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Feeding ecology of Konik horses and donkeys in Belgian coastal dunes and its implications for nature management

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ABSTRACT. Foraging behaviour and diet selection of Koniks and donkeys were studied in order to estimate their possible impact on vegetation development and hence their appropriateness as nature management tools.

Koniks show a larger intake rate and quantity than do donkeys. Koniks do not show significant seasonal differences in biomass intake, whereas donkeys consume significantly more in winter.

Both animal species feed mainly on graminoids. The Konik diet is composed of 86% of graminoids with an additional 12% of herbs. The donkey diet consists of 69 % of graminoids, which are mainly supplemented with browsing (18 %), e.g. twigs and leaves of *Ligustrum vulgare* and *Rubus caesius*.

Calamagrostis epigejos, Rosa pimpinellifolia (fruits), *Carex arenaria* and *Arrhenatherum elatius* are the most important plant species eaten by donkeys (based on number of bites and biomass). Koniks eat *Calamagrostis epigejos* significantly more, qualitatively (number of bites) as well as quantitatively (biomass intake), than any other plant species, but *Cirsium arvense, Calamagrostis canescens, Juncus subnodulosus, Holcus lanatus* and *Claytonia perfoliata* are also frequently consumed.

Koniks as well as donkeys do eat plant species that nature managers would like to see decline in dominance, e.g. *Calamagrostis epigejos*, but browsing on scrub species is insufficient to decrease the area occupied by shrubs.

KEY WORDS : foraging behaviour, diet selection, feeding preference, management, dunes, horse, donkey.

INTRODUCTION

During the 19th and the beginning of the 20th century grazing by domesticated livestock was a common practice in the coastal dunes (De Smet, 1961). Sheep, cattle, donkeys and horses grazed natural vegetation. For example in 1828 the dune area of the western Flemish coast (approx. 2500 ha) was grazed by 450 sheep, 240 cows, 112 donkeys and 51 horses. Wherever they appeared, scrub species were cut down and used as firewood. As a result a semi-natural landscape developed that was largely composed of a mosaic of white dunes, marram dunes, grey dunes, moist dune slack vegetation and dry dune grassland (Massart, 1908).

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Since these agricultural practices were abandoned gradually during the middle of the 20th century shrub development increased. This led to a present-day scrub cover of about two thirds of the remaining open (not built-up) dune area. Among others the area of species-rich dune grassland decreased significantly. These trends, together with the increasing dominance of some competitive grasses e.g. *Calamagrostis epigejos, Arrhenaterum elatius, Elymus repens, Holcus lanatus*, are believed to threaten the relatively large number of dune specific species (van Dijk, 1992; ten Harkel & van der Meulen 1995). In addition, part of the landscape changed from a fine-scale mosaic of different habitats to a more or less monotonous shrub vegetation, which is relatively poor in habitat and in coastal dune specific plant and spider species (Provoost & Hoffmann, 1996[1]; Bonte et al., 2001[2]).

Since the legal protection of all Belgian coastal dune areas (Vlaamse Regering, 1993[3]), interest is growing in the possibility of using appropriate nature management to conserve at least the remaining biodiversity.

Because large herbivores formerly played an important role in the preservation of semi-natural dune communities (WESTHOFF, 1985; HEWETT, 1985; DROST & MUIS, 1988; VAN DIJK, 1992; VAN DEURSEN et al., 1993; KOOIJMAN & VAN DER MEULEN, 1996), the Department of Nature of the Flemish Community decided to introduce cattle, horses, donkeys and sheep into some of their nature reserves.

To reach this goal, equids are considered to be interesting management "tools". Current knowledge about the feeding preferences of equids suggests that they should be very useful to control graminoids (GUDMUNDSSON & DYRMUNDSSON, 1994). They should also affect some tree species (VAN WIEREN, 1987; DUNCAN, 1992). Their impact on herbs and shrubs on the other hand is considered to be lower than that of cattle (DUNCAN, 1992).

