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# FOOD SELECTIVITY OF EUROPEAN BEAVER (*CASTOR FIBER* L.) OCCURRING IN THE AREA LUBACZÓW AND CHOTYŁÓW FOREST DISTRICTS

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Key words: *Castor fiber,* food, chew trees.

Abstract

The aim of the study was to comparison of food selectivity of the European beaver (*Castor fiber*) occurring in the area Lubaczów and Chotyłów Forest Districts. Analyzed percentage distribution of damaged trees in relation to their species and diameter at the chewing site, correlations between the diameter of damaged trees and their distance from beavers' lodges, and correlations between the number of damaged trees and the hardness of the wood of the tree species. Two peaks of beavers' activity were noted in the analysed period (from October 2016 to May 2017), i.e. in October and November when the animals prepared for the winter and stored food, and in January and February when winter stocks are over and vegetation has not started and no herbaceous vegetation. The aspen poplar (*Populus tremula*) was mostly preferred by the rodents (59%), especially in the Lubaczów Forest District, whereas the bird cherry, alder, or willow species (25%) were most frequently chosen by the rodents in the Chotyłów Forest District. The observations also revealed that a majority of the chewed trees (36%) had a diameter of 21–30 cm, but these preferences differed between the study areas. In the Lubaczów Forest District, beavers damaged trees with a larger diameter, compared to those in the Chotyłów Forest District, and the difference was statistically significant ($t = 5.560$; $p = 0.000$).

The relationship between the number of damaged trees and the hardness of wood of the tree species was inversely proportional and negative but statistically insignificant ($r = -0.4$). There was a similar statistically insignificant ($r = 0.47$) correlation between the diameter of the damaged trees and their distance from beavers' lodges. The diameter of damaged trees decreased with the increasing distance from the lodges.

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# WYBIÓRCZOŚĆ POKARMOWA BOBRA EUROPEJSKIEGO (*CASTOR FIBER* L.) BYTUJACEGO NA OBSZARZE NADLEŚNICTW LUBACZÓW I CHOTYŁÓW

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Słowa kluczowe: *Castor fiber,* pokarm, zgryzane drzewa.

Abstrakt

Celem badań był porównanie wybiórczości pokarmowej bobra europejskiego występującego na terenie Nadleśnictwa Lubaczów i Nadleśnictwa Chotyłów. Przeanalizowano rozkład procentowy zgryzionych drzew ze względu na gatunek, ich średnicę w miejscu ścięcia, zależność między średnicą uszkodzonych drzew a ich odległością od żeremi i korelację między liczbą uszkodzonych drzew a twardością drewna danego gatunku. Na terenach, na których przeprowadzono obserwacje, występowały dwa szczyty działalności bobrów – od października 2016 do maja 2017 r. W październiku i w listopadzie zwierzęta przygotowywały się na zimę i magazynowały pożywienie, z kolei w styczniu i w lutym, kiedy zapasy się skończyły, a wegetacja nie rozpoczęła się jeszcze, brakowało roślinności zielnej. Najczęściej wybieranym gatunkiem drzew przez gryzonie była osika (59%), zwłaszcza w Nadleśnictwie Lubaczów, natomiast w Nadleśnictwie Chotyłów – czeremcha, olsza czy wierzba (25%). W przeprowadzonych obserwacjach wykazano również, że najwięcej zgryzanych drzew (36%) miało średnicę 21–30 cm. W Nadleśnictwie Lubaczów bobry uszkadzały drzewa o większej średnicy w porównaniu z Nadleśnictwem Chotyłów i różnica ta była statystycznie istotna ($t$ = 5,560; $p$ = 0,000).

Zależność między liczbą uszkodzonych drzew a twardością drewna danego gatunku była odwrotnie proporcjonalna do tej cechy i była ujemna, lecz statystycznie nieistotna ($r$ = -0,4). Podobnie kształtowała się zależność między średnicą uszkodzonych drzew a ich odległością od żeremi i również była statystycznie nieistotna ($r$ = 0,47).Wraz ze wzrostem odległości drzew od żeremi spadała średnica drzew zgryzanych.

