Relationships between browsing damage and woody species dominance

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ABSTRACT: The paper analyzes data on browsing damage to food-attractive woody species, viz. *Acer campestre, Acer pseudoplatanus, Acer platanoides, Fraxinus excelsior, Sorbus aucuparia* and most often eudominant *Fagus sylvatica*. The field survey was carried out in 2005–2007. Analyzed data come from 34 transects at 15 localities in the CR with different abundance of ungulates (*Capreolus capreolus*, in some areas also *Cervus elaphus* or *Dama dama*). Trees occurring in natural regeneration under a stand were monitored up to a height of 150 cm and the presence of new browsing damage was monitored. Differences between the percent of damaged individuals of the given species of a food-attractive woody species and the percent of damaged individuals of all woody species in the transect as well as the proportion of these parameters significantly correlate with the dominance of the given species being suitable parameters for the analysis of a relationship between the intensity of damage and dominance. At the same time, the higher the proportion of *Fagus sylvatica*, the higher the relative intensity of damage to monitored food-attractive species.

Keywords: browsing; dominance; *Acer*; *Fraxinus excelsior*; *Sorbus aucuparia; Fagus sylvatica*

The intensity of browsing damage to particular tree species by ungulates is always dependent on a broad spectrum of factors. In addition to the abundance of browsing animals, site properties and properties of woody species, the species composition of trees in advance regeneration plays also an important role (different attractiveness of particular species) as well as the density of this advance growth (different amounts of biomass for consumption, difficult access to seedlings etc.). A markedly selective character of damage is considered to be quite characteristic of browsing damage (e.g. Eiberle, Bucher 1989; Motta 1996; Čermák, Mrkva 2003). Thanks to the repeated selective browsing not only delayed natural regeneration occurs but also marked changes in the species composition of trees take place (e.g. Perko 1979; Ammer 1990, 1996; Burschel et al. 1990; Motta 2003; Svoboda et al. 2005).

With changing intensity of the impact of ungulates on woody vegetation not only the actual intensity of damage to trees but also other parameters, e.g. their mortality (dead/damaged), can change. In areas with the higher population density of browsing animals, relatively balanced intensities of damage to the particular trees are observed. Nevertheless, food-attractive species show a markedly higher percentage of mortality. On the other hand, in areas with lower yet evident load, both the rate of damage to the particular species and their mortality often fundamentally differ – with respect to the species resistance (Motta 1996). An increase in mortality can be expected particularly at repeated damage (Eiberle 1978, 1980; Finďo 1992), viz. if brows-

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ing is repeated during the same growing season. Food-attractive species with the good potential of compensation growth are repeatedly damaged most frequently.

The attractiveness of the particular species to consumers (and the rate of damage derived from the attractiveness) is markedly species-specific; nevertheless, it shows considerable variability within the particular areas being in relation to the species and structure of the consumer population. The species composition of advance regeneration (trees are more intensively searched if they occur in combination with less attractive species) and the rareness of a species or its dominance are often mentioned as factors affecting searching the woody species by ungulates. In some cases, damage increases with the relative proportion of a species, in other cases it increases with the decreasing proportion of these woody species in advance regeneration. Both polarities of relationships are interpretable (Strole, Anderson 1999). Differences in the rate of pressure of browsing animals, their food strategy, intensity of tree competition etc. can be of fundamental importance. Relationships between dominance and damage are documented and commented in literature, however, often without more detailed analysis and statistical documentation of their significance (e.g. Horvat 1990; Ammer 1996; Senn, Suter 2003; Stergar 2005) or they were evidenced only for one tree species or particular stand mixture (e.g. Padaiga 1986; Danell et al. 1991; Čermák 1998).

