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Short communication

Foraging behaviour and plant selection in a herd of Icelandic goats

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INTRODUCTION

The Icelandic goat is an indigenous breed, descendant of goats brought to Iceland by Nordic and Celtic settlers in the 9th century (Adalsteinsson 1981). The population is estimated to have been below 1000 individuals for centuries and critically threatened at least twice. Today about 900 goats are found all over the country, mostly in small groups with one large herd located in west Iceland. Very few studies have been conducted on the Icelandic goat. Previously, only one study (on population genetics) has been published (Baldursdottir et al. 2012). The aim of the present study was to shed light on the plant selection and foraging behaviour of the largest goat herd in Iceland.

METHODS

Study location and animals

The study was conducted at Háafell farm in west Iceland in July, August and September of 2012. The study area was a 300 ha hillside with a natural pasture behind the farm and a small part of a cultivated pasture by the farm stables (Figure 1). Drinking water was accessible in several small creeks on the hillside.

The herd numbered 190 adults and 160 kids. At night, most of the goats grouped together in and around the farm stables. In the early morning most of the herd went up to the hillside in small groups for grazing, while some stayed behind on the cultivated pasture where a supplementary silage bale was located and accessible to the goats. The effect of this on the grazing behaviour and plant selection was not investigated. The number of goats roaming the hill therefore varied from one time to another. The hillside was shared with a population of 60 sheep.

Vegetation composition

The natural pasture was fairly homogenous, consisting of a grass rich heathland in the lower regions and gravel beds with sparser and patchy heathland vegetation in the upper areas. Four 50 m transects were randomly positioned on the hillside. Along each transect, ten 50x50 cm quadrats were placed at 10 m intervals and species composition assessed with the Braun-Blanquet method. Total coverage, including mosses and lichens along with bare ground and stones, was set to 100%. Vascular plants were determined to species level, while mosses and lichens were pooled. Species abundance was classified into five categories within each quadrat: 5 (>75%), 4 (50 – 75%), 3 (25 – 50%), 2 (5 – 25%) and 1 (<5%). Overall abundance was calculated by taking the average of the combined proportion within every quadrat from all transects. Plant species abundance was then defined as either dominant (>50%), common (5 – 50%) or rare (<5%). A total of 38 plants, common in the area, were sampled to use as a reference for the faecal analysis.

Plant selection

For estimation of plant selection, fresh faeces were collected on and near a frequently travelled track leading to and from the farm stables. A total of 38 samples were collected, 9 in July, 17 in August and 12 in September. The samples were dried in a forced air oven at 70°C for 72 hours, ground and sifted through a 1 mm mesh. A microscope slide was prepared for each faecal sample. The fresh individual plant species samples were dried and prepared in the same way as the faecal samples (Holechek et al. 1982). The plant fragments in the faecal samples were identified to family level with reference to the individual plant species samples.

Time budget and pasture utilization

To estimate time budget and pasture utilization of the goats, instantaneous scans were taken during 3 days in August (33 scans) and 3 days in September (31 scans) at one hour intervals during daylight hours. Scans were taken with a scope at 600 m intervals from a car driving along the road below the hillside (Figure 1). The position and number of individuals in each goat group on the hillside was marked on a Garmin© map of the area and the behaviour of each individual recorded. The behaviours recorded were foraging, standing, lying down and "other behaviours".

RESULTS

Vegetation composition

The grasses *Agrostis spp.* and *Deschampsia cespitosa* were dominant in the sward of the study area, and *Anthoxanthum odoratum*, *Avenella flexuosa* and *Festuca spp. were classified as common.* The sedges *Carex spp., Juncus trifidus* and *Kobresia myosuroides* were classified as common. *Alchemilla spp.* was found to be a common forb and common small shrubs included *Thymus praecox arcticus, Empetrum nigrum*, and *Vaccinium uliginosum* (Table 1).

