Animal welfare, etológia és tartástechnológia

Animal welfare, ethology and housing systems

Volume 5 Issue 1

Gödöllő
2009

SOCIAL DOMINANCE AND MILKING BEHAVIOUR IN DAIRY GOATS

Jessica Ann Ney, Corinna Müller, Otto Kaufmann

Humboldt-Universität zu Berlin, Landwirtschaftlich-Gärtnerische Fakultät, Institut für Nutztierwissenschaften, FG Tierhaltungssysteme und Verfahrenstechnik,

Philippstr. 13, Haus 10, 10115 Berlin

jessicaney@web.de

Abstract

Social dominance and milking behaviour in three dairy goat herds belonging to the White German Improved breed were investigated. The aims of this study were to analyse the complex relationships between social rank, milking order and milk yield. Furthermore, the behaviour in the milking parlour regarding different social ranks and stimulation during milking (hand stimulation, no stimulation, mechanical stimulation) was observed. Additionally, the occurrence and function of intervention behaviour were examined. The observations took place before, during and after the morning milking. Non-linear hierarchies consisting of circular relationships could be defined in all three herds. Intervenors were either high ranking or higher ranking than at least one of the competitors. Social rank affected the milking order in that higher ranking individuals tended to front positions in the milking parlour. Milk yield and behaviour in the milking parlour were not dependent on social rank. The animals reacted stronger towards mechanical stimulation during milking suggesting that this procedure was unpleasant.

Keywords: dairy goats, social dominance, intervention behaviour, milking behaviour, milking order, stimulation during milking

Tejelő kecskék szociális dominanciája és fejés alatti viselkedése

Összefoglalás

A szociális dominanciát, valamint a fejés alatti viselkedést vizsgálták a szerzők, a Német Fehér Nemesített kecskefajta három állományában. A tanulmány fő célja az volt, hogy elemezze a szociális rangsor, a fejési viselkedés, valamint a kifejt tej mennyisége közti komplex összefüggést. Figyelték továbbá a fejőházi viselkedést eltérő szociális rangszám, valamint a fejés alatti stimuláció (kézi ösztökélés, ösztökélés nélküli fejés, mechanikus ösztökélés) szempontjából is. Azonfelül vizsgálták még a fejés alatt, valamint a fejések közötti viselkedést is. A megfigyelések a reggeli fejések előtt, alatt és után történtek. Mindhárom nyájban körkörös kapcsolatokban meglévő, nem lineáris rangsorokat állapítottak meg. Az előretörők között egyaránt voltak magas rangszámú egyedek éppúgy, mint a legkisebb versenytársak. A szociális rangsor úgy befolyásolta a fejési elrendeződést, hogy a rangsorban előbb álló egyedek megpróbálták megszerezni a fejőház első fejőállásait. A tejhozam és a fejési viselkedés nem függött a szociális rangsortól. Az állatok erősebben tiltakoztak viszont a fejés közbeni mechanikus ösztökélés ellen, ami azt mutatja, hogy ez a módszer kellemetlen számukra.

Kulcsszavak: tejelő kecskék, szociális dominancia, köztes viselkedés, fejési viselkedés, fejési rend, fejés közbeni ösztökélés

Introduction

The social behaviour of goats has been documented by others, regarding social dominance (*Stewart and Scott*, 1947; *Ross and Scott*, 1949; *Sambraus*, 1971; *Shank*, 1972; *Escós et al.,* 1993; *Fournier and Festa-Bianchet*, 1995), effect of group size on social dominance (*Shank*, 1972; *Keil and Sambraus*, 1996), stability of hierarchies (*Keil and Sambraus*, 1996; *Barroso et al.,* 2000), relationship between social dominance and milk yield parameters (*Barroso et al.,* 2000) and agonistic behaviour during dominance fights (*Shank*, 1972). While most studies on farm animals discuss production parameters and biological factors (e.g. reproduction, disease), it is also important to understand the animals' behaviour. Rarely, intervention behaviour, milking order or the effects of stimulation during milking in dairy goats are discussed.

Dominance behaviour in goats

Goats live in social groups, in which a fixed hierarchy is established over a certain period of time (*Anonymous*, 2003). Some describe this hierarchy as linear (*Barroso et al*., 2000), others as non-linear (*Fournier* and *Festa-Bianchet*, 1995; *Keil* and *Sambraus*, 1996). According to *Fournier and Festa-Bianchet* (1995) social groups, in evolutionary terms, are both advantageous and disadvantageous. The main advantage of living in a group is early predator detection, while food competition is the greatest disadvantage. Competition leads to agonistic interactions within the herd. In order to reduce the costs of constant aggression (e.g. time, energy), social hierarchies are established. The hierarchical structure minimizes the agonistic interactions within the group.

So far, goats are the only farm animals which have been documented displaying intervention behaviour – a "friendly" interaction between members of a herd (*Keil and Sambraus*, 1998; *Sambraus*, 1991). Individuals will position themselves between fighting conspecifics, which usually leads to the termination of the fight. It is hypothesized that intervenors are high ranking animals. The intervenors may even maintain a unique relationship to the competitors (*Sambraus*, 1971). The results of *Keil and Sambraus* (1998) show that intervenors were mostly high ranking individuals, although low ranking animals had also been observed acting as intervenor. Here, in general not only the rank but especially the rank relationship between intervenor and the competitors was significance. In most cases, the intervenors were higher ranking than both competitors and in turn assumed a position of authority.

