

## THE IMPACT OF SMALL TERRESTRIAL MAMMALS ON BEECH (*FAGUS SYLVATICA*) PLANTATIONS IN SPRUCE MONOCULTURE

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### Abstract

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Little is known about the impact of small terrestrial mammals on forest regeneration as yet. In order to determine the level of small rodent impact on artificial forest regeneration, 508 saplings have been researched in a spruce monoculture in the Drahany Uplands. With the objective to hone the interpretation of the data, small terrestrial rodents were trapped to help determine species spectrum. The occurrence of *Apodemus flavicollis*, *Clethrionomys glareolus* and *Sorex araneus* was verified. In 52 cases damage to the trunk caused by small rodents was monitored (10.1% of all saplings). 8 specimens (1.6%) had their branches nibbled and 9 saplings (1.8%) had tips of branches or trunk tops browsed. Browsing by *Lepus europaeus* – 423 (83.3%) of all damaged specimens was significant.

small mammals, rodents, impact on beech forest regeneration, spruce monoculture

Over the past 150–200 years, forest management in the Czech lands has focused predominantly on the planting and maintaining of unstable forest monocultures which are distinguished by significant forest pest outbreaks. At present, however, predominantly spruce monocultures have been subject to a gradual change into more natural and stable mixed forests. The impact of small rodents on the either natural or artificial forest regeneration has been traditionally neglected, ignored or tolerated. Yet, as coniferous forests are being changed into mixed ones, this approach has changed over the past several years and attention has been focused on damage caused by small forest rodents and consequently on protection of trees from these animals (HEROLDOVÁ et al., 2007). In recent years a number of research works dealing with this issue has been published (HEROLDOVÁ, 1995; BRYJA et al., 2001; SANIGA, 2003; HEROLDOVÁ et al., 2007). These works have proved that a systematic research in the stages of forest regeneration, which has been more-or-less non-existent, is needed.

This was one of the reasons why research of selected groups of small terrestrial mammals in the Drahany Uplands was launched in 2006 as part of a research project of the Faculty of Forestry and Wood Technology (hereafter FFWT) at MZLU in Brno. Under the project MSM 6215648902 (“Forest and Wood – Support of Functionally Integrated Forest Management and Using Wood as a Renewable Raw Material”) research of selected groups of small terrestrial mammals in the Drahany Uplands is carried out with the objective to determine their species composition in three types of forest stands (beech and spruce monocultures, mixed beech-spruce forest) and the impact on beech saplings. With the exception of works by ZEJDA (1981) and ČERMÁK and JEŽEK (2005) we have virtually no other detailed data on the species composition of small terrestrial mammals in the area. Information determining their impact on forest regeneration is lacking altogether.

This report presents results obtained from monitoring beech saplings in a gap plantation in a spruce

monoculture with the objective to determine the extent of impact of small rodents on artificial regeneration.

## MATERIAL AND METHODS

In 2004–2005 approximately 2,000 beech seedlings (*Fagus sylvatica* Linnaeus, 1753) were planted as a “pot” plantation in a spruce monoculture in the stationary research plot of the Institute of Forest Ecology of the FFWT at MZLU in Brno with the objective to study the possibilities of changing spruce monocultures into mixed forests. In order to determine the impact of small terrestrial mammals on beech saplings a check of the damage caused by small terrestrial mammals to the seedlings was carried out in 2006. Randomly selected 508 specimens were checked, which was approximately one fourth of all the planted specimens. The height and stem diameter were measured in all saplings. In case browsing by small rodents was detected, it was described in detail (damage from winter 2004/2005 and 2005/2006 was not distinguished). When other types of damage were detected (by herbivores or fungi), they were recorded as well. Significance of differences of mean values of certain types of damage was tested by One-Way ANOVA and by t-Test (Independent, by Groups) in the STATISTICA Cz programme.

In order to determine the species spectrum of small terrestrial mammals in the monitored site in the spring and autumn (in 2006), traps using wicks fried in flour and peanut butter as bait were employed. The total of 100 traps were placed in two lines of 50 traps each. They were exposed for three nights and always checked the following morning. This constitutes the total of 600 trap-nights. The caught material was determined according to ANDĚRA and HORÁČEK (2005). Owing to insufficient numbers of trapped specimens, standard ecological indexes were not established (biodiversity index, equitability).

