Thesis of Ph.D. dissertation

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Gödöllő

2015

SZENT ISTVÁN UNIVERSITY

FACULTY OF AGRICULTURAL AND ENVIRONMENTAL SCIENCES

THE EFFECT OF SOCIAL INTERACTION ON THE KEEPING OF WILD BOAR IN CAPTIVITY

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Gödöllő

2015

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1. BACKGROUND AND AIMS

About 30-35% of the Hungarian hunting companies' income comes from the utilization of wild boar. It is much harder to satisfy the guests' increasing hunting claims in open field, so the operators of the wild boar preserves are interested in breeding wild boars in captivity to establish suitable garden live-stock: a well formed wild boar preserve can provide the same experience for hunting guests, so the number of wild boar preserves in Hungary increased. The owners try to increase reproduction and breeding in order to create better livestock in the preserves, thus more intense husbandry technologies can be seen.

European wild boar (Sus scrofa) naturally lives in groups (sounder), consist of sows in relation with each other, their piglets and yearlings (MEYNHARDT 1986). The members of the group live in a tight relationship, therefore social interactions are common and have a strong impact on the wild boars' well-being. The borders between different sounders are well-defined (PÁLL 1982), that is mostly observable on feeding places. There are strict rules in the family groups, hierarchy provides peaceful coexistence between the members. These social groups can change in captivity, especially in intense husbandry where there is no possibility or space to form proper groups. In preserves the group size and density is determined ahead for the maximum economic profit without paying attention to the optimal circumstances for the animals, which proposes many questions. What is the optimal area size or density for the animals? What is the ideal feeding technology? How do the wild boars use the feeders in a wild boar preserve? I have tried to answer these questions in my dissertation.

1. 2. Aims

1. 2. 1. Determination of behavioural units

Previous examinations with domestic pigs were carried out mostly with newly formed groups (e. g. NIELSEN et al. 1995), where the aggressive-submissive behaviour units are more obvious, than in groups living together long. First I have to create my own point of view system to measure and compare the behaviour of the animals with:

1. *To determine aggressive and submissive behavioural units connected to conflict behaviour.*
2. *To test the recognizability of determined behavioural units with independent observers.*

1. 2. 2. The examinations of hierarchy dependent behaviours

According to many researchers (e. g. JANSON 1985) the rank position occupied in the hierarchy can have an effect on feeding behaviour, so the higher rank position has a bigger feeding success. I compared the rank dependent behaviour of three groups (sows, wild boar males, wild boar x mangalica crossbreed males) kept in intensive technology and tried to answer for the following questions:

3. *Does it form a linear hierarchy in groups living together for 8 months at least?*

One of the assumptions is no, because the opportunity of a linear hierarhy's development is considerably rare in the case of a group consisting of 7-8 individuals (MESTERTON-GIBBONS and DUGATKIN 1995).

At the same time others mentioned linear hierarchy in a group of 7 wild boars in a zoo (SCHNEBEL and GRISWOLD 1983).

4. *Is there a relationship between the rank position (RI) and the feeding behaviour?*

My hypotheses was that there will be relationship which has been proved already in case of other species (e. g. macaque: DITTUS 1979). I supposed that the relationship will be positive, so the dominant individuals will spend more time with feeding.

The other hypotheses was that the feeding behaviour will not differ among the individuals, because the amount of the fodder will be enough (BROUNS and EDWARDS 1994).

5. *Is there a relationship between the rank position (RI) and the aggressive-submissive behaviour?*

I supposed that there will be a context between the RI and the aggressive behaviour, the higher ranking individuals will show more aggressive behaviour units than the lower ranking individuals. At the same time the lower ranking animals will show more submissive behaviour units than the higher ranking individuals.

1. 2. 3. Area effect

Previous researches have contrary results how the aggressive behaviour of domestic pigs changes under area decrease: there are researchers who experienced the increase of the aggression (e. g. WENG et al. 1998), while others examined on the contrary (ANDERSEN et al. 2004). Based on the above my question was:

6. *How does the aggressive-submissive behaviour of the sows change if the area size decrease?*

I supposed that the smaller area of the individuals will increase the aggression which was proved already in the case of domestic pigs (EWBANK and BRYANT 1972).

1. 2. 4. Home range examination

According to the literature (e. g. KEULING et al. 2008) the home range of wild boars can be much larger than the area size of an avarage preserve. The behaviour of the animals may change due to the limited space compared to the behaviour of the open space wild boars. My questions were:

7. *Do the wild boars use the whole area of the preserve?*
8. *Do the wild boars divide the feeding places in the wild boar preserve?*

I supposed it do, because the area size (340 ha) of the preserve is much smaller than wild boars' home range mentioned in the literature.

