ZOOMETEOROLOGICAL ASPECTS OF CATTLE'S BEHAVIOUR UNDER GRAZING CONDITIONS

HALÁSZ A ., NAGY G.

University of Debrecen Agricultural Centre
Department of Applied Economics and Rural Development
HU-4032 Debrecen, 138.Boszormenyi rd., Hungary
halasza@agr.unideb.hu

ABSTRACT
The aim of this review is to present some aspects of zoometeorology in the context of cattle behaviour. In the time of a running research programme, our goal is to provide a summary of the environmental factors affecting on behaviour of Hungarian Grey Cattle (HGC) under range conditions. The HGC is a traditional, local cattle breed has been evolving under harsh conditions on rangelands, with a tendency to demonstrate undomesticated behavioural patterns. These, however have been ameliorated with domestication. As we studied this breed's daily life, without human interference, a number of questions arose regarding the environment's impact on the animal's behaviour. Therefore, alongside our behavioural studies, we have started compiling literature studies of zoometeorological factors affecting cattle behaviour under natural conditions. We have found a very complex interdisciplinary approach, including principles of meteorology, ethology, pharmacology, physics and agronomy. This publication aims to present effects in the context of animal behaviour and also help to evaluate our research results on the behaviour of HGC under range grazing conditions.

Keywords: grey cattle, zoometeorology, ethology, behaviour, barometric pressure

INTRODUCTION

The science of zoometeorology emerged simultaneously with the practice of ancient livestock management. The farmers of yore lived in close proximity of their domestic animals, and this allowed them to observe their behaviour on a daily basis. The impact of weather conditions on the animals' behavioural evolution was well known by the pastoral peoples of the past centuries. Farmers of the Middle Ages planned the grazing process carefully, relying on empirical data. They kept records of the weather phenomena of the seasons, and were therefore able to accurately forecast the weather. In the 21st century this knowledge is being passed from father to son in nomadic pasturalism, as there are still remote places on the planet where herdsmen possess this valuable skill. The Eurasian steppe zone stretches along the 50th parallel north, from the Carpathian Basin to Manchuria. Countries like Hungary, Ukraine, Russia, Kazakhstan, Mongolia and China have large rangelands where traditional grazing is still part of the national agricultural practices. Mongolian farmers predict weather without the aid of modern technology. They know exactly when to start grazing in the mountains, and when the spring showers will come to the lowlands. There are still Hungarian herdsmen who know how long a 200-cattle herd can graze on a burnt-out pasture without animals suffering loss in weight, and where to drive the herd before severe weather arrives. The experienced herdsman reads from the behaviour of his livestock like a scientist can do this with high-tec instruments.
Zoometeorology is an interdisciplinary science merging the principles of ethology and meteorology (BISHOP-HURLEY, ET AL. 2007) The environmental factors' mutual effects on each other are quite complex (KOVÁCS, 2010), therefore they need to be examined in a broad context. Earlier zoometeorological observations (MALECHEK AND SMITH, 1975)

pointed out that grazing cattle reacts in a variety of ways to different weather conditions. They have proven that abiotic environment, animal physiology and behaviour are all correlated. Light-intensity or humidity alone do not significantly influence behaviour, but when the effects of humidity levels or air pressure are examined together with light, they show a more detailed and accurate picture.

MATERIAL AND METHOD

The effects of environmental factors:

