Thesis of the Ph.D. dissertation

Hungarian grey cattle behaviour response to weather and grass supply in rangeland conditions

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1 Prelude and Objectives

The Hungarian grey cattle is a corner stone in hungarian cultural landscape and pastoral grazing. Her traditional breeding has not changed for centuries, therefore perfect subject of ethological studies. In the 1970's (BODÓ és mtsai., 1979) the first behavioural studies revealed the general behavioural traits. These observations mainly focused on reproductional behaviour. My objective was to observe the complexity of the grazing cattle-pasture-weather system. I attempt to show the correlations between cattle behaviour and grass supply in context with weather influenced environment. The observed herd contained different age groups, mostly mid-age cows and their calves, but from May to August bulls made their own groups as well. I have recorded daily-ethograms about the marked cows regarding behavioural traits (grazing, resting, ruminating, drinking, social interactions, moving). Beside the ethogram I have documented the behavioural events with photo- and video recordings. My intention was to find relations between animal movement, behaviour and weather effects. I applied GPS- and remote sensing technology to track the herd.

During this research my aim was to document Hungarian grey cattle behaviour in traditional, pastoral environment. Behavioural findings may show correlations with weather conditions and grass supply. I have asked the following questions:

How to describe the Hungarian grey cattle behaviour in pastoral grazing system?

What kind of behavioural traits may occur? How to categorize them?

How weather and grass supply affect on behavioural patterns and spatial variation?

Is there an easy way to extend battery life time in GPS receiver?

Based on previously stated general observations I have defined the following hypothesis:

H1 There are more behavioural traits exist than previously described.

H2 Individual weather factors have significant effect on cattle behaviour in rangeland.

H3 The grass supply has significant influence on grazing-metabolic behaviour.

H4 The spatial variation of Hungarian grey cattle is not consistent. There are firm reasons why she prefers certain areas on pasture.

2 Materials and Methodes

2.1 Breed

Hungarian grey cattle is a traditional breed with wide environmental tolerance. Well adapted for extensive rangelands and pastoral grazing. The herds are roaming on big pastures without restrictions. This cattle's maternal behaviour is a brand logo. Some researchers debate whether is there any genetic relation with auroch (*Bos primigenius*) The 10 (n=10) observed cows (out of 200) were marked with coloured ropes for visual identification. The bright colours can be recognized from long distance and the animals will have not been bothered during behavioural observations. The cows keep 50-100 m flight-zone, therefore high vis-markers were essential. The herd did not receive supplementary feed during the grazing seasons and in winter time housing, hay and salt fed only. The cattle every time returned to the herd-hut – shadoof and elevated, dry calving-mount – throughout the grazing-season.

2.2 Pasture

The study area is 1191 ha rangeland 5 km South-west from Hortobagy village, Hungary. There were two major parts: the North (688 ha) and South (503 ha). Hortobagy River and two local shadoofs (dug well) were the only water sources. Only the gallery forest and the river bank provided wind shelter. The North meadow (Fekete-ret) was kept for cut sward until mid-June. There was medium soil fertility and the grass coverage was almost continous. The Southern pasture had sodic soils, fertility was pour, therefore heterogenous plant cover has been developed. At the Hortobagy-river flood-bank special grass phytocenosis evolved. Mostly reed and rush have grown the area which were primary forage for cattle during summer time. The reed sprawled right after extended floods and intensive grazing rolled it back. Flood water regulary changed the phytocenosis giving place for hygrophytes and the fluctuation of available water drove the grass canopy. TOTH (2004) described the full grass phytocenosis and defined the agro qualification categories as well (NAGY, 2003). Regarding the agro-qualification categories my behavioural observations recorded on poor and bare grass

supply. Toth found that the soil type, in connection with water supply could affect on phytocenosis and grass supply especially in dry years.

2.3 Grass supply

Along the behavioural observations I took grass samples as well. I have made three yield categories (none-low-acceptable). The sampling was taken from one square meter quadrate, leaving 3 cm stubble height and weighted on spot. As the all area is very heterogenous the samples came from the most preferred grazing spots of the pasture (see 2.6).

2.4 Behavioural traits and categories

I applied the CZAKÓ (1985) terminology to describe the animal behaviour and organized the behavioural traits in 4 main categories (Table 1.). Animal behaviour has been observed periodically, in every 20 minutes, and the duration of recording approximately 5 second each. The most typical behaviour pattern has been logged. I used a binocular to find marked cows out of their flight-zone. It was essential to avoid bothering the animals. Staying out of the flight zone (distance kept from strangers) using a 4x4 car (MALECHEK & FIELD, 1975) was an ideal choice. The typical behavioural patterns (grazing, fighting, suckle) have been recorded with digital video camera as well. Meteorological data collected from the national meteo survey data base and we also made local measurements (barometric pressure, temperature). The statistical analysis created by SPSS software pack.

