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# Annual changes in roe deer (*Capreolus capreolus* L.) diet in the Bohemian Forest, Czech Republic/Germany

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**Abstract** The composition of roe deer diet in the Bohemian Forest was analysed with the aim to assess its role in forest habitat altered by bark beetle outbreaks and wind calamities. The annual diet of roe deer was studied at both, Czech and German, sides of the Bohemian Forest using microscopic analyses of faeces. On average, the largest part of the roe deer diet consisted of forbs (32%), followed by three other components—grasses (17%), coniferous trees (13%) and broadleaved trees (11%). Overall the results show that the composition of roe deer diet in the Bohemian Forest is that of a typical concentrate selector.

**Keywords** Roe deer · Diet composition · Faecal analyses

## Introduction

The research of feeding habits of ruminants is of great importance for the preservation of habitat diversity, its knowledge is necessary for rational forest and hunting

management (Cornelis et al. 1999). Roe deer are generalist herbivores that feed on a variety of plant species (Duncan et al. 1998), and as concentrate selectors they depend on high-quality low-fibre food items (browse, forbs and fruits) due to small body size (Illius and Gordon 1992). They are known for their preference of hardwood browse; twigs often form a large part of their diet (Tixier and Duncan 1996). Therefore roe deer can greatly affect natural and artificial regeneration of the forest (Putman 1994; Gill 2000; Gill and Beardall 2001). However, despite roe deer's preference for woody plants, their diet depends highly on the vegetation composition and can contain substantially larger amount of other concentrate food components, e.g. forbs, which can surpass the volume of woody plants (Tixier and Duncan 1996).

During the last decades the roe deer diet has been studied in many European countries (review Cornelis et al. 1999). In the area of Middle Europe, extensive research has been done in Poland (e.g. Borowski and Kossak 1975; Gebczynska 1980) and Czech Republic (e.g. Fišer and Lochman 1969; Homolka 1991, 1993, 1995; Heroldová 1996; Barančková 2004), Matrai studied roe deer diet composition in the mixed forest of Hungary (Matrai and Kabai 1989). But, until now no data have been available on their diet from the area of the Bohemian Forest. Windstorms and bark beetle outbreaks, regularly occurring in this specific locality, substantially altered especially the highly sensitive spruce monocultures by creating large deforested areas (Jonášová and Prach 2008). The composition of available plant species on these newly formed clearings may significantly differ from the adjacent undisturbed forest (Moser et al. 2008). Some plant groups highly palatable to roe deer, e.g. bramble, can prosper more on the hurricane-created clearings (Storms et al. 2006). The changes in food availability can substantially influence the

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roe deer diet composition at these gaps (Gaillard et al. 2003; Widmer et al. 2004).

Complex research of deer spatial and feeding ecology in Bohemian Forest studies deer habitat preferences and activity patterns (using GPS telemetry), and their impact on forest regeneration. The diet composition analyses are an integral part of this project. The aims of presented study were: (1) to analyse the roe deer diet composition in undisturbed and altered parts of the forest, (2) to evaluate its changes during the year and (3) to compare the diet composition between chosen localities.

## Study area

The study was carried out from October 2006 to February 2008 in the western part of the Bohemian Forest situated along the SW frontier of the Czech Republic and Germany. The study started in Šumava (Šumava National Park and Protected Landscape Area)—the Czech part of the Bohemian Forest, where six study sites were chosen for collection of roe deer faeces (Fig. 1). The sites were chosen to represent different habitat types and altitudes of the studied area (Table 1). Since April 2007, the study also included three study sites in the German part of the Bohemian Forest (Bavarian Forest National Park). However, two of these sites, Zwieslerwaldhaus and Hochberg, were eventually evaluated