While some knowledge is available on the feeding behaviour of domesticated horses under semi-natural conditions in European ecosystems (DUNCAN, 1983; DUNCAN, 1992; PUTMAN et al. 1987; GORDON, 1989), much less is currently known about an almost forgotten equid species, the domesticated donkey (*Equus asinus*) (VAN ASSCHE, 1993; HOFFMANN et al., 2001).

To be able to predict the possible long-term effect of the feeding ecology of these large herbivores, we started a large-scale investigation into their diet preferences and their habitat use and location selection in some coastal dune areas. Here we describe some aspects of the foraging behaviour and the botanical characteristics of the diet of the domesticated donkey and the Konik horse (*Equus caballus*), a horse that is closely related to the Tarpan (*E. ferus silvaticus*).

MATERIAL AND METHODS

Sites, animals and management

In April 1997 a small herd of six donkeys (1 stallion, 5 mares) of Romanian origin was released for year round grazing in the nature reserve Houtsaegerdunes (80 ha).

In 1998 four Konik horses (2 stallions, 2 mares), and two Scottish Highland cattle were released also for year round grazing in the northern fenced area (54 ha) of the nature reserve, the Westhoek.

By March 2000 the Konik herd had grown with one 1999-born foal and the donkey herd then numbered 12 individuals (2 stallions, 7 mares and 3 foals).

The animals received no supplementary feeding. Water was available during the whole period at different sites in the study area.

Shrubs of *Hippophae rhamnoides*, *Ligustrum vulgare* and to a lesser extent *Salix repens* occupy the largest part of both dune areas. Before the start of the grazing project in the Westhoek 12% of the original 79 % shrub cover was cut down and removed, resulting in an area of ruderal vegetation composed of a low, grass-dominated layer and patches of tall herbs (*Eupatorium cannabinum*, *Lythrum salicaria* and *Cirsium arvense)*. Old, deteriorating *Hippophae*-scrubs are generally replaced by *Calamagrostis epigejos* or *C. canescens*. Dune grasslands, moss-rich grey dunes, open sand dune and young dune slacks together occupy another substantial part of both dune areas (Table 1). A typical phenomenon of the Houtsaegerdunes is the non-indigenous plant species, introduced in the past as hedge plants along small fields or escaped from neighbouring gardens (e.g. *Syringa vulgaris, Fallopia aubertii*).

Methods

Each month we observed herbivore activities during 48 hours, distributed more or less evenly over 6-hourly morning (6-12 h), afternoon (12-18 h) and evening (18-24 h) sessions. Before starting a session, 1 animal was randomly chosen to be followed for the next 6 hours. Observations were conducted within a 3-m range; animals were not visibly affected by the observations (after a fortnight of habituation to an observer).

Herbivore activities e.g. grazing (food intake), defecating, moving, standing inactive, lying and social interactions were recorded simultaneously by one observer in both areas.

During those observations we used continuous time registration with sessions subdivided in periods of 15 minutes, which is the smallest unit chosen for counting bites and calculating mean bite rates and bite frequencies. All plant species and plant parts seen bitten were recorded. Plant state (dead or alive) was also noted. Mixed bites were registered as different bites of one plant species but were counted only one time for bite rate calculation.

Finally we recorded in which vegetation community and vegetation height class (<10cm, 10-50cm and >50cm) activities occurred.

To estimate mean bite mass of the more frequently consumed plant species, bite simulations were conducted after every observation session. Plants or plant parts were hand-plucked using thumb and a backward bent forefinger, simulating the animals' grazing as closely as possible at the same place where the species was frequently seen bitten (HOBBS et al., 1983; WALLIS DE VRIES, 1994). These samples, consisting of 10 times 30 bites of each plant item, were stored in paper bags, oven dried at 60 °C for 48 hours and weighed to get an estimate of bite mass. Together with the bite rate data, these bite size estimates were used to estimate intake (-rate) at the plant species level.

To investigate diet composition, diet preferences and temporal patterns in feeding ecology, we mainly used

TABLE 1

Main vegetation units of the 'Houtsaeger dunes' and the 'Westhoek noord' based on a vegetation analysis in 1998 respectively 1999 (VAN BRAECKEL unpubl. respectively DEVOLDERE & DEGEZELLE unpubl.).