Table 1.: *Categorization of behavioural traits*

Behaviour	**Category**
Vocalise	Social
Vocalise	Social
Lick	Social
Suckle	Social
Scratch	Social
Fight	Social
Play	Social
Ruminate (standing)	Feed intake/metabolic
Ruminate (lying)	Feed intake/metabolic
Defecate/Urinate	Feed intake/metabolic
Graze (in motion)	Feed intake/metabolic
Graze (standing)	Feed intake/metabolic
Drink	Feed intake/metabolic
Move	Move
Oestrus	Sexual

2.5 Daily behavioural pattern (diurnal cycle)

Looking at the ethograms, the animals' diurnal cycle also appeared. On an average day, with no disturbtion (vet control, dog chase, calf separation), the cows' daily routine started with *movement, graze, drink* and closed with *movement* back to the rest mound. Based on GERE (2003), UNGAR et al. (2005) and BOTHERAS (2010) methods I have drawn the herd's daily activity graph. Inactivity was when the cows slept, rested or did not ruminate while standing. Activity counted when feed-, water intake, movement or sexual events happened.

2.6 Spatial variation

Two type of GPS receivers have been used (Snewi Trekbox, Bluetooth, GT-750 GPS data logger) to describe the animals spatial position and calculate the speed, the daily travel distance and the time spent on pasture. The GPS-collar looged the positional data for 5 days. The coordinates have been transformed into digital map.

The cows grazing preference was observed at the Southern pasture (Malomhazi-pasture), during the 6 hour long (3-3 hours morning-evening) grazing period. The aerial map was divided in 50 x 50 m (2500m^2) grid. I have counted how many cows grazed and for how long in each quadrate. Then I made four categories (low-medium-high-very high) based on the complete number of animals. I calculated values for the all area using TROTTER (2009) Livestock Hour Index (LHI):

LHI (Livestock Hour Index) = $\left[\frac{Grazing\ Time\ (hour)}{Cow\ (head)}\right] \div grid/day$

low ≤ 0,1; medium 0,1 – 0,2; high 0,2 – 0,4; very high ≥ 0,4

3 General description of the Hungarian grey cattle behaviour

I seeked the most homogeneous sample group. The 10 marked cows were in the same age and breeding line. According to a previous observation, only a couple of designated animal will do, as the *herd effect* and interactions sufficiently represent the entire herd. Most researchers agree, that the principal of herd behaviour is all the same with every species: A group of individuals strive towards the middle of the group driven by their survival instinct. The group moves and acts as a single unit, but it comes from an uncoordinated, selfish behaviour of the individuals.

Another important aspect is the observer himself. As the behavioral observations were carried by myself, subjectivity in all cases related to the same observer. I consequently described the entire herd behaviour, through 20-minute cycles and recorded the behavioural patterns of marked individuals. The marked cattle were always within the grazed area and never aggregated in the same subgroup.

In philosophical aspect, the observer may influence the object of observation. In this case the object (marked cow) is fully aware of the presence of the observer therefore it never shows the natural behavioural trait. According to a 2012 study, both the subject (observer) and object are related each other, based on Foerster's secondary (circular) cybernetics model. The point is, that the observer is also part of the observed environment, therefore he observes the observation itself. This philosophical study conducts the theory through interdisciplinar approach (biology, mathematics, logic) and introduce the subjectivity of objectivity.

The sample cows came from the No. 4 (mother)herd, which was an already selected, first-class, genetically homogenious population. Cows average live weight was between 500-550 kilograms. There was only one culled cow, during the 3 years period. The milk production was 2000 liters avarage, which 100% turned to calf rearing. The average birth weight was 30 kilograms and calves gained 170 kilograms in 205 days, till September-separation.