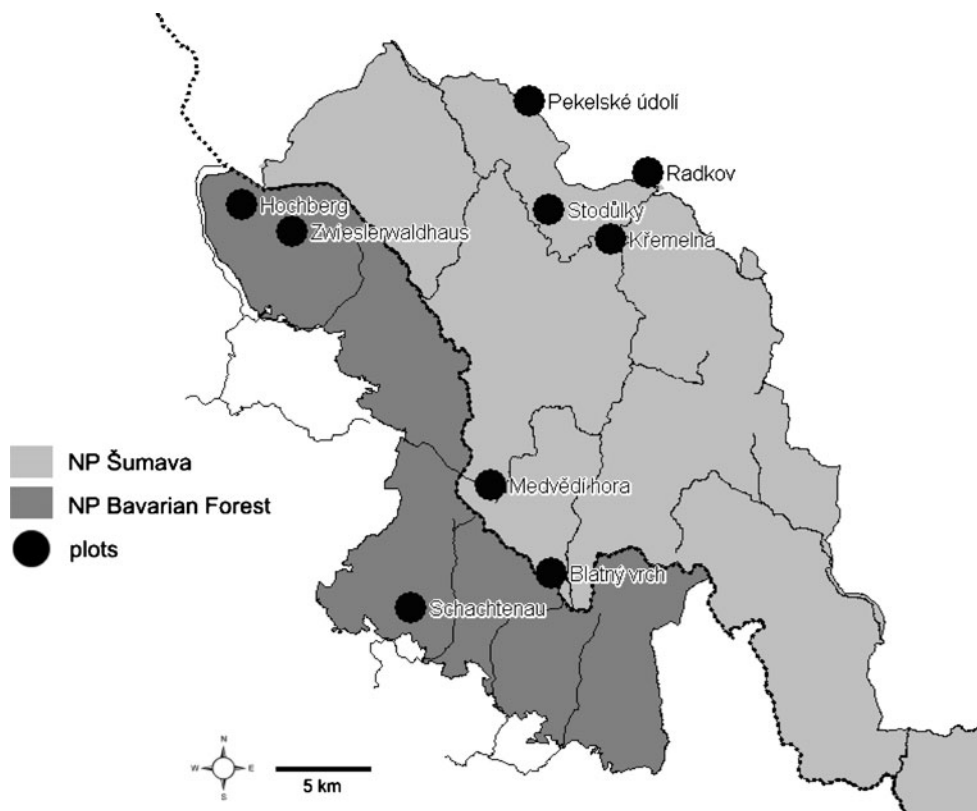
as one, as we were not able to find sufficient number of samples at Hochberg, and because of the similarities in vegetation composition.

The average yearly temperature in the Bohemian Forest varies from 6°C (750 m a.s.l.) to 3°C (1,300 m a.s.l.), with the warmest month being July and the coldest January. Continuous snow cover usually lasts for 90–100 days a year at the lowest altitudes (the average maximum height of snow cover 40 cm) and for more than 200 days at the highest altitudes (average maximum height of the snow cover 150 cm; [www.npsumava.cz](http://www.npsumava.cz); Heurich and Neurfanger 2005). However, the Czech (leeward) and German (windward) sites differ greatly in average rainfall, vegetation composition and geomorphologic structure (more details: [www.npsumava.cz](http://www.npsumava.cz); [www.nationalpark-bayerischer-wald.de](http://www.nationalpark-bayerischer-wald.de)).

## Methods

Faeces were collected on the studied sites within a 2-month period (February/March, April/May, June/July, August/September, October/November and December/January) to evaluate the changes in roe deer diet throughout the year. For each collecting period, we attempted to collect and analyse five faecal samples from each site. Together, 176 faecal samples were collected and processed. However, it was not always possible to collect the expected number of

**Fig. 1** Studied sites in the Czech and Bavarian part of the Bohemian Forest



**Table 1** Brief characteristic of studied sites

	Site	Altitude	Description
<b>Foothill</b>	Pekelské údolí Valley	600–700	Spruce–pine forest; shrub layer contains fir; parts with almost no understorey and parts with richly developed understorey
	Radkov	600–700	Pine–spruce forest with broadleaved trees; well-developed understorey; mowed meadows
<b>NE inter.</b>	River Křemelná Canyon	800–950	Pine–spruce forest; poorly developed understorey; grazed meadows
	Enclave Stodůlky	800–950	Spruce–pine forest and open broadleaved forest mixed with meadows
<b>Tophill</b>	Medvědí hora Mt.	1,150–1,250	Open subalpine spruce forest; poorly developed shrub layer; herb layer—mostly grasses, ferns and <i>Vaccinium</i> spp.
	Blatný vrch Hill	1,150–1,250	Remains of subalpine spruce forest after wind calamity and bark beetle outbreak; willows and spruce in shrub layer
<b>SW inter.</b>	Schachtenau	800–900	Remains of spruce forest after wind calamity with well-developed understorey, mixed with beech forest
	Zwieslerwaldhaus/Hochberg	700–800	Spruce forests with beech; shrub layer mainly beech and spruce, less fir; well-developed shrub layer

