

**Behavioural patterns of heifers under intensive and
extensive continuous grazing on species-rich pasture
in the Czech Republic**

Thesis

**Chování jalovic na intenzivní a extenzivní
kontinuální druhově bohaté pastvě v České republice**

Rigorózní práce

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Praha 2010

Prohlášení:

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V Praze, 5. 10. 2010

Abstract

The consumption of food is one of the most fundamental activities in all animals and takes its ultimate part in maximizing an animal's inclusive fitness. Foraging response mechanisms issue essentially from animal intrinsic characteristics, animal's cognitive abilities and environment, namely quantity and quality of available food resources. Understanding of animal's foraging decisions is not possible without the knowledge of other types of behaviour and factors they affect it. Therefore, the aim of the investigation was to evaluate heifers' behavioural pattern on species-rich semi-natural pasture under a continuous intensive (IG) and extensive (EG) grazing regime as this is currently the most extensive management system employed in central Europe. Ten or eight (IG), and six or four (EG) heifers were continuously stocked in two completely randomized blocks from June to late September in 1998, 1999, 2000, 2006 and 2007. Swards were maintained at a target height of 5 and 10 cm, respectively. Grazing, ruminating, resting, and other activities were monitored during 24-hour observations, and grazing, chewing and ruminating rates (per minute) were recorded. Daily behavioural patterns and the time budgets for particular activities were not significantly different between IG and EG heifers. However, IG heifers did spend more time grazing and slightly less time ruminating and resting than EG heifers. Other activity such as drinking, salt licking, comfort behaviour or social interaction was stable and there was no difference between the two treatments. Grazing rates were found significantly higher for IG heifers. Grazing was negatively affected by increase in air temperature at the expense of resting. Grazing time increased as the season progressed in the both IG and EG treatments, while resting showed a reverse trend. Concurrently, the ruminating time of IG heifers decreased and was variable for EG heifers. As the season progressed further, grazing rates showed a decreasing trend. Considering that the differences in behavioural patterns between IG and EG were not conspicuous, our results indicate that the target sward of 5 cm commonly used in animal husbandry practices in the Czech Republic does offer enough forage to animals. Furthermore, the seasonal patterns of ingestive behaviour showed that the heifers under both grazing intensities balanced their intake by increase of grazing time along with decrease of grazing rates as the season progressed. These findings suggest that the herbage on species-rich pasture was sufficiently available to livestock at both the investigated grazing intensities.

Key words: Stocking rate, Ingestive behaviour, Semi natural grassland, Cattle, Forage availability

Abstrakt

Příjem potravy je jednou z nejzákladnějších aktivit všech zvířat a tvoří rozhodující část při maximalizaci celkové zdatnosti jedince. Mechanismy potravního chování vycházejí z charakteristik zvířete, jeho kognitivních schopností a vnějšího prostředí, zejména množství a kvality dostupné potravy. K pochopení potravního rozhodování zvířete není možné bez znalosti jiných typů chování a faktorů, které je ovlivňují. Proto cílem tohoto výzkumu bylo vyhodnocení chování jalovic na druhově bohaté pastvině při režimu intenzivní (IG) a extenzivní (EG) pastvy, která je v současnosti nejběžnějším pastevním systémem ve střední Evropě. Deset nebo osm (IG) a šest nebo čtyři (EG) jalovice byly na kontinuální pastvě ve dvou úplně znárodnělých blocích od června do konce září v letech 1998, 1999, 2000, 2006 a 2007. Porosty pastviny byly udržovány na cílové výšce 5 cm pro IG a 10 cm pro EG. Po dobu 24 hod jsme zaznamenávali pastevní chování, přežvykování, odpočinek a ostatní aktivity. Dále jsme zaznamenávali rychlost spásání, žvýkání soust a přežvykování (za minutu). Denní vzorce chování a denní časové rozvrhy jednotlivých typů chování se mezi jalovicemi na IG a EG pastvě nelišily. Nicméně IG jalovice strávily více času pastvou a méně času přežvykováním a odpočinkem než EG jalovice. Ostatní typy chování jako napájení, salt licking, komfortní či sociální chování byly stabilní a mezi oběma intenzitami se nelišily. Rychlost spásání však byla signifikantně vyšší u IG jalovic. Spásání bylo negativně ovlivněno zvyšováním teploty vzduchu na úkor odpočinku. Čas strávený pastvou se zvyšoval s postupující sezónou, zatímco odpočinek vykázal opačný trend. Zároveň, čas přežvykování klesal u IG jalovic a u EG jalovic byl variabilní. S postupující sezónou klesala rychlost spásání. Vzhledem k tomu, že rozdíl ve vzorcích chování mezi IG a EG jalovicemi nebyl zřejmý, výsledky poukazují na to, že porost s výškou 5 cm, která je všeobecně užívána v praxi v České republice, nabízí zvířatům dostatek píce. Sezónní změny v příjmu potravy také ukazují na to, že jalovice při obou intenzitách pastvy v průběhu sezóny dorovnávaly svůj příjem zvýšením času stráveného pastvou spolu s poklesem rychlosti spásání. Tyto výsledky naznačují, že druhově bohatý porost poskytuje skotu při obou intenzitách pastvy dostatečné množství píce.