During the three grazing seasons, squarely the *grazing* and *metabolic* dominated like *grazing, defecation, urination, rumination* (Figure 1). At the beginning of the grazing season (April) and at the end of the season (October), thanks to the good grass supply, the cattle usually *grazed on foot* without much *walking*. During the summer months most of the *food intake* is

typically *grazing in motion*. Half of the observed cases, this behavior dominated. The Hungarian gray cattle fierce and difficult to housing the larger groups. She always keeps large flight-zones if possible. The large flight-zone means, that the entire herd spreads if adequate grass and space available. In case of sufficient grass supply, the cattle grazes slowly. Cattle bites 2-3 times before makes the next step. In a calm herd, the personal space could be 10-20 meters and the herd may stretch over one kilometres or more. If the wind speed does not exceed 15 km/h the herd graze continuously in a four-hour grazing-cycle. In this case, the average *grazing in motion* speed is 1-2 km/h, but the increased wind speed or any disturbance can accelerate this motion.

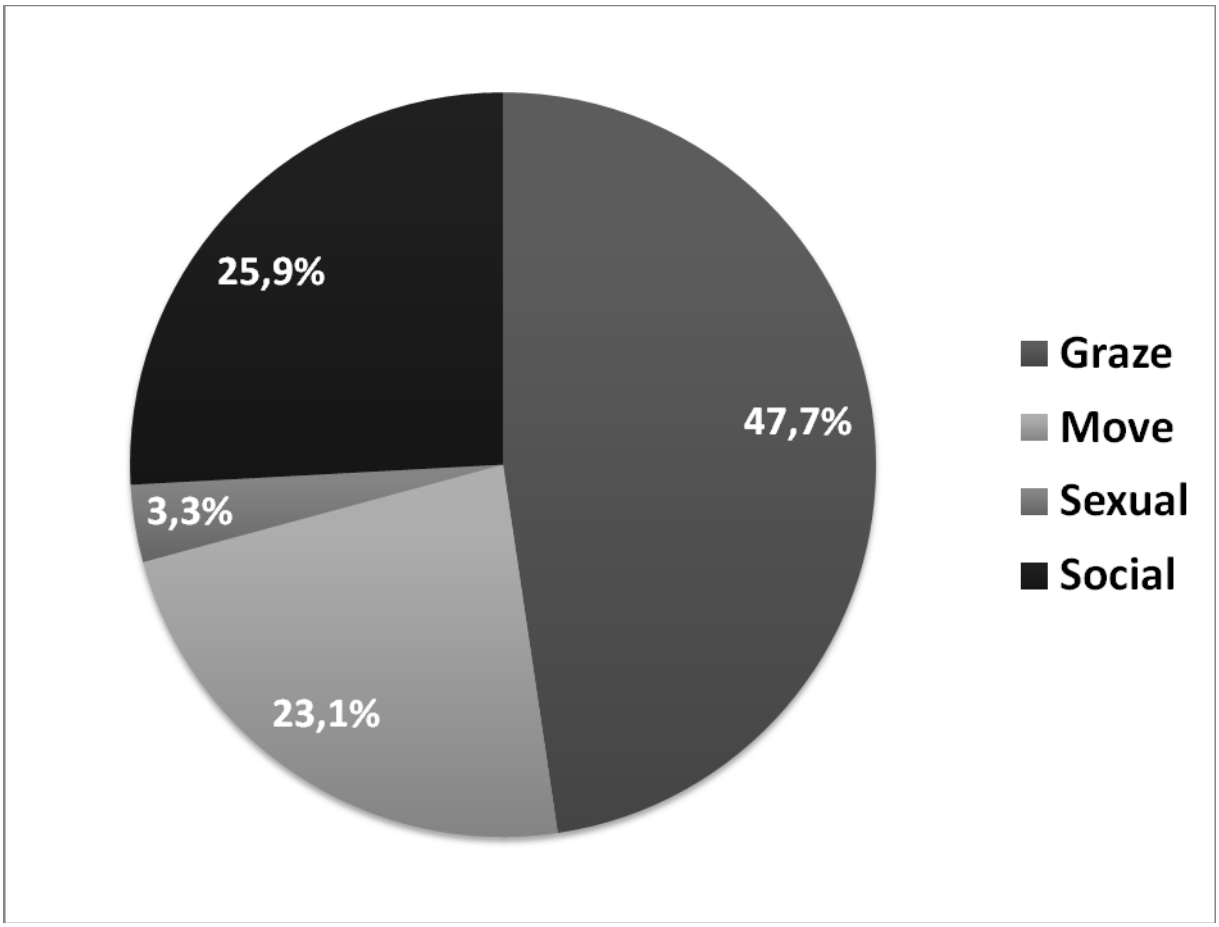

Figure 1. : Distribution of main behavioural trait cathegories between 2010-13 (N=2226)

Social behaviour (playing, fighting, licking, sucking) is the second most frequent (25.9%) behaviour category. Sophisticated social interactions are common at hierarchical, social animals like cattle or apes.

