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DIET PREFERENCE OF EURASIAN BEAVER (*CASTOR FIBER* L., 1758) IN THE ENVIRONMENT OF ODERSKÉ VRCHY AND ITS INFLUENCE ON THE TREE SPECIES COMPOSITION OF RIVER BANK STANDS

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Abstract

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This paper deals with the dietary behaviour and the tree species preference in the river bank stands in the diet of established population Eurasian Beaver (*Castor fiber* L., 1758) in the environment of Oderské vrchy; the objective is to assess the suitability of this environment for future development of the Eurasian Beaver and to asses the influence of the beaver's dietary behaviour on the river bank stands. In the monitored area, the total of 5 tree species with the following preference were recorded: willow (*Salix*) 42.2%, aspen (*Populus*) 28%, dogwood (*Comus*) 15.5%, birch (*Betula*) 7.4% and alder (*Alnus*) 6.9%. The most damaged diameter interval recorded within the all damaged tree species ranges from 2.6 to 6 cm, followed by the interval 6.1–12 cm. Over 61% of the trees felled by the beaver had a bigger diameter. The most sensitive reaction to beaver's dietary behaviour was shown by aspen (reduction of numbers by 27.6%) and by willow (reduction of numbers by 16.6%) on the monitored area.

Eurasian Beaver *Castor fiber*, dietary behaviour, tree species preference

In the Czech Republic, the Eurasian Beaver (*Castor fiber* L., 1758) is an endemic species that was extinct due to commercial exploitation and significant damage inflicted to the forest stands in the 18th and 19th century (Andreska and Andresková, 1993). In the 20th century, due to reintroduction programmes in certain Central European countries and due to natural migration, beavers began to appear permanently in the Czech Republic; in 1967, in the Elbe River, since 1979 in the Moravia River, since 1988 beavers are permanent in the Kyjovka River in Hodonín region and in the Dyje River near Lednice na Moravě (Zajíček, 1992), since 1993 in the South and West Bohemia and since 1996 in the Jihlava River near Pohořelice (Vorel, 2005; Anděra and Horáček, 1982). In the Litovelské Pomoraví Protected Area, beavers are present since the reintroduction in 1991 (Kostkan, 2000). The original strong increase of numbers of sites with beaver's presence shows a steadying tendency and instead of the beavers spreading around their presence changes from temporary to permanent (Anděra and Červený, 2004).

Eurasian Beaver is a strongly territorial species (Wilsson, 1971; Broschart, 1989), closely fixated to water, mainly to sites with slow currents or still waters with stagnant water level as much as possible and with the depth minimum of 1–1.5 m (Vorel, 2005). Beavers can live in a wide range of habitats, starting from big rives to small currents in the foothills; their presence is also significant and interesting in agricultural and ameliorated areas (Heidecke, 1989). The territory size or the length of the inhabited river banks depends on the water system (Novak, 1987) and the habitat (Kostkan, 2000). The presence of continuous alluvial softwood

forest, mainly the presence of species such as poplar (*Populus* sp.), willow (*Salix* sp.), alder (*Alnus* sp., etc.), which form the majority of beaver's diet (Ficek, 2003; Kostkan, 2000), plays an essential role when selecting the site. Along with the composition of the river bank stands, the size and density of additional reforestation is according to Heidecke (1989) also significant.

As for dietary needs, beavers are pure herbivores (Kostkan, 2000). There have been described 86 tree species and 149 herbs consumed by beavers (Heidecke, 1984, 1989; Dzieciolowski, 1996). During the vegetation season, mainly water plants and plants growing on the river banks or farm crops such as blackberry bush (*Rubus* sp.), water-lily (*Nuphar* sp.), willow herb (*Epilobium* sp.), sorrel (*Rumex* sp.), but also mais (*Zae mays*) and others (Nolet *et al*., 1994; Hill and Novakowski, 1984; Novak, 1987) are consumed. The share of tree species represented in the diet increases at the end of the vegetation season when beavers generates reserves for winter. This need results in intake of the following genera: *Populus* spp. and *Salix* spp. (Kostkan, 2000; Ficek, 2003; Nolet *et al*., 1994; Danilov and Kanshiev, 1983; Krojerová, J. *et al*., 2010). In case of lack of presence of those species, beavers consume also the following genera: *Betula* spp., *Acer* spp., and the species: *Tillia cordata, Corylus avellana* and also *Quercus robur* (Doucet and Ball, 1994; Doucet *et al*., 1996).