In 2005–2007, extensive monitoring of browsing damage to trees was carried out in areas throughout the CR in a wide range of natural conditions. The objective of the monitoring was to determine the condition of natural regeneration and its damage on these particular plots using adapted methodology including relatively extensive variability of areas. Nevertheless, a question of the relationship between the intensity of damage and the woody species dominance in advance regeneration was one of problems of our enormous interest. Therefore, on the basis of previous experience, five food-attractive tree species were selected which occurred on these plots from quite a negligible up to eudominant proportion, viz. *Acer pseudoplatanus*, *Acer platanoides*, *Acer campestre*, *Fraxinus excelsior* and *Sorbus aucuparia*. For the purpose of the analysis of a relationship between food-attractive and less attractive tree species data

Table 1. Basic characteristics of monitored localities

Locality	Number of transects	Total area (m²)	Year of monitoring	Number of game/1,000 ha*			
				Capreolus capreolus	*Cervus elaphus*	*Dama dama*	Ungulates
Litovelské luhy	2	375	2005	63	–	11	21
Vrapač	2	225	2005	98	–	63	56
Brumov	2	600	2005	41	26	–	47
Žákova hora	3	355	2006	40	10	–	20
Razula	1	75	2006	29	8	–	15
Jelení bučina	3	555	2006	20	14	–	19
Bučina pod Františkovou myslivnou	1	300	2006	22	18	–	24
Májová	3	860	2006	88	–	15	30
Pálava	3	240	2007	56	–	–	14
Chejlava	3	270	2007	30	8	–	16
Jizerskohorské bučiny	2	450	2007	40	50	50	85
Deblín	5	1,500	2007	65	–	–	16
Sedloňovský vrch	2	240	2007	P**	P**	–	**
Trčkov	1	300	2007	16	20	–	24
Černý Důl	1	150	2007	P**	P**	–	**
Total	34	6,495					

*According to available data of the game management registration or according to information of the state administration or a game manager; conversion to ungulates according to Decree No. 491/2002 Gaz., i.e. 1 individual of ungulate = 1 ind. of *Cervus elaphus* or 2 inds. of *Dama dama* or 4 inds. of *Capreolus capreolus*; P – the species is present,**no data were available

Table 2. Basic overview of results from the particular transects

	N_{all}	pcs/m^2	PD_{all} (%)	$PD_{attrac.}$ (%)	*Fraxinus excelsior*			*Acer campestre*			*Sorbus aucuparia*			*Acer pseudoplatanus*			*Acer platanoides*			*Fagus sylvatica*			Other species*		
					N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)
Litovelské luhy A	175	1.06	44	44	113	35	65	52	63	30													10	30	5
Litovelské luhy B	150	0.71	57	57	71	52	47	69	62	46													10	60	7
Vrapač A	201	2.23	40	38	178	37	89							13	54	6							10	90	5
Vrapač B	107	0.79	58	65	33	55	31	17	65	16				20	90	19	24	58	22				13	8	12
Brumov A	2,719	9.06	9	17	388	9	14							410	26	15	348	14	13	1,537	1	57	36	89	1
Brumov B	1,043	3.48	4	9										284	9	27				741	2	71	18	44	2
Žákova hora A	429	4.79	36	44										233	44	56				178	26	42	18	28	2
Žákova hora B	422	3.43	36	40										25	40	6				394	36	93	3	67	1
Žákova hora C	678	4.08	42	43										635	43	94				43	14	6			
Razula	618	8.24	1	4										140	4	23				353	1	57	125	1	20
Jelení bučina A	1,091	7.27	7	5										969	5	89				122	21	11	–	–	–
Jelení bučina B	710	2.78	3	2										295	2	42	378	2	53	16	6	2	21	19	3
Jelení bučina C	306	2.04	16	16							34	41	11	196	16	64							76	7	25
Bučina pod Fr. myslivnou	365	1.22	13	23							22	32	6	17	12	5				267	14	73	59	4	16
Májová A	521	2.17	47	70										104	70	20				235	57	45	182	27	35
Májová B	312	1.04	47	61										142	61	46				143	41	46	27	15	8
Májová C	331	1.03	42	62										71	62	21				227	38	69	33	21	10
Pálava A	558	7.17	72	68	104	79	19	30	100	6							291	61	54				133	97	26
Pálava B	242	2.69	83	81	61	87	25	51	88	21							93	74	38				37	95	16
Pálava C	672	8.96	83	83	155	93	23	266	92	40							227	65	34				24	100	3
Chejlava A	1,001	11.21	12	16	50	68	5							348	13	34	340	13	34	253	0	26	10	0	1
Chejlava B	1,414	15.21	6	5	136	22	10							490	5	35	478	4	34	304	2	21	6	83	0
Chejlava C	773	9.29	50	52										627	51	75	25	68	11	121	44	14			
Jizerskohorské A	1,312	4.29	8	37										262	37	20				1,023	0	79	27	15	1
Jizerskohorské B	215	1.44	5	19							20	20	9	33	18	15				158	0	74	4	0	2
Deblín A	157	0.52	5	7													15	7	10	73	7	47	69	3	43
Deblín B	249	0.83	13	8							111	8	45							29	16	12	109	18	43
Deblín C	378	1.26	6	21							53	21	14										325	4	86