Milking behaviour in goats

Little is known about the milking behaviour of dairy goats. As stated by *Sambraus and Keil* (1997), wild ungulates remain close to the herd for security. When they travel e.g. to find forage, they move as a group and maintain a certain order in which one member gains leadership. In some herds, it is always the same animal which acts as leader. In other cases, there are several leaders for different functions, i.e. one animal leads the herd to resting places, another to water etc. The order in which the other group members follow is usually constant as well. A further order, which is only formed in farm animals, is the milking order. This is the order in which the individual group members enter the milking parlour. An individual's social rank can affect both milking order (*Sambraus and Keil*, 1997) and milk yield (*Addison and Baker*, 1982; *Patón et al.,* 1995).

Stimulation experiments aimed at investigating whether different forms of stimulation during milking increase milk yield have been carried out in dairy cows (*Hamann et al.,* 1980; *Hamann et al*., 1993). As higher milk flow rate and as shorter duration of milking were achieved in cows, it would be interesting to see whether stimulation affects goats similarly and whether stimulated animals behaved differently during milking. Unfortunately, few authors discuss stimulation experiments in dairy goats.

Study aims

This study's aims are to investigate whether a) a hierarchy is established within the herds b) intervenors are high ranking animals c) social rank affects the milking order d) social rank affects milk yield e) social rank affects the behaviour in the milking parlour and f) different kinds of stimulation (no stimulation, hand stimulation, mechanical stimulation) affect the behaviour during milking.

Materials and methods

Study animals and animal husbandry system

The study was conducted at the *research station Blumberg*, *Humboldt Universität zu Berlin*. All study animals belonged to the White German Improved breed and were polled. The younger goats (1^{st}-2^{nd} lactation) were housed separately from the older animals (2^{nd} lactation onwards). Within the herds, all animals were in the same lactation stadium and had the same reproductive status. Before each observation period, a pilot study was conducted in order to be able to identify each animal individually.

The goats were kept on deep litter in a loose housing system with natural air circulation. The older goats had an area of 44.6 m^2 at their disposal, i.e. 2.4 m^2 per animal. Two metal hayracks (2.5 m per side) amounted to a total feeding area of 10m, giving each goat a trough space of 0.5 m. The younger goats' housing had a floor space of 36.8 m^2, i.e. 1.9 m^2 per animal. A 9.9 m metal hayrack spread out over the entire length of the stable, allowing each animal a trough space of 0.5 m. Each group had constant access to two water dispensers and salt licks.

Milking took place twice a day (7 am and 5 pm). The animals were milked in a side-by-side milking parlour (Westfalia), accommodating 20 goats and consisting of ten milking clusters. Generally, two milkers were present during milking; three were present during the stimulation experiment in 2003. Concentrated feed was administered in the milking parlour; hay was fed in the stalls after milking.

Experimental design

The study lasted two lactation periods in the years 2003 and 2004. Three groups of dairy goats were observed. In 2003, only the older goats were observed (group 1) while the observations in 2004 also included the younger animals (group 2= younger goats; group 3= older goats). Each group consisted of 19 animals. Six animals of group 3 had been members of group 1 the year before. The three groups were analyzed individually due to the herds consisting of animals of different ages and the study taking place over two consecutive years. In this period the behaviour of goats where analysed on 70 selected days from 7 am to 10 am. The following operational behavioural definitions were used:

- *agonistic behaviour*= dominance fights (animals stand on their hind legs and butt one another), threats (the subordinate animal retreats without establishing contact), displacement from water dispenser, salt lick, feeding or resting places (through biting and/or butting)
- *kick off of milking cluster*= getting rid of milking cluster through aimed kicks of one or both hind legs
- *feeding*= biting, chewing and swallowing of food; can occur while the animal is standing or lying
- *rumination*= chewing of cud through repeated sideways movement of jaw; can occur while animal is moving, standing or lying
- *drinking*= mouth is lowered into water dispenser, animal swallows repeatedly
- *resting*= animal standing or lying with eyes opened or closed; not involved in any other activity
- *intervention behaviour*= one animal positions itself between fighting conspecifics
- *other*= e.g. urination, defecation, allogrooming, calling, licking salt lick.

In order to determine the hierarchy, a dominance matrix was established. The older goats were observed 30 minutes before and 30 minutes after milking; observations on the younger goats took place in the first 60 minutes after milking. All agonistic encounters were taken into account. The hierarchical structure was evaluated using the methods of *Keil and Sambraus* (1996). First, the dominance matrices were summarized in order to determine the amount of higher ranking (HRA) and lower ranking animals (LRA) of each individual. The sum of HRA and LRA is the number of established dominance relationships (EDR) for each animal. The rank of an animal was determined using the rank index (RI), which is the quotient of LRA and EDR (values between 0.00-1.00). The higher is the RI, the higher is the individual rank in the hierarchy. Animals with a RI between 0.00-0.33 were classified as low ranking, 0.34-0.66 medium ranking and 0.67-1.00 high ranking. Intervention behaviour was recorded ad libitum each time it occurred on a separate list.