## Introduction

Until recently, the beaver was a rare species in our country. Currently, as a result of reintroduction initiated in the 70$^{s}$ of the 20$^{th}$ century and species protection, beavers have become a common species. The population size of *Castor fiber* in Poland is systematically increasing; the inventories carried out in 1998 indicated that its population size was 12 thousand animals. Subsequently, it increased to 35 thousand in 2009 and approximately 55 thousand in 2014 (DZIĘCIOŁOWSKI 1999, DZIĘCIOŁOWSKI AND GOŹDZIEWSKI 2011, GUS 2014). At present, beavers have spread virtually

across the country with the greatest abundance in the north-eastern part of Poland. As reported by the Central Statistical Office (2016), the number of beavers in Poland was estimated at 121 624 individuals, with the greatest abundance noted in Mazowieckie (16 thousand), Podlaskie (15 thousand), Podkarpackie (14 thousand) Wielkopolskie (12 thousand), and Warmińsko-Mazurskie (11.5 thousand) Provinces and the lowest numbers in Pomorskie and Śląskie Provinces (2 thousand in each) as well as Dolnośląskie (1 thousand) and Opolskie (450 individuals) Provinces.

Beavers are characterised by a unique ability to adapt the environment to their needs. The activity of this species can be beneficial for nature, especially in forest complexes. Beavers play an important role in renaturalisation of forest ecosystems and contribute to water retention in periods of summer droughts and cleaning of water. Areas flooded as a result of beavers' activity are inhabited by many species of invertebrates, amphibians, fish, and waterfowl, and the backwater environs of provide refugia for many species of mammals and birds of prey. Simultaneously, the role of the beaver in shaping the environment and in the enhancement of the attractiveness and aesthetic, recreational, and educational assets of an area should be emphasised (KONOPKA and ERENC 1993). The benefits of beavers' activities are often underestimated and difficult to evaluate.

Yet, beavers can cause losses in the human economy. An increase in the population of beavers in a given area is accompanied by a greater number of reports of damage caused by their activity. The most frequent problems include flooding of fields, grassland, and forest crops, felling and chewing trees in forests, tree stands, and fruit orchards, damage to pond banks, flood embankments, or road and railway embankments, and destruction of agricultural crops, e.g. maize, carrots, and beets etc. The greatest damage is noted in the initial period of beaver family settling down. Its extent declines with stabilisation of the population.

The aim of the study was to determine beavers' food selectivity in the analysed areas, percentage distribution of damaged trees according to their diameter at the chewing site, correlations between the diameter of damaged trees and their distance from beavers' lodges, and correlations between the number of damaged trees and the hardness of the wood of the tree species.

## Material and Methods

The observations were carried out in two Forest Districts: Lubaczów and Chotyłów between October and May at the turn of 2016 and 2017.

The Lubaczów Forest District is located in Lubaczów County in the north-eastern part of Podkarpackie Province. The area of the Forest District is dominated by fertile and very fertile forest habitats, including mixed and riparian forests. The largest share of tree-forming species is noted for pine (51%), oak and birch (11%), and beech (10%) as well as alder, hornbeam, larch, and spruce. The observations were carried out in the Opaka Forestry branch 395 with an area of approximately 15 ha, in which there are 6 ha of meadows and the rest is a pre-felling tree stand (*Plan urządzania lasów Nadleśnictwa Lubaczów*… 2009).

The other area of observation was the Chotyłów Forest District located in Bialsk County in the north-eastern part of Lubelskie Province. The Forest District has 13.3 thousand ha of forest area. Fresh coniferous forest and fresh mixed deciduous forest, with pine (72%), birch, alder, and oak are the main forest-forming components. Beavers were observed in the Lutnia and Wólka Dobryńska Forestry areas (*Plan Urządzania Lasów Nadleśnictwa Chotyłów*... 2014).

The observations were carried out once a week together with an inventory of damage. The tree species and the distance from beavers' lodges were determined and the diameter of all trunks was measured at the felling height with an accuracy of 1 cm using a timber diameter meter (caliper). Additionally, photographic documentation of the animal habitats and transformations induced in the environment was prepared.