Table 2 to be continued

	N_{all}	pcs/m²	PD_{all} (%)	$PD_{attrac.}$ (%)	*Fraxinus excelsior*			*Acer campestre*			*Sorbus aucuparia*			*Acer pseudoplatanus*			*Acer platanoides*			*Fagus sylvatica*			Other species*		
					N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)	N_{sp}	PD_{sp} (%)	D (%)
Deblín D	322	1.07	7	9							159	9	49										163	5	51
Deblín E	331	1.1	12	31							42	31	13							280	10	84	9	11	3
Sedloňovský vrch A	508	5.64	10	42							19	42	4							484	9	95	5	0	1
Sedloňovský vrch B	110	0.73	15	13							39	13	35							70	16	65	1	0	1
Trčkov	958	3.19	13	43							30	43	3							226	44	24	702	1	73
Černý Důl	778	5.19	10	29							17	29	2							755	10	97	6	0	1
Total	20,156				1,289			485			546			5,314			2,219			8,032			2,271		

*In case the abundance of 5 monitored species was lower than 10 pcs, they were included among other species

on the most frequent eudominant species, namely *Fagus sylvatica*, were also processed.

MATERIAL AND METHODS

Browsing damage was monitored on transects 3 m wide and 25 to 100 m long. The transect length was given by the local terrain and stand conditions, regeneration density etc. Transects were established in stands where the evidence of natural regeneration was already apparent. Browsing was evaluated in all species up to a height of 150 cm. Current damage was assessed, i.e. damage coming from the past winter and actual growing season. Trees with damaged terminal shoots or heavy damage to lateral shoots (more than 20% of shoots damaged) were evaluated as damaged. In 2005–2007, this monitoring was realized on more than 60 transects of 20 localities in the CR. Out of these plots, 34 transects at 15 localities were selected and the species mentioned above were included there. Basic characteristics of localities are given in Table 1. The plots characterize a wide range of natural conditions from the 2nd to the 6th forest vegetation zone. The following species occurred in advance growth: *Acer pseudoplatanus*, *Acer platanoides*, *Acer campestre*, *Fraxinus excelsior* and *Sorbus aucuparia* and most often just with *Fagus sylvatica* (see Table 2). Other species occurred in a small proportion < 10% (22 transects); in a part of the plots, there was a very broad spectrum of other species (6 transects) and in the remaining plots, *Picea abies* or *Abies alba* (5 transects) and *Tilia* spp. (1 transect) showed a significant proportion. As for ungulates, *Capreolus capreolus* occurred in all areas. At two localities, only this species, at 9 localities together with *Cervus elaphus*, at 3 localities with *Dama dama* and at 1 locality roe deer occurred together with both the species. Converted abundance of game (according to Decree No. 491/2002 Gaz.) ranged from 14 to 85 individuals/1,000 ha (see Table 1).