Plant selection

Grasses constituted the highest proportions in the faeces samples in all three months, 69% in July, 78% in August and 79% in September. The dominant grass species in the faecal samples were *Agrostis spp*., *A. flexuosa*, *D. cespitosa* and *Festuca spp*. and the common grasses were *A. odoratum*, and *Phleum spp.* Forbs were second most common, constituting 11% in July, 13% in August and 9% in September. The only common forb species in the faecal samples was *Leontodon spp.* Sedges accounted for 11% in July but only 5% in August and September. The common sedges in the faecal samples were *Carex spp.* and *Luzula spp*. The remaining proportion in faecal samples included small shrubs, 8% in July, 4% in August and 5% in September. *V. uliginosum* was common and found

Table 1. List of species found on the hillside, plant type, abundance and proportion in faeces samples. Plant types are marked with Fo (forbs), Fe (Fern), Gr (grasses), Le (legumes), Ru (Rushes), Se (sedges), Sh (small shrubs). Availability and proportion in samples are marked with D = dominant, C = common, R = rare, N/A = not available where ◆ indicates avoidance and ◆◆ choice.

Species	Plant type	Availability	Proportion in samples	Species	Plant type	Availability	Proportion in samples
Agrostis spp.	Gr	D	D	*Kobresia myosuroides*	Se	C	R ◆
Alchemilla spp.	Fo	C	R ◆	*Leontodon autumnalis*	Fo	R	C ◆◆
Anthoxanthum odoratum	Gr	C	C	*Luzula spp.*	Ru	R	C ◆◆
Arabidopsis petraea	Fo	R	R	Moss	-	D	R ◆
Avenella flexuosa	Gr	C	D	*Myosotis arvensis*	Fo	R	R
Bistorta vivipara	Fo	R	R	*Nardus stricta*	Se	R	N/A
Botrychium lunaria	Fe	R	N/A	*Parnassia palustris*	Fo	R	N/A
Calluna vulgaris	Sh	R	R	*Phleum spp.*	Gr	R	C ◆◆
Cardamine pratensis	Fo	R	N/A	*Plantago maritima*	Fo	R	N/A
Carex spp.	Se	C	C	*Poa spp.*	Gr	R	R
Cerastium spp.	Fo	R	N/A	*Potentilla crantzii*	Fo	R	N/A
Deschampsia cespitosa	Gr	D	D	*Rumex spp.*	Fo	R	R
Draba incana	Fo	R	N/A	*Salix herbacea*	Sh	R	N/A
Dryas octopetala	Fo	R	N/A	*Silene acaulis*	Fo	R	N/A
Empetrum nigrum	Sh	C	R ◆	*Taraxacum spp.*	Fo	R	N/A
Epilobium palustre	Fo	R	N/A	*Thalictrum alpinum*	Fo	R	N/A
Equisetum spp.	Fe	R	R	*Thymus praecox arcticus*	Fo	C	R ◆
Euphrasia frigida	Fo	R	N/A	*Tofieldia pusilla*	Fo	R	N/A
Festuca spp.	Gr	C	D	*Trifolium repens*	Le	R	N/A
Galium spp.	Fo	R	N/A	*Trisetum spicatum*	Gr	R	N/A
Geranium sylvaticum	Fo	R	R	*Vaccinium uliginosum*	Sh	C	C
Juncus trifidus	Ru	C	R ◆	*Viola canina*	Fo	R	N/A

in high proportions in two samples, 33% (September) and 20 % (August). The sedge *K. myosuroides* was found in eight samples but always accounted for less than 5%.

Time budgets and pasture utilization

On average, the goats spent 68.2% of their time foraging, 19.2% walking and 9.1% resting, with 3.5% of their time spent on other behaviours like grooming and social interaction. The number of goats foraging at any given time varied considerably. Rain showers caused many of the goats to stop foraging and move to the shelter of the shed. During heavy rain only 15% of the goats were found to be foraging. Rain showers were found to have a highly significant effect on foraging behaviour (U-test, p< 0,001). In 62 of 64 scans, the goats were found to be randomly distributed over the pasture with the two exceptions when heavy rain showers occurred. The distribution pattern, based on the 33 scans in August, is shown in Figure 1.

