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Transhumance of dairy cows on alpine summer pastures: relationships between milk production, pasture management, and insect biodiversity

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Abstract. In the Alps, centuries of coexistence of human activities and harsh climatic and topographic conditions generated the alpine summer pastures agroecosystems, rich in biodiversity and cultural values. The maintenance of species-rich summer pastures and their ecosystem services is linked to the low-intensity livestock grazing. In this study, the interactions between dairy livestock category/productivity, weed encroachment and butterfly biodiversity in 21 summer farms, 16 with lactating cows and 5 with heifers were assessed in the Trento province (Eastern Italian Alps). During transhumance, a seasonal movement of livestock to upland mountain pastures, data on milk production from May to October and Body Condition Score (BCS) at the beginning and at the end of the summer season for 799 lactating cows of different breeds (classified as local, dual purpose or specialised) were collected. A subjective index from 1 (good conditions) to 4 (bad conditions) to different pastures sections based on the level of weed encroachment was assigned. Three plots per summer farm were surveyed three times for data on butterfly diversity. The interaction between month and breed on milk yield and BCS was analysed. Relationships between butterfly biodiversity, weed encroachment and other traits were investigated. Local and dual-purpose breeds performed better during the transhumance than specialized breeds. The category/productivity of livestock and stocking rate were non-related with pasture conditions index and lower stocking rates favoured butterflies species abundance. The ability of local and dual purpose breeds to adapt to summer pastures conditions should be used to devise grazing management programmes to maximize the trade-off between pasture productivity and biodiversity.

Keywords. Highland pastures – Summer farms – Dairy cows – Grassland management – Insect biodiversity.

La transhumance des vaches laitières en pâturages alpins d'été: relations entre la production de lait, la gestion des pâturages et la biodiversité des insectes

Résumé. *Les agroécosystèmes des alpages offrent plusieurs services écosystémiques, qui ont été préservés grâce à l'usage de la transhumance. Le changement de cette pratique met en danger la conservation de ces écosystèmes. On a évalué les interactions entre les catégories et la productivité de bétail laitier, l'invasion des mauvaises herbes et la biodiversité des papillons dans 21 fermes d'été dans les Alpes orientales, dont 16 logeaient des vaches laitières et 5 des génisses. Les données sur la production de lait ont été recueillies de Mai à Octobre, tandis que celles sur le Body Condition Score (BCS) de Jun à Septembre pour 799 vaches laitières de races différentes. Un score subjectif de 1 (bonnes conditions) à 4 (mauvaises conditions) a été attribué par différents secteurs des pâturages selon le niveau d'invasion des mauvaises herbes. Trois parcelles par alpage ont fait l'objet d'une enquête trois fois pour observer les papillons. Nous avons analysé l'interaction entre le mois et la race sur le rendement du lait et sur le BCS, et aussi les relations entre la biodiversité des papillons, l'invasion des mauvaises herbes et d'autres traits. Les races locales se sont révélées plus appropriées pour la transhumance. Les caractéristiques de gestion de bétail et le chargement ne sont pas liés aux conditions de pâturage, tandis qu'un chargement léger semble bénéficier aux papillons. La capacité des races locales à mieux s'adapter devraient être utilisée pour concevoir des programmes visant à améliorer le compromis entre la productivité du pâturage et la biodiversité.*

Mots-clés. *Pâturages alpins – Fermes d'été – Vaches laitières – Gestion des pâturages – Biodiversité des insectes.*

I – Introduction

For centuries mountain farmers have practiced transhumance of livestock in summer farms, which are temporary farms used in summer to incorporate the highland forage into the total amount of resources of permanent farms (Mack *et al*., 2013; Sturaro *et al*., 2013b). The extensive livestock systems in mountainous areas maintain semi-natural grasslands, which can be classified as High Natural Value Farmland that delivers provisioning and non-provisioning ecosystem services (ES) (Rodríguez-Ortega *et al*., 2014; Strohbach *et al*., 2015). In the last decades, the mountain livestock systems experienced an abandonment process in marginal areas and an intensification trend in more productive areas (MacDonald *et al*., 2000; Strijker, 2005; Bernués *et al*., 2011), which deeply affected traditional summer farms management. In several cases lactating cows are no more moved to summer farms. On the other hand, highly specialized breeds are moved to highland pastures, requiring high levels of feed supplement to sustain their productivity (Sturaro *et al*., 2013a). This paper presents a synthesis of the results of a project aimed at analysing the overall sustainability of summer farms in the Trento province (Zendri, 2015; Jerrentrup *et al*., 2016). We assessed the impact of transhumance on body condition score, which is an indicator of the amount of metabolizable energy stored in body reserves on a live animal (Edmonson *et al*., 1989), and milk production of different cattle breeds reared on summer farms in mixed herds. The effects of different intensities of pasture management on weed encroachment and butterfly diversity were also investigated.

