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# The roe deer diet: Is floodplain forest optimal habitat?

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A b s t r a c t . Roe deer diet was studied in the floodplain forest of South Moravia, Czech Republic, by analysis of faecal samples collected in six different parts of the study area. Woody plants were the main component of roe deer diet, and they were supplemented with bramble, forbs and grasses through the year. The composition of roe deer diet agreed with its foraging strategy and consisted mainly of browse. Floodplain forest is optimal for roe deer and offers sufficient food sources. Food sources from nearby fields have no influence on the diet of roe deer. The great potential of roe deer to influence the shrub layer is evident. The intensity of impact of roe deer was not affected by availability of other food sources in the floodplain forest. The impact of roe deer on woody plants in this habitat depended mainly on its population density. Therefore, protection and management of floodplain forest is related to the regulation of densities of ungulate species, and not on additional feeding.

**Key words:** *Capreolus capreolus*, forest habitat, Czech Republic

## Introduction

Roe deer (*Capreolus capreolus*), as well as other deer species, is an important species influencing forest vegetation (P u t m a n 1994, G i l l 2000, G i l l & B e a r d a l l 2001). Its impact on plant communities is important to humans both because of nature protection (browsing can initiate changes in plant diversity), as well as in economical impacts. The renewal and protection of forest stands with high browsing pressure is very expensive. Therefore analyses of diet of roe deer and other species of deer in different habitat types can be useful for forest management planning, optimal forest growth and conservation strategy.

Floodplain forest is a specific biotope (low snow cover, long growing season) which, in comparison to habitats, e. g. secondary spruce stands, offers ungulates a wide variety of food. This could be a reason for lower browsing pressure in floodplain forests. A sufficient amount of high quality alternative food sources results in avoidance of woody plants by roe deer in winter (H o m o l k a & H e r o l d o v á 2003). Therefore, sufficient amounts of preferred food may decrease browsing intensity of the shrub layer and plantations. All the ungulate species in the study area also have access to food available in nearby fields, and they are also provided with additional feeding from October until March consisting of grains (barley, oat; approximatly 0.3 kg / roe deer individual), maize, apples and beet. This additional food influences the extent of winter browsing of woody plants.

Roe deer feeding ecology has been studied in various habitat types. Broadleaved trees were an important component of roe deer diet in mixed forest of Drahanská Vrchovin Uplands (H o m o l k a 1993) and also in Białowieża Primeval Forest (G e b z y n s k a 1980).

Bramble was an important component of roe deer diet in broadleaved forest (M a i z e r e t et al. 1989) and in mixed forest stands in Beskydy Mountains (H o m o l k a & H e r o l d o v á 2003). The feeding ecology of roe deer in agricultural landscape was studied by H o l i š o v á (H o l i š o v á et al. 1982, 1984, 1986a, b). There has been no study of the feeding ecology of roe deer in floodplain forest.

The main aim of this study was to assess the role of roe deer in a floodplain forest ecosystem, in relation to its potential impact on the shrub layer. We tested the following hypotheses:

– due to the limited movements of roe deer its diet is different in each subplot of the study area and is related to food supply;
– roe deer diet consists of woody plants and components of the herbaceous layer. Roe deer supplement their diet with grains and fruits in summer;
– artificial feeding has an important role in the winter diet of roe deer.

## Study Area

The study was carried out from 2001 to 2004 in floodplain forest on the bank of Morava River between villages Mikulčice and Tvrdonice (Czech Republic) (200–220 m above sea level). The study area (1 041 ha) was part of a larger forest complex, which forms a strip, one to three km wide and about 20 km long, along the Morava River (Fig. 1). It is a managed forest,