For each of 34 transects, the following parameters were determined:

- number of individuals of a species – N_{sp};
- number of individuals of attractive species (5 attractive species) – N_{attrac};
- number of individuals of all species – N_{all};
- number of damaged individuals of a species – N_{dam};
- number of damaged individuals of attractive species (5 attractive species) – $N_{dam\ attrac.}$;
- number of damaged individuals of all species – $N_{dam\ all}$;
- damage to a species in % – $PD_{sp} = (N_{dam}/N_{sp}) \times 100$;

- damage to food-attractive species in % – PD_{attrac} = $N_{dam\ attrac}/N_{attrac}) \times 100$;
- damage to all species in % – $PD_{all} = (N_{dam\ all}/N_{all}) \times 100$;
- dominance – $D = (N_{sp}/N_{all}) \times 100$;
- dominance of attractive species – $D_{attrac} = (N_{attrac}/N_{all}) \times 100$;
- a difference between damage to a species and damage to all species $DifPD = PD_{sp} – PD_{all}$;
- a difference between damage to attractive species and damage to all species $DifPD_{attrac} = PD_{attrac} – PD_{all}$;
- the proportion of damage to a species and damage to all species $RPD = PD_{sp}/PD_{all}$;
- the proportion of damage to attractive species and damage to all species $RPD_{attrac} = PD_{attrac}/PD_{all}$.

The data were processed using correlation and regression analysis. The calculation of correlation coefficients for linear correlations and testing their significance by Student's *t*-test was carried out in Excel as well as polynomial regression. Correlations were determined for the particular tree species and for three aggregate groups of species. The groups of species were as follows: *Fraxinus excelsior* + *Acer pseudoplatanus* + *Acer campestre*, the group of the previous 3 species + *Acer platanoides* (both combinations of species actually occurred in transects, see Table 2) and the group of all 5 food-attractive species.

RESULTS AND DISCUSSION

Food-attractive tree species

An overview of the results is given in Table 2, the results of correlation analysis and testing the significance of correlation coefficients are shown in Tables 3 and 4.

The percentage of individuals damaged by browsing (PD_{sp}) negatively correlated with the number of individuals of the given species in a transect (N_{sp}). A statistically significant correlation was found out in *Sorbus aucuparia* and in all groups of species (Table 3). Because the total abundance of species relatively markedly differed in the particular plots (minimum 107, maximum 2,719), it is not possible to consider the simple number of individuals as a utilizable indicator of the species rarity. Thus, the percentage of damaged individuals of a given species (PD_{sp}) also appears to be problematic for analyses.

Assessing the relationship between the intensity of damage and dominance, PD_{sp} was not (in our case) a suitable parameter representing the rate of searching a woody species by "browsers". Particular plots notably differed in their general damage. Damage to all species (PD_{all}) ranged from 4% (Sidonie) to 83% (Pálava B, C) (see Table 2). Thus, the same % damage to a monitored woody species is considered as high on one plot, and on the contrary, as small on the other plot. To assess the effect of the species proportion on damage we would have to have plots roughly of the same $PD_{all.}$ Since the rate of damage is not known in advance, it would take to work with selection which would have to be carried out from the enormous amount of plots. For these reasons, a statistically significant correlation was found out in our database only in *Sorbus aucuparia* (Table 3), which occurred in plots with PD_{all} in the rather narrow interval of 5–17% (Table 2).

Table 3. Correlation coefficients and their significance – food-attractive species

Tree species (group of species)	Number of transects (items)	Correlation coefficient – correlation of N_{sp} with PD_{sp}	Correlation coefficient *r* – correlation of D with		
			PD (% of damaged)	DifPD (differences PD_{sp} and PD_{all})	RPD (rate of PD_{sp} and PD_{all})
Acer pseudoplatanus	18	–0.403	–0.173	**–0.560** **	**–0.471***
Acer campestre	6	0.336	–0.428	–0.553	–0.393
Acer platanoides	10	–0.568	–0.129	**–0.652***	**–0.810******
Fraxinus excelsior	10	–0.591	–0.207	–0.595	–0.526
Sorbus aucuparia	10	**–0.691****	**–0.845******	**–0.895******	**–0.840******
A. pseudoplatanus + *F. excelsior* + *A. campestre*	34	**–0.494******	–0.253	**–0.551******	**–0.440******
A. pseudoplatanus + *F. excelsior* + *A. campestre* + *A. platanus*	44	**–0.504******	–0.193	**–0.493******	**–0.419******
All 5 attractive species together	54	**–0.375******	–0.147	**–0.582******	**–0.532******

