Robust cattle, sheep and goats in green alder shrubs – or how to preserve mountain pastures

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Abstract

Green alder shrubs (*Alnus viridis*) increasingly overgrow mountain pastures and impair ecosystem services by loss of biodiversity, eutrophication and greenhouse gas emissions. Over the centuries, grazing livestock, especially goats, preserved these ecosystems by impeding shrub expansion. Nowadays, livestock numbers are decreasing on remote mountain pastures and goat farming has become unprofitable. A grazing experiment tested if robust cattle and sheep can replace goats as antagonists of green alder and if the available fodder is sufficient. GPS tracking and vegetation mapping were used to analyse movement behaviour and debarking activity of Dexter cattle, Engadine sheep and Pfauen goats. The forage quality of green alder and its understorey was unexpectedly high. Cattle used the space least evenly, preferred flat slopes and open pastures, spent least amount of time in green alder and did not debark any green alder branches. Engadine sheep visited the shrubs nearly as often as goats, but preferred flat slopes and short vegetation. Unexpectedly, this sheep breed debarked a significantly higher share of green alder branches than goats. Dexter cattle cannot replace goats for fast green alder clearance but they may impede shrub encroachment in the long term. Engadine sheep are well suited to recreate biodiverse semi-natural open pastures and maintain their ecosystem services.

Keywords: abandonment; biodiversity; grazing; robust breeds; green alder

Introduction

Green alder shrubs (*Alnus viridis*) increasingly overgrow mountain pastures in the European Alps but hinder natural forest succession. The main reason for shrub expansion is a reduction of farming activities, especially of goat grazing. Green alder is a nitrogen-fixing pioneer shrub and comes along with numerous negative effects including loss of appealing landscape, eutrophication of soils and downstream waters, and emission of greenhouse gases (Bühlmann *et al.*, 2016). Moreover, the understorey vegetation of green alder is species-poor and dominated by only a few broad-leaved herbs (Zehnder *et al.*, 2020). We therefore aimed to test if hardy breeds of more economically-attractive livestock species, cattle and sheep, can replace goats as green alder antagonists.

Materials and methods

A grazing experiment was set up using Dexter cattle, Engadine sheep and Pfauen goats on subalpine, shrub-encroached pastures in the eastern Swiss Alps (46°34'N, 9°50'E; 1,900-2,200 m a.s.l.). The shrub layer consisted of green alder (98%) and elderberry (2%). All chosen breeds were of low productivity and adapted to roam steep terrain and to feed on low-quality forage. We observed two cattle herds, two sheep herds and one goat herd grazing 15 paddocks. Each paddock was grazed twice, but not by different livestock species. To assess the interaction between animal type and the vegetation we measured various parameters: (1) Digestibility of green alder leaves and bark; herbage biomass and digestibility of green alder understorey, of fertile and of nutrient-poor pastures (measured in exclusion cages: 1.2×1.2 m). (2) Movement of animals was monitored by GPS trackers at a frequency of 10s using the methodology of Homburger *et al.* (2015). (3) After each rotation, areas encroached by green alder were systematically searched for signs of de-barking. We counted undamaged and damaged branches, recorded their location

and calculated their ratio. Significance of differences was tested by pairwise comparison with Tukey contrasts.

Results and discussion

Green alder stands are an underestimated forage resource

Because of the high elevation, annual biomass yield was low (Table 1). However, the understorey vegetation of green alder produced 1.5 t ha^{-1} on average, and therefore it ranged between that of fertile pastures (2.3 t ha^{-1}) and nutrient-poor pastures (0.9 t ha^{-1}). In addition, measurements by Wiedmer and Senn-Irlet (2006) indicated an annual production of around 3.8 t of green alder leaves and 1 t ha^{-1} of bark. There was no significant difference in *in vitro* digestibility between the understorey vegetation of green alder and the vegetation of open pastures. The digestibility of green alder leaves was slightly lower ($P<0.05$) than for nutrient-poor pastures and understorey vegetation. The crude protein content of alder understorey and leaves was higher ($P<0.05$) than in any other forage type measured. This is explained by the additional input of symbiotically fixed nitrogen provided by green alder (Bühlmann *et al.*, 2016). Commonly, green alder and its associated vegetation are assumed to be of low forage quality. However, the relatively high productivity and the high digestibility and protein content show that this vegetation type provides an underestimated forage resource for adapted low-productive ruminants.