samples, as it is quite difficult to find fresh roe deer faeces, especially during the vegetation season. There are also winter samples missing from the Medvědí hora Mt., Blatný vrch Hill and Schachtenau sites, since the animals moved to sites at lower altitudes for the winter. For this reason, the design to analyse the differences in roe deer diet composition between 2-month periods had to be changed in favour of four seasons. Because of the problems with the collection of a sufficient quantity of faeces, it was not possible to statistically analyse the differences between single sites. Therefore, the Czech sites were put together into three groups—foothill (Pekelské údolí and Radkov), NE intermediate (Stodůlky and Křemelná) and tophill (Medvědí hora Mt. and Blatný vrch Hill). The Bavarian sites (further SW intermediate sites) Schachtenau and Zwieslerwaldhaus/Hochberg were not pulled together, as they differ greatly in vegetation composition.

Many studies have been performed to compare the differences between the two most often used methods of diet composition analyses—rumen content analysis and microscopic analysis of faeces. The results led some authors to consider the faecal analysis reliable (Anthony and Smith 1974), whereas others have considered this method lacking accuracy (Gill et al. 1983). Even though the method of faeces analyses is negatively influenced by the differences in digestibility of various plant species, we decided to use it because of its main advantages—the possibility to obtain larger amount of samples and to study animal diet without interfering with their behaviour and habits.

We followed a methodology used in Homolka and Heroldová (1992), when a portion of each pellet was homogenised in water, washed and put into a drop of glycerine on a microscope slide. Each sample was then analysed at  $\times 50$  magnification. The surface of the cover slide ( $18 \times 18$  mm) was taken as 100%, so that each visual field

was approximately 2% of the observed area (Barančková 2004; Prokešová 2004). During the analyses, the surface covered by each food component was noted and later used to assess the percentage volume (%v) of each component in a sample. We used  $\times 100$  magnification for more precise identification of fragments.

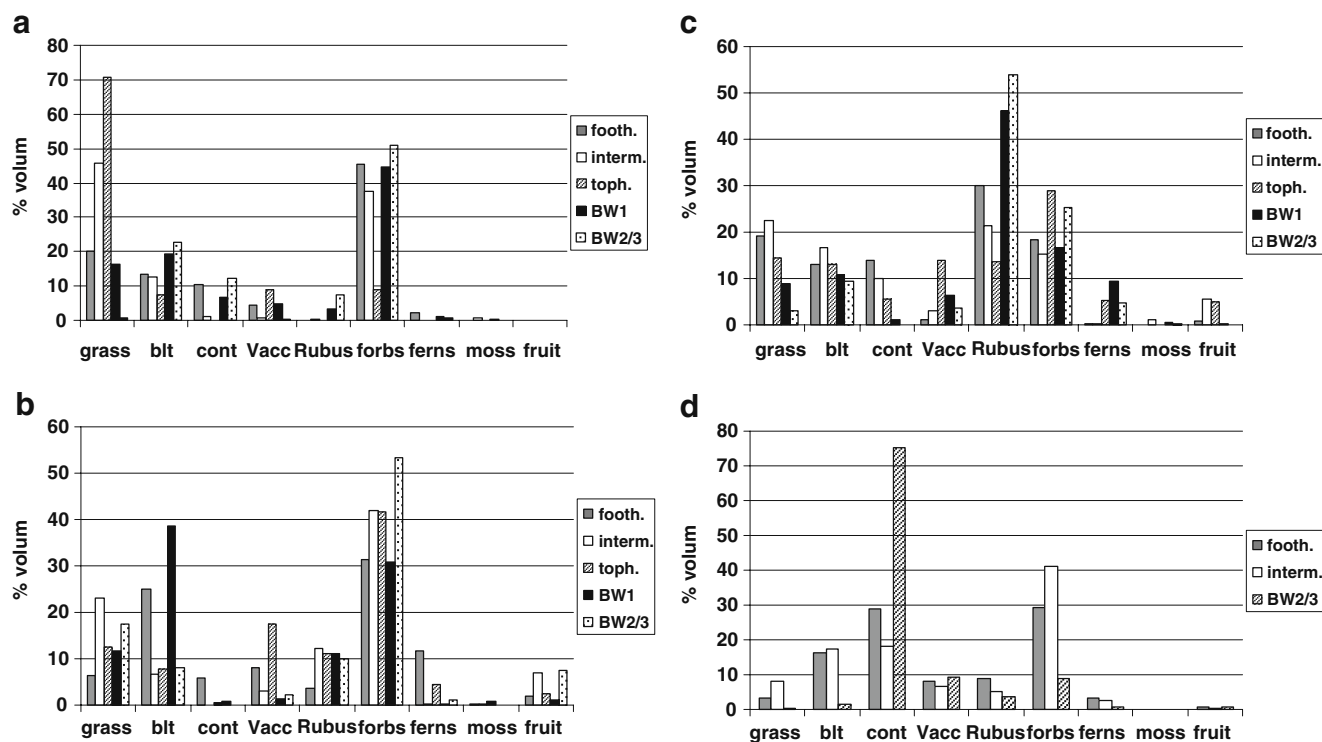
The values of trophic diversity were calculated using the Shannon–Wiener formula  $H' = -\sum (x_i \times \ln(x_i))$ , where  $x_i$  is %v of  $i$ th component (Shannon and Weaver 1949). The equitability index  $J'$  was calculated using the value of diversity  $H'$  and number of components  $S(J' = H'/\ln S)$  (Sheldon 1969).