Vegetation unit + code	Description	Area (ha) Houts.	Area (%) Houts.	Area (ha) West. N.	Area (%) West. N.
White dunes (A)	Open vegetation with *Ammophila arenaria*, *Carex arenaria*, *Festuca juncifolia*	2.69	3.6	2.2	4.11
Grey dunes (T)	Moss and Lichen rich dunes With scattered *C. arenaria* and therofytes.	4.67	5.87	2.8	5.24
Rough vegetations (U/C)	Grass layer (*Holcus lanatus*, *Poa trivialis*, *Claytonia perfoliata*) with scattered patches of tall herbs (e.g. *Eupatorium cannabinum, Cirsium arvense, Lythrum salicaria*)	none	5.55	10.36	
Ruderal vegetation (C5/U+R)	*Arrhenaterum elatius* dominated, with other grasses and *Urtica dioica, Rubus caesius and fruticosus*	4.78	6.01	none	
Dune grasslands (G)	Short grasslands with high plant diversity (e.g. dicotyledons)	0.93	1.17	2.19	4.09
Rose vegetation (I)	Dune grasslands dominated by *Rosa pimpinellifolia*	2.99	3.76	0.55	1.03
Dune-slack pioneer (J1/(S))	Short pioneer vegetation with *Carex* spp., *Juncus* spp. and young *Salix repens* and *Hippophae rhamnoides*	0.29	0.36	1.94	3.64
Rough dune-slack (J9/C1/C3)	Tall vegetation dominated by *Calamagrostis epigejos, C. canescens* and *Lythrum salicaria*	none		1.4	2.61
Reed	*Phragmites australis* dominated	0.23	0.3	none	
Deteriorating scrub (H/C1)	Dead scrub of *Hippophae rhamnoides*, grass layer dominated by *C. epigejos*	3.13	3.94	5.86	10.95
Scrub (L/H/S/P)	Scrub dominated either by *Ligustrum vulgare*, *H. rhamnoides, Salix repens* or mixed with other shrubs + sometimes herb layer with *Claytonia perfoliata.*	54.38	68.4	30.08	56.21
Wood (B)	*Populus* spp. or *Alnus glutinosa* dominated wood patches	4.64	5.8	0.16	0.31
paths	Pioneer vegetation of dry or wet situations	0.8	1	0.78	1.45
Total		**79.53**	**100**	**53.51**	**100**

ANOVA for testing significance of differences between means (F-test). Means were usually based on data at the 15-minute level. In case of inconsistency with the assumptions of ANOVA even after data transformation we used Kruskal-Wallis One way analysis (SOKAL & ROHLF, 1995; SIEGEL & CASTELLAN, 1988). For a test of normality and of homogeneity of variances we used respectively the Kolmogorov-Smirnov and Levenes test.

Multiple comparisons among means were carried out using an a posteriori HSD (equal variances assumed) or Games-Howel test (unequal variances) in SPSS 7.5 for Windows (NORUSIS, 1997).

To compare plant species preference we used the diet-availability ratio (COLEBROOK et al., 1987), discussed by STUTH (1991):

$$D/A = \{(\%\ \text{Diet} - \%\ \text{Availability})/(\%\ \text{Diet} + \%\ \text{Availability})\} * 10$$

STUTH (1991) used the following expressions for three different classes: preferred species: D:A > 0.35; desirable species: -0.35 < D:A < 0.35; undesirable, avoided or forced species: D/A < -0.35.

As a measure of diet we used the number of bites in summer, as a measure of availability we used the above ground biomass of every species in summer in the vegetation patches visited by the animals during the observation sessions (COSYNS & DEVOLDERE, unpubl.).

RESULTS

Bite rate and bite frequency

Bite rate (bites/min. grazing) of Koniks is significantly higher than that of donkeys. This is the case over all seasons with the greatest difference in summer and the smallest in winter (Table 2). Bite rate of both animals varies with seasons. Koniks graze substantially faster in summer than in autumn and winter ($p < .001$). Bite rate of donkeys shows the opposite trend; winter bite rate differs significantly from bite rate in summer and autumn ($p < .001$).