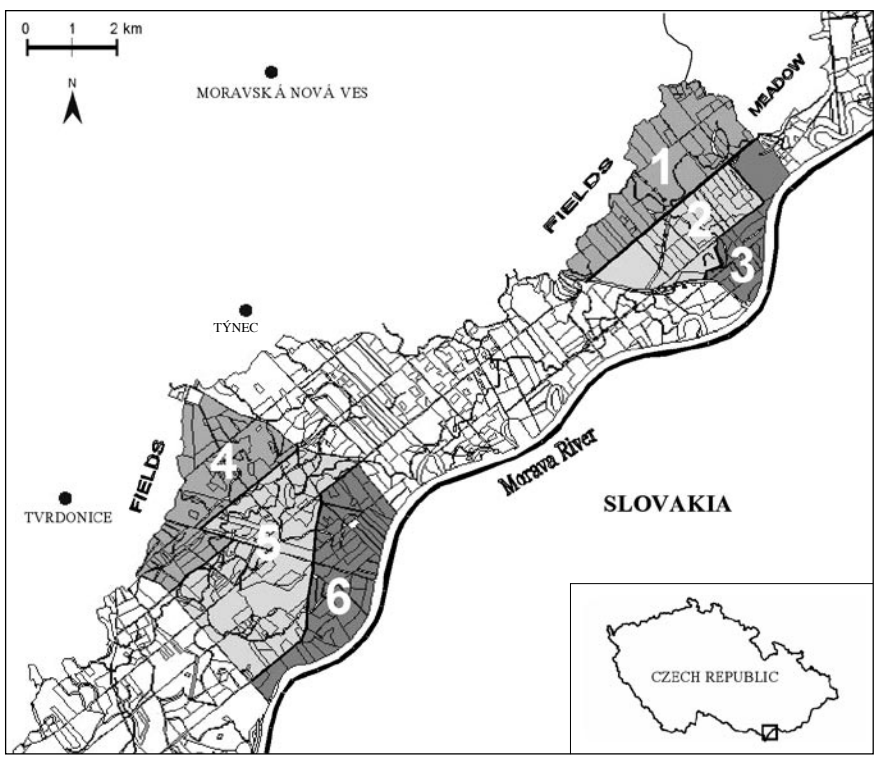


**Fig. 1.** Map of the studied forest with two subareas and six subplots (GIS map provided by The Forests of the Czech Republic, Forest Enterprise).

with mature tree harvesting, especially of oak and ash. Cut-over areas are then planted with harvested tree species.

Revitalization during 1996–1999 renewed and widened water canals (V a š í č e k 2000) and enabled repeated flooding of parts of the forest (F o r e j t e k 2000).

Forest stands of the study area consist of *Quercetum* and *Fraxineto-quercetum*, with dominating tree genera *Quercus*, *Fraxinus* and *Acer*. Vegetation mapping of the shrub layer revealed 19 species of woody plants. Dominant components of the forb layer were *Rubus* spp., *Galium* spp., *Urtica* sp, species belonging to families Lamiaceae, Asteraceae, Poaceae, Cyperaceae, and an invasive species *Aster novii-belgii*. The eastern part of the study area borders on meadows on the bank of the Morava River. Meadows also partly line the western part, and can be found inside the studied forest. The western part of the study area is bordered mostly by fields.

The whole study area was divided into a northern and a southern subarea and each of these into three subplots – eastern (along the Morava River, meadows), central (central part of the forest) and western (by the fields) (Fig. 1). This allowed comparison of roe deer diet composition in six parts of study area and assessment of the influence of fields and meadows on diet.

Ungulates in the study area were represented by three species: roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*). Diet composition of red deer and its food competition with roe deer was studied simultaneously with the present study (P r o k e š o v á 2004).

## Material and Methods

Faecal samples were collected from all parts of the study area each month from November 2001 to October 2002. Five samples from each part of the study area were taken each month. In total, 296 faecal samples were collected.

The composition of roe deer diet was studied using microscopic analyses. Part of each pellet was homogenized in water, washed and put into a drop of glycerin on a microscope slide. Each sample was then analyzed at 50 to 100 magnifications. The surface of the cover slide (18 x 18 mm) was taken as 100%, so that each visual field was approximately 2% of the observed area. 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. Analyses revealed 19 different food components, subsequently divided in 7 main groups: *Rubus* spp., Poaceae, broadleaved woods, forbs, grains, fruits and unidentified.