The milking order was determined by recording the order of entrance into the milking parlour every day. Only the morning milking order was taken into account. Agonistic behaviour (i.e. biting, butting, and kick off of milking cluster) was measured during the entire milking procedure using a group scan. The methods of *Sambraus and Keil* (1997) were utilized to determine the milking order. First of all, each animal's position in the milking order was recorded for each day of the observation period. The *mean position* (m) was calculated for each individual in order to attain a milking order. Then, the *standard deviation* (s) was calculated so that the stability of the milking order could be determined. To exclude extreme values, the *median* (Z) was identified and correlated with the mean (m) using a *Spearman Correlation*. Afterwards, the mean of the standard deviation (s_g) of the entire group was formed. The quotient of s and s_g was defined as the stability factor; every value over 1.00 was referred to as being instable.

A parallel study in operation had group 1 divided into three sub-groups for milking (*Müller*, 2007 – paper being to be published). The sub-groups were: hand stimulation, no stimulation and mechanical stimulation. The mechanical stimulation was alternated every two weeks between alternating *pulsefrequency* (APF) and *prestimulation* (PS)[1]. The behaviour was evaluated separately in regard to the stimulation groups.

Statistical analyses

"*Statistical Package for Social Sciences 12.0*" (SPSS) was used for statistical analyses. Statistical analyses was carried out to identify possible relationships between social rank and milking order, social rank and milk yield and social rank and behaviour in milking parlour.

[1] Normal: Vacuum = 38,0kPa at 90pulse/min; pulse ratio = 60 : 40
PS: stimulation during first 20 seconds of milking at 300 pulse /min, then at 90 pulse/min
APF: alternating stimulation – 6 seconds at 300 pulse/min, 9 seconds at 90 pulse/min

The sample sizes were too small to statistically analyze whether intervenors were high ranking animals or whether different kinds of stimulation affected the behaviour during milking. No further statistical analysis was necessary to determine the hierarchies.

Firstly, the results were divided into qualitative or quantitative data. Non-parametric tests were applied to the ordinal data (qualitative). Quantitative data was tested on normal distribution (test of skewness and kurtosis). Since each test resulted in skewness and kurtosis $\neq 0$, none of the quantitative data was normally distributed and non-parametric tests were used here as well. Spearman Correlations between rank index and the mean (m) of the milking order and between rank index and 150-day-yield were carried out to identify possible relationships. Kruskall-Wallis tests helped identify relationships between rank index and behaviour in milking parlour.

Results

Social dominance and intervention behaviour

Table 1 shows the calculation of the rank index (RI) for each individual. For example, goat 13 in group 1 was dominant over 4 herd members, 10 dominance relationships had been established. The RI for goat 13 was therefore 0.40 (=medium ranking). Group 1 ranked from 0.00 (goat 19) to 0.93 (goat 29). Goat 29 was dominant over 14 other herd members in 15 established dominance relationships; only goat 52 was higher in rank. However, goat 52 was dominant over less animals in total than goat 29, which gave her a lower RI (0.92). This indicates that the hierarchy was non-linear and consisted of circular relationships[2]. There was more evidence of circular relationships within group 1. For example, goat 14 (RI=0.27) was higher in rank than goat 13 (RI=0.40) and goat 50 (RI=0.45), although her RI was lower than theirs. Goat 19 was not dominant over any other animal in eleven established dominance relationships. There was no absolute α-animal, although goat 29 was identified as the leader. The herd consisted of four high ranking, nine medium ranking and six low ranking animals.

The rank index of group 2 ranged from 0.08 (goat 38) to 1.00 (goat 40). Goat 40 was dominant over all animals that she had encountered in 14 established dominance relationships and was the absolute α-animal. Goat 38 was only dominant over one other animal in 13 established dominance relationships.

[2] circular relationships: A is dominant over B. B is dominant over C. C is dominant over A.

Therefore, no absolute Ω-animal was identified. Five animals were high ranking, eight were medium ranking and six were low ranking. In this herd, the hierarchy was also non-linear. For instance, goat 6 (RI= 0.33) was dominant over goat 13 (RI= 0.57) and goat 24 (RI= 0.44), even though she had a lower RI.