The statistical analysis of the results was performed using statistical package *Statistica* 13.1. The normality of the distributions of the analysed traits was assessed with the use of the Shapiro-Wilk test. Since the distributions of the variables were normal, the *t*-test for independent samples was employed to assess the significance of the differences between the means. Pearson's correlation coefficients were calculated to determine the relationships between the analysed values.

## Results

The greatest number of damaged trees in both Forest Districts was noted in February (24%), October and November (22%), and January (19%). There were two peaks of beavers' food activity during the observation periods: in October and November when the animals prepared for the winter and stored food and in January and February in the mating period and beginning of pregnancy. Early spring is the time when animals are probably hungry due to the shrinkage of winter stockpiles and lack of herbaceous vegetation. They also probably forced to repair destroyed during the winter of the lodge. In the subsequent months, the number of damaged trees declined (Figure 1).

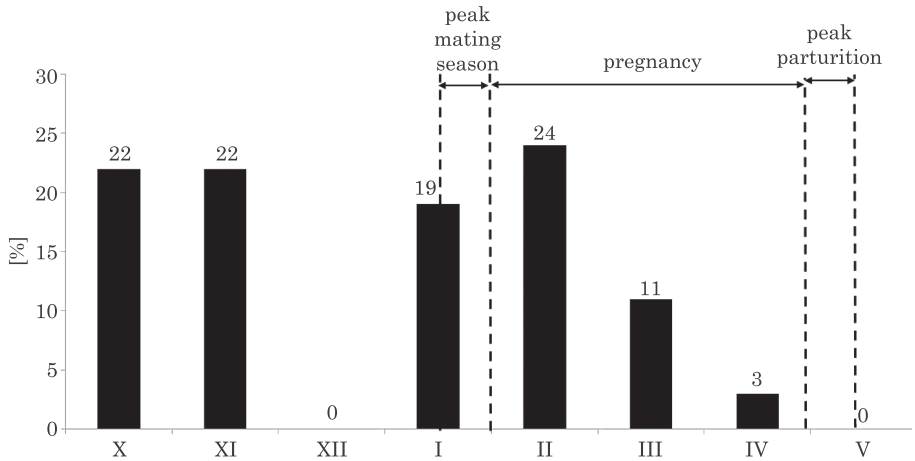


Fig. 1. Percentage distribution of damaged trees in the subsequent months of the study period

