observed did not show that they marked after other individuals more than only defecating.

Males used the dung piles more than three times as often as females in wild vicuñas (Vila, 1994). Only the adult males use the latrines, and they do so for only about half the times they urinate or defecate. A male on a latrine introduces his action with sniffing, turning and tail wagging. Females and males show less ceremonious behaviour when they eliminate away from a latrine (Filipczyková, 2009). Male does not tend to marking all female marks (Tučková, 2012).

6.5. Marking of calves

Results of study (Tučková, 2012) about equids showed that marking was for young and their mothers a means to form or demonstrate social bond between them. The young

may preferentially mark after their mothers, but the mothers are doing this with same probability.

My thesis demonstrably showed that probability that offspring will mark after their mothers is higher than that are not. This may be due to the maintenance of social bonds between a mother and her young, or too that the young learned from their mothers how to mark. As say Lent (1974) youngs of llama guanaco are typical followers. Therefore, they must be able to recognize its mother by the smell. The best ways to create this bond are odorous signals.

6.6. Marking and age

In thesis of Tučková (2012) about equids wrote that older animals mark after younger ones (Tučková, 2012). Interestingly, my results showed just the opposite for guanacos. Not exclusively, but younger individuals marked after older individuals with higher probability. These results were interesting also because it was mutually exclusive with the results that I got about hierarchies in herds which I observed. I mentioned there that older individuals were mostly placed higher in the hierarchy than older individuals.

6.7. Marking and position in hierarchy

Marking may have function as a tool for forming social bonds between individuals (Tučková, 2012). In my research individuals who were higher in hierarchy significantly marked after individuals who were lower in hierarchy. There was the difference between my results and results in study about equids. Kolter and Zimmermann (2001) found that dominant horses did not strictly marked after submissive individuals. I suppose that this difference was result of species specifics based on social system and importance of hierarchy of the guanaco herd.

6.8. Diameter of latrines

Latrines of a bigger diameter were used more often for marking after another individual more than only for marking. Same found Tučková (2012) in equids that more often also use a large pile of dung. I also found relationship between the diameter of used latrine and age of the animal orits position in the hierarchy.

6.9. Type of scent marking

Males are using more often urine than droppings to mark after another animal. It may be that urine contains more volatile substances (Kimura, 2001). This was also observed in more species than among equines (Tučková, 2012). It is likely that urine may be the “cheapest” marking material and therefore could be used most frequently. More possibly, however, urine serves to moisten the marked sites and propagate the chemical signals in the urine itself and in the faeces (Sun *et al.*, 1994). But in this study on guanacos, the probability of using different type of marking was almost same. My results show that probability of the animal use defecation, urination or both ways for marking after was similar. Thus, urination was not dominant way to mark after in this study.

7. CONCLUSION

I described the types of communication system and reproduction in lama guanaco. In these animals, communication is very important and that all its ways. I observed aggressive behaviour towards new coming females and yearlings. The research was therefore focused on scent marking communication and hierarchical organization. I found that the hierarchy was different between observed herds. This result may have been due to differences in the structure of the herd and age of males. Based on the results I can say that marking is important for social interaction between mothers and young, between different individuals in a herd or between male and females. Probability of marking after was higher in animals having higher position in hierarchy, younger animals marking after older and calves marking after its mothers. On the contrary, I found no difference between the type of used types of marking and no demonstrable result of sniffing to latrines before and after marking. Interestingly, if male marked after he was in longer distance from the herd than others marking after individuals. I have not found any support for male marking with higher probability after another animal from herd in comparison to just marking. I think that this thesis help with understanding of behaviour of these interesting animals for future research and for future and current breeders of this awesome animal. It would be interesting to explore some of my hypotheses in more detail in another study.

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9. ANNEXES

Annex 1: Example of the table in which I wrote down win-loss scores between individuals during my observation.

date

loser

winner

	1	2	3	4	5	Male
1						
2						
3						
4						
5						
Male						

Annex 2: Example of the table in which I wrote down everything about marking of individuals during my observation.

Date	Animal	Time	Order on Toilet	Behaviour before	Excretion	Behaviour after	Other animals	where	Number of toilet	Size of toilet	What do other animals	Distance from herd	Place

Annex 3: Example of the table in which I wrote down interaction between individuals during my observation.

Date	Initiator	recipient	Time-beginning	Time-finish	Behaviour	Position ears	Position tail	Other animal-position	vocalisation	Place where	What do other animals	Distance from herd	Place