Ruminant species differ in feeding behaviour

All three ruminant species exploited the areas encroached by green alder (Figure 1). However, they differed in space-use evenness (Camargo evenness: cattle=0.39; sheep=0.52; goats=0.47). Cattle preferred flat slopes and open pastures more clearly than sheep and goats (relative presence in green alder stands: cattle=0.55; sheep=0.76; goats=0.80). Cattle were observed foraging on understorey vegetation, leaves and buds, but they did not debark green alder branches. Unexpectedly, Engadine sheep debarked green alder branches frequently, especially at the edge of the stand, where they could access the shrubs more easily than in the centre. Debarked branches die off within a year, because they lose their transport capacity for assimilates. Thereby, debarking represses green alder stands in the long term. Goats showed almost no preference for open pastures over dense green alder stands. They consumed alder leaves and buds but debarked it less frequently than Engadine sheep (sheep=7.4% of green alder branches; goats=0.8%). In contrast, the bark of the few elderberry trees (*Sorbus aucuparia*) growing in the green alder stands was almost completely stripped. Goats consumed the bark of elderberry immediately when released to the paddocks, whereas they debarked green alder only when very little elderberry was left over.

Table 1. Annual biomass yield, *in vitro* digestibility of organic matter and crude protein content in the dry matter of different vegetation types and plant parts of green alder.[1]

Vegetation type	Annual yield (t ha^{-1})	Digestibility (g kg^{-1} DM)	Crude protein (g kg^{-1} DM)
Fertile and nitrophilous pastures	2.25±0.89b	487±114bc	117±37a
Nutrient-poor pastures and wetlands	0.93±0.52a	531±60c	133±34a
Green alder understorey vegetation	1.53±0.89ab	559±75c	190±39b
Green alder leaves	3.8*	439±54b	211±21b
Green alder bark	1.04*	163±12a	78.1±8.8a

[1] Shown are mean values ± one standard deviation. Different letters indicate significant differences of pairwise comparison with Tukey contrasts at 5% level. * Estimates measured and published in Wiedmer and Senn-Irlet (2006).

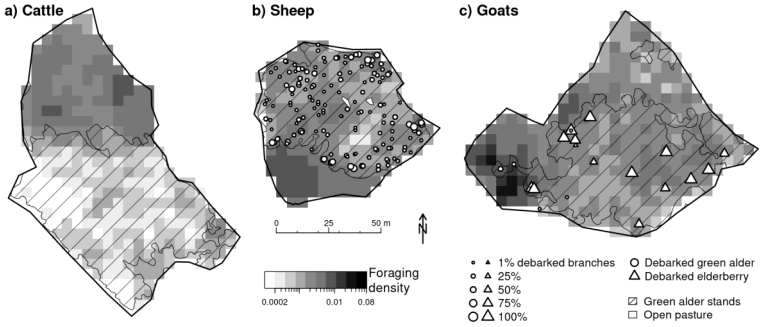

Figure 1. Foraging density (i.e. the relative number of GPS locations classified as foraging per grid cell) and proportion of debarked branches in exemplarily selected paddocks grazed by Dexter cattle (a), Engadine sheep (b) and Pfauen goats (c). For locations without debarking, no symbols are shown.

Conclusions

The forage provided by green alder stands is generally underrated in the nutrition of adapted low-productive ruminants. In contrast to previous assumptions by practitioners and scientists, green alder stands are a valuable forage resource in marginal mountain areas.

Cattle have the smallest direct impact on green alder, but they exploit the understorey vegetation and can open up green alder areas for other types of animals. They cannot replace goats for fast green alder clearance, but they are able to make use of the forage available in green alder stands. Engadine sheep actively counteract green alder expansion by consuming its bark. Hence, they provide an attractive option for regaining open pastures, but they mainly stay within the edge of dense alder stands. Since goats prefer other woody species over green alder and debark them first, they must be kept under high grazing pressure to drive back green alder shrubs. Otherwise, they may only hinder the regeneration of late-successional forest.

All ruminants observed were able to exploit the forage available in green alder stands and thereby, they may at least slow down shrub expansion. Hence, hardy breeds are an important tool to maintain biodiverse, open pastures and mitigate the negative environmental effects of green alder encroachment.

References

Bühlmann T.H., Hiltbrunner E. and Körner C. (2016) Shrub expansion of *Alnus viridis* drives former montane grassland into nitrogen saturation. *Ecosystems* 19, 968-985.

Homburger H., Lüscher A., Scherer-Lorenzen M. and Schneider M.K. (2015) Patterns of livestock activity on heterogeneous subalpine pastures reveal distinct responses to spatial autocorrelation, environment and management. *Movement Ecology* 3, 1-15.

Wiedmer E. and Senn-Irlet B. (2006) Biomass and primary productivity of an *Alnus viridis* stand – a case study from the Schächental valley, Switzerland. *Botanica Helvetica* 116, 55-64.

Zehnder T., Lüscher A., Ritzmann C., Pauler C.M., Berard J., Kreuzer M. and Schneider M.K. (2020) Dominant shrub species are a strong predictor of plant species diversity along alpine pasture-shrub transects. *Alpine Botany* 130, 141-156.