***Table 1*: Calculation of rank index**

GROUP 1				GROUP 2				GROUP 3			
ID	**LRA**	**EDR**	**RI**	**ID**	**LRA**	**EDR**	**RI**	**ID**	**LRA**	**EDR**	**RI**
13	4	10	0,4	1	6	12	0,5	2	1	10	0,1
14	3	11	0,27	4	6	15	0,4	3	4	11	0,36
19	0	11	0	5	3	12	0,25	8	6	7	0,86
20	7	12	0,58	6	3	9	0,33	10	6	10	0,6
21	3	10	0,3	9	7	13	0,54	11	0	6	0
24	10	11	0,91	13	8	14	0,57	12	3	5	0,6
25	5	13	0,38	15	7	13	0,54	14	5	15	0,33
26	9	15	0,6	16	7	10	0,7	17	3	14	0,21
27	4	10	0,4	19	12	15	0,8	18	3	10	0,3
29	14	15	0,93	20	6	14	0,43	21	2	6	0,33
33	8	12	0,67	23	7	16	0,44	25 (20)	10	13	0,77
34	7	14	0,5	24	4	9	0,44	27 (19)	5	11	0,45
35	2	7	0,29	26	1	11	0,09	28 (13)	1	11	0,09
39	4	9	0,44	32	9	10	0,9	29	4	9	0,44
47	1	6	0,17	33	13	15	0,87	30 (26)	12	13	0,92
49	8	13	0,62	36	3	12	0,25	31	4	7	0,57
50	5	11	0,45	37	2	11	0,18	34 (29)	17	17	1
51	4	14	0,29	38	1	13	0,08	35 (35)	3	10	0,3
52	11	12	0,92	40	14	14	1	41	10	13	0,77

ID= each animal was designated an individual number; six animals of group 3 had been members of group 1 the year before, the number in parentheses represents the former ID number
LRA= lower ranking animals; EDR= established dominance relationships; RI= rank index

In group 3, the rank index spanned from 0.00 (goat 11) to 1.00 (goat 34). This indicates that an α-goat as well as an Ω-goat existed. The herd was composed of five high ranking, six medium ranking and eight low ranking animals. As six individuals of group 3 had been members of group 1 the year before, a comparison is possible. Goat 34 (=29) became α-animal in the absence of goat 52. All animals, except for goat 28 (=13) and goat 35 (=35), ranked higher in the second year of the study. Even though an α-animal and Ω-animal were present, the hierarchy was non-linear because of various circular relationships in the medium and lower ranks.

Low ranking goat 28 (RI= 0.09) for example was dominant over medium ranking goat 29 (RI= 0.44).
To discover whether intervention behaviour was dependent on social rank, the total amount of interventions were compared regarding different ranks. No statistical analysis was undertaken as the number of observations was too small. *Figure 1* portrays the occurrence of intervention behaviour in regard to different ranks. Throughout the groups, high ranking animals acted as intervenors most frequently (58%) and low ranking animals displayed this behaviour the least (15%). This tendency was more evident in the older goats than in the young goat herd, in which medium ranking animals acted as intervenor frequently.

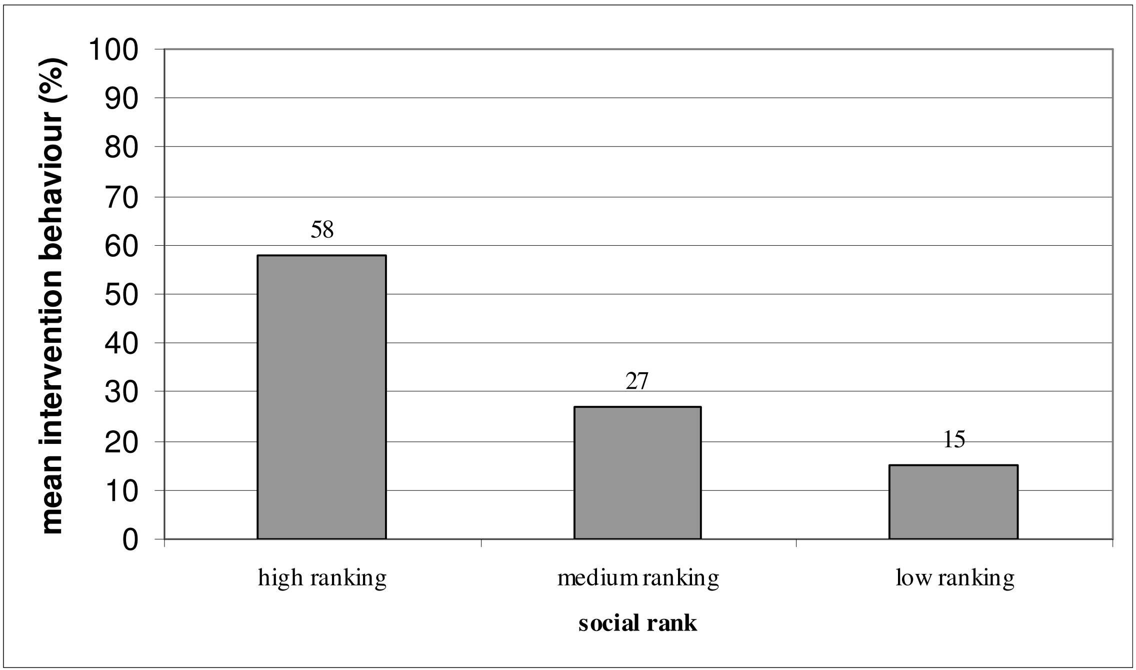

***Figure 1*: Mean intervention behaviour in percent divided amongst social ranks**

The hierarchy was more stable in the older goat herd, which had the same leader in two consecutive years (goat 29/34). This individual acted as intervenor more frequently than any other animal (group 1 = 13x; group 3 = 14x). Not only the intervenor's rank in general but especially which dominance relationship they had towards the competitors was important. Intervention behaviour was displayed in 122 dominance fights during the observation period. In 70% of the cases, the intervenor was dominant over at least one of the fighting individuals. The intervenor was subdominant to both competitors only 6% of the causes. 24% of the dominance relationships had not yet been established. These results suggest that the intervenor was generally higher ranking than at least one of the competitors.