### Site characteristics

The site is located in Rájec nad Svitavou in the area of the Drahaný Uplands (Czech Republic) on the research plot of the Institute of Forest Ecology of the FFWT at MZLU in Brno. The research site was established to carry out environmental research of substance flow in the ecosystem of a spruce monoculture (at present, the relevant forest stand is age class 5, approximately 100 years old). It is situated on a gently undulating plateau with SW exposure in the altitude of 640 m above sea level. The soil type in the area is Cambisol (sensu TOMÁŠEK, 2003), SoLT 5S (sensu PLÍVA, 1991). The spruce monoculture itself lacks undergrowth. In open areas (gap planting) undergrowth occurs and consists predominantly of *Rubus* sp., *Calamagrostis* sp.,

*Avenella flexuosa* (L.) Drejer and ferns, which makes the site favourable for populations of small mammals.

## RESULTS AND DISCUSSION

Analysis of 508 specimens of young beech saplings was carried out on the research site, out of which 58 (11.4%) were healthy and entirely undamaged (N), while 9 saplings (1.8%) were entirely dead (M). 228 saplings (44.9%) were with undamaged trunk (Z) but with a certain degree of damage on branches or leaves, 51 (10%) trees (CM) were partially dead (with a varying degree of necrotic tissue). Other herbivores damaged the total of 110 (21.7%) of all the saplings (Tab. I).

With regard to tree damage caused by rodents, only 9 (1.8%) cases of stem tip or branch browsing were monitored, and only 8 (1.6%) cases of branch browsing. On the other hand, trunk browsing was monitored in 52 saplings (10.2%). The size of damaged area (OK<sub>1</sub>–OK<sub>3</sub>) manifested an interesting trend of correlation between the growing average height and the diameter of the attacked trees and the growing area of browsing. However, these differences were not significant ( $p > 0.05$ ). 11 specimens (3.0%) had browsed stem bases, which accounts for approximately one fifth of trees attacked by rodents. The trend of growing area of damage in relation to the growing average height and stem diameter was noted here as well. Nevertheless, the differences were insignificant as well ( $p > 0.05$ ) (Tab. I).

Apart from damage caused by rodents, the impact of Common Hare (*Lepus europaeus* Pallas, 1777) and Roe Deer (*Capreolus capreolus* (Linnaeus, 1758)) was monitored as well. Roe deer browsed sapling tips of 14 (2.8%) specimens and hare damaged 423 (83.3%) of saplings. Moreover, branch browsing by hare was monitored in 6 (1.2%) of planted beech saplings (Tab. I).

According to BRYJA et al. (2001), small-scale clear-cut areas (similar to the research plot in Rájec) situated in extended forest complexes feature predominantly typical forest species which may be complemented by open habitat species. The monitored species composition corresponds to this finding. In 2006, the occurrence of Yellow-necked Mouse (*Apodemus flavicollis* (Melchior, 1834)), Bank Vole (*Clethrionomys glareolus* (Schreber, 1780)) and Common Shrew (*Sorex araneus* Linnaeus, 1758) was monitored in the site. Owing to the limited period of monitoring and to the character of detected browsing (browsing on saplings' stem base) and also with regard to previous research (ZEJDA, 1981), future confirmation of the occurrence of other small mammal species, such as the Common Vole (*Microtus arvalis* (Pallas, 1779)), Wood Mouse (*Apodemus sylvaticus* (Linnaeus, 1758)) or Pygmy Shrew (*Sorex minutus* Linnaeus, 1758) cannot be ruled out.

## I: Survey of damage to the monitored saplings

Degree of damage	N	%	Height				Stem diameter			
			Ø (mm)	S.D.	max.	min.	Ø (mm)	S.D.	max.	min.
ZN	58	11.4	384	108.27	570	110	6.05	2.5	14	2
M	9	1.8	427	129.94	670	140	6.61	2.2	11	3
CM	51	10.0	343	116.28	540	90	6.7	2.18	11	3
Z	228	44.9	324	121.22	770	110	6.96	2.29	15	3
JPLH	110	21.7	339	141.27	690	90	8.69	2.73	18	3
OK	52	10.2	347	138.82	670	100	7.79	1.93	13	4
OK <sub>1</sub>	31	6.1	190	123.08	625	100	7.58	1.96	13	4
OK <sub>2</sub>	19	3.7	381	155.43	670	105	8.05	1.93	12	5
OK <sub>3</sub>	2	0.4	475	120.21	560	390	8.5	2.12	10	7
OO	15	3.0	338	133.43	550	100	8.2	1.7	11	5
BO	11	2.2	402	162.41	670	140	8.46	1.75	12	6
BO <sub>1</sub>	3	0.6	347	205.02	550	140	8.33	1.53	10	7
BO <sub>2</sub>	8	1.6	423	154.53	670	290	8.5	1.93	12	6
OVM	8	1.6	395	170.29	680	200	8.75	2.25	12	6
MOS	9	1.8	370	53.85	460	300	6.78	2.11	10	3
OVZ	6	1.2	470	140	680	310	9.33	0.82	10	8
OZ	423	83.3	300	114.85	770	80	7.79	2.56	18	3
OS	14	2.8	268	115.92	440	90	7.79	2.01	11	3
JP	58	11.4	334	137.34	670	100	6.57	2.51	15	3