Solar radiation

Incoming solar radiation is composed of different wavelengths. The ultraviolet range (200-313 nm) has bactericide effect that eliminates almost every complex, protein-capsuled bug, sanitizes pastures and cattle's skin. This wavelength is also responsible for the vitamin-D production in the upper layers of the skin, which is essential for bone tissue synthesis.
The visible light spectrum (360-780nm) has a variety of effects on the neuro-endocrine system, through the stimulated retina. It also controls daily metabolism, ovulation, calving and milk production. Zero-light conditions (KOVÁCS, 2010) also have an impact on milk's nutritional value, the quality of fur and the quantity of feed intake.
The infrared range (780-3000nm) delivers heat. This wavelength is very important for ruminants because during the digestion of high fiber feed, large amount of metabolic heat is generated. Heat stress is widely known among cattle farmers, as it has serious symptoms and cattle always try seeking shade or water if possible (TUCKER ET AL., 2007). If the overall body temperature exceeds the comfort zone the bovine body shuts down the non-essential functions such as milk production and muscle synthesis and focuses its energy on cooling by sweating or panting. The Hungarian Grey is an extensive breed with good heat tolerance. Its large ears, constantly wet rhinarium (part of the nose) and the thin abdominal skin all help in getting rid of the extra heat that builds up in the animal body.
Infrared radiation heats up the air indirectly. The Earth's surface absorbs it first, and then re-emits it later. The air at ground level can be warmer than in the upper layers and in hot summers this might be a serious issue. In order to cool their bodies, mammals sweat and thus end up losing water. It is the skin that is most prone to dehydration. Water evaporating in form of sweat increases humidity in the surrounding air, which greatly impacts livestock's daily activities (YIN ET AL., 2011). Animals compensate for the lack or the surplus of heat with longer fur, an increase or decrease in water and feed intake. Solar radiation affects humidity levels, wind speed, and by doing so, it also changes air pressure. This complex chain-effect always forces living organisms to adapt. The body attempts to maintain the most balanced physiological state (homeostasis), because failing to do so puts the animal in some form of distress.

Temperature

The Hungarian Grey Cattle's heat tolerance is relatively wide; therefore Hortobágy rangeland temperature ranging between -20 °C and +40 °C, do not cause shock to the animals. Within this thermo-range we can observe all behavioural activities. It is important to note that over +30 °C a light breeze (up to 5-10 km/h) is essential for non-stressed livestock in order to stay in its comfort zone. On the other hand, at -10 °C only a calm day can assure this. Sexual behaviour begins to manifest with the onset of long daylight time (NAGY, 2010) and mild temperatures, which cause the endocrine system (serotonin, endorphin) to kick into gear. High or low temperatures affect feed intake as well. The skin-

receptors are extremely sensitive, even a 0,05 °C temperature change can trigger changes in behaviour (KOVÁCS, 2010).

Humidity

The level of humidity determines how comfortable the current temperature is to cattle, because the unfavorable vapour content of the air and the moisture on the animal's skin can lead to serious health problems. Both of these can upset the animal's body temperature balance. While the humid air contains less oxygen, the water droplets on fur reduce its isolating capacity. Cooling and body heat preservation both require energy generated by consuming sufficient amount of feed ((KOVÁCS 2010; YIN ET AL, 2011).

Wind

During the summer months, if there is significant rainfall, the horsefly (*Tabanus bovinus, L.,1758*) population increases rapidly, causing distress to all grazing livestock (EGRI ET AL., 2012). Cattle protect themselves by grazing upwind, in order to help keep their bodies cool and to prevent insects from landing on their skin. At wintertime grazing cattle walk downwind in order to protect their most vulnerable body parts (head and chest) from heat loss. The animals are surrounded by a layer of thermo-air 10 cm thick, which serves as natural insulation on days of calm weather. However, if wind velocity reaches 36 km/h (KOVÁCS, 2010) this insulating layer is blown, and the body looses far more heat than it is able to generate.

Air pressure / Weather front effect

The inner ear receptors and the pressure-sensitive mechano-receptors (KOVÁCS, 2010) of the upper skin notify the neuro-endocrine and the autonomic nervous systems about atmospheric pressure changes. The ionized oxygen-concentration, determines the animal's blood-serotonin level (KRUEGER AND SMITH, 1960; KÉRDŐ ET AL., 1972; SOYKA, 1977; SULMAN, 1980; PFEIFER AND SULMAN, 1982; ADAMS ET AL, 2012). This hormone is a neurotransmitter, responsible for controlling mood (behaviour), appetite and sleep. Under warm or cold weather front the barometric pressure is rising or dropping and at the same time, air electricity (ionization) also changes dramatically, which has direct influence on serotonin hormone synthesis. The Hungarian Grey cattle population lives at a relatively low altitude, where barometric pressure, under weather front-free conditions, is between 1000-1010 hPa. This value could decrease or increase rapidly throughout the day. During warm weather fronts, serotonin level increases, causing relaxed behaviour; however there is a critical level, where serotonin-depression may occur and the animal becomes restless, stops grazing and no longer shows sexual behaviour. At the level of 990 hPa, serotonin depression can be so severe as to cause milk production (lactation) and reproduction cell synthesis to come to a halt.