Arc-sin transformation of data from food analyses was used to improve their homogeneity (S o k a l & R o h l f 1981). One-way ANOVA (Bonferroni Post-Hoc Test, STATISTICA 6.0) was used to assess possible differences in diet composition between the six subplots of the study area. The frequency volume $\%f = 100 \times f / \Sigma f$, was calculated according to O b r t e l & H o l i š o v á (1974). The values of trophic diversity were calculated using Shannon-Weaver formula $H' = - \Sigma p_i \times \ln (p_i)$. Index of equitability (J') was calculated using the value of diversity (H').

## Results

The analysis of roe deer diet did not confirm the hypothesis that food composition is different in each subplot of the study area during individual periods of the year (One-Way ANOVA, $p > 0.05$). The composition of the diet did not differ between individual subplots of the study

**Table 1.** Percentage volume (%v) and relative frequency (%f) of roe deer diet components through the year and diet diversity (H') and equitability (J') (BLT - broadleaved trees).

| | XII. - I. | | II. - III. | | IV. - V. | | VI. - VII. | | VIII. - IX. | | X. - XI. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **%v** | **%f** | **%v** | **%f** | **%v** | **%f** | **%v** | **%f** | **%v** | **%f** | **%v** | **%f** |
| *Rubus* spp. | 23.48 | 18.07 | 41.07 | 18.68 | 45.94 | 17.36 | 42.15 | 19.83 | 32.62 | 21.48 | 32.38 | 20.65 |
| Poaceae | 0.88 | 13.08 | 4.34 | 13.23 | 5.26 | 14.05 | 5.15 | 14.77 | 3.05 | 15.56 | 4.59 | 18.71 |
| Asteraceae | 13.55 | 11.84 | 0.66 | 15.56 | 1.93 | 9.92 | + | 2.11 | 0.03 | 3.33 | 0.54 | 6.45 |
| rape | 2.17 | 0.62 | 0.39 | 5.06 | 0.38 | 4.55 | 0.06 | 1.27 | 2.28 | 3.33 | 0.06 | 0.65 |
| fruits | 0.93 | 11.84 | 0.13 | 3.50 | 0.02 | 0.83 | 0.14 | 1.69 | 0.05 | 1.48 | 0.29 | 3.23 |
| Ranunculaceae | 0.03 | 0.31 | + | 0.39 | 1.01 | 15.29 | 0.16 | 15.19 | 0.16 | 10.37 | 0.20 | 10.32 |
| Lamiaceae | 0.32 | 0.31 | 0.39 | 6.62 | 0.08 | 5.79 | 0.19 | 8.44 | 0.03 | 1.85 | 0.15 | 5.81 |
| *Plantago* sp. | - | - | 0.02 | 1.17 | + | 0.41 | 0.03 | 4.22 | 0.02 | 1.11 | + | 0.65 |
| unidentified | 4.28 | 16.82 | 1.83 | 9.73 | 0.69 | 4.13 | 0.25 | 2.11 | 0.67 | 3.33 | 2.73 | 3.87 |
| forbs | 0.17 | 2.80 | + | 0.78 | 0.02 | 1.24 | 0.01 | 1.69 | 1.04 | 8.89 | + | 1.94 |
| *Urtica* sp. | - | - | - | - | - | - | 0.05 | 0.42 | - | - | - | - |
| grains | 0.22 | 1.87 | 0.43 | 3.11 | - | - | 0.07 | 0.84 | + | 0.37 | 0.19 | 1.94 |
| *Tesdalea* sp. | 0.08 | 0.62 | 0.04 | 0.39 | + | 0.41 | + | 1.69 | - | - | - | - |
| *Verbascum* sp. | 0.05 | 0.31 | - | - | - | - | - | - | - | - | - | - |
| *Veronica* sp. | 0.03 | 0.31 | - | - | - | - | - | - | - | - | - | - |
| *Gallium* sp. | - | - | 0.05 | 2.72 | 0.07 | 2.89 | + | 0.42 | - | - | - | - |
| mosses | - | - | 0.06 | 0.39 | 0.09 | 3.31 | - | - | - | - | - | - |
| Fabaceae | - | - | - | - | 0.13 | 2.48 | 0.22 | 5.49 | 0.85 | 7.41 | 0.09 | 4.52 |
| BLT | 69.53 | 21.18 | 50.57 | 18.68 | 44.37 | 17.36 | 51.36 | 19.83 | 59.20 | 21.48 | 59.74 | 21.29 |
| H' | 1.36 | | 1.46 | | 1.49 | | 1.47 | | 1.42 | | 1.42 | |
| J' | 0.52 | | 0.54 | | 0.55 | | 0.53 | | 0.56 | | 0.56 | |