## Notes:

ZN – entirely undamaged sapling

M – entirely dead sapling

CM – only part of the sapling dead

Z – sapling with a healthy stem (the remaining part damaged in varying ways)

JPLH – leaf damage caused by other herbivores

OK – stem browsed by rodents (OK<sub>1</sub> = up to 1 cm<sup>2</sup>; OK<sub>2</sub> = 1–10 cm<sup>2</sup>; OK<sub>3</sub> = over 10 cm<sup>2</sup>)

OO – insular browsing of the stem

BO – browsed stem base – the part of stem directly above the ground (BO<sub>1</sub> = up to 1 cm<sup>2</sup>; BO<sub>2</sub> = 1–10 cm<sup>2</sup>)

OVM – branch browsing by small rodents

MOS – tree tip or branch browsed by small rodents

OVZ – branch browsed by hare

OZ – browsing of tree tip or branches by hare

OS – browsing of tree tip by roe-deer

JP – other damage (fungi, mechanical damage, other unspecified damage)

Of the listed small terrestrial mammal species, predominantly *C. glareolus* and possibly also *M. arvalis* impact on artificial regeneration on the monitored site. Both species feed on tree bark, yet almost exclusively in winter. During the vegetation period, when other food sources abound, these species virtually do not do any damage (HANSSON and LARSSON, 1978; HANSSON, 1985; HEROLDOVÁ, 1995). During the vegetation period, *C. glareolus* in Central Europe feeds predominantly on herbs, tree leaves and large tree seeds (HOLIŠOVÁ, 1971). However, in spruce monocultures it feeds less on seeds and focuses more

on fungi (HANSSON and LARSSON, 1978; HANSSON, 1985). The *Microtus* genus voles are considered generalist herbivores. However, they are known to be selective in choosing certain herb species (BERGERON, 1996).

According to BAXTER and HANSSON (2001), voles tend to feed on tree bark predominantly under snow cover. Trees with the diameter of up to 10 cm are frequently attacked, at times also trees with the diameter of 25–50 cm. Species of the *Microtus* genus, such as *Microtus agrestis* (Linnaeus, 1761), possibly *M. arvalis*, are able to move upwards along the tree

stem under the snow cover and to remove virtually all the bark up to the height of 1 m and more. While *C. glareolus* tends to damage stems at the height of over 1 m above the ground or above the snow cover (HANSSON and ZEJDA, 1977), Bank Vole can damage the entire stem (HEROLDOVÁ et al., 2007).

The impact of small terrestrial rodents on forest regeneration tends to be considered less significant. The relatively low number of attacked saplings and very low number of captured specimens of *C. glareolus* and small terrestrial mammals in general on the monitoring site in Rájec, may attest to the same fact. However, low numbers of small rodents probably indicate that their populations are in the pesi-

mum stage and their numbers will grow in future years, which will consequently increase the probability of damage to the trees. In case the population of *C. glareolus* grows significantly, the species may expand to all the more or less suitable habitats, including beech plantations, and consequently may damage the planted saplings significantly. Monitoring of these populations in future years may show whether gap planting of leafy tree species within vast spruce monocultures are significantly threatened by small terrestrial mammals. The first year of monitoring in the Drahany Uplands shows that if numbers of small rodents are very low, browsing by *L. europaeus* poses the most significant threat.

## SOUHRN

Vliv drobných zemních savců na výsadbu buku (*Fagus sylvatica*) ve smrkové monokultuře  
Vliv drobných zemních savců na lesní obnovu není dosud dostatečně znám. Pro stanovení míry impaktu drobných hlodavců na umělou lesní obnovu bylo provedeno šetření 508 stromků ve výsadbě buku ve smrkové monokultuře v oblasti Drahanské vrchoviny. Ke zpřesnění interpretací výsledků byl uskutecněn odchyt drobných zemních savců pro zjištění druhového spektra. Potvrzen byl výskyt *Apodemus flavicollis*, *Clethrionomys glareolus* a *Sorex araneus*. Poškození kmene drobnými hlodavci bylo zaznamenáno v 52 případech (10,1 % všech stromků). Osm jedinců (1,6 %) mělo ohryzány větve a devět stromků (1,8 %) okousané špičky větví nebo vrcholky kmene. Významný byl okus vrcholků stromů a větví od *Lepus europaeus* – 423 (83,3 %) poškozených jedinců. Méně významný byl okus špiček stromků od *Capreolus capreolus* – 14 (2,8 %) poškozených jedinců.

drobní savci, hlodavci, vliv na umělou obnovu bukového lesa, smrková monokultura

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