Klíčová slova: zatížení pastviny, pastevní chování, polopřirozené travní porosty, skot, dostupnost potravy

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1. INTRODUCTION

Understanding livestock behaviour in relation to varying environmental conditions and forage dynamics is paramount in designing management strategies for livestock production. To understand the animals foraging decisions is not possible without the knowledge of other types of behaviour and factors which affect it.

1.1. Fitness of food intake

The consumption of food is one of the most fundamental activities in all animals and takes its ultimate part in maximizing an animal's inclusive fitness. In order to meet the nutrient demands of survival, growth and reproduction which are basic components of fitness, the animals must forage effectively and in relation to the environment and available food resources. An animal's foraging behaviour is therefore the result of natural selection in natural environments over the evolutionary time.

Fitness coming up from foraging is formed by aggregate of benefits and costs of food intake. The fitness benefits of food intake are represented by its contribution to survival, growth, and reproduction and can be measured by energy and nutrient intake. Against benefits there is a set of intrinsic and extrinsic costs of food intake. Among intrinsic costs belong traits related to food sources such as content of toxins in the food (Illius and Jessop 1995, Provenza *et al.* 2003), risk of parasites contamination (Hutchings *et al.* 1999) or metabolic processes during digestion which may cause worst escape to predators (Witter and Cuthill 1993). Extrinsic costs are associated with the activity of foraging such as the increase of time spent foraging together with increase of ingested food or selection of diet of higher quality. An increase in foraging time may imply reduced vigilance and consequently increased risk of exposure to predators (Houston and McNamara 1999); further decreased time available for courtship, mating, reproduction, defence of resources or reduced time for rest (Stephens and Krebs 1986, Krebs and Davies 1987). Animals thus face time budget conflict between feeding and other competing activities. The amount of time an animal devotes each day to different activities is a common measurement in behavioural ecology studies and a prerequisite for the development of time-energy budgets which can be essential for the insight in the evolution of behaviour (Krebs and Davies 1997) and useful for tools managers and decision-makers in animal production and conservation.

1.2. Foraging behaviour and diet selection of large herbivores

Foraging behaviour of herbivores operates on basis of hierarchical set of decisions across different spatial and temporal scales. At small scale such as bite or feeding station (*sensu* Senft *et al.* 1987) the animals make short-term decisions to maximize instantaneous nutrient intake, whereas at larger scale, for instance on natural pastures at landscape level, the animals decide on daily intake basis (Fryxell 1991, WallisdeVries *et al.* 1999). The temporal scale reflects the variability in food resources arising either naturally through normal changes in plant physiology, phenology, and growth associated with seasonal or even diurnal changes in environmental conditions, or by grazing. Both natural and grazing-induced temporal variability in forage quality and availability occur at short term scales over few seconds to several hours, at medium term scale over few days to weeks within a vegetation season, and at long term including seasonal cycles (O'Reagain and Schwartz 1995) and inter-annual variability due to rainfall variability (Pavlů *et al.* 2006).

Food resources of herbivores are marked by relatively high heterogeneity in their quality and spatio-temporal availability and animals must respond to it by adopting diverse foraging strategies. Foraging itself then comprises four key phases that can be considered as approach, appraisal, ingestion and defoliation (Griffiths *et al.* 2003). Each of these phases is subject to key cues and rules controlling animal's decision making. Together with this, animal behaviour is driven by an array of factors of different nature and result in a variety of grazing response patterns. Foraging response mechanisms issue essentially from animal intrinsic characteristics such as body size (Schwartz and Ellis 1981, Belovsky and Slade 1986), morphological traits functionally related to the ability of forage selection (Pérez-Barbería and Gordon 1999, Pérez-Barbería and Gordon 2001), physiological state of individual animals, namely age, sex or reproductive state (Grings *et al.* 2001, Ruckstuhl *et al.* 2003, Lamoot *et al.* 2005, Farrugia *et al.* 2006) and animal's cognitive abilities including learning (Bryant *et al.* 1991, Provenza 1995, Provenza *et al.* 2003) and spatial memory (Bailey *et al.* 1989, Laca and Ortega 1996, Howery *et al.* 1999).

