Knowledge co-production between herders and scientists for the better management of species-rich pastures

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Abstract

The substantial research gap between rangeland/livestock science and conservation biology/vegetation ecology has led to a shortage of evidence needed for grazing-related conservation management. Knowledge co-production and long-term knowledge partnerships between scientific and traditional knowledge could help fill this gap. We worked closely with traditional herders in Hungary (including co-design and co-publication) on understanding grazing behaviour of beef cattle on species-rich grasslands. We found that cattle grazing on species-rich pastures displayed at least 10 different behavioural elements as they encountered 117 forage species from highly desired (preferred) to rejected, with small discrimination error. Herders had broad knowledge of grazing desire and they consciously aimed to modify desire (modify selection behaviour, grazing preference) by slowing, stopping or redirecting the herd. Many of these have conservation benefits. We also prepared a global review on forage-related knowledge of herders based on scientific papers and video documentaries, and collaboratively discussed with traditional herders. We found 35 indicators used by herders to describe forage species. These indicators were used in context-specific management decisions, with a variety of objectives to optimize grazing.

Introduction

The substantial research gap between rangeland/livestock science and conservation biology/vegetation ecology has led to a shortage of evidence needed for grazing-related conservation management. Connecting scientific understanding with traditional ecological knowledge of local livestock keepers through knowledge co-production and knowledge partnership could help bridge research and knowledge gaps (see some example: Barani 2007, Biró et al. 2019, Reid et al. 2014, Schlecht et al. 2006).

An understanding of traditional ecological knowledge systems is increasingly acknowledged also as a means of helping to develop global, regional and national, but locally relevant policies (Sharifian et al. 2021, 2023). Pastoralists often use lands that are unsuitable for crops due to biophysical and climatic extremities and variabilities (Krätli and Schareika 2010, Manzano et al. 2021). Forage plants of pastures that are often unpredictable in availability (Molnár et al. 2020, Sharifian et al. 2023), are utilized by herding communities by applying locally relevant multigenerational knowledge. In this presentation we will show our study of the

grazing behaviour (plant selection and avoidance) of beef cattle on species-rich lowland pastures in Central Europe (Molnár et al. 2020), and a global review of the forage-related knowledge of pastoralists and herders and how this knowledge is used in herd and pasture management (Sharifian et a. 2023).

Methods

We studied the grazing behaviour (plant selection and avoidance) of beef cattle (ca. 33 000 bites) on species-rich lowland pastures in Central Europe, as well as the related traditional herding practices. We also did >450 outdoor interviews with traditional herders about livestock behaviour, herders' decisions to modify grazing behaviour, and effects of modified grazing on pasture vegetation. The whole multi-year research was done in close collaboration with several key knowledgeable herders, starting with co-design of the research, doing data collection and data analysis and discussion together and finishing with co-publication (papers and conference presentations).

In the other study we analyzed the forage-related knowledge of pastoralists and herders by reviewing scientific papers (based on keyword search) and video documentaries (searching on the internet through keywords and directly contacting specialist researchers) with the original voices of herders on forage plants and indicators, their use in land management, and plant-livestock interactions. Semi-structured interviews were also conducted with key knowledge holders in Iran, Mongolia, Kenya, Poland and Hungary. The key results and conclusions were discussed again with two key knowledgeable herders before publication. We found 35 indicators used by herders to describe forage species and manage herds and pastures.

Results

We found that cattle grazing on species-rich pastures displayed at least 10 different behavioural elements as they encountered 117 forage species from highly desired (preferred) to rejected (Fig. 1., Molnár et al. 2020). The small discrimination error suggests that cattle recognize all listed plants 'by species'.