The data were arc-sin transformed to improve their homogeneity (Sokal and Rohlf 1981). Depending on the number of samples One-way ANOVA with subsequent Bonferroni post hoc test,  $t$  test or nonparametric Kruskal–Wallis test in SPSS 11.5 were used to assess the differences between compared study sites or seasons.

## Results

### Average diet composition and its differences between sites

Analyses of food fragments preserved in the faeces revealed the presence of various parts of forbs (e.g. Asteraceae, Fabaceae, Lamiaceae and Ranunculaceae), shrubs (e.g. *Rubus fruticosus*, *Rubus idaeus* and *Vaccinium* spp.), tree species (e.g. *Abies alba*, *Betula* sp., *Fagus sylvatica*, *Picea abies* and *Swida sanguinea*), as well as the presence of ferns and mosses. As expected, the chosen sites differed in diet composition (Fig. 2). The largest part of roe deer diet was formed by woody plants and forbs. At the Czech sites (foothill, NE intermediate and tophill), the most abundant diet component was forbs, with over 30% on average.



**Fig. 2** Average diet composition on studied sites during seasons. **a** spring, **b** summer, **c** autumn, **d** winter. *blt* broadleaved trees, *cont* coniferous trees, *Vacc* *Vaccinium* spp., *footh* foothill sites, *interm* intermediate sites, *toph* tophill sites, *BW1* Schachtenau, *BW2/3* Zwieslerwaldhaus/Hochberg

Average roe deer diet at the SW intermediate sites contained slightly larger amount of conifers (29%) than forbs (26%). The diversity index was the lowest at intermediate localities ( $H'=1.27$ ) and the highest at tophill and SW intermediate localities ( $H'=1.30$ ). The value of equitability index ( $J'$ ) varied from 0.31 at foothill localities up to 0.38 at tophill localities.

Comparison of means (one-way ANOVA; Bonferroni post hoc test) between sites showed differences in the volume of grasses, broadleaved and coniferous trees and bilberry. The diet at NE intermediate sites contained a larger volume of grasses in comparison to other studied sites, with the exception of tophill sites ( $p_{1-3}<0.05$ ). The largest amounts of woody plants were found in the diet at SW intermediate sites—Schachtenau differed from all other plots in the volume of broadleaved trees ( $p_{1-4}<0.05$ ) and Zwieslerwaldhaus/Hochberg in the volume of conifers ( $p_{1-4}<0.001$ ). The last difference was at tophill sites, where roe deer consumed the largest amount of bilberry ( $p_{1-4}<0.001$ ).