*Coefficient is significant at α = 0.05, **coefficient is significant at α = 0.03, ***coefficient is significant at α = 0.02, ****coefficient is significant at α = 0.01

Table 4. Correlation coefficients and their significance – relationships between *Fagus sylvatica* and food-attractive species (24 transects)

Parameter	Correlation coefficient *r* – correlation of the parameter with	
	dominance of *F. sylvatica*	dominance of food-attractive species
PD of *Fagus sylvatica* (% of damaged)	–0.155	–0.069
DifPD of *Fagus sylvatica* (differences PD_{sp} and PD_{all})	–0.040	–0.360
RPD of *Fagus sylvatica* (rate of PD_{sp} and PD_{all})	–0.340	–0.015
PD_{attrac} (% of damaged)	0.184	–0.213
$DifPD_{attrac}$ (differences PD_{attrac} and PD_{all})	**0.533********	**–0.632********
RPD_{attrac} (rate of PD_{attrac} and PD_{all})	**0.585********	**–0.605********

*Coefficient is significant at α = 0.05, **coefficient is significant at α = 0.03, ***coefficient is significant at α = 0.02, ****coefficient is significant at α = 0.01

The difference between damage to a given tree species and damage to all tree species (DifPD) correlated negatively with the dominance of this tree species; the same relationship was detected for the proportion of damage (RPD) and dominance. Statistically significant correlations were determined for *Acer pseudoplatanus*, *Acer platanoides*, *Sorbus aucuparia* and for all groups of species (see Table 3). The same correlations with dominance (D_{attrac}) were also found out for the difference or proportion of damage to 5 attractive woody species and damage to all species ($DifPD_{attrac}$ and RPD_{attrac}) (see Table 4). Both parameters, i.e. the difference and the proportion, can be considered to be suitable to assess relationships between the tree species dominance and the intensity of its damage by browsing.

Thus, it is possible to note that the relative intensity of damage to food-attractive tree species increases with their decreasing relative proportion. Results of regression analysis (Fig. 1) show that the relationship is rather of polynomial than linear character. With respect to the character of both parameters it is evident that with increasing dominance the effect of a species on the total damage (PD_{all}) also increases. At high dominances, the difference and proportion of damage to a species and damage to all species approaches zero or is close to one.

Statistically significant correlations between dominance or otherwise expressed relative abundance of a species and the intensity of damage were found out in the natural regeneration of *Carpinus betulus* in the Moravian Karst (Čermák 1998) – a statistically significant negative correlation ($r = 0.702$, $α = 0.05$) between the percentage of damaged individuals and dominance. Padaiga (1986) found out the negative correlation between damage and dominance for *Pinus sylvestris* and *Populus tremula* in mixed stands of these two species in Lithuania. Danell et al. (1991) found higher browsing damage to *Pinus sylvestris* in mixed stands in Sweden as compared with pure stands or stands where *Pinus sylvestris* clearly dominated.