At the same time it is possible, that the behaviour of the wild boars will remind better of the behaviour of the animals kept in small enclousers and the different sounders (individuals) will move on the neighbourhood of one feeder and the whole area of the preserve will not be used.

1. 2. 5. Feeding arrangements

Animals are fed in several different ways in the preserves and in wild boar farms without examine how to affect to the behaviour of the individuals. The fodder is placed mostly in a long line, in piles or dispersed in a larger surface. It is supposed from previous researches (e. g. BROUNS and EDWARDS 1994), that the feeding arrangements affects the behaviour of the individuals. My question was:

9. *How does a different layout of the feeding arrangement (line, piles, disperse) affect the feeding behaviour individually and in group-level?*

Fodder placed in line may reduce the aggression, because the individuals may use a section of the line.

Supposedly the evenly dispersed corn reduce the aggression, because the corn is not aggregate so much to do fighting for it.

At the same time fodder placed in piles can increase the intake of the corn, but moving among the patches and the fight for the occupation of the patch can reduce the feeding time.

2. MATERIAL AND METHODS

There were two study areas. The behavioural examinations took place at the Horatius Animal Coordination Centre in Gödöllő, where I have been living for more than 12 years with many different wild animals, like wild boars, wolves, deers and bears. The open field examination was carried out in the Karád Wild boar Preserve, property of SEFAG Zrt, with a population of more than 350 wild boars.

2. 1. The examined animals

There were three groups in the examinations. The group of *sows* (average weight±SD: 69±17.62 kg; average age±SD: 4.87±1.68 year) included 4 wild boars and 3 crossbreeds (Wild boar x Vietnamese pot-bellied pig). Each animal could be identified by its distinct physical characteristics. All of them have been living together for more than one year, it was supposedly a stable hierarchy among them.

The group of males included 10 five-year-old *wild boars*, they have been living together since they were piglets. The group was transported to the place of examination from Nagygombos a year earlier. It was difficult to identify the males, almost impossible on video films. I did not have a possibility to mark them, so after a longer observation period I was able to identify 3 of them whose behaviour was compared later on.

The third group included 7 *wild boar x mangalica crossbreed* (75%-25%) boars, they have been living together since their childhood. At the time of the examination they were five years old. They were transported to the place of examination from Heréd 1,5 year before the experiment. The animals were identified by furpaint marks (Porcimark 200 ml) to be able to identify rank positions.

The sows were included in the experiment of determination of behavioural units and the effects of area decrease, the male groups were used in the feeding experiment.

2. 2. Determination of behavioural units and testing their reliability

To determine the behavioural units the sows were observed for three days followed each other at feeding time for an hour. Every kind of behaviour seen was noted, then the aggressive and submissive behavioural units accurately defined. The reliability of behavioural units was tested with the help of independent observers (MARTIN and BATESON 1993).

2. 3. Hierarchy dependent examinations

2. 3. 1. Statement of the hierarchy

The animals included in my experiments have been living together for a long time, so to set up the hierarchy and examine the dominant and subordinant relations, food competition situations were used. A hierarchy was set up among the sows based on observed wins and defeats per pairs (dyads). The method I used was adapted from a method developed by JAMESON et al. (1999) and carried out by BATCHELDER et al. (1992) to map the hierarchy of 68 stags. The procedure is based on a mathematical model of even comparisons, involving an evaluation method. According to their results, the dominance can be determined by the scale values provided by the model, based on the comparison of animals-pair (dyad). I modified this calculation to count the hierarchy among the sows, and may have established the hierarchy's quality (ÚJVÁRY et al. 2012). I applied the formula onto dyads. The formula is: $\mathbf{R_{ij}=(V_{ij}-D_{ij})/N_{ij}}$, (where R_{ij} is *i* individual's dominance value compared to *j* individual; V_{ij} is the number of *i* individual's victories against *j* individual; D_{ij} is the number of *i* individual's defeats against *j* individual; N_{ij} is the number of encounters between *i* and *j* individuals - I did not take neutral encounters into

consideration). The calculations were made for each sow. As one of the pair's members (i) was always the same individual, only the *j* individual changed. I therefore compared *i* individual with the *j1, j2, j3, j4, j5* and *j6* individuals (6 dyads). Based on the formula, all sows received six D_{ij} values, which were averaged. The position a given sow occupied in a hierarchy is verifiable based on the average D_{ij} value (RI-rank index: $-1 \geq RI \leq 1$), and the hierarchy's quality is verifiable based on the 7 average D_{ij}.