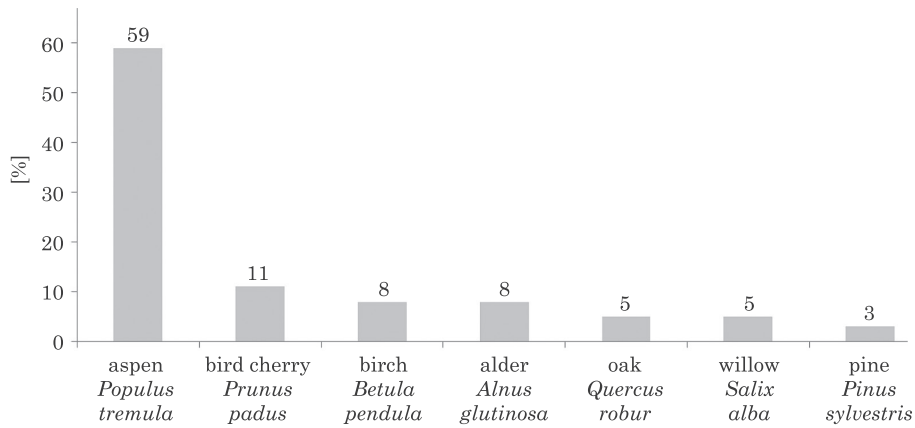


Fig. 2. Percentage share of damaged species in the total number of damaged trees

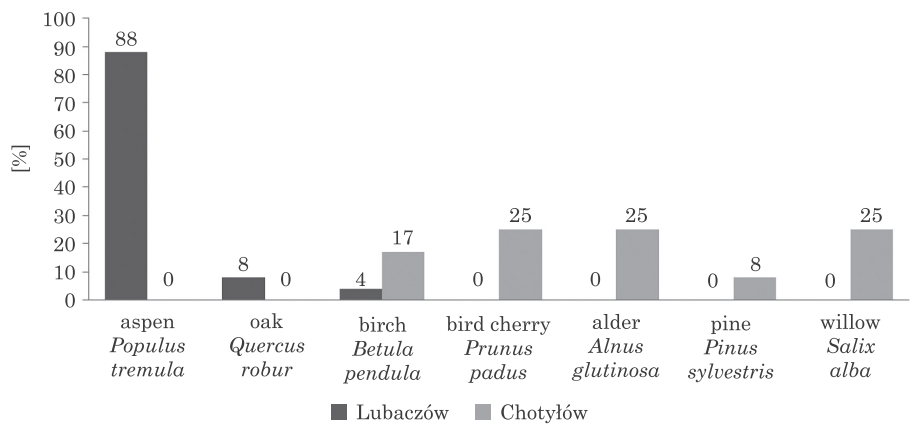


Fig. 3. Percentage distribution of damaged species in the compared Forest Districts

The aspen poplar (*Populus tremula*) was mostly preferred by the rodents (59%), especially in the Lubaczów Forest District, where it accounted for 88% of damaged plants. The beavers were less inclined to chew the bird cherry (*Padus avium*), black alder (*Alnus glutinosa*), or silver birch (*Betula pendula*). Noteworthy is the fact that bird cherry, alder, or willow trees were chewed by the animals most frequently (25%) in the Chotyłów Forest District (Figures 2–3). In the winter period, damage to pine trees (*Pinus sylvestris*) was noted as well (8%).

The observations indicate the highest percentage (36%) of chewed trees with a diameter of 21–30 cm (Figure 4); however, this preference differed between area the Forest Districts. In the Lubaczów Forest District, beavers damaged trees with a larger diameter than that of the trees observed in the Chotyłów Forest District (Figure 5); the difference estimated with the $t$ test for independent samples was statistically significant ($t = 5.560$; $p = 0.000$).

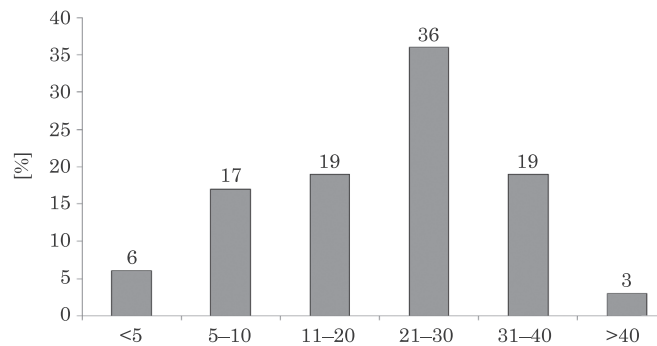


Fig. 4. Percentage distribution of damaged trees according to their diameter measured at the chewing site

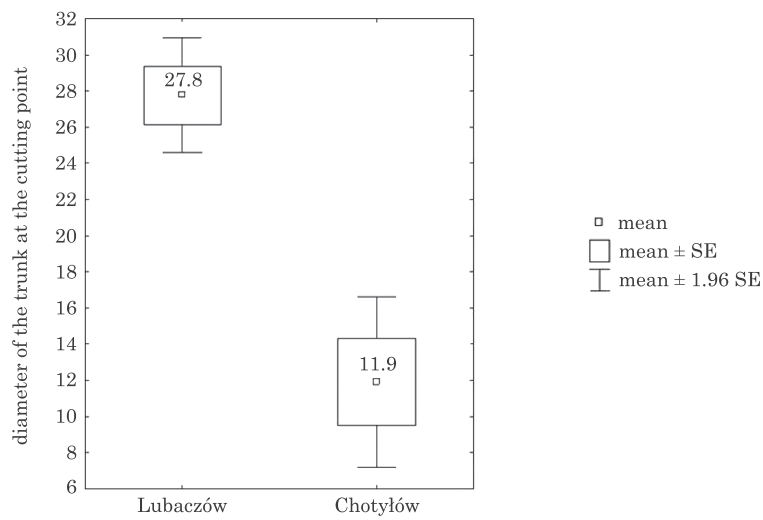


Fig. 5. Distribution of the mean diameters of damaged trees in the compared Forest Districts (test $t$ for independent samples: $t = 5.560$, $p = 0.000$)