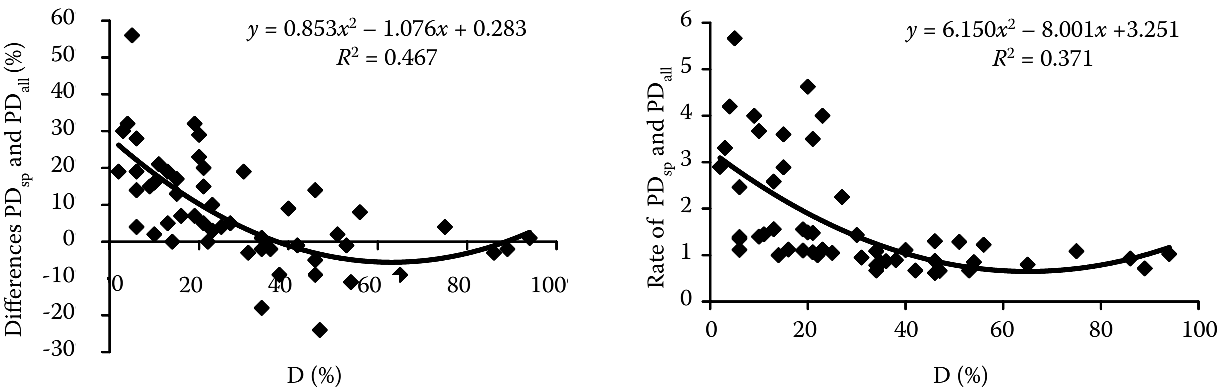

Fig. 1. Polynomial dominance of a species (D) with the difference in damage to a given tree species and damage to all species (DifPD) and the proportion of damage to a given species and damage to all species (RPD)

Greater damage to species occurring in lower proportion was also noted by PAULENKA (1986), HORVAT (1990), AMMER (1996), PRŮŠA (2001), SENN and SUTER (2003) or STERGAR (2005). However, these were more or less partial studies and the relationship between the species proportion and damage was not tested in detail.

MORAVČÍK (1997) demonstrated an opposite relationship, i.e. positive correlation between the species proportion and the rate of damage, on data from an extensive inventory carried out by IFER (Institute for Forest Ecosystem Research) and IFMP (Institute for Forest Management Planning) in 1995. The occurrence of browsing damage slightly increased with the higher proportion of conifers on an area of 4 km^2, i.e. in the vicinity of the stand. This dependence was most evident in plantations of *Picea abies* where it reached statistical significance.

Fagus sylvatica in relation to food-attractive tree species

No statistically significant relationship was found out between the dominance of *Fagus sylvatica* (D) and its damage expressed anywise (PD, DifPD, RPD) (see Table 4). Likewise, no significant relationship was found between the dominance of food-attractive woody species (D_{attrac}) and damage to *Fagus sylvatica* (PD, DifPD, RPD).

In *Fagus sylvatica*, a negative correlation was detected between dominance and the percentage of damaged individuals in the Moravian Karst in 1996 (ČERMÁK 1998). These were relatively young stands, and in subsequent years of monitoring carried out on the same plots the correlation was found no longer. The situation was explained by changes in the density of advance regeneration and by its effect on the intensity and character of damage. In the course of growing up, beech created fast-growing clusters of individuals. Thus, these clusters in principle impassable were damaged minimally regardless of the proportion of beech. Dense clumps were damaged only along their periphery, namely in winter. The relationship between the natural seeding density and damage to trees is commented in literature inconsistently. In some cases, trees were damaged to a larger extent in dense natural seeding (FINĎO 1985), in other cases, by contrast, particularly in less dense natural seeding (CUMMINS, MILLER 1982). The effects of advance growth density are also possible in the case of this paper with respect to differences on particular plots (see Table 2). Nevertheless, the character of the database does not make it possible to check the data.

A statistically significant positive correlation was found between the dominance of *Fagus sylvatica* and damage to attractive tree species expressed as a difference or proportion with damage to all species ($DifPD_{attrac}$, RPD_{attrac}) (see Table 4). The higher the percentage proportions of *Fagus sylvatica*, the higher the relative intensity of damage to monitored food-attractive species. This relation is a logical complement to correlations commented in the previous subchapter.

A relationship between the relative proportions of differently food-attractive woody species and their damage by browsing was documented by EIBERLE and BUCHER (1989) from the Bern canton. On 199 plots in silver fir/beech stands, the authors monitored browsing damage by roe deer to the advance growth of *Fagus sylvatica*, *Acer pseudoplatanus*, *Fraxinus excelsior*, *Sorbus aucuparia*, *Abies alba* and *Picea abies*. In line with our data, they found that the higher proportion of *Acer pseudoplatanus*, *Fraxinus excelsior* and *Sorbus aucuparia* decreased damage to *Fagus sylvatica* and *Picea abies* as well as to *Abies alba*. In addition, they reported that at the high abundance of *Fagus sylvatica* and *Picea abies* in advance growth, damage to *Abies alba* increased and, *vice versa*, the high proportion of *Abies alba* contributed to higher damage to *Fagus sylvatica* and *Picea abies*.