Another aspect of intervention behaviour is unique relationships between two individuals. Even though mothers and daughters were never members of the same herd, five full siblings were housed together (group 1: goats 14/34; group 2: goats 32/33; 26/38 and 15/23; group 3: goats 3/12). It was interesting that, with the exception of goats 14/34, all full siblings had a similar rank. Goats 32/33 were high ranking, 15/23 and 3/12 were medium ranking and 26/38 were low ranking.

Only high ranking full siblings 32/33 profited from a coalition through defending their rank positions together. Goat 32 acted as intervenor twice – in both cases, her sister was involved. Although the full siblings 26/38 assumed the two lowest ranks within the herd, goat 26 acted as intervenor in a fight in which her sister was involved on one occasion.

Milking order and behaviour in milking parlour

The milking order of the young goats was only stable to 58%, whereas the milking order of the older conspecifics was slightly higher at 65%. Regarding different ranks, the higher ranking goats had the most stable milking order (mean stability factor= 0.82), followed by the low ranking animals (0.98). Medium ranking goats had a mean stability factor of 1.07 and were therefore instable in their milking order.

Rank index and milking order correlated negatively in groups 1 (r_s= 0.565; n= 19; p= 0.012; α= 0.05) and 2 (r_s = 0.695; n= 19; p= 0.001; α= 0.05). The higher an individual's rank, the higher the position in the milking order. *Figure 2* shows that animals assuming front positions were mostly high ranking individuals whilst medium and low ranking animals tended to middle and rear positions. However, no correlation was found for group 3 (r_s= -0.377; n= 19; p= 0.111; α= 0.05).

To find out whether there was a relationship between social rank and milk yield. Spearman Correlations were undertaken on rank index and 150-day-yield. Even though high ranking animals had the highest mean milk yield (562 l/150 days) and the medium ranking ones had the lowest mean milk yield (532 l/150 days), no correlations were found between rank and milk yield (group 1: r_s= 0.018; n= 19; p= 0.942; α= 0.05; group 2: r_s= -0.242; n= 19; p= 0.319; α= 0.05; group 3: r_s = -0.304; n= 19; p= 0.206; α= 0.05). The high ranking goats did not always achieve the highest yields. In groups 2 and 3, the respective α-animal achieved the highest yield (goat 40= 615 l; goat 34= 771 l). The opposite was the case in group 1: the Ω-animal had the highest yield (goat 19= 813 l).