DISCUSSION

Plant selection

The diet of the goats was dominated by four different grasses; *A. flexuosa*, *Agrostis ssp. D. cespitosa* and *Festuca spp*. (Table 1). Of these, *Agrostis ssp*. and *D. caespitosa* were also dominating species on the hillside. However, *A. flexuosa* was classified as common on the hillside while dominant in the faecal samples, indicating a preference for that species. *A. odoratum* was both common on the hillside and in the faecal samples. *Ph. pratensis* was not found on the hillside but dominated the cultivated pasture and the hay bales. It was found to be common in the faecal samples, which indicates considerable foraging from the hay bale and/or from the small cultivated pasture. However, the dominance of *A. flexuosa* in the faecal samples indicates also considerable hillside foraging since it was neither found in the bales nor on the cultivated pasture. Forbs and sedges were not as common as grasses in the faeces, never exceeding 11% in all three months. However, the goats appeared to actively seek out certain rare forbs and sedges like *Leontodon spp.* and *Luzula spp*., while at the same time seemingly avoiding certain common ones like *Alchemilla spp*., *K. myosuroides* and *J. trifidus*. Many sedges like *J. trifidus*, and *K. myosuroides have* low digestibility and low nutritional value and goats have been reported to avoid related species such as *Nardus stricta* (Illius *et al*. 1999). However, the low intake of *Alchemilla ssp*. found cannot be explained by nutritional value or low digestibility but rather by methodological bias. Plants low in fibre, such as most forbs, are more digestible than fibre rich plants, such as grasses and sedges (Buxton & Redfearn 1997) and disappear to a larger degree during digestion. This can result in a biased outcome of microhistological fragment identification (Mayes & Dove 2000). As *Alchemilla spp*. is highly digestible, it is therefore likely that its value as a foraging plant for the goats is higher than measured. In general, the presence of forbs in faeces samples is expected to be underestimated while fibre rich plants, like grasses, are more likely to be proportionally overestimated.

Goats have often been reported to be selective of browse species (i.e. leaves and shoots), regardless of their availability (Osoro et al. 2013). Our data do not support this. In the area, *E. nigrum, Th. praecox articus* and *V. uliginosum* were all common while *Calluna vulgaris* and *Salix herbacea* were rare. Of these, both *E. nigrum* and *Th. praecox articus* seemed to be avoided, *i.e.* appearing very rarely in the faecal samples, and *S. herbacea* was not found at all. The only small shrub browsed was

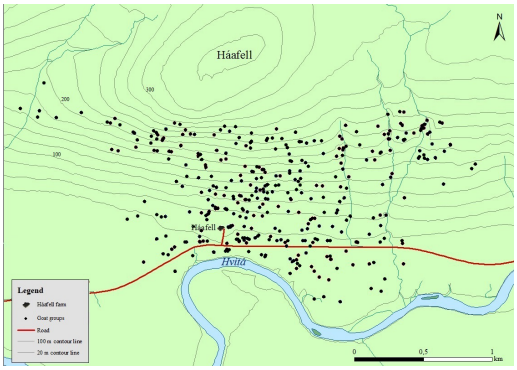

Figure 1. Distribution of goat groups on the hill

V. ulignosum, which was both common in the pasture and in the faecal samples and seemed therefore to be selected according to availability.

Foraging behaviour

The goats travelled around most of the hillside while foraging. The herd spent 60-66% of their time foraging, which is similar to that reported in other studies (*e.g.* Vas & Andersen 2015). Activity levels varied considerably throughout the day. Previous studies have shown goats to follow a diurnal pattern, foraging early in the morning (at dawn) and late afternoon (at dusk) (*e.g.* Ferreira et al. 2013). This herd, on the other hand, behaved somewhat differently. They started to forage early in the morning but later in the day their behaviour was less predictable. External factors, such as weather, can affect the foraging activity of animals (Boe & Ehrlenbruch 2013). During the observation days, heavy rain frequently occurred. During rain showers, only 15% of the herd was found to be foraging. A pairwise comparison of the percentage of goats foraging during scans during rain showers (N=16) versus scans when it did not rain (N=48) showed a highly significant difference. Heavy rain probably explains the unusual diurnal foraging pattern recorded at Háafell farm during observation days. Further studies are therefore needed to map the diurnal foraging pattern of the Icelandic goat.

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