Eurasian Beavers, as herbivores, play a fixed role in the ecosystem and in the material and energy cycling. Beavers' adaptations and active qualitative and quantitative change of the parameters of their habitat create a whole variety of inter-species dependencies in the ecosystem. Some interactions with other environmental components belong to the strongest influence of mammals on the ecosystem and the landscape (Kostkan, 2000). Many of the studies above focusing on dietary ecology of Eurasian Beaver show its significant influence on the plant communities, where beavers are present.

In the river and lake bank stands, beavers fell trees and change the stand composition in the zone close to the water. In the areas used extensively by beavers, forests temporarily disappear and the areas provide a chance for non-forest flora and fauna (Valachovi and Gímeš, 2003). The beaver dames retain water and slow down the current; during the flood, the dames cause the flood wave to drop and the water is dispersed into the system (Dziciolowski, 1996; Zavyalov, 2002). Retained water then increases the biodiversity of the created marshlands (Hagglund and Sjoberg, 1999).

The tree species preference in the Eurasian Beavers' diet becomes an often discussed topic, mainly in relation to the damage inflicted to commercially significant tree species and to bank river stands. The objective of the submitted study is the analysis of the dietary preference of Eurasian Beaver and the assessment of its influence on the composition of the bank river stands on the permanently inhabited sites in Oderské vrchy; this study should be also one of the underlying documents for the long-term prospective of its existence in this area.

MATERIAL AND METHODS

The monitoring was carried out in the south-eastern part of Nízký Jeseník on the plateau of the Oderské Vrchy. Oderské Vrchy is a cold region, average temperature amounts to approx. –4 °C in winter and to 15.5 °C in summer. The geology structure is composed by conglomerates, loess and gravel sand. Oderské vrchy are mainly part of the natural forest zone No. 29 – Nízký Jeseník. Due to the average altitude (approx. 650 m.a.s.l.), the main forest vegetation zone is the beech and fir-beech zone. The original mixed and broad-leaved forests were transformed into spruce monocultures in the past; the percentage of these single-species stands amounts up to 90% on the plateau presently. The Oderské Vrchy region is part of the basins of the following rivers: the Odra River, Bečva River and Morava River. The hills of Oderské Vrchy are covered by mixed forests and the unregulated stream of the Odra River is lined with floodplain forests.

2 sites with the same conditions and with identical initial stand composition in the alluvium of the Plazský potok stream were selected in order to assess the tree species preference within the beaver's diet and the influence of beaver's dietary behaviour on the species composition on the river banks. On the site No. 1 (Plazský) the presence of Eurasian Beaver dates back to the year 1997 and the occurrence marks prove that beavers are present on this site permanently. On the site No. 2 (Check) the presence of beavers has never been recorded. On both river banks, both sites were divided into three zones according to the distance from the bank (zone I = 0–50 m, zone II = 51–100 m, zone III = 101–150 m). In those three zones, 10 same-sized areas were selected and then 120 sampling plots sized 25 × 25 m were selected within those areas.

On the site No. 1, the activity of the beaver population was monitored from fall 2007 to spring 2010. Records were kept about the tree species consumed; records about the tree diameters and the type of beaver's dietary activity (perfect or imperfect felling) were kept regularly from October to April.

In 2010, all present tree species and their diameter average were listed once.

The CANOCO 4. – the geobiocenology statistical software – and Monte-Carlo permutation test were used to assess the collected data. The data were then tested by the Principal components analysis (PCA) for the overall variability of sampling plots in individual zones.

