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Game damage to forest trees

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ABSTRACT: Humans should behave in such a way that they will not endanger the existence of other living entities. After all, human activities affected the tree species composition and wildlife living conditions. Humans are now responsible for the preservation of delicate equilibrium in nature. Two localities were chosen for the research of game damage caused to standing trees – shooting areas Lužánky and Červený jelen, both situated in the vicinity of Jindřichův Hradec in South Bohemia. Seasonal character of tree-damage origin as well as its relation to the chemical content of spruce (*Picea abies* [L.] Karst.) and pine (*Pinus sylvestris* [L.]) bark were investigated. This area is typical of high game stock; trees are damaged by browsing and bark stripping. Particular advice for game management with respect to minimizing tree damage is presented. The data set of chemical bark analyses was statistically evaluated by *t*- and *F*-test and significant differences in element contents were detected between damaged and undamaged pine bark for N-substances ($P = 0.003309$), Ca ($P = 0.001460$), P ($P = 0.004343$), Mg ($P = 0.001419$) and K ($P = 0.016290$). Humans have influenced many changes in the distribution of different animal and plant species. Among others they are responsible for the altered species composition. Typically the extinction of large predators produces changes in food chains. In forest stands influenced by human activities the reasonable game management and the regulation of game stock seems to be one of the main tools in forest protection.

Keywords: bark; nutrients; hoofed game damage; browsing

Damage to standing trees caused by hoofed game browsing and bark stripping is a serious problem, one of the most serious problems of contemporary Czech forestry. Protection practices against game damage are described e.g. in Švarc et al. (1981) and Prien (1997). Hromas (1995), Husák (1995), Mlčoušek (1995) and Plaňanský (1995) reported how to decrease damage to standing trees. Reimoser and Suchant (1992) investigated game damage in Austrian conditions. Relationships between forest development and occurrence of hoofed game were investigated by Jorritsma et al. (1999). Trees with damaged bark usually suffer from the penetration of fungi spores and decay of diverse extent, which consequently decreases financial income hand in hand with low timber quality. Čermák et al. (2004) dealt with the quantification of volume and financial losses in timber production in connection with fungal attack of standing trees. Average timber volume losses due to decay development are increasing. According to his investigations, the loss of timber production during stand ageing can reach 48 m^3/ha in the 5^{th} stand age class.

Trees damaged by browsing by big game are afflicted by different types of decay. The penetration of infection is often lethal – many kinds of fungi cause the wood to become discoloured or to rot. It is expedient to investigate differences in the content of substances and elements between healthy and damaged spruce and pine bark (Tables 1 and 2).

Many authors defined the basis of damage caused by game. For example Pollanschütz (1995) described these injuries as damage to trees and tree seedlings caused by animals (especially cloven-hoofed game and rabbits) leading to a decrease in financial revenues and increase in costs used for the stand protection. Forest protection costs as well as costs designated for the tree damage sanitation constitute an economic loss. Damage can be defined as physiological disadvantages. From this aspect, the disturbances of tree (stand) development lead to a consequent decrease in wood production. The concept of damage depicts a reduction in utility value. It describes the damage of a single tree or of the whole forest stand from the economic point of view.

Originators of damage have to be identified in order to prevent tree damage. In practice it is not as easy as it appears at first sight. Determination of the actual wildlife species that causes damage to forest trees has to be carried out according to marks on damaged trees, such as incisor width, height of the lower boundary of nibbled or excoriated bark of trees. Other clues that can be used for the determination of damage originators are marks such as trails, lairs and droppings. Determination of browsing originators becomes more difficult with elapsed time. The exact time of browsing occurrence is also vital for the determination of hoofed game species causing the damage. The unevenly circular surface area of removed bark is typical of browsing by the cloven-hoofed game, the boundaries of the damaged place are flaggy with tattered and partially plucked phloem. Red deer prefer thinner trunks for bark stripping (Vodňanský et al. 2006).

