

Robust cattle valorise ecosystem services of marginal grassland

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Abstract

Semi-natural, marginal pastures offer a plethora of ecosystem services but they are often underused in modern agriculture. We analysed if robust cattle valorise these services more efficiently than highly productive cattle. We assessed anatomy, feeding and movement behaviour of Highland cattle (HC) as a model for robust cattle and compared it to the medium-productive Original Brown and high-productive Angus×Holstein in a controlled experiment in the Swiss Alps. Additionally, we investigated the vegetation of 25 pastures of HC with adjacent pastures of highly productive cattle. HC differed significantly from productive breeds: (1) HC were significantly lighter, but had large claws and covered less distance. Consequently, trampling pressure was lower and trampling-adapted plant species were rarer on HC pastures. Since these plants outcompete more-susceptible species, biodiversity was higher on HC pastures. (2) HC grazed least selectively and foraged unattractive plants, whereas high-productive cattle preferred nutrient-rich, easily digestible forage. Thereby, HC reduce problematic plants. (3) HC used the pasture most evenly and exploited different resources. (4) The productive breeds lost weight on the marginal pastures, whereas HC gained weight, indicating a more efficient roughage conversion. Robust cattle make efficient use of marginal grassland, thereby valorising these pastures and promoting biodiversity.

Keywords: biodiversity, cattle breeds, forage selection, movement behaviour, productivity

Introduction

Marginal pastures offer a plethora of ecosystem services, such as biomass production, outstanding biodiversity and landscape aesthetic for recreation and tourism. These services are valorised and maintained by livestock (Martin-Collado *et al.*, 2019). However, due to their comparably small biomass production and low forage quality, these pastures are difficult to integrate into modern intensive agriculture. Consequently, they are underused and abandoned. The abandonment of marginal land may be enforced by output-orientated livestock breeding which enormously changed livestock characteristics during the last century. In cattle, high-productive, specialised dairy or beef cattle emerged. They differ from low-productive, traditional breeds in appearance and productivity, but probably also in anatomy, movement and foraging behaviour. Such differences could have far-reaching consequences for pasture vegetation and the way in which cattle valorise ecosystem services of marginal grasslands.

Materials and methods

Sub-study I (Pauler *et al.*, 2020a; Pauler *et al.*, 2020b) investigated three cattle breeds representing different levels of productivity: (1) low-productive Highland cattle, (2) dual-purpose Original Brown and (3) high-productive Angus×Holstein crossbreed. The cattle simultaneously grazed three types of heterogeneous subalpine pastures in the Swiss Alps (2026 m asl.). Individual body weight and claw base area were measured. To analyse the movement behaviour, we recorded speed, space use evenness and step frequency using GPS tracking and pedometers. We visually observed foraging behaviour of each cow by recording selected plants and compared biomass proportions of each plant species before and after grazing. Differences among breeds were tested by Tukey Range Tests. Preference or avoidance for different plant species were derived from the coefficients of a linear, mixed-effects model. Sub-study II (Pauler *et al.*, 2019) explored long-term breed effects on pasture vegetation. We conducted an observational vegetation study in Switzerland and Germany. At 25 sites, pastures grazed by Highland cattle for at least 5

years, were compared to similar, adjacent pastures of more productive cattle. We recorded the percentage cover of all plant species, assigned them to indicator values of trampling and grazing tolerance (Briemle *et al.*, 2002) and analysed data by generalized linear mixed-effects models.

Results and discussion

Breeds differed consistently with respect to almost all factors analysed. Especially Highland cattle differed from the two more productive breeds significantly, while there was only little divergence between Original Brown and Angus×Holstein cattle: Highland cattle were significantly lighter (358 kg) than Original Brown (582 kg) and Angus×Holstein (679 kg). Claw base was smaller in Highland cattle, but it was relatively large compared to body weight (Figure 1A). Hence, physical pressure to the ground is lower in Highland cattle. Accordingly, we found significantly less trampling-adapted plant species on Highland cattle pastures (Figure 2A).

GPS and pedometers indicated that Highland cattle moved least, but used the space most evenly (Figure 1B). The more productive a breed was, the higher the forage selectivity and step frequency. Highland cattle foraged most evenly (Figure 1C) and thereby chose the diet of lowest quality. Since they were least choosy while foraging, they needed to walk shortest distances, as they just fed on what was in close proximity to their mouth. Thereby, they additionally reduce trampling pressure. Original Brown and Angus×Holstein foraged more broad-leaved grasses and legumes than Highland cattle (Figure 3), while nutrient-poor species, woody or grazing-adapted plants were consumed by Highland cattle much more frequently. The silver thistle ('Ca. acau' in Figure 3), for example, was clearly avoided by Angus×Holstein, whereas Highland cattle were indifferent. Accordingly, grazing adapted plants were significantly less abundant on pastures grazed by Highland cattle for at least 5 years (Figure 2B,C).