On the other hand, the forage intake and diet selection reposes on the interactions of quantity and quality parameters of the sward. Basic parameter characterising the sward, namely on natural pastures, is the high diversity of plant species composition. Main indicators of forage quantity are biomass yield, sward height or plant density. Indicators of forage

quality consist in nutrient content, digestibility, and/or phenological stage (Pavlů *et al.* 2006). If abundant forage, the animals selectively feed on high quality patches (Bailey 1995). When better quality forage becomes restricted below a certain threshold, for instance due to seasonal dynamics and reproductive state of the sward (Ginane *et al.* 2003), the animals modify their grazing time and/or biting rate in order to maintain daily intake and diet digestibility (Forbes 1988, Funston *et al.* 1991). Forage availability can be reflected in sward height, which determines bite size (weight) and biting rate (Forbes 1988, WallisDeVries *et al.* 1998, Griffiths *et al.* 2003). Generally, on short swards bite size is small and animals increase their biting rate (WallisDeVries and Daleboudt 1994, Barrett *et al.* 2001). The animals compensate decreasing forage by increasing of daily grazing time or biting rate or by both.

The system is therefore interactive and animal behaviour display certain level of plasticity reflecting a range of trade-offs and constraints which animals face in a variable environment.

1.3. Grazing behaviour and grassland management

Behaviour of grazing animals and foraging strategies they adopt are of interest for various reasons. First, grasslands are the most abundant ecosystem where herbivory plays a dominant role, performed mostly by domestic animals (Holechek *et al.* 1995). The interface of plant – animal interaction represents fundamental link between primary and secondary productivity. Grazers respond to changes in their resources by means of their grazing strategy. In turn, grazing behaviour affects the structure of plant community. Therefore, the understanding of grazing behaviour is crucial for predicting the effects of potential local and global changes in grassland ecosystems. Secondly, it is of interest in the domain of natural resources management. Grazing by wild or domesticated animals in national parks, nature reserves, wilderness areas or forests may have impact on the landscape and vegetation. The understanding how animals exploit their environment can be relevant to the management of these resources (Van Dyne *et al.* 1980). Last, but not least is agricultural and economic interest. Grazing by domesticated ruminants for the production of animal products is of high economic importance throughout the world. The plant-animal interface is the central feature of these systems (Forbes 1988). Food intake is major determinant of animal production and, through its effect on sward structure, of plant production. Therefore, better knowledge of intake should facilitate better management and optimise the economic performance of the agricultural system.

2. AIM

Therefore, the aim of the investigation was to evaluate heifers' behavioural pattern on species-rich semi-natural pasture under a continuous grazing regime as this is currently the most extensive management system employed in central Europe.

The objective was to investigate how heifers cope with various grazing intensities and the ongoing seasons in terms of grazing time and rate of biting. Specific questions addressed were: (1) is there any effect of grazing intensity on the daily activity pattern of heifers? (2) Is there any effect of grazing intensity on the biting rate of heifers? and (3) Is there any effect of grazing season on heifers' grazing behaviour?

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ANNEX

Curriculum vitae

CURRICULUM VITAE



Name: **Doc. Mgr. Pavla Hejčmanová, Ph.D.** (Nežerková)

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Nationality: Czech

Family: married, 2 children

Education

- 1993-1999 Faculty of Sciences, Charles University in Prague, Czech Republic
Master of Sciences in Biology and Chemistry, special focus on botany- ecology
Pedagogical licence
- 2000-2005 Post-graduate study at the Institute of Tropics and Subtropics, Czech University of
Agriculture in Prague, special focus on wildlife ecology and management of
protected areas in Africa (Ph.D.)
- 2010 Habilitation in the field of “Ecology” (Associated professor) at the Faculty of
Environmental Sciences, Czech University of Life Sciences, Prague

Occupation

- 2010 till present Associated Professor at the Dpt of Forest Management
Faculty of Forestry and Wood Sciences, Czech University of Life Sciences in
Prague
- 2001 - 2009 Professor Assistant at the Dpt of Animal Sciences and Food Processing in TS
Institute of Tropics and Subtropics, Czech University of Life Sciences in Prague

Teaching area

Behavioural Ecology
Biodiversity Conservation and Protected Areas
Scientific Seminar (leading students in their work on their MSc./Ph.D. theses)
Statistical Methods

