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GPS based tools for extensively reared cattle: relationship between temperature and animal activity

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Abstract. A study was conducted to track a group of grazing cows by GPS-GPRS technology. GPS devices were placed in the neck of 3 non-gestating and non-lactating Morucha cows (averaged 8 years old). The GPS units emitted data regarding animal position every 10 minutes for a period of 28 days in which the animals could range freely in the experimental farm. Data were processed using the appropriate software to generate parameters related to animals' activity, such as velocity of movement or estimated grazing area. It was observed that the hours of activity and rest matched those of daily daylight and night time, albeit a period of two hours of little activity was observed during the early afternoon. Likewise, activity varied along the days of study, probably due, among other factors, to the changes in weather conditions. A significant positive correlation between the activity shown by the animals and the temperature registered throughout the day was noted, although the latter directly depends on daylight and night time periods. The development and implementation of these monitoring systems in the future on a practical level may contribute to an appropriate and efficient management of extensively reared cattle, especially in remote, difficult to access and large areas, while providing valuable information about the interactions between animals and the environment.

Keywords. Management – Remote – Global position system – Grazing area – Movement.

Outils basés sur le GPS pour le contrôle de l'élevage extensif du bétail: relations entre la température et l'activité des animaux

Résumé. *Une étude a été réalisée, en utilisant la technologie GPS, pour faire un suivi à un groupe de vaches au pâturage. Les dispositifs, qui ont été placés au cou de 3 vaches de race Morucha non gestantes ni en lactation (8 ± 2,5 ans), ont émis des données sur la position des animaux chaque 10 minutes pendant une période de 28 jours dans lequel ils se déplaçaient librement dans la ferme expérimentale. Les données ont été traitées avec un logiciel approprié pour obtenir les paramètres liés à l'activité des animaux (vitesse de déplacement, surface de pâturage…). Il a été noté que les heures d'activité et de repos des animaux coïncident avec les heures de lumière et d'obscurité, et qu'il y avait une période de moins d'activité dans le milieu de la journée. De la même manière, l'activité a varié au fil des jours de l'étude, probablement, entre autres facteurs, à cause de la variation des conditions météorologiques. Il y a eu une corrélation significative entre l'activité des animaux et la température tout au long de la journée, bien que celle-ci soit affectée par des périodes de lumière et d'obscurité. Le développement et l'implémentation au niveau pratique de ces systèmes dans le futur peuvent contribuer à contrôler et gérer le bétail d'une manière plus appropriée et efficace, surtout dans les zones de pâturage grandes et de difficile accès, et aussi à étudier les interactions entre les animaux, et entre eux et l'environnement dans lequel ils se déplacent.*

Mots-clés. *Gestion – À distance – Système de positionnement global – Zone de pâturage – Mouvement.*

I – Introduction

There is an increasing interest in the use of gps-gprs technology to monitor livestock activities, the effects of weather on animal behaviour still remain to be fully considered. Nevertheless, not only will climate conditions influence animal welfare, but also animal performance (Roselle *et al.*, 2013). The study of the response of animals' behaviour throughout the year in different locations to temperature changes (increases and decreases) may serve as a model to estimate animals' reaction to unfavourable weather conditions. Morucha is a rustic cattle breed traditionally reared on pasturelands ("dehesa") on the west of Spain, particularly in Salamanca province. It is characterized by medium adult size that has evolved into a compact format during the last 30 years, thus improving its meat yield, which is under Geographic Protected Indication "Carne Morucha de Salamanca" (De la Fuente *et al.*, 2014). The objective of this experiment was to study the activity throughout the day of this cattle breed usually reared under extensive pastureland conditions and to describe the possible influence of weather on this activity.

II – Materials and methods

1. Animals, location and data sampling

Three specially designed GPS-GPRS devices were fitted to the neck of three, non-gestating and non-lactating, 8 years old morucha cows. The hardware was able to real-time record and transmit position data every 10 minutes for a 28 days period. Data were automatically uploaded into a website where they were also real-time available.

The trial was conducted in "Finca Muñovela" (817 m above sea level; 40°54'13'' N; 5°46'47'' W), owned by the "Instituto de Recursos Naturales y Agrobiología" of Salamanca (IRNASA, CSIC) in Barbadillo (Salamanca, Spain), where the animals had been grazing for at least one month before the commencement of the trial. The area is characterized by temperate climate, with dry and temperate summers (Köppen-Geiger climatic classification: Csb; AEMET, 2011).

Weather conditions were recorded by a weather station located in the same farm where the animals were grazing. Temperature-humidity index (THI) was calculated according to Dikmen and Hansen (2009): THI = (1.8×T+32)-[(0.55-0.0055×RH)×(1.8×T-26.8)], where T is temperature (°C) and RH is relative humidity (%). As the experiment progressed, humidity values were decreasing; however, the rise in temperature resulted in an increase in THI (Fig. 2), rainfall being almost irrelevant.

2. Data processing

Position data were recorded in worksheets and processed by using Excel, Access and ArcGis software to calculate the distance to interest points (such as, e.g., ponds), distance travelled by the animals and speed of these movements (the latter can be assumed as an indicator of the animal's activity through the field; Dolev *et al.*, 2014; Trotter *et al.*, 2010). Regression analyses and graphs were performed on SigmaPlot 9.01 (Systat Software, Inc., Chicago, USA).

III – Results and discussion

Daily pattern of movement can be seen in Figure 1A. As can be seen, activity and rest peaks are recorded in daylight and night hours, respectively. Cows increase their activity around 7:00 and reach a maximum around 12:00, in which activity starts decreasing. Afterwards there is a rest-like period between 14:00 and 16:00. A hiccup is observed at 17:00, speed increasing until 19:00, when the maximum peak is attained. Then there was a sharp decrease in speed which remained at a relatively low level all night long.