II – Materials and methods

The study was conducted in the Trento Province (north eastern Italian Alps) in 21 summer farms (1680 ± 307 m a.s.l.), where multi-breed cattle herds grazed during the summer season (mid-June to September) of 2012. Ownership of summer farms is mainly public (usually district councils), and each summer farm normally hosts cattle from several permanent farms. As a consequence, usually the summer farms herds are composed by mixed breeds. Heifers grazed in five summer farms (1756 ± 366 m a.s.l.), and lactating cows in the other sixteen farms (1657 ± 295 m a.s.l.). Data on herd composition and milk yield were obtained from Provincial veterinary services and official recordings, whereas data on pasture area, pasture subdivision into sections and stocking rate were obtained through an on farm survey. A two steps analysis was performed. First, the effects of transhumance on 799 cows of two specialized dairy breeds (90 Holstein Friesian, 314 Brown Swiss) and of two dual-purpose groups (241 Simmental, and 154 classified as “local breeds”, mainly Grey Alpine and Rendena) on cows’ performance were analysed. Body condition score (BCS) was determined by two trained operators in summer farms, in July and September, using a five-classes scoring (from 1, emaciated, to 5 obese) as stated by Edmonson *et al*. (1989) for dairy breeds. Milk yield was recorded in May (in permanent farms before transhumance), June, July and September (in summer farms) and October (in the permanent farms after transhumance). In August official milk recording activity is interrupted. The BCS and milk yield data were analyzed (MIXED procedure, SAS, Institute Inc., Cary, NC) with a model including the fixed effects of breed, month (and their interactions), class of parity (2 classes) and class of days in milk (5 classes) of cows, and the individual nested within summer farms as random effect. At summer farm level, the differences in weed encroachment and butterfly biodiversity of pastures were examined. The different pasture sections were subjectively scored from 1 (good quality) to 4 (bad conditions) according to the level of weed encroachment. Data on butterfly diversity (Hesperioidea and Papilionidea) were collected three times during the summer season in a subsample of 15 summer farms. For each summer farm, three plots were selected: one next to the farm building (max. 50 m), and two at almost 300 m from the farm building following random directions. A mixed model was used to analyse the effects of distance from farm, animal category (lactating cows *vs.* heifers) and their interaction on butterfly species richness (Jerrentrup *et al*., 2016). The correlation among management data (stocking rate and feed supplement), weed encroachment index and mean butterfly species richness were tested.

III – Results and discussion

Milk yield was affected by the interaction between the breed and the month of control (Fig. 1). In May and June milk production differed between breeds, with Holstein Friesian having the highest milk yield, Brown Swiss and Simmental the intermediate and local breeds the lowest (P <0.001). However, Simmental had the greatest milk yield in July (P<0.05), whereas the differences among breeds in the other months were non significant. The greater yield loss observed in specialised breeds when compared to the dual-purpose and local breeds agrees with the results obtained by Horn *et al*. (2014). Monthly average milk yields of all the breeds decreased during the summer season, despite of supplementary feeding, and recovered partially after returning to the permanent farms. This decrease could partially be explained by the advancing stage of lactation (average days in milk at the beginning of transhumance was 205 ± 105), and indicates that transhumance is a stressful challenge for dairy cattle, moved from a constant resource availability and shelter to outdoors grazing, where feeding involves long walks on steep slopes and a variable diet quality.

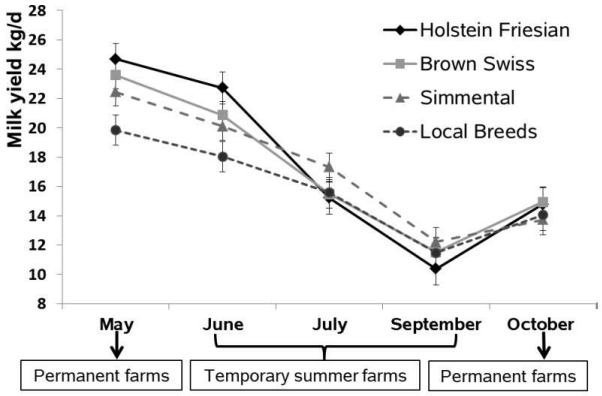

Fig. 1. Monthly milk yield of different cow breeds (Zendri, 2015).

The BCS confirmed the expected differences among breeds (average values: from 2.54 for Holstein Friesian to 3.01 for Local Breeds; P<0.001). Differences between early (July) and late (September) summer season were, however, modest and not significant for all breeds.

The stocking rates were lower in summer farms with grazing heifers (0.86 ± 0.53 LU/ha) than in those with lactating cows (1.10 ± 0.56 LU/ha). Supplementary feeding was provided in all the summer farms housing cows with a daily average of 4.0 kg of concentrates/cow (SD = 1.2). Farms with grazing heifers tended to have greater weed encroachment than those with lactating cows (3.17 ± 0.51 *vs*. 2.83 ± 0.38 weed index per summer farm, respectively (one way ANOVA: P<0.10). Stocking rate, amount of feed supplement and weed encroachment were not correlated (P>0.05), which suggests a disruption of the traditional link between herd average needs and intensity of pasture management.

Sampled butterfly species were 70% sedentary and 30% mobile (Jerrentrup *et al*., 2016). Low mobility makes sedentary butterflies more sensitive to changes in their habitats (Curtis *et al.*, 2015). Butterfly species richness was affected by the interaction between the distance to the farm and the type of grazing animals (P<0.05). Butterfly species richness was greater far than near the farm building for farms with lactating cows (close: 9.6 ± 3.3; far: 18 ± 7.6 species abundance per summer farm; P<0.05), whereas no differences were observed for farms with heifers (close: 10.4 ± 5.8;

far: 14 ± 3.4 species abundance per summer farm). Near the farm, species richness was lower for grazing cows than for grazing heifers ($P<0.05$) most likely due to the adverse impact of an intense trampling and grazing on flower abundance and on the vegetation structure. This was not observed in summer farms with heifers.

IV – Conclusions

The traditional link between pasture management and cow's productivity has weakened in summer farms. The transhumance of specialized breeds, despite supplementary feeding, causes a strong reduction of milk yields, without improving significantly pasture conditions. A sustainable management of summer farms should focus on local or dual purpose breeds, more adaptable to the transhumance conditions. Summer pastures managed with moderate stocking rates of herds composed of local breeds would ensure a positive effect on butterfly biodiversity, without decreasing the milk yield, since local breeds adapt better to summer grazing than specialized breeds.

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