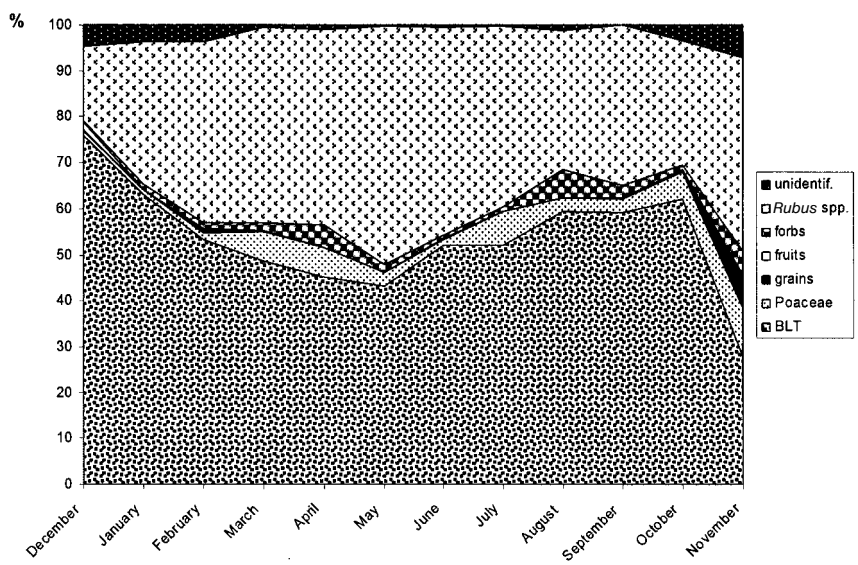


**Fig. 2.** Amount of main food components in roe deer diet in floodplain forest through the year (data from six subplots of study area).

area. No differences were found in the amount of agricultural crops in the diet of roe deer between subplots of the study area which bordered fields and those far from fields ($p > 0.05$). Food analyses revealed statistically significant differences in the average amount of bramble and woody plants between subplots 1 and 2 and other subplots ($p < 0.05$). Food diversity was the lowest in December and January, and the diversity in these months was significantly different in comparison to other months (One-Way ANOVA, $p < 0.05$). The maximal values of diversity were in periods April–May and October–November, when it was significantly different from other periods (Table 1). The most important component of the diet of roe deer in the floodplain forest was woody plants (average 56%). The amount of woody plants throughout the year varied from 27 to 76% ($p < 0.05$) (Fig. 2). The lowest amount of woody plants was in November, when there was an increase in volume of bramble and *Poaceae* (Table 1, Fig. 2). The woody plants in the diet were *Quercus*, *Swida* and *Crataegus*. Roe deer also consumed *Acer*, *Spinus* and *Fraxinus*.

Woody plants in roe deer diet were through the year supplemented with bramble, grasses and forbs (Table 2, Fig. 3). Pearson's correlation coefficient was the highest between woody plants and bramble ($r = -0.757$) (Table 2). High level of negative correlation between these two food components is well expressed by the steepness of regression curve (Fig. 3).