Bite frequency (Bites/min. observation time) of Koniks does not show any significant difference between seasons. On the contrary, donkeys reach a substantially higher bite frequency in winter than they do in the other two seasons ($p < .001$) (Table 3).

Koniks spend significantly more of their time grazing (73%) than do donkeys (52%) ($p < .001$). Neither Koniks nor donkeys show a significant seasonal variation in grazing pattern, although donkeys tend to increase grazing time from summer to winter (Fig. 1).

TABLE 2

Variation in mean bite rate (bites/ min. foraging time) of konik and donkey per season. All results are significantly different between both herbivores within seasons (columns) ($p < .001$).

(Bites/min. grazing)	Seasons		
Animal	**Summer**	**Autumn**	**Winter**
Konik	33.74	24.10	26.28
Donkey	10.41	12.59	18.13

TABLE 3

Bite frequency (bites/min. observation time) of konik and donkey per season. Bite frequency is used as a preliminary measure for their intake. Therefore mean bites/min. observation time is compensated for differences in mean bite rate between seasons. Significantly different results ($p < .001$) between periods are indicated (***).

(Bites/min. observ.)	Seasons		
Animal	**Summer**	**Autumn**	**Winter**
Konik	20.12	18.66	20.05
Donkey	6.30	6.80	8.60 (***)

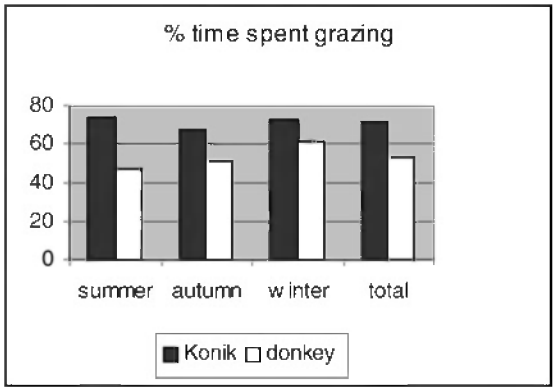

Fig. 1. – Mean grazing time of konik and donkey as % of total observation time/season. Koniks spend significantly more of their time grazing than donkeys ($p < .001$). Koniks do not show significant seasonal differences. Donkeys tend to increase foraging time from summer to winter (but $p = 0.052$, F-test).

Forage class

We observed significant differences ($p < .001$) among animal species, although they both feed mainly on grasses and grass-like species. The diet of the Konik horse is composed of 86% grasses, the remainder being mainly herbs e.g. *Cirsium arvense*, *Stellaria media* and seedlings of *Claytonia perfoliata* (12%). Woody species (mainly *Rubus caesius*) are only consumed in small amounts. Graminoids were eaten significantly more in summer than in autumn or winter ($P < .001$). Herbs (mainly *Claytonia* and *Stellaria*) were eaten substantially more in winter (Table 4).

TABLE 4

General diet composition (% of total number of bites) of konik and donkeys in two Belgian coastal dune nature reserves during summer-winter 1999-2000. Overall number of bites (compensated for differences in observations) is significantly different between both equid species ($p < .001$).

Forage class	Summer	Autumn	Winter	Total (***)
Konik				
Graminoids	93.6	87.1	80.6	86
Herbaceous plants	4.4	11.2	18	12
Woody plants (browse)	2	1.7	1.4	2
Donkey				
Graminoids	60.6	79.5	86	69
Herbaceous plants	10.4	7.4	6.6	13
Woody plants (browse)	29	13.1	7.4	18

The donkey's diet consists of 79 % graminoid species, the remainder provided mainly from browsing of woody species, e.g. twigs and leaves of *Ligustrum vulgare* and *Rubus caesius,* fruits of *Rosa pimpinellifolia* and *R. canina* (13%). Woody material was eaten more in summer and autumn than in winter ($p < .001$). Herbs were the smallest part in this diet (8%) and were mainly eaten in winter (*Claytonia perfoliata*).

Plant species

Koniks and donkeys consume a wide variety of plant species. During the whole observation period Koniks ate 89 plant species: 24 graminoid species, 54 herb species and 11 woody species.