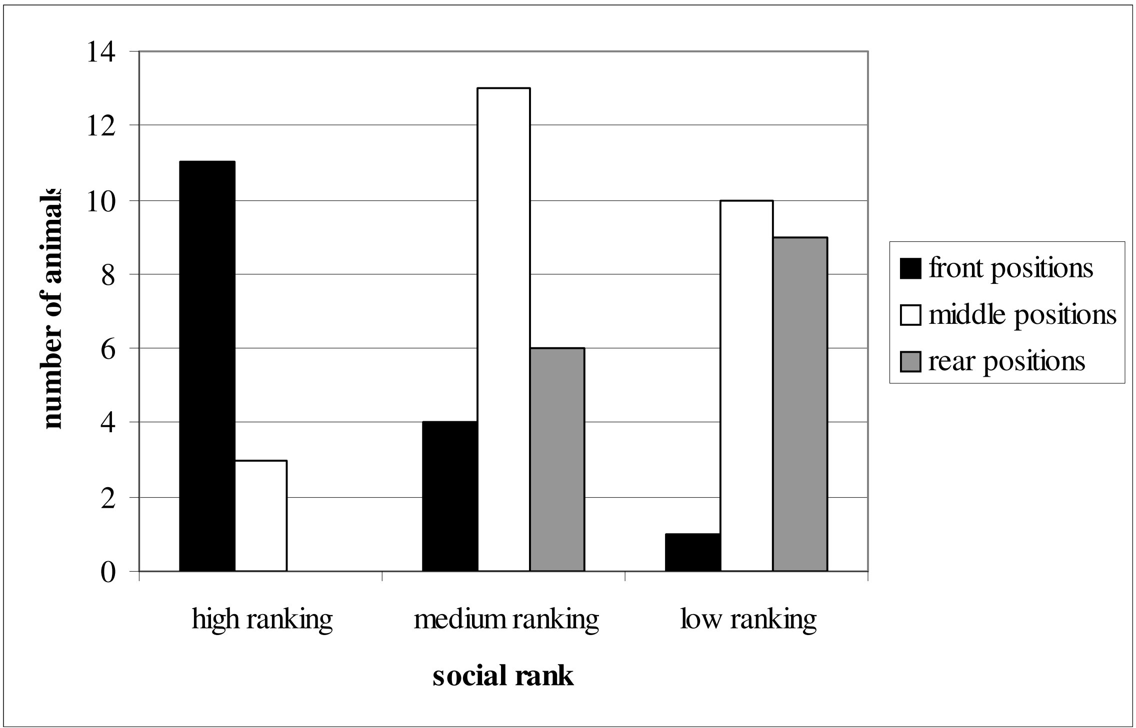

***Figure 2*: Number of animals positioned in front, middle and rear positions of milking order regarding social rank**

Kruskall-Wallis and *Mann-Whitney U tests* were used to identify the statistical relationship between social rank and behaviour in the milking parlour. Dominance behaviour and the behaviour "kick off of milking cluster" were taken into account. There was no significance in the occurrence of dominance behaviour throughout the ranks (group1: χ= 0.587; df= 2; p= 0.745; α= 0.05; group 2: χ= 0.078; df= 2; p= 0.962; α= 0.05; group 3: χ= 0.239; df= 2; p= 0.887; α= 0.05). High ranking animals displayed dominance behaviour in 35%, medium ranking in 33% and low ranking in 32% of the cases. The behaviour "kick off of milking cluster" occurred most frequently in medium ranking individuals (55.2%) and least frequently in high ranking animals (17%). Although a tendency is evident, no statistical significance was found (group1: χ= 1.477; df= 2; p= 0.478; α= 0.05; group 2: χ= 2.050; df= 2; p= 0.359; α= 0.05; group 3: χ= 1.491; df= 2; p= 0.475; α= 0.05). These results indicate that social rank did not affect the behaviour of the animals in the milking parlour.

Stimulation during milking

Group 1 was divided into three sub-groups at milking. The first sub-group was stimulated by hand, the second was not stimulated at all and the third was stimulated by mechanical stimulation. The mechanical stimulation was alternated between alternating pulse frequency (APF) and prestimulation (PS) every two weeks. The behaviour in the milking parlour towards the different stimulation methods was observed. Because the stimulation sub-groups were too small (n<5), no statistical analysis was carried out. Agonistic behaviour as well as the behaviour "kick off of milking cluster" occurred far more frequently in the animals that underwent mechanical stimulation (*Figure 3*). This indicates that both types of machine stimulation were more unpleasant for the goats than hand stimulation or no stimulation. The values of APF and PS hardly differed. Both kinds of machine stimulation obviously had a similar effect on the animals' behaviour.

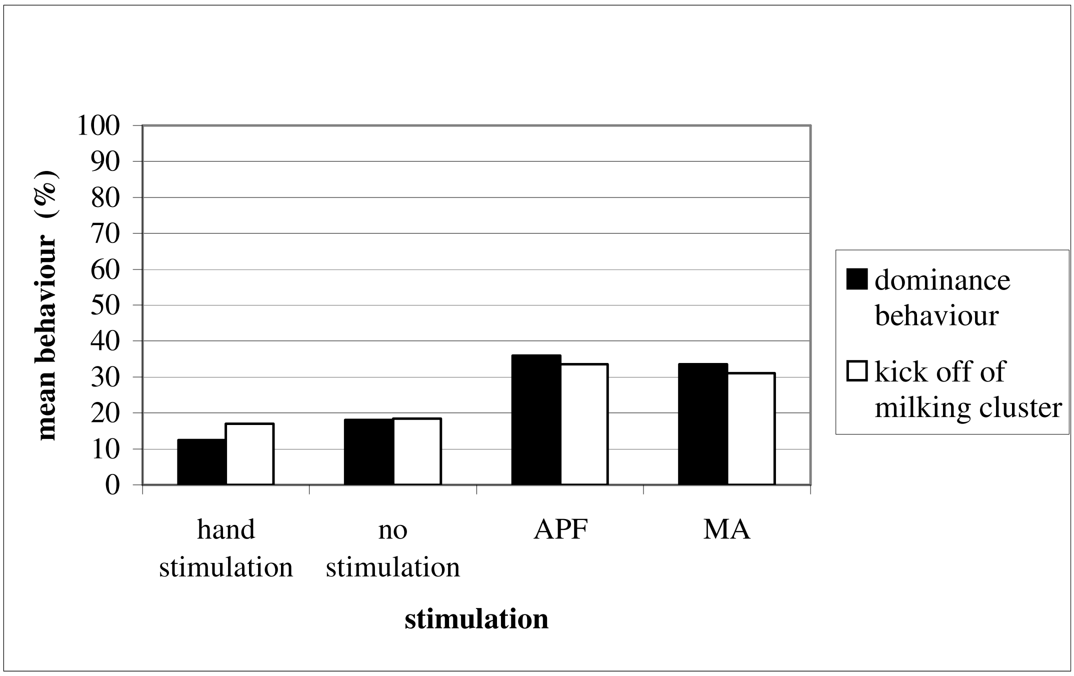

***Figure 3*: Mean percentage of dominance behaviour and kick off of milking cluster in milking parlour within stimulation sub-groups**

Discussion

Social dominance and intervention behaviour

According to *Sambraus* (1991) and *Anonymous* (2003) the rank of each herd member is determined through dominance fights. In groups with established hierarchies, insignificant fights occur only occasionally. However, these fights generally do not create a shift in the hierarchy. Serious fights occur when two unacquainted animals meet. A first encounter can take several hours, during which the animals are fighting until the loser takes flight and with this subordinates itself. After one animal has won, the hierarchy between the two individuals is settled: the winner has a higher rank than the loser. *Keil and Sambraus* (1996) state that in order for a hierarchy to be established, each animal must be familiar with each other group member individually. Recognition is initialized by sniffing at the base of the other's horns. Rather than fighting, the higher ranking animal now assumes a threatening position in order to keep the other at a distance. No physical contact is established during this act (i.e. no danger of injury).