Absolvent: 9 successfully defended Bachelor theses, 10 successfully defended Master theses,
Current students: 2 bachelor theses, 5 Master theses, 5 Ph.D. students

Language skills

Czech - native
French - active, international certificate DALF
English, Spanish, Wolof (Senegal) – active
Russian, German - passive

Other skills

Certificate of competency according to § 17 of the Act No. 246/1992 coll. on **Protection Animals against Cruelty** in present statues at large, issued by Central Commission for Animal Welfare, the Czech Republic – licence to provide scientific research and practical measures on animals
MS Office, ArcGIS 9.0, ArcView 3.2, STATISTICA package, CANOCO package,

Membership in professional societies:

Derbianus - Czech Society for African Wildlife
Czech and Slovak Ethological Society
Czech African Society

Overview of absolved scientific and vocational training

October 2010	Conservation Breeding Specialist Group IUCN Annual Meeting, Cologne Zoo, Germany, training in Conservation planning tools (e.g. Miradi).
September 2009	European Congress of Conservation Biology, European Society of Conservation Biology.
August 2009	<u>Course on multivariate data analyses using CANOCO package</u> , Czech University of South Bohemia, Faculty of Sciences, under the leadership of J. Lepš and P. Šmilauer.
Autumn 2008	<u>A series of courses on statistical methods using the STATISTICA package</u> , StatSoft, Ltd., Czech Republic.
August 2008	<u>Summer school on statistical methods</u> , SC&C Partner, Ltd., Brno, Czech Republic
November 2006	Certificate of competency according to § 17 of the Act No. 246/1992 coll. on Protection Animals against Cruelty in present statues at large, issued by Central Commission for Animal Welfare, the Czech Republic
September 2006	ETET 2006, l'École Thématique en Écologie tropicale, "Les réseaux trophiques: de la théorie à la gestion rationnelle des ressources biologiques des écosystèmes terrestres et aquatiques", IRD France, IRD Sénégal - Mbour
July 2002	ZOO Dvůr Králové nad Labem, Professional practice in the branch of African ungulates breeding and management, assistance to veterinary interventions, etc.
May 2002	Workshop "Methods of inventory of flora and vegetation v West Africa", University Cheikh Anta Diop (UCAD) in Dakar, Senegal
October 2001	Institute of Rural Economy (IER), Mali, assistance in the development project "Breeding of small ruminants in the West Africa";
January- March 2000	Centre National d'Etudes Agronomiques des Regions Chaudes (CNEARC), Montpellier, France, focus on Rural development in the tropics. Participation in the European Programme ERASMUS – SOCRATES;
1998	Slovenia: phytogeographical study stay, Faculty of Sciences, Charles University
1996	Rumania: ornithological study stay, Faculty of Sciences, Charles University

Participation on projects:

- "Protection, breeding and economic use of antelopes in Senegal", the Czech Aid Development**
Deputy Coordinator of the project, funded by the Government of the Czech Republic, and running since 2000, cooperation with Direction of National Parks in Senegal (DPSN) and Society for the Protection of Environment and Wildlife in Senegal (SPEFS)
- "Species diversity and ecology of selected West African vertebrates", grant IAA 6093404**
Principal co-investigator of the research project of the Grant Agency of Czech Academy of Sciences, within the cooperation with Institute of Vertebrate Biology in Brno, Academy of Science of the Czech Republic, running period 2004 – 2008
- "Behaviour of heifers under different intensity of continuous grazing", GACR 523/06/P422**

Investigator of the postdoctoral research project of the Czech Science Foundation, running period 2006-2008

4. **„Support to nature reserves and national parks in Senegal“, Czech Republic Development Cooperation RP10/2007** Leading team member (active researcher and scientific advisor) of the international development project funded by the Ministry of Environment, the Government of the Czech Republic, running period 2007-2009

5. **“Effect of long-term fertilization on grassland functioning”, GACR 521/08/1131**
Research team member, running period 2008-2012

Area of research interest

Behavioural ecology (foraging behaviour, grazing behaviour, maternal care), Habitat assessment, Wildlife and forest management, Conservation biology, Ecosystem ecology, Nutrient cycling

Publication activity

Short overview: 17 papers in journals with IF, H-index = 5; SCI = 32

1. Papers in scientific journals with IF

Hejčmanová, P., Vymyslická P., Koláčková K., Antonínová M., Policht R., Stejskalová M., Hejčman M. Suckling behaviour of eland antelopes (*Taurotragus* spp.) under semi-captive and farm conditions. *Journal of Ethology*, *in press*

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