In the *male wild boar* group it was impossible to identify the total hierarchy, because of the lack of individual recognizability, therefore I could only compare 3 of the boars.

In the group of *wild boar x mangalica crossbreed* the calculation method used with the sows did not prove to be useable to identify hierarchy, because there was not any interaction between two of the boars. To identify the correct hierarchy I used a different, but similar calculation which was used by BORBERG and HOY (2009). The RI calculation was based on the number of won and lost fights of the individual, how many others beat or failed to beat it. The correct formula is: $\mathbf{RI=[(S*P_s)-(N*P_n)]/(S+N)*(n-1)}$ (where **S:** is the number of won fights, $\mathbf{P_s}$: the number of those that were beaten by the individual, **N**: is the number of lost fights, $\mathbf{P_n}$: is the number of those that won the fight against the individual, **n**: is the group size).

2. 3. 2. The place occupied in the hierarchy and the behavioural elements

I dispersed corn kernels on the ground which correspond to a surface of approximately 2 m long and 60 cm and recorded the **sows**' behaviour with a video camera daily for 10 minutes at the feeding-time for 10 days. I dispersed corn kernels on the ground which correspond to a surface of approximately 14,5 m long and 60 cm and recorded the **wild boars**' behaviour for 20 minutes at the feeding-time for 6 days. I dispersed corn kernels on the ground which correspond to a surface of approximately 11,5 m long and 60 cm and recorded

the **crossbreed boars**' behaviour daily for 20 minutes at the feeding-time for 6 days. The changes in time spent feeding, *other* category and aggressive-submissive behavioural units were examined individually.

2. 4. Area decrease

The sows took part in this experiment. The animals were living in a pen of 62,5 meters length and 13 meters width (783,25 m^2; 'big area'). I dispersed corn kernels on the ground which correspond to a surface of approximately 2 m long and 60 cm and recorded the animals' behaviour with a video camera daily for 10 minutes at the feeding-time for 10 days. Later the area was decreased onto a smaller one (165,75 m^2; "small area"). The examination was carried on the day following the transfer. The records were made at the same way. The frequency of the aggressive and submissive behavioural elements were analyzed.

2. 5. Home range examination

The aim of the home range examination was to establish how the animals divide the feeders in a 340 ha wild boar preserve, or rather do they make use of the whole area of the preserve. We judged the movings of the animals by the location of the coloured faeces. The used markers were glitters, known by cosmetics and decoration techniques (BUCZKÓ and HELTAI 2010).

2. 5. 1. Testing the usability of the glitters

In preliminary examinations we established that glitters did not cause any physical problems in wild boars and they were traceable from the faeces. Glitters marked the faeces after 24 hours and were visible for five days after consumption.

Wild boars could move free in the whole Karádi Wild boar preserve. The study occurred during the winter. Four feeding places were present in the preserve; the mean length was 200 metres.

We marked the forage (corn) at the feeding sites with colourful glitters (Panduro, Glitter flakes, 0,6mm), with one specific colour (green, silver, red, dark blue) for each feeder. 750 kg of corn was used per feeding sites and was marked with 1 kg of glitters. Faeces were collected four days later. On the same day, as the faeces were collected, the marking was repeated with four other colours (gold, purple, white, light blue) and faeces were collected another four days later. Between the two marking days, the feeding sites were not repositioned or moved in any way.

Faeces were collected following four specified routes: a) between the feeding sites, following the paths commonly used by the animals; b) next to the fence (at about 5 metres from it); c) from north to south following the preserve service roads; d) from west to east following the preserve service roads. The entire length of the routes was 13.716 metres. The mean distance between the feeders was 770 metres (SD=198.37). For each route two people collected fresh faeces, one on each side of the roads, except regarding the route next to the fence for which only one person was in charge of the collection.

The location of the fresh faeces found was registered using GPS, the samples were washing under flowing water with smaller and smaller hole and we noted the colours found in them.

We created minimum convex polygons (MCP) (MOHR 1947, WHITE and GARROTT 1990) for each glitter colour. We intersected the overlapping MCPs of the colours that were fed the same days and the sizes of the overlapping areas were calculated.

In order to test the correlation between the distance from the feeders and the frequencies of the faeces found, buffers was created around the feeding sites (8 rings with a radius of 100 metres) and dissolved the barriers between them.

The frequencies of faeces locations for each 100 metre distance ring was calculated regardless of glitter colour. Linear regression was used to test the relationship between the distance categories and the frequencies of faeces locations.

All spatial analyses were performed using *Arcview GIS* (v3.1). All statistical analyses were performed using *Graphpad InStat* (3.05).