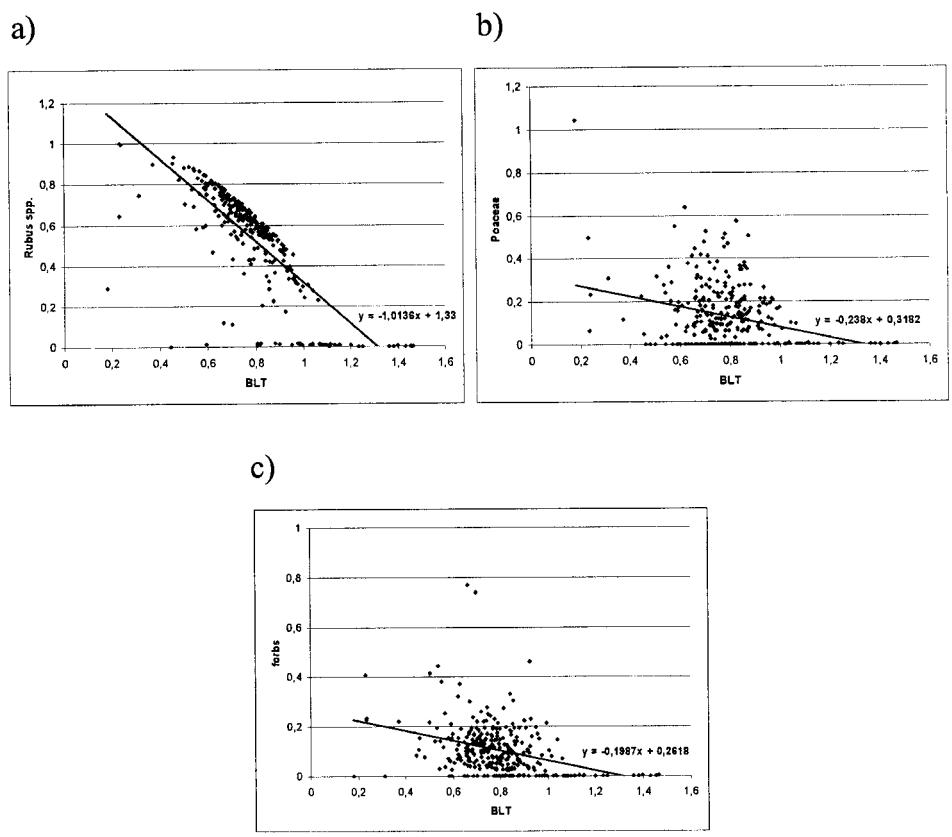


**Fig. 3.** Correlation between woody plants (BLT - broadleaved trees) and other food components in roe deer diet a) *Rubus* spp., b) Poaceae, c) forbs.

**Table 2.** Correlation between main components of roe deer diet based on Pearson correlation coefficient (** correlation is significant at the 0.001 level; * correlation is significant at the 0.05 level) (BLT – broadleaved trees).

| | **BLT** | **Poaceae** | **grains** | **fruits** | **forbs** | ***Rubus* spp.** |
|---|---|---|---|---|---|---|
| **BLT** | 1 | -0.303** | NS | NS | -0.359** | -0.757** |
| **Poaceae** | -0.303** | 1 | NS | NS | 0.184** | NS |
| **grains** | NS | NS | 1 | 0.335** | NS | NS |
| **fruits** | NS | NS | 0.335** | 1 | NS | NS |
| **forbs** | -0.359** | 0.184** | NS | NS | 1 | 0.224** |
| ***Rubus* spp.** | -0.757** | NS | NS | NS | 0.224** | 1 |

Bramble was the second largest component of the diet of roe deer. The volume of bramble varied from 16 to 51% through the year (Fig. 2). The amount of grasses was lowest in December and January, and highest in November (Fig. 2). Forbs were found in all periods of year, but their amount did not surpass 3.5% (Table 1, Fig. 2).

Fruits (bramble, hawthorn, blackthorn, chestnut, apples) were present in the diet throughout the year but only in small amounts. Grains were also present in the diet during the whole year, with the exception of April and May. The volume of fruits and grains did not surpass 1%. The maximum amount of fruits and grains was found during winter. Changes in their consumption were not related to the browsing of woody plants. No increase in volume of grains was observed at the end of summer and in autumn, but they increased in winter ($p > 0.05$) (Table 1).