However, under certain circumstances, i.e. competition over resources such as food (*Addison and Baker*, 1982; *Masteller and Bailey*, 1988; *Barroso et al.*, 2000; *Anonymus*, 2003) or resting places (*Barroso et al.*, 2000), a higher ranking individual will drive away a lower ranking group member.

Hierarchies were identified in all three herds; in most cases, α- and Ω-goats could also be determined (*Table 1*). The hierarchies were composed of complex circular relationships and were therefore non-linear. This was due to the husbandry system since some animals had encountered one another as juveniles and others met as mature animals. The relationship between goat 29 and goat 52 (group 1) was an example for this. Since goat 52 was one month older than goat 29, it is possible that she already assumed a higher rank as a juvenile. This established dominance relationship remained unchanged in the following years.

Intervention behaviour in farm animals is known to be unique to goats but there is little documentation. As this behaviour has also been observed in wild ruminants, e.g. Oryx (*Engel*, 1997; *Feuerriegel*, 1997), it does not seem to be a consequence of domestication. It is assumed that this behaviour serves as species preservation and that it is intended to restore harmony within the herd. When wild ungulates direct their attention towards fights within the herd, they are more susceptible to predation as they are less vigilant. This theory is supported by the fact that intervenors only reacted after the fighting had reached a certain intensity or duration (*Engel*, 1997; *Feuerriegel*, 1997). *Keil* and *Sambraus* (1998) discovered that intervenors were high ranking goats. Moreover, the rank relationship between each competitor and the intervenor was especially important.

In this study, it was also the high ranking animals which acted as intervenor most frequently (58%). When the social status of the intervenors is considered in regard to the competitors, the results are similar to those in other publications. The intervenors were higher in rank to at least one of the competing animals in 70% of all cases. Very rarely, the intervenor was subdominant to both competitors.

Since unique relationships between the animals had only been documented in regard to family tree (e.g. mother-daughter, full siblings) and other relationships remained unknown (e.g. which animals had encountered one another as juveniles), this aspect could only be partly analyzed. Five full siblings were housed together. The observations suggest that the social rank of one sister is dependent on that of the other sister. This would explain why most full siblings had similar ranks. It would be interesting to analyze whether intervention has the function of helping a family member or “friend” in further studies.

As stable hierarchies are important for the wellbeing of ungulates, care should be taken not to separate acquainted animals (e.g. full siblings, animals of the same juvenile group, members of an established herd) from one another when keeping dairy goats. It is possible that the removal of one animal could lead to a shift in the hierarchy. This phenomenon would be intensified through possible coalitions. If one coalition partner is removed, the other would have to fight alone and may sink to a lower rank. This disturbance would concern the entire herd.

Milking order and behaviour in milking parlour

Sambraus and Keil (1997) came to the conclusion that the animals tended to assume approximately the same position in the milking order every day and that the milking order is generally constant for a period of time. *Patón et al*. (1995) deem it possible that each goat has a preference for a certain position in the milking order. This means that a given animal assumes a position in the milking order at the beginning of its lactation period and maintains this position throughout lactation (*Sambraus and Keil*, 1997). In this investigation, no herd member was identified as being absolutely consistent in its milking order. However, the individuals assumed similar positions each day. In *Sambraus and Keil* (1997) this was caused by a non-linear dominance structure, meaning that circular relationships within the hierarchy caused daily variations in the milking order. High ranking individuals in *Sambraus and Keil’s* (1997) study did not have a stable milking order. Contrary to these results, the high ranking animals were the most stable in this investigation. The leaders of each herd, however, were not stable in their respective milking orders because they were dominant over all other herd members (except for in group 1) and with that chose their positions in the milking order freely.

Donaldson et al. (1967) found that low ranking goats assumed front positions in the milking parlour. On the other hand, *Sambraus and Keil* (1997) discovered that the animals which assumed front positions in the milking order were high ranking. Due to the animal husbandry system and insufficient space requirements, the low ranking animals took flight from high ranking group members and in turn reached the milking parlour faster. If the space requirements in the approach to the milking parlour are insufficient, the milking parlour is used as an escape route. In this investigation, high ranking animals assumed front positions in the milking order. This situation reflects positively on the husbandry system as the low ranking animals obviously did not flee into the milking parlour from higher ranking individuals. If given the chance, goats will follow a "natural" milking order in which higher ranking individuals take lead and lower ranking animals follow but avoid contact. In this study, the approach to the milking parlour led over an open space, allowing the animals to move freely. The milking personnel may guide the animals into the milking parlour but forcing them is not recommendable or else their "natural" milking order can no longer be maintained.