The third most frequent (23.1%) behaviour category is the *moving* (locomotion) behaviour. The average distance is about 5-6 km per day, but in the spring and autumn 10 km a day is usual. The shrinking grass supply, the search for dry resting place and wind protected area are all responsible for the longer daily distance. Cows moving across the rangeland using narrow tracks called *"capp"*.Theese routes avoid the hard terrain, like swamps or tussocks. During the summer period these wetlands provide extra forage for the animals. The reed-shoots are perfect protein source for the younger cattle.

The *sexual behaviour* category (3.3%), appears ocasionaly as *jumping* or *in oestrus* ("ooze or heat")

The *social behaviour* had growing tendency probably due to the aging animals. As the average age was 10 years, the marked animals had a certain position in the hierarchy. The most experienced cows provided more social interactions (fighting, sucking) and they got herd-positions (sentinels or nurse) as well. The best fitness and agility destine the leader cow to protect her position, however a regular fight is inevitable.

3.1 The observed features of the grazing herd

The three-year observation period allows to describe the cattle grazing behaviour. Every spring starts with fights for the dominance and it sets for the grazing season. The older (more than 10 years) cows forming the leader group. If the pastor herdsman does not intervene, these older cows lead the herd. Oestrus may affect on the leader cow and she might loose this hierarchical advantage but most of the time only new comers question the leadership. The bulls do not intervene the matriarchial system except sexual periods. In this case, a non in oestrus cow replace the leader. Bulls rarely fight, because of high stress and size differences. Older and younger bulls are together with the cows this how herdsman preventing competition. The maternal behaviour is very strong in this breed. At the first 6 months cows

aggressively defend their young. The personal space and flight zone (more than 500 m) much bigger in this period. Every cow in the herd are very alert in the early spring period.

3.2 "3-parts dispersion"

The herd regulary divided in three different subgroups. One group is mainly formed with older cows. These cows led the herd and contained no more than 20-30 heads. The second group formed from young cows and suckler calves. The third - lagging – group had only freshly calved cows. These subgroups are typical in Hungarian grey cattle herds on rangelands.

3.3 The "Sentinels"

If the cows left their youngs behind, 2-3 “sentinel” cows watched them. Calves always tend to the middle of the herd. If the cows sensed any danger they all surrounded the youngsters to protect them. In extreme cases the cows rushing back to the calves from kilometre away.

3.4 “Walking with the wind”

During summer time cattle walks against wind – in autum doing opposite way. Bovine heat regulation largely depends on wind speed, as the cranial parts of the body can deliver more heat than the caudal portion. The insects prefer the head, mainly because of the wetter parts (muzzle, eyes) are there. In July horn flies swarming only start of sufficient strength (5 km / h) winds at the herd. In case of no wind and scattered legyezéssel tail, alert each other to böglyöket groups. The knowledgeable Shepherd also takes into account the prevailing wind direction. Optimum comfort is a basic requirement that heat generated by a sheath of insulating body around to take the animal. In summer cooling and insect repellent effect, they are trying to take advantage of the cows. Cooler, damper weather turn away from the wind and go. In this case, strictly observed the "home Drift" (slow movement toward herd hut). The wind direction and wind speed can be watched while tracking the animals

The leading cows finding their way using smell but also rely on spatial orientation points (embankment, solitary trees). High heat and cool autumn days are also the dominant wind direction, wind since the summer, fall and move in the wind over the pasture.

3.5 Heat Stress

It was four days of the test period, when the average daily temperature exceeded 25 C°. The distance traveled per day was between 3900 and 7300 meters. The distribution of the forms of

behavior was not detected in relation to temperature. This result is contrary Brown-Brandl et al. (2006; 2010) with observation. The US beef-fattening farm researchers conducted observations related to heat stress, and found that over 35 C° (air dry bulb temperature of 28 C° in the neutral range), dark skin cattle breeds (Angus, MARC III), fewer feeding show, inpatient and combative behavior, such as light-furred breeds (Charolais, Gelbvieh). It adds that the sexual inclination of this high temperature did not decrease significantly. A further investigation showed that the behavior of the animals with water spray does not changed significantly, but a rising trend has been observed in favor of feeding and inpatient (rest) behaviors and drank and were less than animals.