## Discussion

Differences in roe deer diet composition throughout the year were predicted, as a result of the different vegetation composition in each subplot of the study area. The results showed that the diet composition did not change in subplots of study area throughout the year. All parts of the floodplain forest offered roe deer sufficient amounts of food sources for an optimal diet. The amount of field crops in roe deer diet was small. This means that the food sources from fields did not influence diet composition, and that floodplain forest offers enough food sources. As expected, woody plants were an important component of roe deer diet in the floodplain forest throughout the year, and their consumption was the highest in winter. Similar diets were reported by G e b z y n s k a (1980) in Białowieża Primeval Forest, and H o m o l k a (1993) in the mixed forest stands of Drahanská Vrchovina Uplands. The renewal of forest stands in the research area is based on artificial plantations. These are protected from animals by fencing. Woody plants growing on open areas have in comparison to those on shaded areas higher nutritional content, and this makes them more attractive to animals (M i l l e r et al. 1982, A u g u s t i n e & M c N a u g h t o n 1998, P a r t l et al. 2002). Woody plants in enclosures are more exposed to light than those in the shrub layer, and this can lead to an increase in their attractiveness for feeding. Considering the composition of roe deer diet, it is possible that plantations without fencing would not successfully grow due to feeding by ungulates. It is interesting that the impact of red deer on woody plants is probably even higher than the impact of roe deer. The amount of broadleaved trees in red deer diet in floodplain forest was bigger than in the diet of roe deer (P r o k e š o v á , in press). Intensity of woody plants browsing can be reduced with the presence of other high-quality food sources. For example in the Beskydy Mountains, where roe deer could browse on large amounts of

raspberry, feeding on broadleaved trees was only mild (H o m o l k a & H e r o l d o v á 2003). In addition to woody plants, floodplain forest offers roe deer other palatable and high-quality food sources such as bramble and forbs. This study shows that both these components substituted for certain amount woody plants in roe deer diet. An important component of diet was bramble, which was consumed in large amounts throughout the year. It is possible that the higher abundance of bramble could indirectly cause a reduced impact on broadleaved trees. High dominance of bramble in roe deer diet, where it substituted for woody plants, was reported by J a c k s o n (1980), M a i z e r e t et al. (1989) and H o m o l k a (1995, 1996). Forbs were found in greater amounts during the period of vegetation growth, which is not of greater importance for reduction of browsing intensity. Low amounts of forbs in the diet of roe deer were confirmed also by G e b z y n s k a 1980 and H o l i š o v á et al. 1986b. Low amounts of forbs in diets in studies using faecal analyses could partly result from their good digestibility (H o l i š o v á et al. 1986b), but the difference between the volume of forbs in faeces and rumen was not proved (H o m o l k a & H e r o l d o v á 1992). Grasses are hard to digest for roe deer (H o f m a n n 1989). Their volume in the annual diet in floodplain forest did not exceed 5.5, with no variation between subplots of the study area. This means that, even in spring, roe deer living in the forest periphery did not use crops growing in fields during winter. The expected increase in the amount of fruits and grains at the end of summer and in autumn was not confirmed. The amount of both components stayed low. This means that roe deer did not use field crops to a greater extent. Higher volume of grains in the diet was found from October to March. This increase correlates with the period of supplementary feeding. The increase in the volume of grains was not high enough to substitute woody plants considerably. Therefore additional feeding does not have an important influence on roe deer browsing intensity.

Roe deer diet was not influenced by food sources from fields and additional feeding. This means that floodplain forest offers enough quality food sources for roe deer and is therefore an optimal habitat for its existence.

The great potential of roe deer to influence the shrub layer is evident from the results, but the intensity of impact was not influenced by availability of other food sources in floodplain forest. The real impact of roe deer on woody plants in this habitat will depend above all on its population density. Red deer diet in floodplain forest also consists mainly of woody plants (P r o k e š o v á 2004). Therefore the protection and forest management of floodplain forest will depend on the regulation of the densities of both ungulate species, and not on the additional feeding.

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