A modified tree species composition evocated the impoverishment of food sources for hoofed game during the last centuries of intensive land use. Hoofed game reoriented themselves to forest tree species – in fact a valuable source of important nutrients and chemical substances. Game managers and foresters should consider the options whether they are able to prevent great damage to forest stands caused by big game. This question becomes crucial in the conditions of vast pine and spruce monocultures.

In Central Europe hoofed game feeding in hard times has a long-term tradition; it is recommended even in older hunting literature. In relation to forest protection, the danger of increasing browsing is highlighted as far as hoofed game feeding is not carried out correctly (Vodňanský 1997). Since availability and nutritional quality are seasonally variable, the importance of alternative food resources changes between seasons (Moser at al. 2006). In recent years distinct opinions appeared which impugned the necessity and expediency of winter hoofed game feeding (Komárek, Kočiš 1991; Hromas 1997, etc.).

MATERIAL AND METHODS

Two localities were chosen for the purposes of observation and evaluation of tree damage caused by hoofed game – shooting area Lužánky and shooting ground Červený jelen.

Shooting ground Lužánky is situated in the southern part of the Bohemian and Moravian Upland. Average annual temperature is 6°C, the area is situated at an elevation of 600–730 m above sea level. The main part of the shooting ground belongs to the 6th vegeta-

Table 1. Changes in the content of substances and elements between intact and hoofed game-damaged pine bark (g/kg)

Scotch pine mean values	N-subst.	Lipids	Ash matter	Pulp	Nitrogen-free substances	Sugars	Ca	P	Mg	K	Na	Co
Intact bark	35.72	59.05	38.25	209.15	655.43	146.57	5.19	0.64	0.68	2.47	0.08	0.07
Damaged bark	46.86	52.51	34.45	221.70	644.15	156.42	3.64	0.81	0.88	3.10	0.11	0.05

Table 2. Changes in the content of substances and elements between intact and hoofed game-damaged spruce bark (g/kg)

Norway spruce mean values	N-subst.	Lipids	Ash matter	Pulp	Nitrogen-free substances	Sugars	Ca	P	Mg	K	Na	Co
Intact bark	34.35	47.01	43.14	246.99	630.69	140.85	9.07	0.60	0.72	2.82	0.09	0.10
Damaged bark	31.40	50.75	47.80	217.80	652.15	142.44	7.34	0.65	0.66	3.19	0.09	0.09

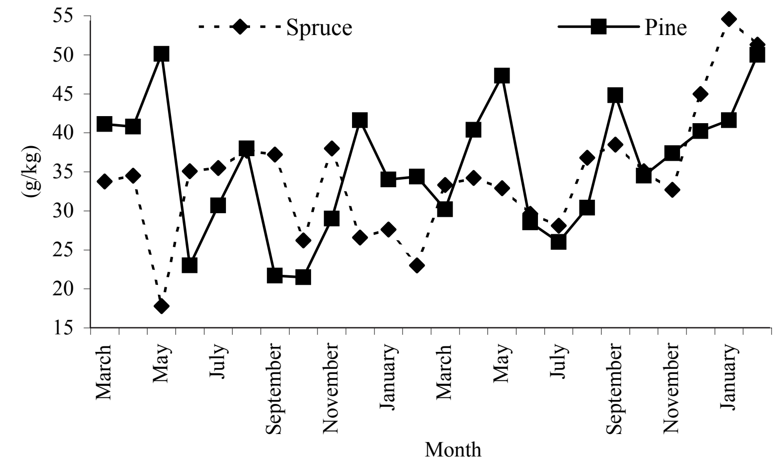

Fig. 1. Content of nitrogen substances in spruce and pine bark in the course of 2-year investigation

tion gradient *Piceeto-Fagetum*. Norway spruce (*Picea abies* [L.] Karst.) is the prevailing tree species covering 75% of the area, European beech (*Fagus sylvatica* [L.]) is a major broadleaved tree species growing on 2% of the area. Red deer, mouflon, roe deer and wild boar are present there all the year round.

Shooting area Červený jelen is situated at an elevation of 420–460 m above sea level. Average annual temperature is 7.8°C. Scotch pine (*Pinus sylvestris* [L].) covers 70% of the investigated area, Norway spruce 20%, oak with 3% is the main broadleaved tree species.