2. 6. Examination of the layout of the feeding arrangement

In this examination the method of corn dispersal was varied in the two male groups. The changes in time spent feeding and in aggressive or submissive behavioural units either individually or as a group were examined.

Through three continuous weeks, the corn dispersal method was changed weekly, always the same amount corn and the same feeding surface size was used.

On the first week a long diagonal line of corn was made in the middle of the feeding site. I repeated this in the following 6 days, I recorded 20 minutes. The following week the corn was placed in 15 piles arranged in 3x5 in the group of wild boar males, while 10 piles were placed in the group of crossbreed males arranged in 3-4-3. On the third week the corn was dispersed evenly in the whole feeding site.

2. 7. Statistics

To analyze the data SPSS statistic program was used. The normality of the distribution regarding each variable was tested with a *Kolmogorov-Smirnov* test. Because of the normal distribution of data regarding the sows, *Pearson Rank correlation* test was used to search for relationships between the different dependent (feeding, aggression, submission, other) and independent (rank, weight, age) variables and rank position. Because of the non-parametric distribution of data regarding the boars, *Spearman correlation* test was used to

search for relationships between the different dependent (feeding, aggression, submission, other) variables and rank position (in results, by all three groups the negative sign by the 'r' value means that the place occupied in the hierarchy starts from the small towards the bigger one, so the number of the leader is 1).

Because of the data's normal distribution, *paired-samples T-tests* was used to compare the frequency of behavioural elements showed in the "small" and the "big" area. The relation of the occurring behavioural patterns on the given areas to each other was tested with a *one-way ANOVA* and *S-N-K post-hoc* tests.

Kruskall-Wallis test and *Duncan post-hoc* test was used to compare the test days and the feeding methods. *Spearman correlation* was used to examine the correlation between the rank position and the different variables (feeding, aggression, submission, other).

3. RESULTS

3. 1. Determination of behavioural units and testing their reliability

The only mentioned behavioural unit previously noted by other researchers was the bite (JENSEN and YNGVESSON, 1998) in the group of the sows.

In my research the behavioural units were put into three category: dominant, submissive and neutral. Dominant behavioural elements are: *hit, bite, running toward somebody* and *chasing*. The submissive behavioural elements are: *head lift, recess, avoidance* and *escape*. Neutral units are: *feeding* and *other* (1. table).

1. table. Defined behavioural units.

Dominant	
Hit	One individual delivered a knock with the head against the head, body or neck of the other individual with **closed mouth**.
Bite	One individual delivered a knock with the head against the head, body or neck of the other individual with **open mouth** (JENSEN and YNGVESSON, 1998).
Running toward somebody	Fast approach toward another boar with closed or open mouth for maximum 2 seconds. The movement is longer than 1 meter.
Chasing	Fast approach towards another boar with closed or open mouth for more than 2 seconds. There is no physical contact.
Submissive	
Head lift	Standing in one place and orienting to the attacker with raising head and voice while conracting its body. The individual can go to recess or escape from this position or the attacker leaves.
Recess	Moving away from the attacker caused by any agressive behaviour. Moving is maximum 2 metres.
Avoidance	The evasion of the other individual showing passive behaviour with changing the direction.
Escape	Runaway into a contrary direction of the attacker caused by any of the agressive behaviour more than 2 metres.
Neutral	
Feeding	The head of the individual is over the forage and it can root.
Other	The behaviour of the individual can not be assigned into any of the categories. Into the behavioural category *other*

	behaviour was considered where the sow located far from the corn stopped walking, orientating its attention in the direction of the food and waited.

In the male groups the *bite* element could not be used reliably, thus the element *hit* was redifined. On the other hand there was a new dominant element seen in the male groups: *moving toward somebody* (2. table).

2. table. Modified and new behavioural units.

Hit	One individual delivered a knock with the head against the head, body or neck of the other individual with **open or closed mouth**. Each push movement should be counted as one.
Moving toward somebody	The individual runs towards the other for maximum 2 seconds with closed or open mouth. The movement is no longer than 1 metre.

To check the reliability of the behavioural variables *concordance index (KI)* was counted between independent observers. The results were the followings for the different behavioural units: *moving toward somebody* (**0,92**); *running toward somebody* (**0,91**); *hit* (**0,81**); *chase* (**0,81**); *headlift* (**1**); *recess* (**0,93**); *avoidance* (**0,96**); *escape* (**0,76**).