*t* test revealed only three significant differences within pairs of sites. SW intermediate sites differed between each other in the amount of broadleaved trees ( $p<0.001$ ) found in larger quantity in the diet at Schachtenau (windthrow gap), and coniferous trees ( $p<0.001$ ), constituting a substantial part of the diet at Zwieslerwaldhaus/Hochberg (undisturbed forest). The third difference was the amount of bilberry at tophill sites ( $p<0.001$ ), with the diet at

Medvědí hora Mt. consisting of 25% *Vaccinium* spp. on average.

#### Annual changes in diet composition

The most important item of the roe deer diet throughout the whole year was forbs. Their average volume did not fall below 20% and reached a maximum of 40% in summer. Broadleaved trees had a consistent average volume of at least 11% during all four seasons. Conversely, the amount of coniferous trees decreased with the progressing vegetation season, later increased during autumn and reached the maximum of 36% in winter (Table 2).

The Kruskal–Wallis test was used to analyse the differences between sites during each season separately. During all seasons, the diet at the sites differed in the volume of grasses ( $p_{1-4}<0.01$ ) and bilberry ( $p_{1-4}<0.05$ ). The volume of ferns was significantly different during each season, with the exception of spring ( $p_{1-3}<0.05$ ).

When comparing the diet composition at single sites between seasons, ANOVA revealed significant differences in five main components—grasses, conifers, bramble, forbs and fruits (Table 3). The highest difference was found in the volume of conifers and bramble, with the first being most abundant at all sites during winter ( $p_{1-5}<0.01$ ) and the second reaching the largest volume at all sites in autumn ( $p_{1-5}<0.001$ ). Fruits and grasses were significantly more

**Table 2** Variability in diet composition on five studied sites during four seasons (numbers in brackets represent number of analysed samples)