For the selection of appropriate forest stands the criteria such as tree species representation, stand age, current and former hoofed game damage and stand size (> 0.5 ha) were used. Continuous occurrence of hoofed game was also an important aspect. Four forest stands were chosen for the respective experiment in this way. In order to get bark from the same patch on the stem where the browsing and/or bark stripping usually take place, samples were taken at a height of 1.4–1.6 m. Moreover, contents of micronutrients can differ in various parts of the tree stem (Hagen-Thorn, Stjernquist 2005). Samples (up to 300 g each) were peeled off from trees with intact bark and for a comparison also from trees that were already browsed by hoofed game. All damaged trees were marked in a given month so as to avoid repetitive sample taking.

The following substances and macro- and microelements were investigated: nitrogen substances, lipids, ash matter, pulp, nitrogen-free substances, sugars, calcium, phosphorus, magnesium, potassium, sodium and cobalt.

RESULTS AND DISCUSSION

We performed chemical analyses of the bark of damaged and undamaged trees and we analyzed the changes in the content of nutrients and elements during the whole year. Damaged pine forest stands are richer in some substances and elements than healthy forest stands, e.g. the content of nitrogen substances is higher in damaged pine bark by 11.14 g/kg, pulp is higher by 12.55 g/kg, sugars are higher by 9.85 g/kg, phosphorus is higher by 0.17 g/kg, magnesium by 0.20 g/kg, potassium by 0.63 g/kg, sodium

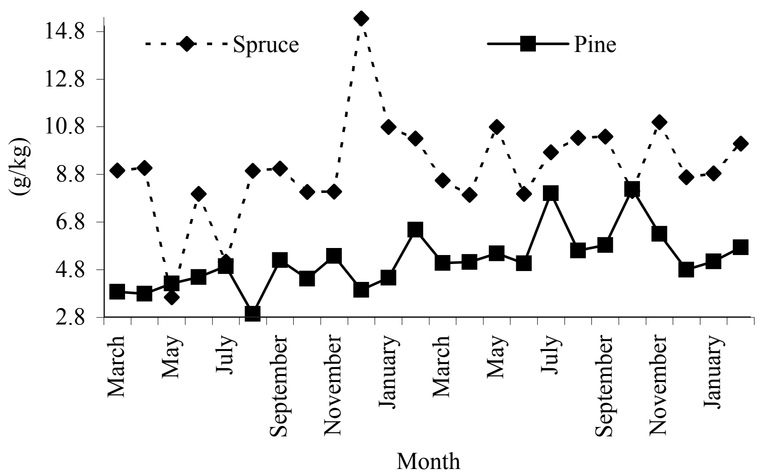

Fig. 2. Content of Ca in pine and spruce bark in the course of 2-year investigation

Table 3. Statistical analyses of pine bark (mean 1 damaged, mean 0 undamaged bark)