Air Ions

Ionized air is essential for a healthy respiratory system (TCHIJEWSKI, 1960; SOYKA, 1977). Ions are charged particles and because of their electrostatic nature they connect themselves to the proteins' membrane. Throughout a complex process negatively charged air (oxygen) molecules are able to block serotonin production (KRUEGER, 1960), while positively charged carbon-dioxide release more plasma serotonin.

In the atmosphere positive and negative ions are both present, but radioactive minerals (radium, uranium), radioactive gases (e.g. radon), cosmic rays, lightning, wildfire and high voltage discharge may change their ratio (WAHLIN, 1989; LEE, 1993; COTE, 2003;

SERRANO ET AL., 2006). Evaporating water produces negative ions, while radioactivity mostly produces positively charged particles.

SUMMARY OF FINDINGS

As the environment continuously has effects on animals' bodies, they try to maintain homeostasis through thermoregulation. While factors like wind or humidity help the body in getting rid of extra heat, solar radiation or metabolic energy increase body heat. Barometric pressure and ionized air affect mechano receptors and the neuro-endocrine system. The dominating weather fronts (warm-, cold-, neutral ones) determine the level of plasma serotonin, and thus define the animals' mood and directly determine their major behavioural patterns. (*Figure 1.*)

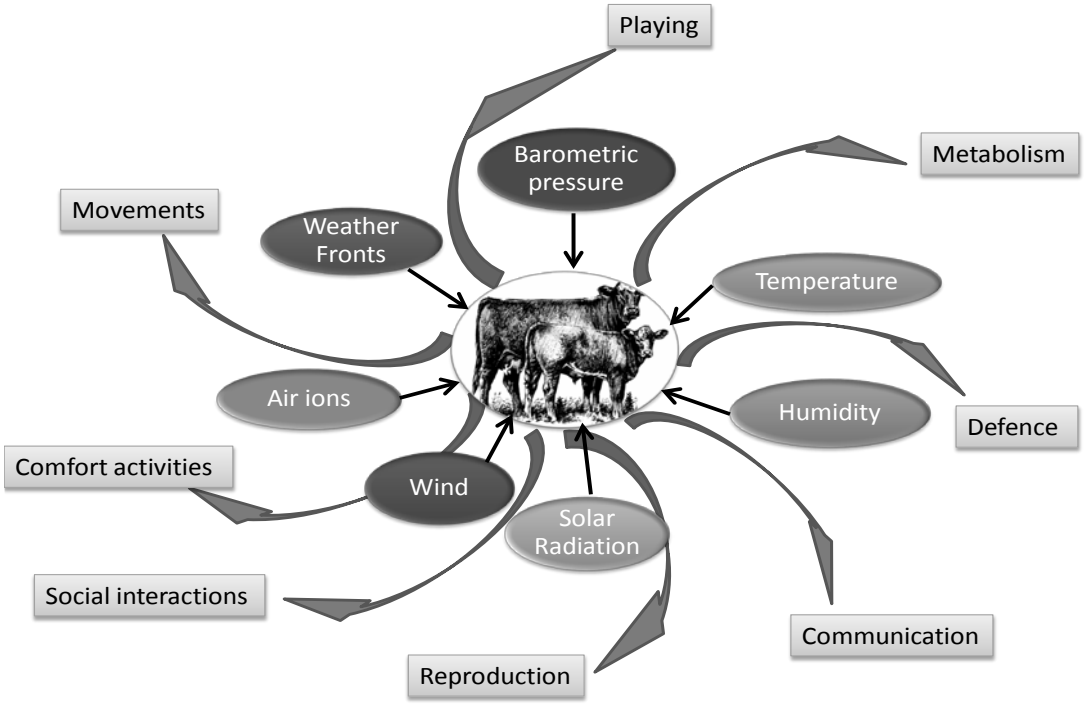

Figure 1. Schematic pattern of environmental variables influencing cattle s behaviour on pasture

Source: Author's personal studies (2013)

Our research has concluded, at the present stage, to measure barometric pressure and daily walked distance, because under weather fronts the atmospheric ion ratio could change (WAHLIN, 1989), and as a result, fronts have indirect effect on serotonin production and animal behaviour. Throughout this complex mechanism we are able to compare pressure, spatial position and behaviour.