Highland cattle pastures were significantly more species-rich than comparable pastures of productive cattle (Figure 2D) and these differences increased with the duration a pasture was grazed by the breeds. This finding is well explained by the lower trampling pressure and the less selective foraging behaviour of Highland cattle, which prevent highly competitive species from overgrowing more susceptible plants.

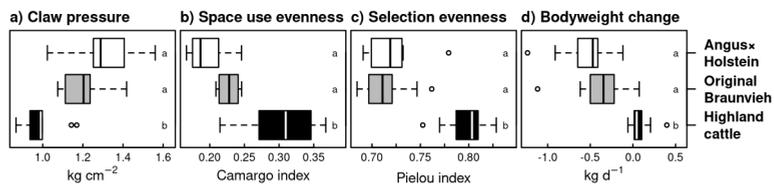


Figure 1. Differences in grazing-relevant characteristics of three cattle breeds. Different letters indicate significant differences among breeds ($P < 0.05$).

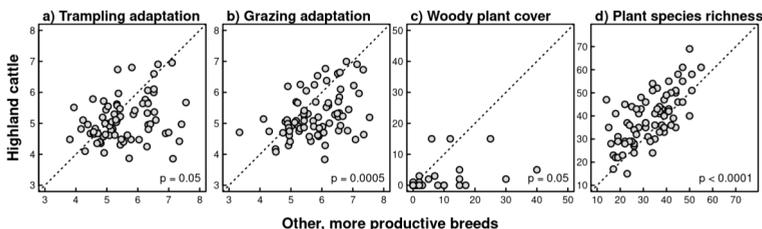


Figure 2. Vegetation indices of paired pastures grazed by Highland cattle or productive breeds.

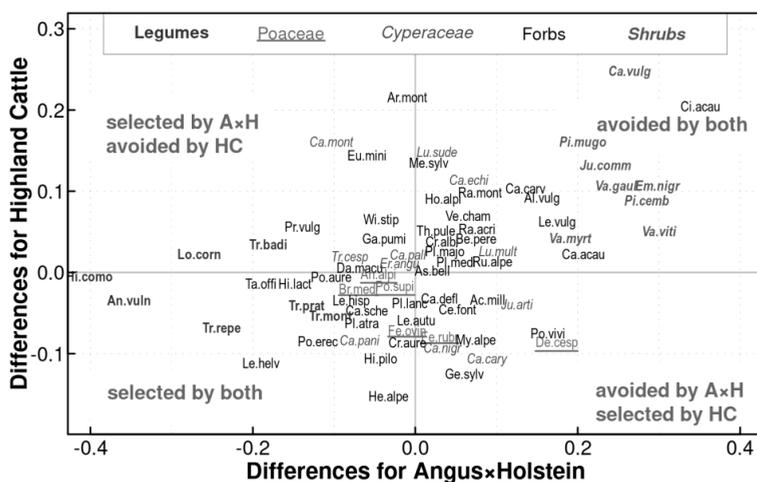


Figure 3. Preference and avoidance of plant species by Highland Cattle (HC; y-axis) and Angus× Holstein (A×H; x-axis), measured as differences in biomass proportions before and after grazing. Negative values indicate preference, positive values avoidance.

On nutrient-poor pastures, cattle commonly lose body weight. Although Highland cattle chose a diet of lower forage quality, they gained weight (0.08 kg d^{-1}), whereas the other two breeds lost 0.3 kg d^{-1} (Original Brown) and 0.6 kg d^{-1} (Angus×Holstein; Figure 1D). Highland cattle compensated the lower energy intake by their unhurried movement behaviour, their warming fur and likely by a more efficient food conversion of the fibre-rich diet.

Conclusions

Robust cattle such as Highland cattle are able to cope with the low forage quality of marginal pastures and make efficient use of them (provisioning ecosystem services). They preserve the biodiversity of semi-natural grasslands most efficiently (supporting services) and maintain open landscapes for recreation and tourism (cultural services). Hence, robust breeds are an ideal option to valorize ecosystem services of semi-natural, marginal pastures.

References

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