3. 2. Ranking and correlation between rank positions and behavioural units

3. 2. 1. Sows

I established a linear hierarchy among the sows based on average dominance values. I did not find any significant correlations between *age* and the *rank* position (r=-0.718, N=7, p= 0.069), *weight* and the *rank* position (r=-0.688, N=7, p=0.088). However after excluding the youngest and lightest leader from the analysis, who has been living in the area since the age of piglet,

significant correspondence were found between rank and age (r=-0,811, p=0,05, N=6) and weight (r=0,952, p=0,003, N=6). In that case the older and bigger weighted sows occupied the higher ranks in the hierarchy.

I found a strong positive correlation between the *rank* and the *time spent feeding* (r=-0,796; p<0,001; N=70). Likewise, I found a positive correlation between the *rank* and the *time spent displaying aggressive behaviour* (r=-0,686; p<0,001; N=70). I received a negative correlation between the *rank* and the time *spent displaying submissive behaviour* (r=0,723; p<0,001; N=70). I received a negative correlation between the *rank* and the *time spent with others* (r=0,775; p<0,001; N=70).

3. 2. 2. Wild boars

Three out of the 10 wild boar males were recognizable: the alfa male, the omega male, and the third one seemed to have a position in the last third of the hierarchy. The comparative examinations were carried out between these three males.

I found positive correlation between the *rank* and the *time spent feeding* (r_s=-0,748, p<0,001, N=18). Likewise I found a positive correlation between the *rank* and the *time spent displaying aggressive behaviour* (r_s=-0,855, p<0,001, N=18). I received a negative correlation between the *rank* and the time *spent displaying submissive behaviour* (r_s=0,895, p<0,001, N=18). I received a negative correlation between the *rank* and the *time spent with others* (r_s=0,787, p<0,001, N=18).

3. 2. 3. Wild boar x mangalica crossbreed boars

I set up linear hierarchy among the crossbreed boars. I found a medium strong positive correlation between the *rank* and the *time spent feeding* (r_s=-0,393, p=0,010, N=42). Likewise I found a positive correlation between the *rank* and the *time spent displaying aggressive behaviour* (r_s=-0,688, p<0,001, N=42).

I received a negative correlation between the *rank* and the time *spent displaying submissive behaviour* (r_s=0,776, p<0,001, N=42). We received a negative correlation between the *rank* and the *time spent with others* (r_s=0,405, p=0,008, N=42).

3. 3. Area decrease

Compare the aggressive and submissive behavioural units showed in "small" and "big area", the frequency of both behavioural categories was increased (*aggression*: t=-4,823, df=39, p<0,001; *submission*: t=-5,722, df=39, p<0,001). Significant differences were found in the variable *running toward somebody* (t=-6.4; df=9; p<0.001), *hit* (t=-5.572, df=9, p<0.001), *recess* (t=-2.4, df=9, p=0.04), *avoidance* (t=-6.326, df=9, p<0.001) and *escape* (t=-8.281, df=9, p<0.001). The frequency of these behavioural elements increased significantly in the "small" area.

3. 4. Use of feeding sites

We collected 210 samples and glitters were found in 162 (77,1%) samples. Among them 70% contained at least 3 different colours. Colours overlapped largely with each other. Additionally the MCPs of each colour contained colours from other feeding places. The results of both examinations were not much different from each other. Thus the animals seemed to move in similar areas.

The frequency of the colours decreased with the distance from their feeding sites, but increased when approaching other feeding places, the wild boars spent more time nearby feeding sites, used it more intensive than other part of the preserve.

3. 5. Feeding arrangement

3. 5. 1. Wild boar males

Comparing the three layouts of feeding arrangement, on a group level there was a significant difference with *feeding* (chi^2=120,392, df=2, p < 0,001) time: the boars spent the most time with feeding when the corn was dispersed evenly. The alfa male spent more time with feeding than the others in lower positions in all three layout variations. However, changing the method of corn dispersal made the omega male spend more time with feeding. The omega male spent the least time with feeding (**30,5 %**, chi^2=14,764, df=2, p=0,001) when the corn was dispersed in a line, while it spent the most when the corn was evenly dispersed (**92,4%**). The same happened to the male from the last third of the hierarchy: it spent the least time with feeding (**40,6 %**, chi^2=14,327, df=2, p=0,001) when the corn was in a line and the most time when it was spread evenly (**94,4%**).

3. 5. 2. Wild boar x mangalica crossbreed boar males

Comparing the three layouts of feeding arrangement, on a group level there was a significant difference in *feeding* (chi^2=48,46, df=2, p < 0,001) time. The crossbreed males spent the most time with feeding when the corn was dispersed evenly. The layout of feeding arrangement affected the feeding behaviour of the boars, there was a significant difference between the three layouts. This was not true for the alfa male (Rank#1).