	Mean		*t*-value	df	*P*	Valid N		Std. dev.		*F*-ratio	*P*
	1	0				1	0	1	0		
N-subst.	**46.8625**	**35.7167**	**3.19162**	**30**	**0.003309**	8	24	8.87673	8.45354	1.102627	0.788695
Lipids	52.5125	59.0458	–1.13736	30	0.264390	8	24	16.57110	13.21596	1.572189	0.387408
Ash matter	34.4500	38.2542	–0.38649	30	0.701864	8	24	21.79692	24.77137	1.291546	0.770361
Pulp	221.7000	209.1542	1.34856	30	0.187572	8	24	16.98478	24.28039	2.043579	0.335054
N-free s.	644.1500	655.4333	–0.92467	30	0.362516	8	24	19.63539	32.37256	2.718159	0.176771
Ca	**3.6438**	**5.1913**	**–3.50437**	**30**	**0.001460**	8	24	0.42765	1.21262	8.040325	0.008647
P	**0.8113**	**0.6442**	**3.08536**	**30**	**0.004343**	8	24	0.09658	0.14182	2.156404	0.298972
Mg	**0.8813**	**0.6750**	**3.51515**	**30**	**0.001419**	8	24	0.09963	0.15467	2.409817	0.233910
K	**3.0975**	**2.4696**	**2.54551**	**30**	**0.016290**	8	24	0.47737	0.63785	1.785409	0.439740
Na	0.1075	0.0767	1.56261	30	0.128634	8	24	**0.08207**	**0.03158**	**6.755295**	**0.000414**
NO_3	0.1725	0.1787	–0.33565	30	0.739474	8	24	0.03412	0.04857	2.026340	0.341026
Co	48.8175	65.0288	–0.71386	30	0.480832	8	24	37.66812	60.03478	2.540142	0.207300
Sugars	156.4206	146.5715	0.80988	30	0.424387	8	24	40.82732	25.49770	2.563891	0.083064
Temp.	2.9625	7.4958	–1.61743	30	0.116254	8	24	6.38188	7.00599	1.205152	0.853153
Precipitation	47.7125	64.2750	–0.96845	30	0.340565	8	24	**19.25256**	**46.64963**	**5.871097**	**0.022301**

by 0.03 g/kg. Opposite development was detected in the following substances and elements: the content of lipids is lower in damaged pine forest stands by 6.54 g/kg, ash matter is lower by 3.8 g/kg, nitrogen-free substances by 11.28 g/kg, calcium by 1.55 g/kg, cobalt by 0.02 g/kg.

These elements and substances have higher volumes in damaged spruce bark: lipids by 3.74 g/kg, ash matter by 4.66 g/kg, nitrogen-free substances by 21.46 g/kg, sugars by 1.59 g/kg, phosphorus by 0.05 g/kg, potassium by 0.37 g/kg. Opposite development in the volume of elements and substances: the content of pulp is lower in damaged forest stands by 29.19 g/kg, nitrogen substances by 2.95 g/kg, calcium by 1.73 g/kg, magnesium by 0.06 g/kg, cobalt by 0.01 mg/kg.

Bark samples were taken in a 2-year period and changes in the content of elements and substances are shown in Figs. 1 to 5.

The *t*-test confirmed statistically significant differences in element content between damaged and undamaged pine bark. Significant differences were detected for N substances (P = 0.003309), calcium (P = 0.001460), phosphorus (P = 0.004343), magnesium (P = 0.001419) and potassium (P = 0.016290). Comprehensive values are shown in Table 3.

Nitrogen substances (proteins and another substances) form a major part of body organs, tissues, enzymes, hormones, pigments in animal bodies. They are inevitable for muscular progression and embryonic development. They cannot be substituted by any other nutrients.

Calcium is necessary for muscular contraction, appropriate utilization of proteins and together with phosphorus they are important for the mineralization of bones and teeth. Phosphorus is essential for skeleton progression and metabolism as well as for muscular activity. The correct Ca:P ratio plays an important role in phosphorus utilization. A higher proportion of P is required by females at the time of pregnancy. Potassium is necessary for the appropriate metabolism of sugars and proteins as well as for the function of some enzymes. Magnesium is vital for bone formation, decreases blood coagulation and prevents development of thrombosis.

Based on research findings and present knowledge, the following principles and

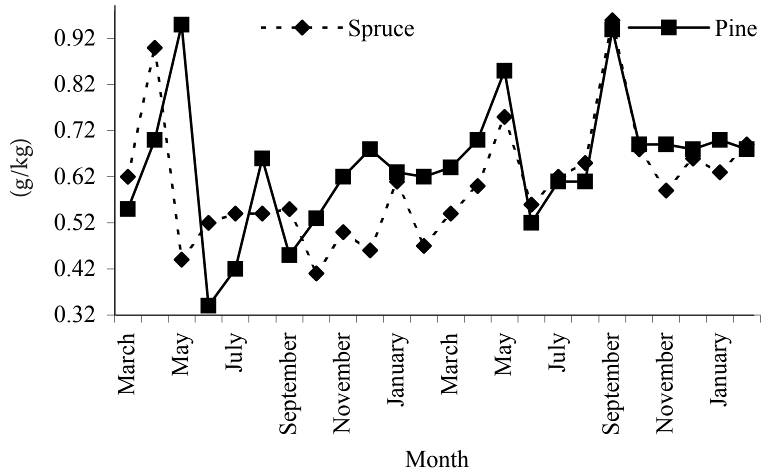

Fig. 3. Content of P in pine and spruce bark in the course of 2-year investigation