MARÓTI Agóts-based (2010) 70.2 HSP's work in connection with heat shock proteins in the Hungarian Grey selection of the wild type allele was observed type of fixation of the genome, which can be related to the presence of significantly more HSP 70.2 mRNA formation. The higher mRNA levels correlated positively with the amount of heat stress proteins, which allows for faster and more efficient hőstresszes period of adaptation for the animal. Since heat stress on the occasion of reduced appetite and milk production, this will affect the calf rearing ability. A breed for centuries the greater the electoral weight of the calves (208 kg) was one of the most important aspects, such as hot environments are less adapted to the individual farming practices have long been selected out. The above assessment, therefore, only strengthens previous declarations that the Hungarian Grey Hortobágyi perfectly adapted to dry environments, as it was under double selection pressure and still stands today.

The cows of a light-gray, the calves were 4 months of “pirók” (foxy color). From previous biophysical research, it is known that the polarized light - light waves reflected from a selected propagation plane visible - attracting vermin (polarotaxis). The larger the horizontally polarized, reflected light polarization, the more attractive stack (al KRISKA et. 2009). Blaha et al. (2012) pointed out that the brighter and blurrier hair of a mammal, less attractive to parasites. So a clear coat, because more noticeable in open areas - which does not benefit from a wild animal - but almost invisible to the stack to make the grazing animal.

3.6 Meteopathy

KELLER et al. (2005) in their study confirmed the psychological evidence that a good mood is related to the high-pressure air and a pleasant spring temperatures warm. Among the parameters of the test pressure as zeitgeber (exogenous stimulus, see. One light effect) appeared. The meteopathy of the Hungarian grey was confirmed in my own research, which is

closely related to the kind of extensive holding. Further comparative studies are needed to determine how elastic the kind of weather sensitivity. The closed a constant microclimate strongly distort the reactions of animals.

Insects and birds sensitivity of the weather front examined by Novinszky and Puskas (1996). According to research results, it is based on the Péczely's typisation, Puskás's front-types, the time of staying occlusion (closing mixed in) front of the gypsy moth activity significantly greater than the other front-type case. It made a similar statement the same research group (Gyurácz and Puskas, 1997;. Somogyi et al 2014), the reed warbler and the incidence approaching warm front is the case. Based on the above presumes that because in both front-type low pressure environment is created and the gypsy moth and the reed warblers can tolerate the unstable (ref. also anti-cyclone cyclone) weather situations.

4 New scientific results

I have found different behavioural categorization in previous studies. Based on these scientific works I created my own behavioural main categories (feed intake-metabolic; move; social; sexual; Figure 2.). I have described 3 specific behaviours. I defined the *watch* and the *sentinel* behavioural traits. The Hungarian grey cattle herd has its own organisation and hierarchy. I described first the *3-parts dispersion* in Hungarian grey cattle herd.

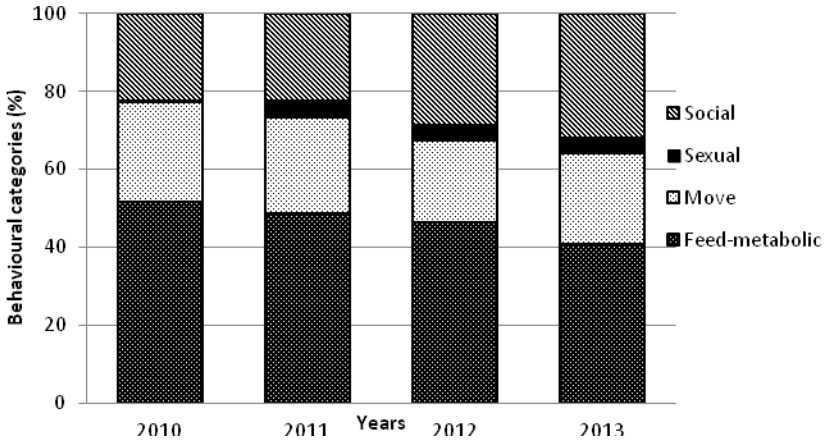

Figure 2. : Distribution of behavioural categories between 2010-13 között (N=2226)

- I proved that at low barometric pressure (P≤1000 hPa) conditions the herd less active, the feed intake-metabolic behaviour is underrepresented.
- There are correlations between *feed intake-metabolic* and *move* behaviours and barometric pressure (Figure 3.). In case of *move* there is no *feed intake.*