	Foothill				NE intermediate				Tophill				Schachtenau				Zwieslerwaldhaus/Hochberg					
	(10/9/7/33)				(6/10/12/11)				(1/16/17/0)				(4/10/5/0)				(2/5/2/16)					
	Min	Max	Mean	St. dev.	Min	Max	Mean	St. dev.	Min	Max	Mean	St. dev.	Min	Max	Mean	St. dev.	Min	Max	Mean	St. dev.		
<b>Grass</b>	Spring	0	49.36	19.95	16.79	41.46	56.56	45.90	5.60	70.58	70.58	–	–	2.95	38.01	16.49	15.10	0	1.26	0.63	0.89	
	Summer	0	21.19	6.32	6.42	11.45	35.46	22.99	7.57	2.27	26.47	12.44	8.28	1.42	19.69	11.72	5.84	4.88	26.64	17.60	8.76	
	Autumn	0.71	35.15	19.18	13.49	10.49	50.26	22.42	12.08	0.02	47.04	14.41	14.60	1.72	21.48	8.84	8.18	2.41	3.59	3.00	0.84	
	Winter	0	34.71	3.48	6.31	0.38	28.56	8.15	9.41	7.60	7.60	7.60	–	7.99	29.72	19.29	8.89	10.79	34.68	22.74	16.89	
<b>blt</b>	Spring	4.59	24.84	13.52	7.03	4.99	19.54	12.78	5.41	0	19.08	7.80	6.47	2.03	85.15	38.74	36.76	3.15	14.13	7.93	3.97	
	Summer	3.32	50.62	24.87	16.12	2.77	10.67	6.58	2.90	0	41.17	13.18	12.75	5.64	17.14	10.71	4.34	9.31	9.48	9.39	0.12	
	Autumn	2.72	31.59	13.00	12.88	2.90	39.08	16.57	14.05	0	0	0	–	1.82	11.67	6.80	5.31	4.64	20.28	12.46	11.06	
	Winter	0	48.01	16.32	14.68	0	37.55	17.25	14.28	0	0	0	–	0	3.30	0.74	1.17	0	0	0	0	
<b>Cont</b>	Spring	0	48.32	10.27	16.60	0	6.79	1.13	2.77	0	0	0	–	0	2.16	1.15	0.84	0	0	0	0	
	Summer	0	20.08	5.90	7.22	0	0	0	0	0	3.34	0.57	1.11	0	3.30	0.74	1.17	0	0	0	0	
	Autumn	0	49.98	13.78	23.56	0	36.21	10.01	13.27	0	22.58	5.65	7.60	0	2.16	1.15	0.84	0	0	0	0	
	Winter	0	83.17	29.04	25.44	0	45.88	18.23	17.78	0	0	0	–	0	7.60	4.72	3.40	24.71	95.53	75.11	18.21	
<b>Yacc</b>	Spring	0	10.99	4.62	3.50	0	2.97	0.61	1.19	8.91	8.91	–	–	0	7.60	4.72	3.40	0	0.63	0.32	0.45	
	Summer	0.79	13.81	7.99	4.96	0	17.99	3.04	5.79	0.61	49.73	17.46	18.82	0	4.78	1.51	1.59	1.11	3.30	2.26	1.03	
	Autumn	0	3.37	1.22	1.10	0	26.79	3.00	7.56	0	45.21	13.91	12.84	0.96	18.44	6.30	7.26	3.10	4.25	3.68	0.81	
	Winter	0	25.00	8.19	7.34	0.42	13.62	6.81	4.63	0	0	0	–	0	10.04	3.17	4.75	0.00	19.63	9.22	4.85	
<b>Rubus</b>	Spring	0	0.08	0.03	0.03	0	1.03	0.26	0.41	0	0	–	–	0	0	0	0	0	14.56	7.28	10.30	
	Summer	0	30.81	3.55	10.23	0	42.28	12.32	16.30	0	53.04	11.01	16.73	0	27.16	11.02	12.00	4.84	16.46	10.08	5.71	
	Autumn	0	56.45	29.86	23.13	0	69.62	21.46	26.79	0	55.63	13.63	13.94	0	70.79	46.04	27.47	43.79	63.72	53.76	14.09	
	Winter	0	47.40	8.90	14.00	0	23.79	5.22	8.16	0	0	0	–	0	0	0	0	0	35.07	3.79	9.19	
<b>Forbs</b>	Spring	17.22	76.19	45.26	20.33	21.58	45.99	37.45	9.05	8.90	8.90	–	–	38.64	53.13	44.81	6.19	46.15	56.08	51.11	7.02	
	Summer	19.00	63.11	31.32	15.89	20.97	54.78	41.97	11.73	22.90	62.88	41.55	10.41	0.00	70.76	30.80	29.53	41.32	60.21	53.31	7.07	
	Autumn	1.09	54.74	18.46	20.89	0	52.06	15.36	17.84	17.84	0.59	58.98	28.81	19.01	0.93	41.41	16.71	14.97	17.00	33.44	25.22	11.63
	Winter	0	54.70	29.30	17.95	27.21	59.65	41.01	11.47	0	0	0	–	0	2.95	0.96	1.39	0	30.63	8.99	8.00	
<b>Ferns</b>	Spring	0	11.02	2.16	3.51	0	0	0	0	0	0	–	–	0	0	0	0	0	1.27	0.63	0.90	
	Summer	0	45.59	11.80	13.98	0	1.22	0.26	0.41	0	20.88	4.43	5.92	0	0.81	0.26	0.35	0	3.01	1.14	1.56	
	Autumn	0	1.04	0.15	0.39	0	1.89	0.19	0.55	0	26.52	5.26	7.53	0.87	22.18	9.45	8.06	1.63	7.94	4.78	4.46	
	Winter	0	18.66	3.49	5.25	0	14.83	2.55	4.48	0	0	0	–	0	0	0	0	0	4.00	0.72	1.09	
<b>Moss</b>	Spring	0	1.23	0.12	0.39	0	5.11	0.85	2.08	0	0	–	–	0	0	0	0	0	0	0	0	
	Summer	0	1.35	0.15	0.45	0	1.34	0.32	0.51	0	6.51	0.78	1.76	0	0	0	0	0	0	0	0	
	Autumn	0	0	0	0	0	11.48	0.99	3.30	0	0.68	0.13	0.25	0	1.89	0.61	0.79	0	0.33	0.16	0.23	
	Winter	0	1.34	0.11	0.33	0	1.38	0.16	0.42	0	0	0	–	0	0	0	0	0	0.30	0.02	0.07	
<b>Fruit</b>	Spring	0	0	0	0	0	0	0	0	0	0	–	–	0	0	0	0	0	0	0	0	
	Summer	0	15.52	2.01	5.08	0.40	26.07	6.81	7.68	0	20.72	2.39	5.19	0	5.30	1.13	1.62	0.55	29.97	7.38	12.67	
	Autumn	0	5.22	0.95	1.93	0	45.50	5.62	12.78	0	22.24	4.88	7.05	0	0.66	0.20	0.30	0	0	0	0	
	Winter	0	3.27	0.57	0.73	0	1.26	0.28	0.50	0	0	0	–	0	0	0	0	0	3.37	0.58	0.87	