The relationship of the number of damaged trees was inversely proportional to the hardness of the wood of the analysed tree species. The calculated correlation between the number of chewed trees and wood hardness [kg cm$^{-2}$] was negative and statistically insignificant ($r$ = -0.4). The number of damaged trees decreased with the increasing hardness of the wood (Figure 6). There was a similar correlation between the diameter of damaged trees and their distance from beavers' lodges, which was statistically insignificant as well ($r$ = 0.47). The diameter of the damaged trees decreased with the increasing distance from the lodges (Figure 7).

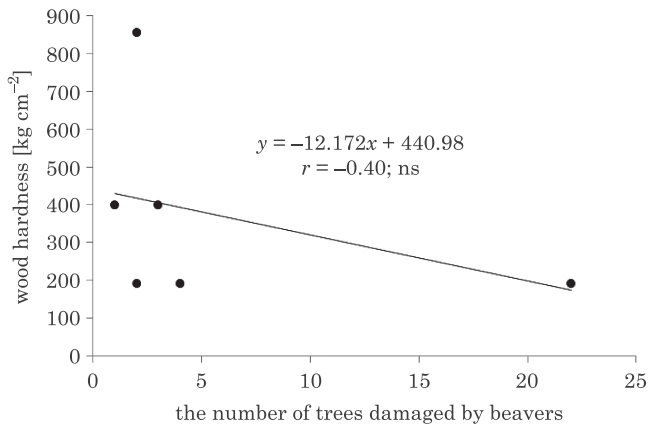


Fig. 6. Correlation between the number of damaged trees and hardness of the wood of the analysed species [kg cm$^{-2}$] (Kokociński 2004)

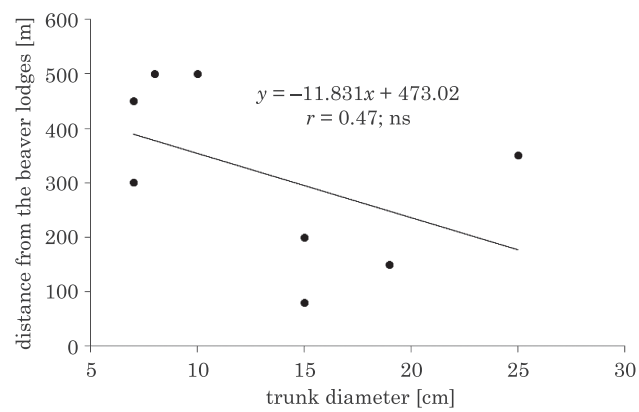


Fig. 7. Correlation between the diameter of damaged trees and their distance from beavers' lodges

## Discussion and Conclusions

Beavers are herbivores eating almost all species of littoral and aquatic plants; their menu comprises over 200 species of herbaceous and 100 woody plants (CZECH 2000a). In general, this diversity is limited by the availability of food, as beavers feed in a relatively narrow 20-meter littoral zone. Besides the depth of the water reservoir, also the abundance of woody food required for winter survival determines the site of settlement. From mid-October, shrubs and deciduous trees stored for the winter time are the diet of beavers. The animals do not eat wood but leaves, young shoots, thin twigs, phloem, and bark. They especially prefer aspen and other poplar species as well as willow, followed by birch, hazel and other deciduous species (CZECH 2000b). As shown by the present observations, the feeding preferences of beavers depended mainly on the abundance of vegetation growing in the living habitat. They most often chose quick-growing tree species, i.e. aspen poplar, common willow or bird cherry in the first and second age class. This is confirmed by research carried out in the Czech Republic, where a strong preference for poplar and willow has been demonstrated as well (FICEK 2003, JOHN 2001, BELOWSKI 1984, FUSTEC et al. 2001, BRENNER 1962, DERWICH 2001). Aspen is digested by the beaver faster than other tree species, and the daily consumption of other plants was inversely proportional to their digestibility. Other studies (NOLET et al. 1994, DZIĘCIOŁOWSKI 1996) have proposed a hypothesis of the preference for willow associated with the low content of resin and essential oils, which beavers try to avoid. Additionally, the number of tree species in the diet increases at the end of the growing season, when beavers collect reserves for the winter. To meet this need, beavers consume species from the genera *Populus spp.* and *Salix spp.* (KOSTKAN 2000, FICEK 2003, NOLET et al. 1994, DANIŁOW and KANSHIEV 1983, KROJEROVÁ et al. 2010). In the absence of these species, beavers eat *Betula spp., Acer spp.* as well as *Tillia cordata, Corylus avellana*, and *Quercus robur* (DOUCET and BALL 1994, DOUCET et al. 1996).