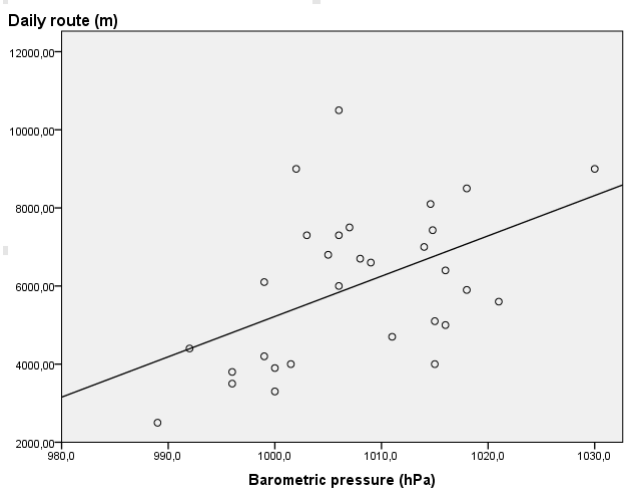

Figure 3. : Relationship between barometric pressure change and daily walked distance (N=36)

- I named which Peczely-front types are the most responsible for the behavioural changes. (Table 2.). Prior to the observation day and the following day's front were significantly affected on behaviour. The feed intake-metabolic behaviour traits appeareance follows the next day front type (r=0,445, p=0,007). The most *feed intake-metabolic* events have happened during the anticyclone over Carpathian-basin (A). There were major effects of the anti cyclones from West (Aw) (p=0,049) and North (An) as well. I have observed similar events at categories of *move* (p=0,004) and *social* (p=0,039). In both cases the high pressure local-anticyclone and the northern-anticyclone caused the highest event numbers. The average temperature, barometric pressure, humidity, wind speed and direction have no significant effect on the four main behavioural categories.

Table 2. : Average number of events within the main behavioural groups based on the 5 most frequent
Peczely-front types.

Behavioral trait / Front type		Feed intake-metabolic		Moving		Social		Sexual	
		Avg. no. of event ±SE [1]	p [2]	Avg. no. of event ±SE	p	Avg. no. of event ±SE	p	Avg. no. of event ±SE	p
Front today	10-An[3]	46.3±6.7	0.716	22.4±3.7	0.271	5.4±2.5	0.950	0.4±0.3	0.467
	1-mCc [4]	42.9±6.1		16.9±6.0		3.9±1.7		0.1±0.1	
	5-Ae [5]	49.2±15.4		8.2±4.3		4.6±2.4		0	
	8-Aw [6]	50.2±11.2		10.8±4.7		5.0±1.9		0	
	12-A [7]	53.5±15.1		18.3±3.4		4.8±2.0		0	
Front tomorrow	1-mCc	38.7±8.3	**0.049**	3.8±2.3	0.004	2.3±1.0	0.039	0	0.164
	10-An	50.3±6.4		21.7±2.9		3.0±0.7		0.43±0.3	
	12-A	**71.2±4.5**		17.3±3.1		7.5±1.4		0	
	5-Ae	39.3±15.8		11.8±3.0		6.5±3.0		0	
	8-Aw	51.3±3.2		9.3±3.5		1.7±0.3		0	

[1]standard error; [2]Kruskal-Wallis test (level of significance: p≤0.05); [3]Anticyclone north of the Carpathian Basin; [4]rear flow system of meridional cyclon; [5]Anticyclone above Ukraine; [6]Anticyclone stretching from west; [7]Anticyklone above the Carpathian Basin

Examining the relationship between grass supply and animal behaviour (Table 3.), significant association was found between the event number of feed intake-metabolic group and grass supply of the area (p=0.033).

Behavioral trait / Grass supply category	Feed intake-metabolic						Moving			Social			
	SG①	MG②	LR③	SR④	Avg. no. of events (S.E.)	p⑤		Avg. no. of events (S.E.)	p	Watch	Scratch	Avg. no. of events (S.E.)	p
No	0	10	0	0	30.3±11.8	0.033*	20	15.1 ±2.2	0.964	0	0	30.83 ±2.3	0.304
Low	109	158	63	7	29.7±8.1		156			24	9		
Appropriate	255	173	121	47	52.8±5.3		226			30	31		

Table 3. : Associations between grass supply and the most frequent behavioural tratits and –groups.

① Graze (standing) ② Graze (in motion) ③ Ruminate (lying) ④ Ruminate (standing) ⑤ Kruskal-Wallis test (level of significance: $p \leq 0.05$)

- I developed a cost-effective animal tracking device with long battery life, and without any need of data traffic subscription.
- I strengthen observations of other researchers about maternal instinct and private space.
- Spatial variation of the Hungarian grey cattle is unbalanced. Based on the livestock hour index (LHI) I determined the preferred places of residence at Malomházi pasture (Figure 4.). The observed animals stayed no more than 1-2 hours at *low* (LHI ≤ 0.09) or *medium* (LHI: 0.1-0.19) preferred cells. However, the most of the visited quadrats were included in the *medium* preferred group. This finding can mainly be explained by the large extent of this group. The cattle spent the most of her time at the northern part of Malomházi pasture (LHI ≥ 0.4), frequently camping daily here. In accordance with the literature, spatial variation is mainly influenced by proximity to water sources, spread of tussock grass and acceptable grass supply (at least 6 cm and 300 g/m^2).