ACKNOWLEDGEMENT

The work/publication is supported by the TÁMOP-4.2.2/B-10/1-2010-0024 project. The project is co-financed by the European Union and the European Social Fund.

REFERENCES

ADAMS, A.L., FRIEND, T.H., HOLUB, G.A., BEGHAM, L.R., RIGGS, P.K., GAREY, S.M., TERRILL, C.L. AND CARTER, M.J. (2012): Stress affects plasma serotonin, but not tryptophan, in Holstein steer calves. ADSA-AMPA-ASAS-CSAS-WSASAS Joint annual meeting July 15-19 2012, Texas A&M University, College Station.

BISHOP-HURLEY, G. J., SWAIN, D.L., ANDERSON D.M., SIKKA, P., CROSMAN, C., CORKE, P. (2007): Virtual fencing applications: Implementing and testing an automated cattle control system. Computers and Electronics in agriculture, 56. pp. 14-22.

COTE, J.Y. (2003): The ion miracle ISBN-10: 2922562018

EGRI, A., BLAHO, M., KRISKA, G., FARKAS, R., GYURKOVSZKY, M., ÅKESSON, S. AND HORVÁTH, G. (2012): Polarotactic tabanids find striped patterns with brightness and/or polarization modulation least attractive: an advantage of zebra stripes. Journal of Experimental Biology 215. pp.736-745.

KÉRDŐ, I., HAY, GY. AND SVÁB, F. (1972): New possibilities on the increasing of driving safety. Budapest, Hungary, MEDICOR

KOVÁCS, A. (2010): Agrometeorológiai és klimatológiai alapismeretek 8. fejezet, Zoometeorológia, pp. 263-290. ISBN: 978-963-286-598-0

KRUEGER, A.P., SMITH, R.F. (1960): The Biological Mechanisms of Air Ion Action**.** Journal of General Physiology 43.pp. 533–540.

LEE, W.B. (1993): AlphaLab Inc. owner https://www.trifield.com/content/about-air-ions/

MALECHEK, J. C., SMITH, B. M. (1975): Behavior of Range Cows in Response to Winter Weather. Journal of Range Management, 29. pp. 9-12.

NAGY, A. D. (2010): A cirkadián óra génszintű vezérlése – vizsgálatok csirke tobozmirigy modellen, PhD értekezés tézisei, Pécsi Elméleti Orvostudományok Doktori Iskola

PFEIFER, Y., SULMAN, F. G. (1982): Effect of Negative Air Ion Treatment on Blood Serotonin in Weather Sensitive Patients. Bionic Products Pty Ltd research

SERRANO, C., REIS, A.H., ROSA, R., LUCIO, P.S. (2006): Influences of cosmic radiation, artificial radioactivity and aerosol concentration upon the fair-weather atmospheric electric field in Lisbon (1955–1991). Atmospheric Research 81.pp. 236– 249.

SOYKA, F. (1977): The ion effect. ISBN 0-553-14388-3

SULMAN, F.G. (1980): The Effect of Air Ionisation, Electric Fields, Atmospherics and other Electric Phenomena on Man and Animal. Charles C. Thomas, Springfield, III., 400 p.

TCHIJEWSKI, A. L. (1960): "Air Ionization: Its Role in the National Economy". Moscow: State Planning Commission of the U.S.S.R. (Translated by the office of Naval Intelligence, Washington D.C.).

TUCKER, C.B., ROGERS, A.R., SCHUTZ, K.E. (2007): Effect of solar radiation on dairy cattle behaviour, use of shade and body temperature in a pasture based system. Applied Animal Behaviour Science 109. pp.141–154.

WAHLIN, L. (1989): Atmospheric electrostatics. ISBN 0 471 91202 6

YIN, J.F., ZHENG, Y.F., WU R.J., TAN, J.G., YE, D.X., WANG, W. (2011): An analysis of influential factors on outdoor thermal comfort in summer International Journal of Biometeorology 56. pp 941-948.