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Selection of Browse Twigs by Moose*

[With 6 Tables]

The relative selectivity by moose of twigs from 26 browse species was tested in a small enclosure from June 1971 to March 1973. Twigs of *Vaccinium vitis-idaea*, *V. myrtillus*, *Pirus communis*, *Rubus idaeus*, and *Salix cinerea* were highly preferred by moose on a year long basis. Sixteen species were moderately preferred. *Fraxinus excelsior*, *Sarothamnus scoparius*, *Ribes nigrum*, *Oxycoccus quadripetalus*, and *Evonymus verrucosa* were classed as low preference browse. Selectivity varied significantly among seasons. Species preference by season were: Spring — *Vaccinium vitis-idaea*, *Ledum palustre*, *Vaccinium myrtillus*, *Alnus glutinosa*, *Carpinus betulus*, and *Rubus idaeus*; Summer — *Pirus communis*, *Vaccinium myrtillus*, and *V. uliginosum*; Autumn — *Pirus communis* and *Vaccinium vitis-idaea*; Winter — *Vaccinium vitis-idaea*, *Salix cinerea*, *Rubus idaeus*, *Pirus communis*, *Carpinus betulus*, *Alnus glutinosa*, *Vaccinium myrtillus*, *Salix caprea*, *Populus tremula*, and *Ledum palustre*. Food tastes differed among moose, thus, several animals are needed to adequately evaluate browse preference. The similarity in browse selectivity by moose and red deer indicate that the two species may compete directly for food when grazing the same range.

1. INTRODUCTION

The purpose of this study was to determine the relative selectivity by moose (*Alces alces* Linnaeus, 1758) of twigs from 26 species of trees, shrubs, and half-shrubs commonly found in forest habitats of northeastern Poland. Such information is needed to identify key food plants, to assess the potential carrying capacity of a range, and to recognize possible conflicts with other herbivores.

Previous experience and research have shown that food preference investigations with wildland grazers are best conducted with tame captive animals (Alkon, 1961; Short, 1966; Radwan & Campbell, 1968;

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Des Meules & Heyland, 1969a and b; Dzieciołowski, 1970). Bergerud & Nolan (1970) concluded that young pen-reared caribou ate the same plants as wild caribou.

Efforts to determine the food preference of wild animals in their native habitat are hampered by many procedural difficulties. The observations may be useful in special situations such as the feeding of fodder in winter (Żurowski & Sakowicz, 1965), but usually the results serve only as a general indication of preference (Davison & Sullivan, 1963).

2. EXPERIMENTAL PROCEDURE

The selectivity trials were conducted with 1 female and 3 male tamed moose, that had been pen-reared during various years near the Augustów Forest in

Table 1

List of tree, shrub, and dwarf-shrub species used in tests of food preferences with four tamed mooses.

No	Scientific name	No. of tests
1	<i>Populus tremula</i> L.	92
2	<i>Rubus idaeus</i> L.	92
3	<i>Salix caprea</i> L.	92
4	<i>Calluna vulgaris</i> (L.) Salisb.	92
5	<i>Corylus avellana</i> L.	91
6	<i>Sorbus aucuparia</i> L.	90
7	<i>Vaccinium myrtillus</i> L.	90
8	<i>Vaccinium vitis-idaea</i> L.	90
9	<i>Vaccinium uliginosum</i> L.	90
10	<i>Tilia cordata</i> Mill.	85
11	<i>Salix cinerea</i> L.	60
12	<i>Oxyccus quadripetalus</i> Gilib.	58
13	<i>Ribes nigrum</i> L.	52
14	<i>Frangula alnus</i> L.	50
15	<i>Pinus silvestris</i> L.	46
16	<i>Picea excelsa</i> (Lam.) Lk.	46
17	<i>Quercus robur</i> L.	46
18	<i>Carpinus betulus</i> L.	46
19	<i>Fraxinus excelsior</i> L.	46
20	<i>Alnus glutinosa</i> (L.) Gaertn.	46
21	<i>Betula pubescens</i> Ehrh.	46
22	<i>Pirus communis</i> L.	46
23	<i>Juniperus communis</i> L.	46
24	<i>Ledum palustre</i> L.	46
25	<i>Sarothamnus scoparius</i> (L.) Wimm.	21
26	<i>Evonymus verrucosa</i> Scop.	18

northeastern Poland (53°51' N and 23°00' E). The animals were two months old at the beginning of the trials and 17 months at the end (in some cases trials were completed earlier).