regulations can be recommended for the reduction in tree damage caused by hoofed game. An elementary condition is the reduction in the number of cloven-hoofed game to such a stock that will enable new forests to be naturally established. It is not only in the interest of forests and game animals but also of all humans (Zatloukal 1995). It is also expedient to improve the carrying capacity of the hunting ground, i.e. to recover crop fields, to plant fructiferous broadleaved trees on the boundary of grazing areas. The location of feed racks is not advisable either in young forest stands or in their neighbourhood. On the contrary, feed racks should be placed in mature forest stands. Pine bark can be used as feedstuff; felled trees can be left on the ground for hoofed game browsing. The felling should be carried out in older stands which are not situated in the proximity of young stands and non-established plantations. It is expedient to carry out juvenile thinning in young pine forest stands only in spring and summer. When this operation takes place in autumn or winter, hoofed game are attracted by freshly cut timber, animals concentrate in these stands, they primarily nibble felled trunks and when there is nothing left, they continue browsing on other standing trees. No such negative browsing occurs in forests where juvenile thinning is carried out in spring or summer. This way of felling timing enables quick bark withering and the timber is not attractive for hoofed game any more – standing trees growing close to felled ones are not subsequently damaged. Shooting should be carried out continuously during the hunting season. Increased shooting at the end of the year makes the hoofed game stressed. For this reason game animals spend a lot of time in young forests where they cause damage to standing trees. Forestry and game management must not be contradictory. The solution of this situation consists in the achievement of ecologically adequate hoofed game stock. Nowadays, game management has to be primarily considered as an activity aimed at the preservation of equilibrium in the nature – animal protection associated with the protection of forest environment.

The most notable facts standing against the background of great damage to forest trees are as follows:

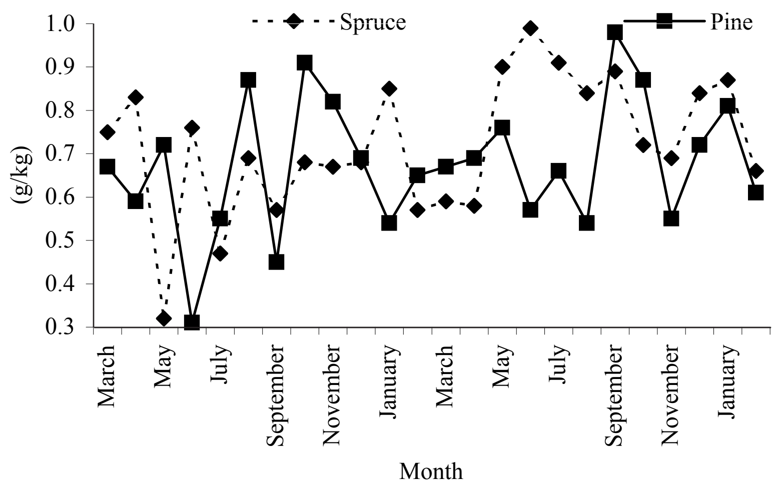

Fig. 4. Content of Mg in pine and spruce bark in the course of 2-year investigation