CONCLUSIONS

The analysis of data of browsing damage monitoring demonstrated that the intensity of damage to food-attractive woody species increased with their decreasing relative proportion and increasing proportion of *Fagus sylvatica* in advance regeneration. Thus, with a reduction in the abundance of these species due to browsing a pressure on their populations increases, which can result in the acceleration of their selection and the subsequent impoverishment of the tree species composition. The disappearance of minority species from the stand species composition has been repeatedly proved.

To analyze the intensity of damage to trees, damage to the given tree species related to the total damage to trees (viz. a difference or the % proportion of damaged individuals of the given species and % of damaged individuals of all species) appeared to be most suitable.

References

AMMER CH., 1990. Auswirkungen des Bestockungswandels und der Waldschaden auf die Schutzfunktion des Bergwaldes gegenüber Schneebewegungen. In SCHUSTER E.J. (ed.), Zustand und Gefahrdung des Bergwaldes: Ergebnisse eines Rundgespräches 21. April 1989. Hamburg, Verlag Paul Parey: 102–111.

AMMER CH., 1996. Impact of ungulates on structure and dynamics of natural regeneration of mixed mountain forests in the Bavarian Alps. Forest Ecology and Management, *88*: 45–53.

BURSCHEL P., BINDER F., EL KATEB H., MOSANDL R., 1990. Erkenntnisse zur Walderneuerung in der Bayerischen Alpen. In SCHUSTER E.J. (ed.), Zustand und Gefahrdung des Bergwaldes: Ergebnisse eines Rundgespräches 21. April 1989. Hamburg, Verlag Paul Parey: 40–49.

CUMMINS R.P., MILLER G.R., 1982. Damage by red deer (*Cervus elaphus*) enclosed inplanted woodland. Scottish Forestry, *36*: 1–8.

ČERMÁK P., 1998. Vliv sudokopytníků na lesní ekosystémy Moravy. Lesnictví-Forestry, *44*: 278–287.

ČERMÁK P., MRKVA R., 2003. Browsing damage to broadleaves in some national nature reserves in 2000–2001. Ekológia (Bratislava), *22:* 394–403.

DANELL K., EDENIUS L., LUNDBERG P., 1991. Herbivory and tree stand composition: moose patch use in winter. Ecology, *72*: 1350–1357.

DANELL K., NIEMELA P., VARVIKKO T., 1991. Moose browsing on Scots pine along a gradient of plant productivity. Ecology, *72*: 1624–1633.

EIBERLE K., 1978. Folgewirkungen eines simulierten Wildverbisses auf die Entwicklung junger Waldbäume. Schweizerische Zeitschrift für Forstwesen, *129*: 757–768.

EIBERLE K., 1980. Methodische Möglichkeiten zum Verständnis der waldbaulich tragbaren Verbissbelastung. Schweizerische Zeitschrift für Forstwesen, *131*: 311–326.

EIBERLE K., BUCHER H., 1989. Interdependenzen zwischen dem Verbiss verschiedener Baumarten in einem Plenterwaldgebiet. Zeitschrift für Jagdwissenschaft, *35*: 235–244.

FINĎO S., 1985. Ohrozenie mladých lesných porastov odhryzom spôsobovaným jeleňou zverou v Chránenej poľovnej oblasti Poľana. Folia Venatoria, *15*: 33–55.

FINĎO S., 1992. Tolerancia drevín na poškodzovanie odhryzom. Lesnictví-Forestry, *38*: 379–390.

HORVAT T., 1990. Prehranska ekologia rastlinojede divjadi kot element sanacije razpadajočich jelovo-bukovih gozdov v spodnjem montanskem pasu. [Diplomsko delo.] Univerza v Ljubljani, Biotehniška fakulteta: 80.