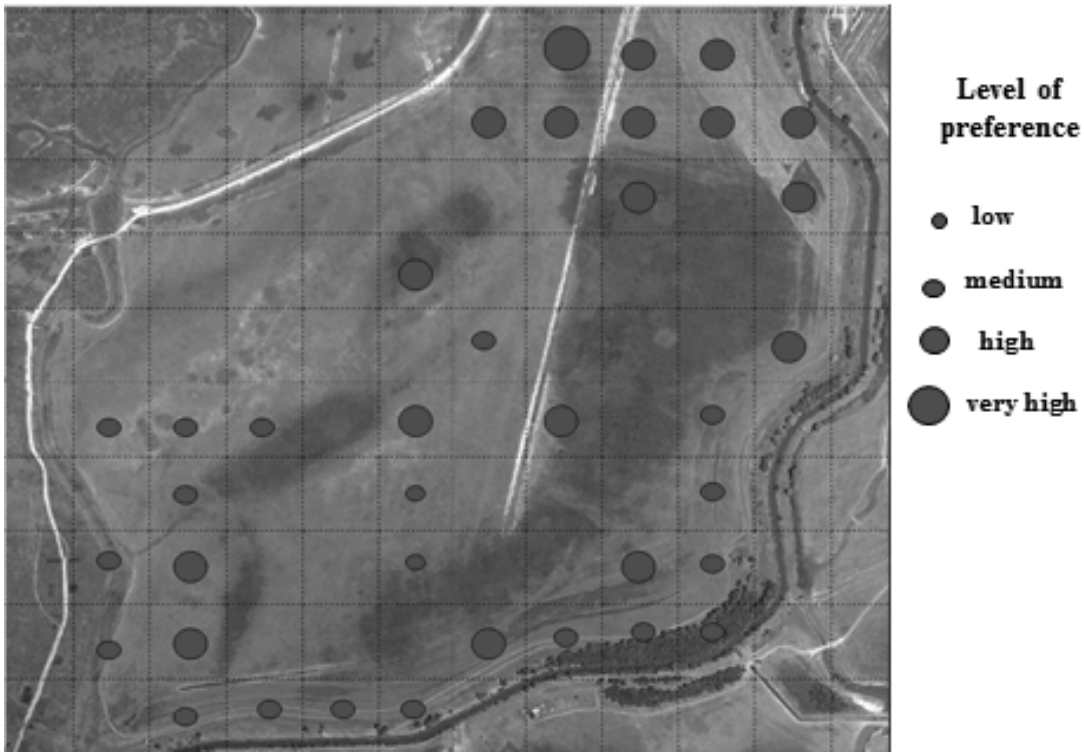

Figure 4.: Prefered residence spots at Malomhazi-pasture
(N 47.535889° E 21.123172°)
(Based on Trotter et al., 2010)

5 Practical applications

My results revealed that, in addition to present livestock systems, being aware of associations between environmental factors and animal behaviour would be useful. Animal handling before veterinary inspection causes unnecessary stress to both animals and humans. It can be avoided knowing the above detailed cause-effects. In case of family holdings, employing only a few people, it would be helpful to know that in what weather conditions are not suitable for treatment. Furthermore, the applied GPS tracking device can be improved with an SMS-based alarm system. If the animal has entered a prohibited area, the owner is immediately informed. Farm accidents could be avoided if farmers learn the breed-specific flight zone.

5.1 Maternal instinct and personal space

I confirmed the previous observations related to maternal instinct and the definition of personal space. It is significant that in younger individuals (typically the first heifers are sufficiently) moving away from the herd. This distance, however, never greater than 1000 m. The personal space of Hungarian Grey discriminated breed, known researcher and herdsman dependent, but typically 20-30 m. In the case of motor vehicles and the ever-goulash with them at 1-3 m are possible.

5.2 Behavior and environment relationship

The study raised questions years of the responses focused on animals. According to the findings of previous research on the temperature, wind speed and solar radiation may have more influence on animal behavior. Some say, however, be of animal behavior and the environment to examine the relationship more complex way. During my own research I have found to get a more detailed picture, when atmospheric factors parallel set of behavioral methods.