During the same period donkeys ate 111 plant species: 18 graminoid species, 63 herb species, 27 woody, 1 fern,1 lichen and 1 moss species.

In both cases about one third of all plant species known in the respective study areas were bitten.

With mean bites/min. foraging time as the criterion, the Konik diet over the whole period was mainly composed of grasses. *Calamagrostis epigejos, Poa trivialis* and

Holcus lanatus were bitten substantially more than all other plant species. *Claytonia perfoliata*, *Stellaria media*, *Calamagrostis canaescens* and *Juncus subnodulosus* make up a second group of frequently bitten plant species. (Table 5).

When mean intake rate is the criterion, *Calamagrostis epigejos* is still the most important species (P<.001) but Koniks seems to eat also considerable amounts of *Cirsium arvense* (Table 5).

Donkeys frequently consume *Festuca juncifolia, Calamagrostis epigejos* and *Carex arenaria* and, to a significantly lesser extent, also *Arrhenaterum elatius*, *Claytonia perfoliata*, fruits of *Rosa pimpinellifolia* and *R. canina*, *Holcus lanatus*, *Elymus repens* and leaves and twigs of *Fraxinus excelsior* and *Ligustrum vulgaris* (Table 6).

When comparing the plant species preferences of both equids, using the D/A classification designed by STUTH

TABLE 5

Konik diet. The twelve most bitten plant species in the northern fenced part of the nature reserve the Westhoek. Mean bite rate is indicative for the most frequently bitten species. Over the whole period these are *Calamagrostis epigejos*, *Poa trivialis* and *Holcus lanatus* (HSD results are given underneath the diagonal). Zero-bite observations per species are left out of calculation of the mean assuming that during these zero-bite periods the plant species were not met with by the Konik. With mean intake rate (dry matter/min. grazing) as criterion *Calamagrostis epigejos* is by far the most important plant species consumed (HSD test right side). (***: p<0.001;**; p<0.01; p<0.05; ns: p >0.05). Empty cells indicate a lack of information.

Species	Mean B/min	DM g/min	1	2	3	4	5	6	7	8	9	10	11	12
1. Calamagrostis epigejos	8.43	2.04	1		***		***	***	***					***
2. Poa trivialis	7.81	NA	ns	1										
3. Holcus lanatus	7.4	1.39	ns	ns	1		ns	ns	ns					ns
4. Stellaria media	5.41	NA	***	***	ns	1								
5. Claytonia perfoliata	4.53	0.7	***	***	***	ns	1	ns	ns					ns
6. Juncus subnodulosus	4.21	0.7	***	***	***	ns	ns	1	ns					ns
7. Calamagrostis canescens	3.39	1.02	***	**	***	ns	ns	ns	1					ns
8. Carex arenaria	2.1	NA	***	***	***	*	ns	ns	ns	1				
9. Agrostis stolonifera	1.54	NA	***	***	***	***	*	ns	ns	ns	1			
10. Eupatorium cannabinum	1.28	NA	***	***	***	***	***	**	ns	ns	ns	1		
11. Rubus caesius	0.88	NA	***	***	***	***	***	***	ns	ns	ns	ns	1	
12. Cirsium arvense	0.87	1.35	***	***	***	***	***	***	ns	ns	ns	ns	ns	1

TABLE 6

Donkey diet. The twelve most bitten plant species in the nature reserve the Houtsaegerdunes. Zero-bite observations per species are left out of calculation of the mean assuming that during these zero-bite periods the plant species was not met with by the donkey. Bite rate is indicative for the most frequently bitten species. Over the whole period these are *Festuca juncifolia*, *Calamagrostis epigejos* and *Carex arenaria*. With mean intake rate (dry matter/min. grazing) as criterion Calamagrostis epigejos is by far the most important plant species consumed (HSD test right side). (HSD ***: p<0.001;**; p<0.01; p<0.05; ns: p >0.05).