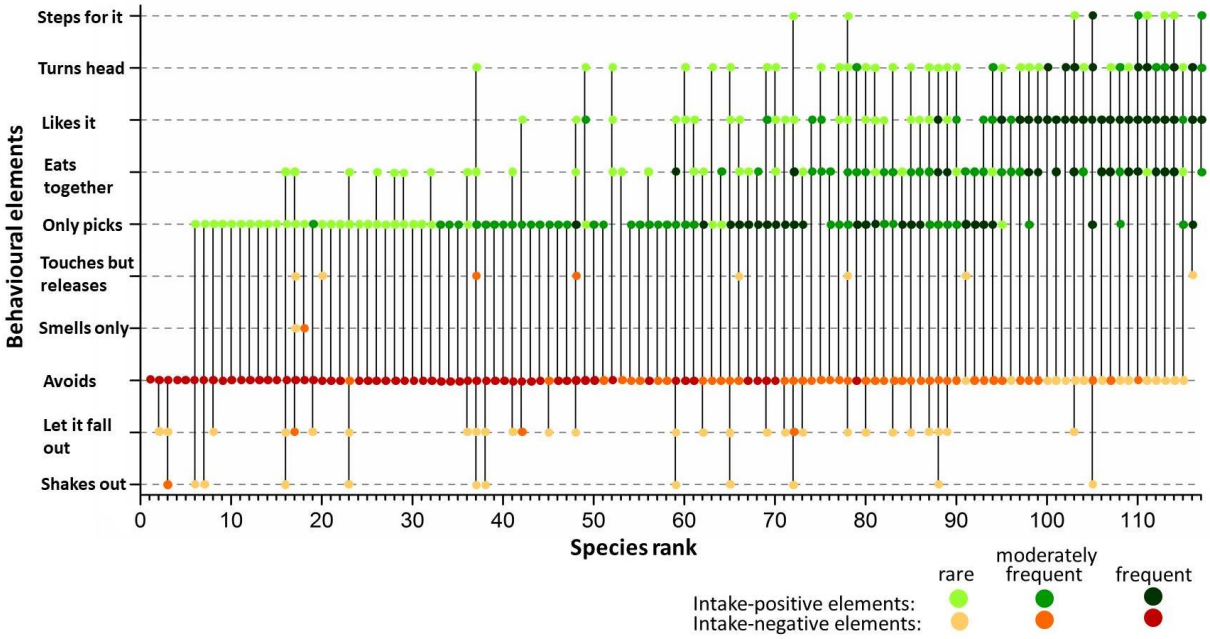

Fig. 1 Frequency of behavioural elements toward 117 plant species. Species were ordered from left to right according to their ranks based on their desirability index (proportion of intake-positive types, in %). Coloured dots indicate frequency of behavioural elements (from light (rare) to dark (frequent)). Dots of the same plant species are connected with a thin vertical line.

We also found that herders had broad knowledge of grazing desire and preference, and they consciously aimed to modify desire (selection behaviour on the short- and long-term) by slowing, stopping or redirecting the herd. Modifications were aimed at increasing grazing intensity in less desired patches and decreasing grazing selectivity in heterogenous swards. Many of these have significant conservation benefits (Table 1).

Table 1 Conservation relevant herding techniques of traditional herders in Central Europe used to control grazing behaviour, animal distribution, modify intake of livestock, change selectivity of grazing, and protect the forage resources on their pastures (frequency of application: ***: used often, *: used rarely).

Traditional herding techniques to control grazing behaviour	**Freq. of use**	**Conservation relevance of traditional herding techniques**
Attention to livestock, keep monitoring them for prompt and proper interventions with the least possible stress	***	Fine-tuned livestock-herder-pasture relation is the basis for proper management
Protecting the pasture from unnecessary disturbance and promoting regeneration after a grazing period	**	Herders consciously protect pasture vegetation according to their indicators
Designing daily 'menu' (sensu Meuret 1997, Meuret and Provenza 2015) along the grazing route (sequence of foods to maintain and boost appetite, and increase desirability of less preferred forage species)	**	Designed menus help utilize the pasture evenly, animals move less and fatten better (cf. profit) (leads to lower grazing pressure)
Letting them spread and graze calmly	***	Movement and trampling are decreased, smaller disturbance to breeding birds
Selecting an area to be grazed during its highest desirability status, depending on season and weather	**	Utilizes less preferred parts of pasture, often improving its forage quality
Block movement of the herd, or just slow them to get them satisfied with the less preferred forage of the patch, eat mixed forage	***	Less selective grazing results in more homogenous utilization and can prevent spread of pasture weeds
Targeted grazing of less-desired, less preferred forage species, improving pasture by grazing	***	Prevents accumulation of litter, and suppresses bushes and tall plants (like *Phragmites, Typha*)
Increasing willingness to graze less selectively and more intensively by shortening a meal from 4-5 to 1-1.5 hours	*	Less selective grazing (more homogenous utilization, and management of pasture weeds)
Move them faster (towards watering / resting places) to prevent excessive grazing trails	*	Too many grazing trails could cause degradation (spread of weeds)