This pattern of daily activity is very similar to the one reported by previous authors: there is an increase in activity during the morning; movements decrease by early afternoon and gradually increase by late afternoon (Trotter *et al.*, 2010). Thus, high speed values are indicative of travelling periods, very low values indicate resting periods, whereas grazing events usually occur at intermediate speed levels (Sarova *et al.*, 2010). By representing animals' position in a map (data not shown) it could be confirmed that animals were moving and travelling from 9:00 to 12:00 and from 18:00 to 20:00. It could be concluded that grazing periods were around sunrise (6:00-7:00) and sunset (21:00-22:00), whereas drinking activity took place in the two occasions when animals passed by the ponds (14:00 and 21:00).

The study of the relationship between THI and animals' speed of movement give rise to a significant linear direct correlation (Fig. 1 B). Thus, as the THI increases, so does the speed at which the cows move. Nevertheless, taking into account that correlations do not involve causality, it must be pointed out that THI variations within the day follow day-night pattern and, hence, animals movement.

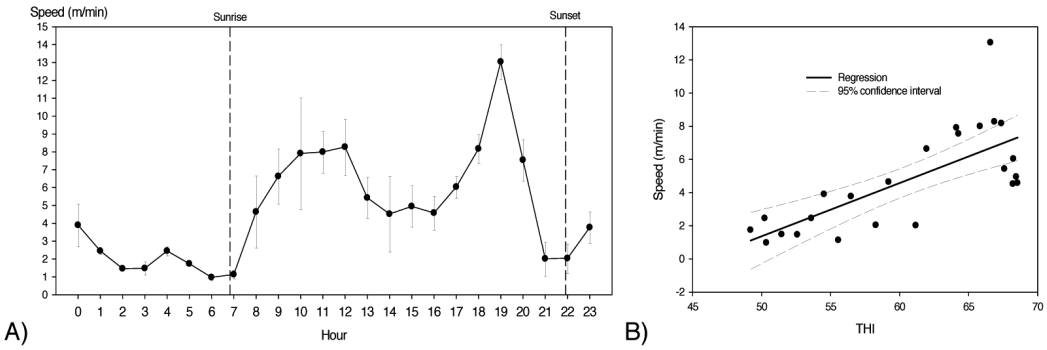

Fig. 1. A) Evolution of average hourly speed of monitored animals during the day. B) Linear regression of hourly speed *vs*. THI values: speed = 14.7 + 0.32×THI; r^2 = 0.530; P<0.001.

The average daily speed of animals during the experimental period and the evolution of THI are shown in Figure 2A. As the experiment progressed, an increase in THI was observed, as well as subtle decrease in animals' activity (speed of movement). Even though some authors opine that grazing time through the day may be independent of weather conditions, this idea is not generally accepted. Conversely, animals seem to look for shaded places in the early afternoon or when the temperature rises (central and hottest hours of day; Roselle *et al.* 2013; Trotter *et al.*, 2010).

When the weather conditions are maintained, animals tend to show similar patterns of activity and grazing over days (Hejcmanová *et al.*, 2009). In the present experiment we could observe a significant linear inverse small relationship between ITH and animals' speed of movement (Fig. 2B). Thus, despite keeping the same intra-day movement pattern, the average daily activity of the animals throughout the study (inter-days) may have decreased, at least partly, in response to the increase in ITH. In this regard, animals' behaviour evolves over time due to changes in climatic conditions (Hejcmanová *et al.*, 2009). Although, as previously indicated, it can be assumed that this fact does not necessarily entail a reduction in grazing times (and hence in animal's performance), this question is still to be answered.

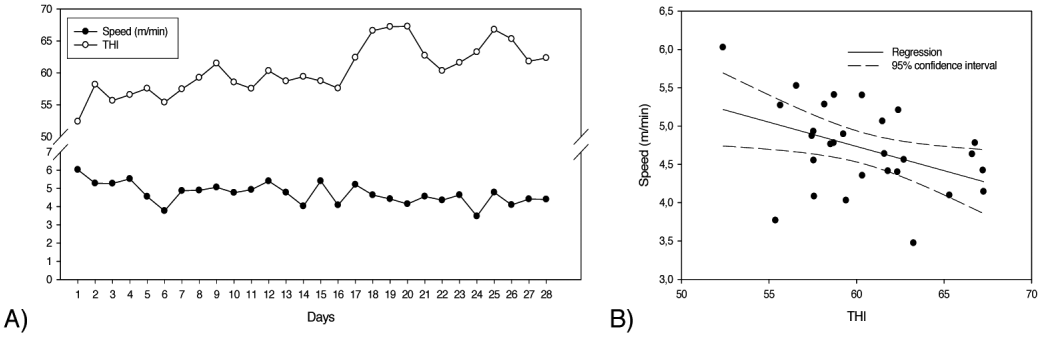

Fig. 2. A) Evolution of average daily speed of monitored animals and temperature and humidity index (THI) during the experimental period. B) Linear regression of average daily speed *vs.* THI values: speed = 8.53-0.06×THI; r^2 = 0.179; P<0.05.

The development and implementation of these monitoring systems in the future on a practical level may contribute to an appropriate and efficient management of extensively reared cattle, especially in remote, difficult to access and large areas, while providing valuable information about the interactions between animals and the environment.

IV – Conclusions

Morucha grazing animals are more active during the daylight hours, maximum and minimum speeds of movement being reached during the afternoon and the night, respectively. This scheme positively correlates with intra-day pattern of THI. However, as the average daily THI increases over days, animals tend to modify their behaviour towards a decrease in speed of movements and, hence, overall activity.

From a practical viewpoint, these monitoring systems may contribute in the future to an appropriate and efficient management of extensively reared cattle.

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