Species	Mean B/min	DM g/min	1	2	3	4	5	6	7	8	9	10	11	12
1. *Festuca juncifolia*	9.56	0.7	1	***	ns	***	ns	ns	***			ns	ns	ns
2. *Calamagrostis epigejos*	6.84	6.36	ns	1	***	***	***	***	ns			ns	***	***
3. *Carex arenaria*	6.04	0.42	ns	***	1	***	ns	ns	***			ns	***	***
4. *Arrhenaterum elatius*	5.26	3.1	***	ns	ns	1	***	***	ns			ns	***	*
5. *Claytonia perfoliata*	4.37	0.48	ns	***	ns	ns	1	ns	***			ns	ns	*
6. *Rosa pimpinellifolia* (fruit)	3.70	1.11	***	***	ns	ns	ns	1	***			ns	ns	ns
7. *Rosa canina* (fruit)	2.63	4.83	***	***	ns	ns	ns	ns	1			ns	***	*
8. *Holcus lanatus*	2.61		***	***	***	ns	ns	ns	ns	1				
9. *Elymus repens*	2.48		***	***	***	ns	ns	ns	ns	ns	1			
10. *Fraxinus excelsior*	2.43	3.4	***	***	***	ns	ns	ns	ns	ns	ns	1	ns	ns
11. *Ligustrum vulgare*	2.43	1.05	***	***	***	ns	ns	ns	ns	ns	ns	ns	1	ns
12. *Ammophila arenaria*	1.98	1.68	***	***	***	***	ns	ns	ns	ns	ns	ns	ns	1

(1991), we found some similarities but also some striking differences. Koniks prefer *Holcus lanatus, Calamagrostis epigejos* and desire *Rubus caesius,* whereas *Eupatorium cannabinum, Cirsium arvense* are undesirable (Table 7). Donkeys prefer *Carex arenaria* and desire *Calamagrostis epigejos* and *Avenula pubescens.* Undesirable to donkeys were e.g. *Arrhenaterum elatius, Rubus caesius, Ammophila arenaria, Festuca rubra* and *Achillea millefolium.*

TABLE 7

Plant species preferences of konik and donkey expressed by the diet-availability ratio (COLEBROOK et al., 1987).
Only those Plant species of which the total available biomass exceeds 1% of the total biomass in the area are taken into account.

Preferred D/A > 0.35	
Konik	**Donkey**
Holcus lanatus *Calamagrostis epigejos*	*Carex arenaria*
-0.35 < Desirable D/A ≤ 0.35	
Rubus caesius	*Calamagrostis epigejos*
Undesirable D/A ≤ -0.35	
Eupatorium cannabinum *Rosa pimpinellifolia* *Cirsium arvense*	*Avenula pubescens* *Arrhenaterum elatius* *Ammophila arenaria* *Rubus caesius* *Achillea millefolium*

Plant parts and plant state

Green leaves are by far the most bitten plant parts by both herbivore species (Table 8). This is certainly true for all grass (-like) species, but not necessarily the case for herbaceous or woody plant species. For example donkeys prefer fruits of *Rosa* spp. and the inflorescences of *Hieracium umbellatum*, *Melandrium album* and *Eupatorium cannabinum* above their foliage.

Koniks were seen biting inflorescence, young leaves and shrivelled plants of *Cirsium arvense,* inflorescences of *Eupatorium cannabinum* and, to a much lesser extent, fruits of *Rosa pimpinellifolia* and *Rubus caesius.* During winter Koniks not infrequently dig up and consume roots and rhizomes of *Urtica dioica* and *Epilobium hirsutum.*

DISCUSSION

Temporal feeding behaviour

As hindgut fermenters equids have to spend a lot of their time foraging (DUNCAN, 1992, ILLIUS & GORDON, 1993). Free-ranging horses devote 50-70% of their time to eating and only 20-30% to resting. Towards the autumn the time spent grazing increases (GUDMUNDSSON & DYRMUNDSSON, 1994). However, the increase in foraging time is limited. Camargue horses -although nutritionally stressed at the end of the winter show only a slight increase of 6 % in feeding time, suggesting a certain threshold above which further increase in feeding time would not outweigh the costs of sleep deprivation or fatigue (DUNCAN, 1992).