In the second study we identified indicators herders use to understand the forage plant-livestock-herder relationship and to manage herds and pastures. The indicators of forage plants described botanical features, livestock behavior during grazing, and the impact of plants on livestock condition and health (Table 2). The indicators were used in context-specific management decisions, with a variety of objectives to optimize grazing. We identified ten global principles: 1) Livestock-centered perspective of forages; 2) Close monitoring and prediction of forage quantity and quality; 3) Use (targeted grazing) of plants with medicinal and good nutritional properties to improve livestock status and health; 4) Inner need for responsibility of the herder in

modifying livestock's forage selection and intake; 5) The livestock is herded but to a certain degree it is allowed to play a decisive role in forage selection, place of grazing; 6) Using different livestock types to make use of various forage resources; 7) Making use of 'all' plant resources, through understanding and utilizing relative and changing palatability; 8-9) Adapting to changing forage availability by proper timing of grazing at multiple temporal, and at multiple spatial scales; and 10) Keep focusing on context-influenced change of forage preference and intake (Fig. 2).

Table 2 Indicators used by traditional herders and pastoralists to describe forage plants in different parts of the world, number of local indicators found, and number of countries where these indicators were documented (indicators were grouped, see bold categories).

Indicator	**No. of local indicators**	**No. of countries**
General valuation (good forage, bad forage)	590	12
Types of livestock that eats is	362	14
Nutritional value	244	17
Seasonal variation	187	12
Only parts are eaten	174	10
Human factors	127	6
Scarcity fodder	117	14
Availability	115	8
Animals like or dislike it	102	12
General	98	10
Prevents/cures disease	49	5
Appetite	41	4
Physiological stage	37	5
Sensitivity	35	6
Morphological characteristics	35	9
Method of preparation	33	2
Habitat	32	9
Population trends	23	4
Causes disease	19	7
Animal product quality	17	7
Stress	15	1
Plant herbage yield	13	2
Hay quality	13	3
Chemical content	10	9
Taste	10	7
Causes injury	9	7
Regrowth, resprouting	8	5
Plant size	8	5
Grazing behavior	5	5
Host to harmful species	5	4
Smell	4	2
Colour	3	5
Interannual variation	2	3
Feeding behavior	2	1
Plant gender	1	1

Fig. 2 A) Hungarian herders point out "*I see the grass through the mouths of my animals*" (Molnár, 2017) which is similar to the observation of a French shepherd as described by Despret and Meuret (2016), that "*his* [the shepherd's] *fingers know and anticipate what the sheep's mouths know*". Both statements, though from herders situated in different countries and herding regions, accentuate the fact that herders' knowledge is partially gained through the close monitoring of the relationship between their animals and the forage. B) Hungarian herders say "*Tippan* (small tussocky *Festuca pseudovina* grass) *is the soul of the Hortobágy steppe!*", which is very close to the observation made by Mongolian herders living 6000 kilometers away who perceive that "*Botjul* (small tussocky *Festuca lenensis* grass) is the best grass that my livestock can find to feed on in Mongolia" (Gantuya et al. 2019, 2021).

Discussion and Conclusions

The traditional herd management practices, presented here, have significant conservation benefits, such as avoiding under- and overgrazing, and targeted removal of pasture weeds, litter and encroaching bushes, tall competitive plants and invasive species (Molnár et al. 2020, Sharifian et al. 2023). We argue that knowledge co-production with traditional herders who belong to another knowledge system could help connect isolated scientific disciplines especially if ecologists and rangeland scientists work closely with traditional herders, co-designing research projects and working together in data collection, analysis and interpretation. Stronger links between these disciplines could help develop evidence-based, specific conservation management practices while herders could contribute with their practical experiences and with real world testing of new management techniques (Molnár et al. 2016, Török et al. 2016, Vadász et al. 2016).

Although pastoralists vary greatly across the globe, the character and use of their traditional forage-related knowledge do seem to follow strikingly similar principles. Understanding these may help the local-to-global-level understanding of these locally specific systems, support bottom-up pastoral initiatives and discussions on sustainable land management, and help to develop locally relevant global and national policies.

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