Similar observations were reported from the Poleski National Park, where an interesting fact of consumption of alder buckthorn (26%) and pedunculate oak (17%) was described (JANISZEWSKI et al. 2017). The study conducted in the Chotyłów and Lubaczów Forest Districts showed the bird cherry (11%), oak (5%), and pine (3%) as components of beavers' diet. As reported by NOLET et al. (1994), beavers can choose plant species to supplement specific nutrients whose content in the preferred species is low.

The present study has shown that the beavers chose species of trees with a trunk diameter in the range of 21–30 cm (36%) as well as 11–20 cm

and 31–40 cm (19%). In contrast, a Czech report has demonstrated preferences for species with a trunk diameter below 20 cm (78%). The diameter of the most damaged tree species ranged from 2.6 to 6 cm, the second diameter chosen most frequently was in the range from 6.1 to 12 cm, and the third most preferred group comprised trees with a diameter below 2.5 cm (DVORAK 2013). The observations conducted in the Lubaczów and Chotyłów Forest Districts have indicated that beavers may also be interested in trees with larger diameters. It should be borne in mind that a larger diameter of a felled tree requires a longer time spent by beavers on the land, which increases the potential danger e.g. from predators. Therefore, beavers select trees in terms of their species and trunk diameter. The investigations conducted by JANISZEWSKI et al. (2017) described preferences for trees with a diameter up to 15 cm with a mean 88% percentage share of such trees (from 79.0% to 90.9%).

In the Lubaczów and Chotyłów Forest Districts, there was a negative but statistically insignificant ($r$ = -0.4) correlation between the number of chewed trees and wood hardness (kg $cm^{-2}$). Similar results were presented by CZYŻOWSKI et al. (2009) in their research carried out in Lublin and Nadwieprzański Landscape Park ($r$ = -0.3211). The number of damaged trees decreased with the increasing hardness of wood. There was a similar inversely proportional correlation between the diameter of damaged trees and their distance from beavers' lodges.

In areas that are intensively used by beavers, forests temporarily disappear and non-forest flora and fauna encroach (VALACHOVI AND GÍMEŠ 2003). The strong preference for willow or poplar trees can slow down the succession of these species on wet floodplains. Simultaneously, the fact that beavers willingly chew these species contributes to transformation of the tree stand and enhances the development of other vegetation species thus creating favourable living conditions for aquatic environment fauna (JANISZEWSKI et al. 2014). Some shoots and branches from felled trees are used by beavers to build dams. However, it has been shown that the selection of constructions materials depends on the occurrence and availability of woody vegetation in the littoral zone. No selection of tree or shrub species in acquisition of building material has been reported (JANISZEWSKI et al. 2006).

The presence of beaver families in the studied area does not interfere seriously with human activities and forest management, although periodic flooding can be the greatest nuisance. Damage to the forest environment caused by waterlogging is not estimated to be high. Areas flooded by beavers are usually an inconsiderable part of the entire production area and have no economic significance, since the habitats in river and stream

valleys are characterised by the presence of trees with low quality of raw material. These tree stands have low mass reserves, which also makes the economic losses in forest management negligible (Brzuski and Kulczycka 1999). Furthermore, this type of small retention increases the biodiversity and creates a specific microclimate.

In the present situation related to the occurrence and increasing numbers of this species on the territory of Poland, these studies may be used in practice, for example when planning trees plantings in coastal watercourses and water reservoirs.

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