RESULTS AND DISCUSSION

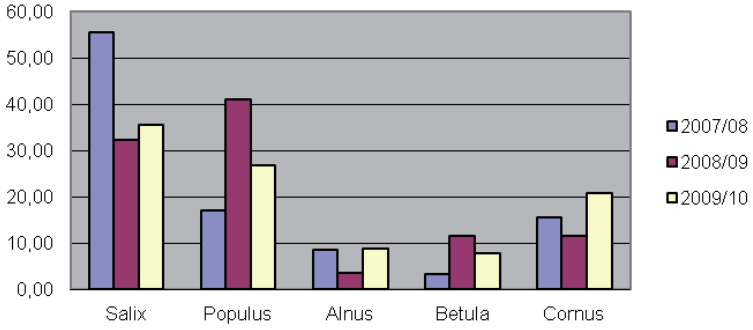
Based on the three-year monitoring and the data assessment, it was found that willow (*Salix*) with its

share amounting to 42.2%, aspen (*Populus*) with its share amounting to 28%, dogwood (*Cornus*) with its share amounting to 15.5%, birch (*Betula*) with its share amounting to 7.4% and alder (*Alnus*) with its share amounting to 6.9% are the most consumed i.e. damaged tree species by the beaver. The share of individual tree species in beaver's diet showed year-on-year changes (Fig. 1). Whereas in the first year of the monitoring (2007/08), willow (*Salix*) with its share amounting to 55.5% was the dominant species, in the second year the species with the highest share was the aspen (*Populus*) with its share amounting to 41%. In the third year of the beaver monitoring, the willow (356%) was again the most dominant species in beaver's diet, however, contrary to the first year of the monitoring, a significant part of the diet was also the aspen (26.7%) and dogwood (20.8%). The qualitative same result of the year-on-year change of tree species preference was established also by Havránek *et al.* (2010).

The found results of the monitoring correspond partly with the data published by several authors. From the total of 27 tree species that were recorded to be consumed by beavers in the Czech Republic (Vorel, 2005), e.g. the Czech authors such as Ficek (2003) and John (2001) and the authors as Belowski (1984) and Fustec *et al.* (2001) proved a strong preference of poplar and willow. Also Brenner (1962) and Derwich (2001) list poplar as the beaver's most preferred species. On contrary, Friček (2006) found out that the beaver's diet consisted by 40% of ash and by 32% of willow. Other papers (Rosell *et al.*, 2005) list the alder and sorbus as the most damaged species with the willow ranking the third most preferred species. Along with the preferred species, the authors also report the felling of other trees species such as birch and alder, which are used as building material (Janýšková, 1997), and such as ash (*Fraxinus* spp.) or elm (*Ulmus s*pp.) (Urban *et al.*, 2008). The theories about the tree species preference focus mainly on the reasons for selecting the damaged tree species. Fryxell *et al.* (1994) describes that aspen is digested by the beaver faster than other tree species and that the daily consumption of the individual species is in the inverse proportion with the digestibility of that respective species. Another research (Nolet *et al.*, 1994; Dzieciolowski, 1996) discusses the hypothesis that the willow preference is based on the low resin and essence oil content, which beavers try to avoid. The reasons for the difference in the tree species preference can be accounted to the different share of the individual tree species within the river bank stands, i.e. the spectrum of felled tree species corresponds with the offer of the respective environment. An objective assessment of the tree species preference on the marked sampling plots requires also the list of the tree species composition of the river bank stands (Kostkan, 2000; Tučková, 2001).

As for the preference of average diameter of the damaged tree species, species with the diameter under 20 cm (78%) prevailed in the beaver's diet; the diameter of the most damaged tree species ranged from 2.6 to 6 cm, the second most preferred diameter interval ranged from 6.1 to 12 cm, and the third most preferred range included trees with diameter below 2.5 cm. Another significant group consisted of tree species with the diameter ranging from 12.1 to 20 cm (Tab. I). The monitoring showed no year-on-year changes in the average diameter of the damaged tree species.