abundant during winter than in summer and autumn, while forbs were eaten more in spring and summer (Table 3).

**Discussion**

The average diet composition of roe deer but also its seasonal changes in the Bohemian Forest were very similar to patterns observed in other studies addressing the diet composition of roe deer throughout the year (Helle 1980; Jackson 1980; Hosey 1981; Barančková 2004).

The results of roe deer diet analyses in the Bohemian Forest showed their high preference for woody plants and forbs. While forbs dominated during the vegetation season, during winter roe deer consumed more woody plants. The same pattern, woody plants dominating in roe deer diet over forbs during winter period, while feeding predominantly on forbs during summer, was also observed in other mountain habitats (e.g. Staines and Ratcliffe 1991; de Jong et al. 1995). Grasses usually do not form a large part of the roe deer diet, due to the large volume of poorly digestible fibre (Dannel et al. 1994). This food item can play a more important role during spring (Cornelis et al. 1999) when it is more easily digested and supplements for the still undeveloped forbs, which seems to apply also to the roe deer diet in the Bohemian Forest.

The volume of woody plants, especially coniferous trees, usually increases significantly in winter when the availability and quality of previously abundant food sources (forbs, bramble and bilberry) decreases. This pattern was also observed during studies in central Finland (Helle 1980) and in Scotland (Latham et al. 1999). Coniferous trees are often considered a starvation food for deer (Crête and Courtois 1997), with some species, e.g. silver fir, being more browsed than others, e.g. spruce (Senn and Suter 2003). Also in the Bohemian Forest the volume of conifers was

higher in roe deer diet during winter, especially at SW intermediate sites, which may result just from the much higher cover of silver fir in the shrub layer at these sites. Despite of the increase in proportion of coniferous browse in roe deer winter diet, roe deer still fed intensively also on other food sources. This probably resulted from very untypical weather during this season (2006/2007 and 2007/2008). The winter temperatures during studied years were unusually high and snow cover unusually low and short-lasting, or practically nonexistent, enabling the roe deer relatively easy access to food sources usually inaccessible during this time of year.

Food availability is considered by some authors to be the main cause of variation in deer diet (Duncan et al. 1998; Cornelis et al. 1999). The vegetation regeneration on windthrow gaps increases the availability of browse, e.g. bramble (Degen et al. 2005; Moser et al. 2008), thus making them attractive feeding places for roe deer (Gaillard et al. 2003). However, the results of our study, similarly to those of Storms et al. (2006), did not support the prediction of higher use of browse by roe deer on these clearings in comparison to undisturbed forest growth. This may be influenced by the quality of food sources on clearings. Several studies found the quality of food sources on these gaps to be lower than in the undisturbed forest (Happe et al. 1990; Moser and Schütz 2006). This may reduce the attractiveness of clearings as food sources for roe deer, a concentrate selector dependent on high-quality food.

Diet composition is one of the factors influencing an exceedingly complex relationship between roe deer and vegetation. Even though the results of our study are not surprising, they are an important part of long-time study of ungulate diet in the Czech Republic (e.g. Homolka 1991, 1993, 1995; Homolka and Heroldová 1992; Barančková 2004) and obtained data are essential for roe deer management as well as forestry management in the Bohemian Forest.