3. 6. New scientific results

1. The research defined less obvious behavioural elements in wild boar groups with stable hierarchy.
2. It proved that the rank position of wild boars correlates with the time spent feeding, so the higher the rank position of the male or female, the longer time they spent with feeding.

3. The thesis made it clear that if the size of the habitat is decreased, the aggression and submission increase and the subordinate wild boar sows chose to use a physical contact avoiding strategy: the avoidance.
4. The feeding site experiment showed that the wild boars do not use the whole area of the preserve, despite of its much smaller size to their home range.
5. It also proved that in the 340 ha preserve the sounders do not share the feeding sites, every animal uses every feeding site and the most important routes are between the feeding sites.
6. The thesis evinced that regarding wild boar management in captivity the method of corn dispersal affects the feeding behaviour of wild boar males, with the appropriate layout of feeding arrangement (corn disperse) the disadvantages of low ranking individuals can be eliminated.

4. CONCLUSIONS AND FUTURE RECOMMENDATIONS

4. 1. Dominant and submissive behavioural units and their reliability

It was necessary to create my own point of view system, because the members of the groups examined have been living together for long, hence the level of aggression is lower than in a newly formed group, the aggressive and submissive behavioural units are not that obvious. There are different opinions on whether to note only the obvious aggressive-submissive behaviour elements, like fights, or it is worth to note the less obvious ones like threats and avoidance (LEHNER 1996), because the separation of these elements is unreliable. In my thesis the high concordance indexes between the observers proved that the aggressive and submissive behavioural units can be seperated clearly.

The behavioural units defined by this research: *moving and running toward somebody* which is a threat shown by the dominant animal. These two units only differ in time and distance, still can express the level of aggression as well (ÚJVÁRY et al. 2012). Based on the new definitions formed by my thesis the level of aggression can be ranked where the weakest is the *moving toward somebody* which is a warning behaviour element, not necessarily causes a reaction in the threatened animal. *Running toward somebody* is a more aggressive movement and based on my observations it was always followed by a reaction from the attacked animal. The next step is the *hit* which includes physical contact, then the strongest is the *chase*, because this „steals" the most time from feeding, the aggressor uses the most energy for this element.

The submissive behavioural units defined by this thesis can be ranked by the reactions to the aggressor. The weakest submissive unit is the *head lift.* This is often enough for the aggressor to leave the „attacked" animal alone. The *recess* and *escape* only differ in the distance used to move away from the aggressor. This also shows the level of submission, the further the submissive wild boar moves, the stronger submissive behaviour it displays. The *avoidance*

is a conflict avoiding behaviour unit, it can be seen without direct aggression: the approach of the dominant animal is enough for the submissive individual to display this behavioural element.

Tracking the change of the behavioural units during the research allows not only quantitative analyzis but qualitative as well.

4. 2. Rank place occupied in hierarchy

Linear hierarchies were set up among the 7 sows and among the 7 boars. It corroborates the findings of others (e. g. DREWS 1993), but contradicts with MESTERTON-GIBBONS and DUGATKIN (1995), who found that the opportunity of a linear hierarchy's development is considerably rare in case of a group consisting of 7-8 individuals.

The research found positive correlation between ranking and time spent feeding, so the higher the rank position of sow or male was, the more time they spent with feeding. The strongest correlation was found in the group of sows, which means that forming hierarchy is the most important in their group. In nature wild boars live in family groups which includes sows, their piglets and yearlings. The correlation was weaker in the wild boar groups: in nature they leave the group in young age, then live in a loose male group where hierarchy plays a role, but the group breaks up soon and from then males live in solitary. The weakest correlation was in the group of crossbreeds. It might be caused by domestication where human tried to reduce aggression, so domestic pigs are less aggressive than wild boars.

4. 3. Area decrease

More aggressive and submissive behaviour was observed in group level when the area was decreased: the number of *running toward somebody*, *hit* and *bite* raised. The *chase* which is the strongest aggressive unit reduced, maybe because the smaller space was not fortunate for this type of movements. My

results agree with numerous researchers' (poultry: ADAMS and CRAIG 1984; domestic pig: WENG et al. 1998; sheep: DOVE et al. 1974), the high density causes increased aggression in most animals in husbandry.

To compare the four submissive behavioural variables the *avoidance* and *escape* behavioural units occurred mostly in the "small area". *Escape* is an answer to aggression and domination, while the *avoidance* marks a conflict-avoiding behaviour. Based on my and other's (THOULES 1990) results it can say that the food competition could be a passive process, which appears through the conflict-avoiding behaviour of the subordinates individuals, that in case of wild boar sows amplified due to the area decrease.