The data found in the literature regarding the diameter intervals vary heavily. Aldous (1983) states that the most preferred diameter ranges from 8 to 15 cm. Henry and Bookhout (1970) state that the diameter of 90% of the tree species felled by beavers is under 8 cm; similarly results were reported by Sieber (2002). In his study from Norway, Rosell *et al.* (2005) reports the most preferred group of tree species with the diameter ranging from 1 to 5 cm whereas Heidecke (1989) ranging from 5 to 15 cm. According to the result published by Kostkan (2000), the diameter of the most consumed tree species ranges from 5 to 20 cm; similar results were reported by Žatka (2006) who found the highest percentage (94%) of damaged trees with the diameter under 12 cm. Our results correspond with those reported (Ficek, 2003; Friček, 2006); we found out that the diameter of the most preferred tree species is below 6 cm (measured at the tree stump). Based on the results and the literature above, one can assume that the preference of individual diameter intervals is given by the age and the tree species composition of the available stand. Some tree species, e.g. aspen,



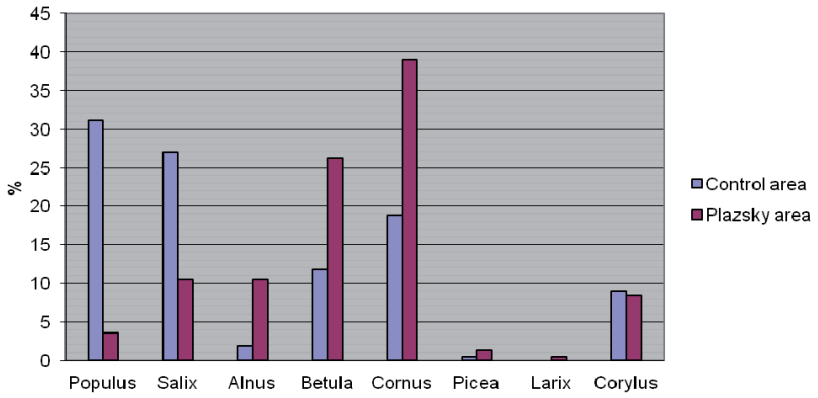
1: *Seasonal share of tree species in beaver's diet (%)*

I: *Beaver's preference of diameters of damaged tree species*

Diameter interval of tree species	Damage of tree species			
	Total pcs	%	Perfect felling pcs	Imperfect felling pcs
under 2.5 cm	70	17.81	61	9
2.6–6 cm	136	34.61	115	21
6.1–12 cm	106	26.97	85	21
12.1–20 cm	47	11.96	24	23
20.1–30cm	22	5.60	11	11
30.1–40 cm	11	2.80	7	4
40.1–50 cm	1	0.25	1	
over 50 cm	0	0		
Total	393	100.00	304	89

II: *Statistical data evaluation (with Monte Carlo permutation test)*

Zone	Environmental variable	F ratio	% of explained variable	p
I: 0–50 m	Check/Plazsky plot	3.27	7.9	0.012
II: 51–100 m	Check/Plazsky plot	0.52	1.4	0.788
III: 101–150 m	Check/Plazsky plot	0.3	0.8	1



2: *Percentage of tress species on monitored plots in the zone under 50 m*

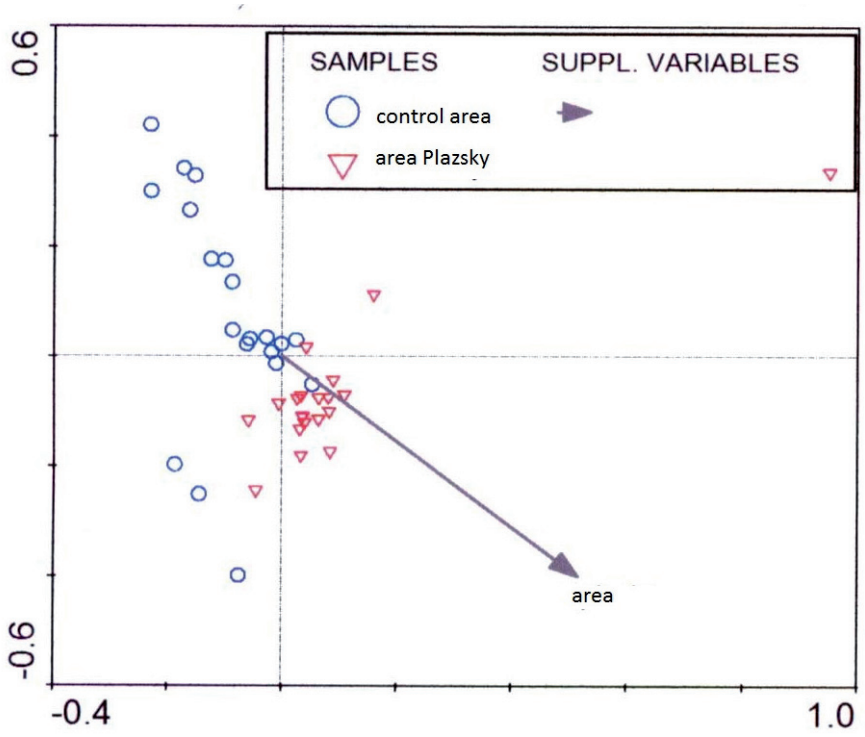
are preferred for its high attractiveness also when being large in diameter.