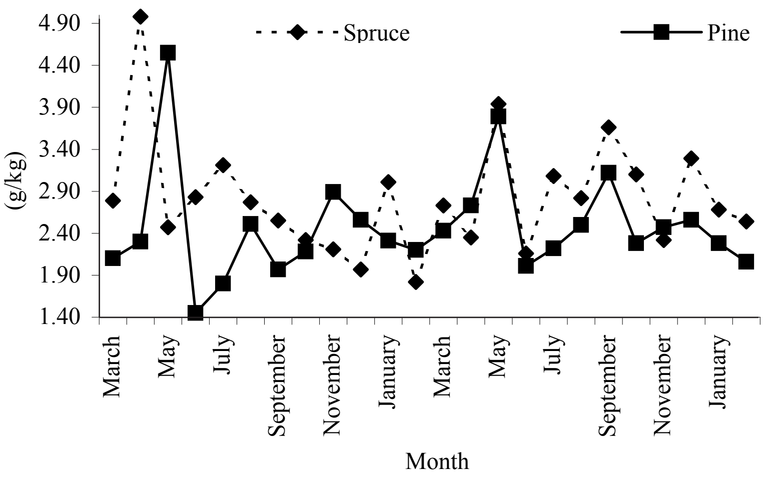

Fig. 5. Content of K in pine and spruce bark in the course of 2-year investigation

– The high number of cloven-hoofed game is not in accordance with standard stock. The number of wildlife ruminants has to be equalized with food sources in the area.
– Feed racks placed close to young forest stands consequently increase damage to nearby forest stands.
– Insufficient and low-class hoofed game feeding in hard times. It is usually convenient to feed wildlife game according to its needs.
– Game animals are substantially stressed and cannot fulfil regular pasture cycles because of the lack of rest areas.
– Annual spruce and pine shoots as well as bark are very rich in nutrients and elements; they contain many nourishing elements and necessary substances for animal nutrition, they serve as an indispensable source of energy.
– With regard to the content of substances and elements, spruce and pine bark is comparable to a superior feedstuff.
– Game animals prevent alimentary troubles by the intake of pulp whose artificial source is contained in bark.
– Increasing power consumption and growing need of timber during the last centuries led to changes in forest structure from mixed all-aged forests to conifer (mainly spruce) monocultures. In consequence plant species diversity and food sources for hoofed game decreased. Animals focused on other food sources and started to damage forest stands and farm crops.
– Natural animal species diversity and animal abundance were changed. Some wildlife species were preferred; some animals were introduced (sika deer, fallow deer, white-tailed deer, mouflon).
– Until the first half of the 19th century almost all large predators were wiped out in Central Europe.

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Škody zvěří na lesních dřevinách

ABSTRAKT: Člověk by se měl ve vztahu k přírodě chovat tak, aby neohrozil existenci jiných organismů. Bohužel v důsledku lidské aktivity došlo ke změně druhové porostní skladby dřevin, pestrosti a výskytu rostlinných a živočišných druhů. Člověk má nyní odpovědnost za zachování křehké rovnováhy v přírodě. Pro výzkum škod působených spárkatou zvěří na lesních porostech byly zvoleny dvě lokality v blízkosti Jindřichova Hradce – honitby Lužánky a Červený jelen. Byl zkoumán sezonní charakter poškození a jeho vztah k chemickému složení borové (*Pinus sylvestris* [L.]) a smrkové (*Picea abies* [L.] Karst.) kůry. Zkoumaná oblast vykazuje vysoké počty spárkaté zvěře, stromy jsou poškozovány ohryzem a loupáním kůry, případně okusem. Soubory dat z chemických analýz kůry u poškozených a nepoškozených jedinců borovice a smrku byly zhodnoceny statisticky pomocí *t*- a *F*-testu. Statisticky průkazný rozdíl v koncentracích mezi poškozenými a nepoškozenými stromy byl dosažen u dusíkatých látek (P = 0,003309), vápníku (P = 0,001460), fosforu (P = 0,004343), hořčíku (P = 0,001419) a draslíku (P = 0,016290) u borovice. Člověk stojí v pozadí mnoha změn v přírodě, mimo jiné významným způsobem zasáhl do potravních řetězů vyhlazením velké části predátorů z volné přírody. V silně antropicky ovlivněných lesních porostech se racionální hospodaření se spárkatou zvěří a regulace jejích stavů stává jedním z hlavních nástrojů ochrany lesa.

Klíčová slova: kůra; živiny; škody spárkatou zvěří; ohryz

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