4. 4. Use of feeding sites

Seventy % of the faeces with glitters contained at least 3 different colours, meaning that the animals used at least 3 feeding places. Therefore wild boars did not divide the feeding sites among themselves and each animal used more than one feeder. However it is an open question how sounders behaved at feeding sites. PÁLL (1982) say that strange sounders or individuals get not mixed even at feeding places, fightings will occur certainly among them if the personal space is violated. My observations contradict to it, but it is possible that wild boars (sounders) divided the feeding sites in time, all sounders arrived and departed from the feeders in particular time, but for this the condition is that one sounder could not eat up the feeder, there has to be sufficiency (nearby ad libitum) food.

The minimal difference between the MCPs of the two days means that the behaviour of the animals changes, feeders are not used daily. The MCPs based on faeces collection in our study did not cover the whole area of the preserve, despite the fact that wild boar's home range can be much larger than 340 ha (e.g. MAILLARD and FOURNIER 1995, SODEIKAT and POHLMEYER 2002). The probability of finding a specific colour decreased by

the distance to its original feeder, but increased again at other feeding sites. Thus, wild boars appeared to move among the feeding places and spent longer time in there compared to other places (ÚJVÁRY et al. 2014). The large number of colours found at the feeding sites of the same colour show that the animals returned to the original site within a short time (RIBÁCS et al. 2009).

4. 5. Examination of the layout of feeding arrangement

In the case of wild boar husbandry the most common feeding procedure is to disperse the fodder on the ground. There are feeding procedures which can cause bigger competition between the group members and it can be detrimental for the ones in lower rank positions. Based on my results it can be stated that in the case of the two male groups the evenly dispersed corn provided the most time for feeding for the group, because this way they could keep the most distance from each other. The most aggression occured when the corn was dispersed in a line which agrees with the results of ANDERSEN et al (1999). The crossbreed boars spent the most time with *other* category at feedings of piles, included the changing among the piles. The same behaviour was observed at the alpha boar in the wild boar group. If the results are evaluated by the rank positions, it shows that changing the method of feeding can eliminate the disadvantages of individuals being in the bottom of hierarchy in both groups, so when fodder is dispersed evenly, time spent with feeding increases in the case of lower ranking individuals.

To establish a suitable garden live-stock an ecological and ethological basis of farming is indispensable, which is based on the knowledge of the animals' behaviour, their interactions with each other and the hierarchy: the managers can predict the form or level of aggression in the newly formed groups and with the appropriate actions the behavioural problems can be eliminated.

5. PUBLICATIONS RELATED TO THE SUBJECT OF THE THESIS

5. 1. Publications in scientific magazines with impact factor

ÚJVÁRY, D., SCHALLY, G., BUCZKÓ, M., SZABÓ, L., SZEMETHY, L. (2014): A simple method for the assessment of wild boars' *(Sus scrofa)* habitat use. In: *Journal of Veterinary Behavior: Clinical Applications and Research*, 9 (3) 127-130. p.

ÚJVÁRY, D., HORVÁTH, ZS., SZEMETHY, L. (2012): Effect of area decrease in a food competition situation in captive wild boars (Sus scrofa). In: *Journal of Veterinary Behavior: Clinical Applications and Research,* 7, 238-244. p.

5. 2. Publications in scientific journals without impact factor

BIRÓ, ZS., KATONA, K., BLEIER, N., LEHOCZKI, R., **ÚJVÁRY, D**., SZILÁGYI, ZS., MARKOLT, F. ÉS SZEMETHY, L. (2012): A kőrösladányi vadaskert vaddisznó állományának hatása a védett növényekre. In: *Természetvédelmi Közlemények*, 18, 67-76.p.

ÚJVÁRY, D., SZEMETHY, L. (2010): Keeping and feeding problems of wild boars in captivity. In*: Hungarian Agricultural Research,* 20 (3), 18-21. p.

5. 3. Publications in Hungarian scientific magazines

ÚJVÁRY, D., HORVÁTH, Zs., és SZEMETHY, L. (2009): Rangsor a rácson belül. In: *Magyar Vadászlap,* 18 (6) 369-371. p.

5. 4. Book unit (Hungarian)

ÚJVÁRY, D., SZEMETHY, L. (2010): Rangsor a rácson belül. In: Csányi S. és Heltai M. (szerk).: *Vadbiológiai olvasókönyv: Szemelvények a vadbiológia új eredményeiről a Vadvilág Megőrzési Intézet munkatársainak ismeretterjesztő cikkei alapján*. 205 p. Budapest; Mezőgazda Kiadó p. 170-176 (ISBN: 978-963-286-592-8).