The influence of the dietary behaviour of Eurasian Beaver on the tree species composition of the river bank stands was tested based on the found difference of tree species composition between the sampling plots on both sites (Check vs. Plazský) in three zones according to the distance from the river bank (Fig. 2). Statistically significant difference was found in zone I (under 50 m from the river bank). The assessment of data collected in zones II and III showed no statistically significant difference (Tab. I).

Then the overall variability of the sampling plots in the individual zones I, II and III was evaluated using the principal components analysis (Fig. 3). This test also proved the statistically significant difference in the zone under 50 m from the river bank.

The results of performed analysis confirm that the dietary activity significantly reduces the occurrence of poplar (decrease by 27.6%) and willow (decrease by 16.6%) in the zone I (under 50 m from the river bank). The percentage of alder and birch increased taking up the share of poplar and willow, i.e. increase of the less preferred species by beavers; the percentage of dogwood increased too, i.e. a species that scored the third most preferred tree species on the Plazský site.

Our results about the significant influence on the tree species within 50 m from the river bank correspond to a certain extent with the findings of Nietsche (2003), who proposes to create a 10-meter buffer zone along the river in order to reduce the damage inflicted by beavers; Stadler (1996) proposes a 20-meter buffer zone. Similarly Sieber (2002) found 90% of damaged trees within 20 m from the river bank. Havránek (2010) concludes in his results that beavers use the forest stands located within the distance of 25 m from the river bank. Whereas Friček (2006) or Dzieciolowski (1996) conclude that the beaver's influence on alluvial river bank stands demonstrates itself in repeated regeneration and not in destruction of the stands, this paper proves the influence on the species composition in forest



3: *Results of the overall variability of the sampling plots in the individual zones (principal components analysis)*

stands located within 50 m from the river bank – similar conclusions were made by Žatka (2006) or Novak (1987). This significant difference of the acquired results and literature can be credited to the short monitoring of the dietary behaviour of Eurasian Beaver on the site (three-year cycle) i.e. a period during which the regeneration potential of the damaged tree species cannot fully develop.

SUMMARY

The tree species preference of Eurasian Beaver is an often discussed topic, mainly in relation with the damage inflicted both to the commercial tree species and to the river bank stands. The objective of this study is to analyse the dietary preference of Eurasian Beaver on the permanently inhabited areas of Oderské Vrchy as the underlying information for long-term prospective of beaver's existence in this area. The monitoring and data collection took place during the seasons from 2007 to 2010. Overall, the intensive consumption of 5 species in the interest area was recorded with the following ranking: willow (*Salix*) 42.2%, aspen (*Populus*) 28%, dogwood (*Cornus*) 15.5%, birch (*Betula*) 7.4% and alder (*Alnus*) 6.9%. The most preferred diameter interval of the damaged tree species ranged from 2.6 to 6 cm and the second most preferred interval then from 6.1 to 12 cm. More than 61% of all trees felled by beavers were recorded within those diameter intervals. A significant influence of beaver's activity on the tree species composition of the river bank stands was recorded, mainly within 50 m from the river bank. On the monitored sites, the most sensitive reaction to beaver's dietary behaviour was shown by aspen (*Populus*), where the reduction in numbers was recorded to amount to 27.6%, and by willow (*Salix*), with the reduction in numbers amounting to 16.6%.

Detailed knowledge about dietary behaviour of Eurasian Beaver – on already inhabited sites or on new sites being inhabited – is the underlying information for defining the management of this protected species; its numbers have been increasing recently which has resulted in extensive damage inflicted both to river bank and commercial stands. This again leads to several conflicts between nature conservation and land owners.

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