Our results with Koniks are to some extent in agreement with these conclusions, although grazing time in summer and autumn appears to be only slightly greater (3%) than time spent grazing in winter. Perhaps Koniks are at the border of feeding capacity in the winter- not being able to enlarge consumption anymore. The rather poor condition of one of the lactating mares in winter can be interpreted as a first signal for nutritional stress and the inability to increase intake for maximum nutrient assimilation. We therefore hypothesise that the feeding strategy of Koniks is based on high intake when food items are of high quality and best available (late spring, summer and early autumn) and that they rely upon their body reserves during periods of inadequate food availability.

TABLE 8

Konik and donkey diet composition at the plant part level (% of total number of bites)

Forage class	leaf	stem	Flower	fruit	seedling	root	bark
	Konik						
Graminoids	73.07	0.01	0	0	0	0	0
Herbaceous plants	9.79	7.19	0.44	0.07	7.25	0.17	0
Woody plants	0.95	0.72	0.01	0.23	0.03	0	0.07
Total	***83.81***	***7.92***	***0.45***	***0.3***	***7.28***	***0.17***	***0.07***
	Donkey						
Graminoids	71.71	0.27	0.42	0.29	0.19	0.01	0
Herbaceous plants	5.91	5.46	0.40	0.26	0.01	0.03	0
Woody plants	6.49	4.78	0.06	3.41	0.01	0	0.29
Total	***84.11***	***10.51***	***0.88***	***3.96***	***0.29***	***0.04***	***0.29***

Donkeys increase their intake significantly in winter and hence are able to maintain good condition. Donkeys are capable of consuming fibre at a high rate because of an efficient tooth and jaw apparatus and an ability to swallow larger feed particles (MUELLER et al., 1998). Donkeys are also known to be capable of digesting low quality food. Compared to horses, they have lower energy requirements (IZRAELY et al., 1989a; IZRAELY et al., 1989b). We suggest that a combination of these factors makes it profitable for them to feed more in winter. So donkeys seem to behave in a slightly different way when faced with decreased quality but still adequate quantities of food.

Botanical aspects of the diet

Free ranging horses consume a wide variety of plant species and are seasonally dependent in their selection. The availability of plant species has a great influence on their selection (GUDMUNDSSON & DYRMUNDSSON, 1994). Horses prefer grasses and other graminoid species above herbaceous species that have a larger amount of less favourable secondary compounds (PUTMAN et al., 1987; GORDON, 1989; DUNCAN, 1992; GROOT BRUINDERINK et al., 1997). Diet selection by Koniks and donkeys is quite similar. They seem to select first those graminoid species that are common and widespread. When it is possible, they can be very selective, consuming leaves and twigs, flowerheads or fruits of different herbaceous or woody species, which perhaps offer them some indispensable nutrients. At such times donkeys seem to prefer woody as well as herbaceous species whereas Koniks seem to select almost only herbaceous species. Reasons for that remain unclear. Nevertheless many herbaceous species are almost not or never eaten presumably because of secondary compounds or structural defences.

So far both animals can be considered as interesting nature management 'tools':

First of all Koniks as well as donkeys eat dominant plant species that nature managers would like to see decline in dominance, e.g. *Calamagrostis epigejos, Arrhenaterum elatius* and *Cirsium arvense*. However, browsing on scrub plants is insufficient to cause a visible decrease in their presence. Only some trimming effect and ring barking are achieved by the donkeys, while the Koniks have no foraging impact on scrub plants whatsoever. This minor impact of both equids on woody species might, however, result from the relative abundance of the more preferred graminoid species. In other areas, where graminoid presence is limited, donkeys have had considerable impact on woody species (VAN ASSCHE, 1993; VELTER, pers. comm.).

Within the given circumstances of relatively low-productive dune ecosystems, both animal species seem to perform well. Generally they cope well with periods of scarcity of food resources. However, they use different feeding strategies, presumably based on physical and physiological differences.

Before deciding on herbivore species and densities to be used for specific management goals, the feeding ecology of other large herbivores and of the effects of increasing animal densities on animal diet selection and vegetation dynamics need further attention. Clearly further assessment of food quantity and quality is inherent within this kind of research.

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