5. 5. Presentation in an international conference

SZEMETHY, L., **ÚJVÁRY, D.**, KOVÁCS, V., CSÁNYI, S. (2014): Wild boar in the" garden" – negative behavioural changes in wild boar "gardens". In: 10th international symposium on wild boar and other suids, Velenje, abstracts, 24 p.

KOVÁCS, V., **ÚJVÁRY, D**., SZEMETHY, L. (2014): The examination of the group structure and aggressive behaviour of wild boar (*Sus scrofa*) in open field and in wild boar preserve. In: 10th international symposium on wild boar and other suids, Velenje, abstracts, 70 p.

ÚJVÁRY, D., SZEMETHY, L. (2011): Aggressive and submissive behavioural elements of captive wild boars in feeding situation. In:„Tradition, innovation, sustainability" X. Wellmann International Scientific Conference, Hódmezővásárhely (2011) Agrár- és Vidékfejlesztési Szemle, 6 (1.) CD melléklete ISSN 1788-5345

ÚJVÁRY, D., SZEMETHY, L (2010): The effect of feeding method on the aggressive behaviour and time spending with feeding of wild boars kept in captivity. In: Centeri, Cs., Bodnár, Á. (szerk): Kárpát-medencei Doktoranduszok Nemzetközi Konferenciája (TUDOC) (2010), Gödöllő, Hungary, p. 16. (ISBN 978-963-269-187-9)

5. 6. Presentation in a Hungarian conference

KOVÁCS, V., **ÚJVÁRY, D.**, SZEMETHY, L. (2014): A vaddisznó (*Sus scrofa*) szociális viselkedése szabadterületen és zárt tartásban. In: A Magyar Etológiai Társaság XVI. kongresszusa, Tihany, p. 26.

BÍRÓ, ZS., BLEIER, N., KATONA, K., LEHOCZKI, R., **ÚJVÁRY, D**., SZEMETHY, L., SZILÁGYI, Zs. és MARKOLT F. (2011): A kőrösladányi vaddisznóskert hatása a védett növényekre In: KOSZTYI, B (szerk.): *Többfrontos természetvédelem: A VII. Magyar Természetvédelmi Biológiai Konferencia Program és Absztrakt kötete*. Debrecen, Magyarország.

ÚJVÁRY, D., SZEMETHY, L. (2009): Vaddisznók viselkedésének jellegzetességei zárttéri tartásban. In: TŐZSÉR, J. (szerk.): *Gödöllői Állattenyésztési Tudományos Napok. Előadások és poszterek összefoglaló kötete.* Szent István Egyetem, MKK, Állattenyésztés-tudományi Intézet, Gödöllő, Hungary. p. 100.

5.7. Poster in an international conference

ÚJVÁRY, D., SCHALLY, G., BUCKÓ, M., SZABÓ, L., SZEMETHY, L. (2012): A simple method for the estimation of the wild boar's home range in a wild boar preserve. In: 9th International Symposium on Wild Boar and Other Suids, Hannover, Germany. Book of abstracts pp. 58

ÚJVÁRY, **D**., SZEMETHY, L. (2010). The effect of different feeding arrangements on the behaviour of wild boar kept in captivity. 8th International Symposium on Wild Boar and Other Suids, York, England. Book of abstracts pp. 67.

BÍRÓ, ZS., SZEMETHY, L., BLEIER, N., **ÚJVÁRY, D**., KATONA, K., LEHOCZKIi, R. (2010): Impacts of fenced areas for wild boar on nature conservation. 8th International Symposium on Wild Boar and Other Suids, York, England. Book of abstracts pp. 66.

5.8. Poster in a Hungarian conference

ÚJVÁRY, D., SZEMETHY, L. (2014): A vaddisznók rangsorban elfoglalt helyének jelentősége. In: A Magyar Etológiai Társaság XVI. kongresszusa, Tihany, p. 26.

ÚJVÁRY, D., HORVÁTH, ZS., SZEMETHY, L. (2009): Területcsökkenés hatása zárt térben tartott vaddisznók viselkedésére. In: Kari tudományos konferencia, Nyugat-magyarországi Egyetem Erdőmérnöki Kar, vadgazdálkodási szekció, Sopron, p. 331-335.

ÚJVÁRY, D., HORVÁTH, ZS., SZEMETHY, L. (2007): Területcsökkenés hatásának vizsgálata fogságban tartott vaddisznóknál táplálék-kompetíciós helyzetben. X. Jubileumi Etológiai Kongresszus, Göd