With regard to research methodology, incurred over the years that the observations are too subjective. This is refuted by many domestic and foreign research studies as well as a few observed cases, the test criteria will not change, even in time of immersion may highlight some of the links as well. My field experience also showed that the same is difficult to simultaneously keep an eye on designated individuals, but in good routine, with due objectivity (unchanged standards) are available.

5.3 Grazing time and distance traveled per day

All literature is equal to the length of the grazing period, which is a constant value for the extensive varieties, two peaks daily (morning and evening), an average of eight hours long. If enough (approx. 40-50 kg / head) green grass is available, animals that recover are taken over a longer or shorter time, but with plenty of pasture grass supply is heavily sorting, so almost even walked if I had a site can be recorded on the daily amount of carbon. Thus, the daily distance traveled 3-6 km of normal. Front effect the stock restless and food recorder (pasture) behavior gets lower priority. The restless animals may also stop the grazing and feed search / recorder behavioral characteristics marginalized. In such cases, the reduced distance traveled on a daily basis, they may just go drinking for animals and food intake behavior do not show. The observation days, the pastor did not initiate the herd, the animals grazing in the direction determined independently without outside interference. Older cows are led by cattle, the pasture dry matter can be found looking for (this causes a feeling of fullness), so in case of small supply of grass, reeds, sedges area is also a source of feed. Throughout the season grazing pastures find the optimal themselves. The shepherds experience and the results of previous research in parallel, I could be verified with older cows orientation abilities. Regular grazing animals develop a routine that can help you confidently move a large pasture.

5.4 The selection criteria

The selection of the observed individuals in the group tried to homogeneity. I tried the same Sex (young heifers, young cows), individuals belonging to the age group marked for sustainability research. The juveniles have increased the 'immersion' safety so that sufficient commodity was available in this group in order to ensure a 10-10 animals, which have worked for years. Age at death and eventual scrapping of sex and tried egyeddel appropriate for the group to make up the deficit. The test groups of females (cows) animals was observed, from which only the calves have been reported exception, as election (first six months) all the cows left calf. Since the observations were carried out with only 10 subjects in higher frequency could not be planned. That animal could safely observe the designated hour three times. The 10 cows indicated corresponding to 10 reps. The observation by one person at the same time is the safety of the same judgment, in view of the fact that the current behavior of the animal considers any question marks in the same way.

5.5 Future of the Hungarian grey cattle

In terms of the future of Hungarian gray primary role for the gene conservation to be. They may still be latent genes in the genome of the Hungarian Grey, which may be further breeding objectives (disease resistance, feed conversion). In the sense of preserving averages are selected and more beautiful forms and horns - the colors and the maternal qualities of the selection criteria. There are farmers who see the future of hybrids and the carcase yield and the bigger crowds kept in mind. For more role if the mother is famous for taking advantage of the properties is used as a surrogate mother (ref. Belgian blue-KO-BE program). South West Hungary successfully grazed extremely steep land where the landscape-can play an important role in rehabilitation. The BSE issue of immunity is also worth to walk around as a kind imaginable variant, which is not only due to the isolation of resistance. Geographical Identified Product prevail as the Hungarian gray dry or bio-products as well.

List of publications related to the dissertation

Registry number: DEENK/215/2016.PL
Subject: PhD Publikációs Lista

Candidate: András Halász
Neptun ID: ZA0FLW
Doctoral School: Doctoral School of Animal Husbandry
MTMT ID: 10017527

List of publications related to the dissertation

Hungarian book chapters (1)

1. Nagy, G., Horváth, P., **Halász, A.**: Quo vadis (merre tovább) közép-kelet európai gyepek? In: Gazdasági és üzleti kihívások a Kárpát-medencében. Szerk.: Lázár Ede, Státus Könyvkiadó, Csíkszereda, 153-164, 2011. ISBN: 9786068052526

Hungarian scientific articles in Hungarian journals (4)

2. Tasi, J., Bajnok, M., **Halász, A.**, Szabó, F., Harkányiné Székely, Z., Láng, V.: Magyarországi komplex gyepgazdálkodási adatbázis létrehozásának első lépései és eredményei. *Gyepgazdálk. Közl. 2014* (1-2), 57-64, 2016. ISSN: 1785-2498.

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Total IF of journals (all publications): 0,5
Total IF of journals (publications related to the dissertation): 0,5

The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of Web of Science, Scopus and Journal Citation Report (Impact Factor) databases.

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