Barroso et al. (2000) stated that a significant relationship existed between social dominance and milk yield. However, it was not the high ranking animals which achieved the highest yields but the medium ranking goats. These individuals were least stressed by the pressures of a hierarchy. While low ranking animals must constantly avoid group members, high ranking animals must always defend their acquired position in the hierarchy. *Patón et al.* (1995) came to a different conclusion. In their study, high ranking goats achieved the highest yields.

Addison and Baker (1982) found that low ranking goats were under more pressure due to dominance fights and therefore had lower milk yields. In this study, no statistical relationship could be proven between social rank and milk yield. This implies that lower ranking animals were not at a disadvantage in this husbandry system.

Stimulation during milking

To investigate whether milk flow rate in goats can be increased and milking duration can be decreased by mechanical stimulation, group 1 was stimulated by alternating *pulse frequency* and *prestimulation*. Both forms of mechanical stimulation led to increased intensities of agonistic behaviour and the behaviour "kick off of milking cluster". Defensive behaviour in a goat which is used to the milking procedure indicates pain to the animal (*Anonymous*, 2003). Mechanical stimulation can be unpleasant for the animals due to high frequent pulsation. However, the general behaviour of the animals did not imply severe pain. The mechanical stimulation appeared to be unpleasant to the animals.

The investigated mechanical stimulations are not practical in dairy goats as the animals reacted uneasily towards them. However, the final results concerning effect of mechanical stimulation on duration of milking and milk yield are being awaited (*Müller*, paper being to be published).

Conclusion

The goat herds investigated in this study had non-linear hierarchies which consisted of complex circular relationships. Intervention behaviour was displayed either by goats which were dominant over at least one of the competitors or by high ranking individuals while lower ranking animals rarely acted as intervenor. High ranking goats assumed front positions in the milking parlour, indicating that social rank affects milking order. As the animals reacted uneasily towards both forms of mechanical stimulation, these were considered as unpleasant.

References

Addison, W.E., Baker, E. (1982): Agonistic behavior and social organization in a herd of goats as affected by the introduction of non-members. Applied Animal Ethology 8: 527-535.

Anonymous (2003): Artgerechte Ziegenhaltung – Merkblatt Nr. 93. Tierärztliche Vereinigung für Tierschutz e.V., Bramsche.

Barroso, F.G., Alados, C.L., Boza, J. (2000): Social hierarchy in the domestic goat: effect on food habits and production. Applied Animal Behaviour Science 69: 35-53.

Donaldson, S.L., Albright, J.L., Black, W.C., Ross, M.A., Barth, K.M. (1967): Relationship between entrance order and social dominance in dairy goats. American Zoology 7: 807.

Engel, J. (1997): Die Bedeutung von Junggesellengruppen für die Haltung von Säbelantilopen (*Oryx damma*) in Zoologischen Gärten. Dissertations These, Universität Erlangen-Nürnberg.

Escós, J., Alados, C.L., Boza, J. (1993): Leadership in a domestic goat herd. Applied Animal Behaviour Science 38: (1) 41-47.

Feuerriegel, K. (1997): Aspects of oryx behaviour and ist relevance to management. Dissertation thesis, Hamburg University.

Fournier, F., Festa-Bianchet, M. (1995): Social dominance in adult female mountain goats. Animal Behaviour 49: 1449-1459.

Hamann, J., Tolle, A. (1980): Comparison between manual and mechanical stimulation. Milchwissenschaft 35: (5) 271-273.

Hamann, J., Mein, G.A., Wetzel, S. (1993): Teat tissue reactions to milking: effects of vacuum level. Journal of Dairy Science 76: 1040-1046.

Keil, N.M., Sambraus, H.H. (1996): Zum Sozialverhalten von Milchziegen in grossen Gruppen. Archiv für Tierzucht 39: (4) 465-473.

Keil, N.M., Sambraus, H.H. (1998): „Schlichter" bei sozialen Auseinandersetzungen von Hausziegen. Zeitschrift für Säugetierkunde 63: 266-272.

Masteller, M.A., Bailey, J.A. (1988): Agonistic Behaviour among mountain goats foraging in winter. Canadian Journal of Zoology 66: 2585-2588.

Patón, D., Martín, L., Cereijo, M., Rota, A., Rojas, A., Tovar, J. (1995): Relationship between rank order and productive parameters in Verata goats during milking. Animal Science 61: 545-551.

Ross, S., Scott, J.P. (1949): Relationships between dominance and control of movements in goats. Journal of Comparative Physiological Psychology 42: 75-80.

Sambraus, H.H. (1971): Das Sozialverhalten von domestizierten Ziegen. Zeitschrift für Säugetierkunde 36: 220-224.

Sambraus, H.H. (1991): Nutztierkunde. Verlag Eugen Ulmer GmbH & Co., Stuttgart.

Sambraus, H.H., Keil, N.M. (1997): Die Konstanz der Melkordnung von Ziegen in großen Gruppen. Journal of Animal Breeding and Genetics 114: 397-404.

Shank, C.C. (1972): Some aspects of social behaviour in a population of feral goats (Capra hircus). Zeitschrift für Tierpsychologie 3: 488-528.

Stewart, J.C., Scott, J.P. (1947): Lack of correlation between leadership and dominance relationship in a herd of goats. Journal of Comparative and Physiological Psychology 40: 255-264.