MORAVČÍK P, 1997. Faktory ovlivňující rozsah poškození lesních porostů zvěří. Sborník ze semináře Nové metody pro hodnocení vlivu zvěře na les, část 5. Jílové u Prahy, IFER: 1–31.

MOTTA R., 1996. Impact of wild ungulates on forest regeneration and tree composition of mountain forests in the western Italian Alps. Forest Ecology and Management, *88*: 93–98.

MOTTA R., 2003. Ungulate impact on rowan (*Sorbus aucuparia* L.) and Norway spruce (*Picea abies* (L.) Karst.) height structure in mountain forests in the eastern Italian Alps. Forest Ecology and Management, *181*: 139–150.

PADAIGA V., 1986. Measures for protecting forest stands from elk damage. Metsanduslikud Uurimused, *21*: 26–37.

PAULENKA J., 1986. Vplyv poľovnej zveri na odolnostný potenciál mladých lesných porastov. Folia Venatoria, *16*: 31–50.

PERKO F., 1979. Odnosi med rastlinstvom in rastlinojedo divjadjo v ekosistemih Snežnižkich gozdov. Pregled gojitve in odstrela jelenjadi v lovskem letu 1978. Notranjsko lovskogojitvenih območij (LGO), Sneznik: 28–38.

PRŮŠA E., 2001. Pěstování lesa na typologických základech. Kostelec nad Černými lesy, Lesnická práce: 593.

SENN J., SUTER W., 2003. Ungulate browsing on silver fir (*Abies alba*) in the Swiss Alps: belief in search of supporting data. Forest Ecology and Management, *95*: 151–164.

STERGAR M., 2005. Objedenost mladja drevesnih vrst v odvisnosti od zgradbe sestoja. [Diplomsko delo.] Univerza v Ljubljani, Biotehniška fakulteta: 70.

STROLE T.A., ANDERSON R.C., 1999. White-tailed deer browsing: species preferences and implications for central Illinois forests. NCASI Technical Bulletin, *781*: 520–521.

SVOBODA M., NAGEL T., HAHN K., NIELSEN A.B., ROŽENBERGAR D., DIACI J., 2005. Co nevíme o ekologii jedle bělokoré. In: NEUHÖFEROVÁ P. (ed.), Jedle bělokorá – 2005. Sborník referátů, 31. 10–1. 11. 2005 Srní. Praha, ČZU v Praze, FLE, katedra pěstování lesů a Správa Národního parku a chráněné krajinné oblasti Šumava: 9–11.

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Vztah mezi poškozením okusem a dominancí dřevin

ABSTRAKT: Práce analyzuje data o okusovém poškození potravně atraktivních dřevin *Acer campestre, Acer pseudoplatanus, Acer platanoides, Fraxinus excelsior*, *Sorbus aucuparia* a nejčastěji eudominantní dřeviny *Fagus sylvatica*. Terénní průzkum probíhal v letech 2005–2007, analyzovaná data jsou z 34 transektů na 15 lokalitách ČR s různou početností zvěře (*Capreolus capreolus*, na některých plochách také *Cervus elaphus* či *Dama dama*). Monitorovali jsme dřeviny do výšky 150 cm v přirozené obnově pod porostem, byla sledována prezence nového poškození okusem. Rozdíl mezi procentem poškozených jedinců daného druhu potravně atraktivní dřeviny a procentem poškozených jedinců všech druhů dřevin na transektu a stejně tak podíl těchto parametrů významně negativně korelují s dominancí daného druhu dřeviny a jeví se jako vhodné parametry pro analýzu vztahu intenzity poškození a dominance. Zároveň platí, že čím vyšší je zastoupení *Fagus sylvatica*, tím vyšší je relativní intenzita poškození sledovaných atraktivních dřevin.

Klíčová slova: okus; dominance; *Acer*; *Fraxinus excelsior*; *Sorbus aucuparia*; *Fagus sylvatica*

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