**Table 3** Differences in diet composition on studied sites during the year

		Foothill				NE intermediate				Tophill				Schachtenau				Zwieslerwaldhaus/Hochberg			
		Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter
<b>grass</b>	spring	-	NS	NS	0.17 <sup>a</sup>	-	0.16 <sup>a</sup>	0.13 <sup>a</sup>	0.27 <sup>a</sup>	-	0.2 <sup>a</sup>	0.16 <sup>a</sup>	0.3 <sup>a</sup>	-	0.17 <sup>a</sup>	0.14 <sup>a</sup>	0.29 <sup>a</sup>	-	0.14 <sup>a</sup>	0.11 <sup>a</sup>	0.24 <sup>a</sup>
	summer	NS	-	NS	0.93 <sup>a</sup>	NS	-	NS	0.1 <sup>a</sup>	NS	-	NS	0.099	NS	-	NS	0.1 <sup>a</sup>	NS	-	NS	0.1 <sup>a</sup>
<b>cont</b>	autumn	NS	NS	-	0.13 <sup>a</sup>	NS	NS	-	0.14 <sup>a</sup>	NS	NS	-	0.133	NS	NS	-	0.13 <sup>a</sup>	NS	NS	-	0.13 <sup>a</sup>
	winter	0.29 <sup>b</sup>	0.38 <sup>a</sup>	0.31 <sup>a</sup>	-	0.3 <sup>b</sup>	0.36 <sup>a</sup>	0.29 <sup>a</sup>	-	0.31 <sup>a</sup>	0.36 <sup>a</sup>	0.29 <sup>a</sup>	-	0.31 <sup>a</sup>	0.36 <sup>a</sup>	0.3 <sup>a</sup>	-	0.37 <sup>a</sup>	0.43 <sup>a</sup>	0.37	-
<b>Rubus</b>	spring	-	NS	-0.26 <sup>a</sup>	NS	-	NS	-0.25 <sup>a</sup>	NS	-	NS	-0.23 <sup>a</sup>	NS	-	NS	-0.24 <sup>a</sup>	NS	-	NS	-0.24 <sup>a</sup>	NS
	summer	NS	-	-0.17 <sup>a</sup>	NS	NS	-	-0.16 <sup>a</sup>	NS	NS	-	-0.13 <sup>a</sup>	NS	NS	-	-0.15 <sup>a</sup>	NS	NS	-	-0.15 <sup>a</sup>	NS
<b>forbs</b>	autumn	-0.26 <sup>a</sup>	-0.17 <sup>a</sup>	-	0.18 <sup>a</sup>	-0.24 <sup>a</sup>	-0.19 <sup>a</sup>	-	0.18 <sup>a</sup>	-0.2 <sup>a</sup>	-0.18 <sup>a</sup>	-	0.16 <sup>a</sup>	-0.21 <sup>a</sup>	-0.17 <sup>a</sup>	-	0.17 <sup>a</sup>	-0.22 <sup>a</sup>	-0.18 <sup>a</sup>	-	0.18 <sup>a</sup>
	winter	-0.2	-0.11 <sup>b</sup>	NS	-	-0.15	-0.1 <sup>b</sup>	0.09	-	NS	-0.11 <sup>a</sup>	NS	-	-0.14	-0.1 <sup>a</sup>	NS	-	-0.17 <sup>a</sup>	-0.14 <sup>a</sup>	NS	-
<b>fruit</b>	spring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	summer	NS	-	-	NS	-	-	-	NS	-	-	-	NS	-	-	-	0.04	-	-	-	-
	autumn	NS	NS	-	NS	NS	-	NS	NS	NS	NS	-	0.04	NS	-	0.04	NS	-	0.04	NS	-
	winter	NS	-0.03 <sup>b</sup>	-0.03	-	NS	-0.03 <sup>b</sup>	-0.03 <sup>b</sup>	-	NS	-0.03 <sup>b</sup>	-0.04 <sup>a</sup>	-	NS	-0.03 <sup>b</sup>	-0.03 <sup>a</sup>	-	NS	-0.03 <sup>a</sup>	NS	-

Gray highlighted data belong to the gray highlighted diet categories

<sup>a</sup> Statistically significant at 0.001

<sup>b</sup> Statistically significant at 0.01

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