Twigs from 26 species of trees, shrubs and half-shrubs (Table 1) were offered to moose in small bundles during spring (March-May), summer (June-August),

autumn (September-November) and winter (December-February). During vegetation season twigs of deciduous species were given with leaves growing on them. Tree and shrub bundles contained 20 twigs; dwarf shrub bundles contained 50 twigs each. Twigs were collected immediately before the feeding test. All twigs within a bundle were approximately equal in size.

Once a day at a designated time 3 bundles, each containing twigs of one plant species, were placed before the moose in a small enclosure. After one hour the uneaten material was collected and the degree of use for each twig was classified as follows: 1, whole twig remained; 2, $\frac{1}{4}$ of twig eaten; 3, $\frac{1}{2}$ of twig eaten, and 4, $\frac{3}{4}$ of twig eaten. The consumption of leaves was appraised in the same way as in the case of shoots. Data on shoots and leaves were processed separately by an analysis of variance. There was no other food available during the test.

For the period June 1971 to March 1973 541 feeding tests were conducted.

Species were classified into one of three preference groups as follows: high when 75 percent or more of the material tested was eaten by moose on a yearlong basis, medium when the utilization ranged from 25 to 74 percent, and low when utilization was less than 25 percent.

Differences in selectivity between seasons, animals, and plant species were tested statistically at the 0.05 level of significance by an analysis of variance (Table 2 and 3). Data were processed on a digital computer (ODRA 1304) at the Computation Center, Polish Academy of Sciences.

3. RESULTS AND DISCUSSION

The relative selectivity of twigs by moose on a seasonal and yearlong basis are shown in table 4.

3.1. Annual Preference

Vaccinium vitis-idaea, *V. myrtillus*, *Pirus communis*, *Rubus idaeus*, and *Salix cinerea* were classed as high preference browse on a yearlong basis. The high ranking of *V. vitis-idaea* and *V. myrtillus* is noteworthy since both of these dwarf-shrubs occur below the stratum (50 to 250 cm above ground) where moose usually feed.

Sixteen species were classed as second choice. This group includes *Populus tremula*, *Salix caprea*, *Alnus glutinosa*, *Frangula alnus*, *Sorbus aucuparia*, *Betula pubescens*, *Corylus avellana*, *Pinus silvestris*, *Quercus robur* and *Juniperus communis*. Because of their widespread occurrence throughout the forest habitat these species are considered a staple source of food for moose.

Five browse species were classed as low preference food. The low ranking of *Fraxinus excelsior* was unexpected since this species, especially the coppice, was commonly eaten by moose in a nearby forest association of *Carici elongatae Alnetum*. However, the frequent use may reflect a tense trophic condition in the habitat.

Table 2

Results of analysis of variance for tests with consumption of shoots.

Variaton	Sums of squares	No. of degrees of freedom	S^2	F test	
3-directional biased classification	$SS_2=793712.23$	415			
Error	$SS=505142.45$	1226	412.02		
General	$SS_1=1298854.68$	1641			
For seasons and mooses from the estimation of parameters	$SS_4=105313.61$	6	—	—	interaction seasons \times mooses
Interaction seasons \times mooses	$SS_5=18439.86$	9	2048.87	4.97*	
Bias of variation seasons \times mooses	$SS_3=123753.47$	15	—	—	
For seasons (biased)	$SS_{11}=103690.11$	3	—	—	for mooses
For mooses (unbiased)	$SS_{12}=1623.50$	3	541.17	1.31	
For seasons and mooses from estimation of parameters	$SS_4=105313.61$	6			
For mooses (biased)	$SS_6=1973.37$	3	—	—	for seasons
Seasons (unbiased)	$SS_7=103340.24$	3	34446.74	83.60*	
Seasons and mooses from estimation of parameters	$SS_4=105313.61$	6	—	—	
For mooses and plants from estimation of parameters	$SS_9=46834.96$	28	—	—	interaction mooses \times plants
Interaction mooses \times plants	$SS_{10}=43838.54$	75	584.52	1.42*	
Biased variation mooses \times plants	$SS_8=512573.50$	103			
For mooses (biased)	$SS_6=1973.37$	3	—	—	for plants
For plants (unbiased)	$SS_{14}=466761.59$	25	18670.46	45.31*	
For mooses and plants from estimation of parameters	$SS_9=468734.96$	28			
For seasons and plants from estimation of parameters	$SS_{16}=565532.91$	28	—	—	interaction seasons \times plants
Interaction seasons \times plants	$SS_{17}=85685.64$	75	1142.48	2.77*	
Biased variation season \times plants	$SS_{15}=651218.55$	103			

* Statistically significant differences at 0.05 level.

Table 3

Results of analysis of variance for tests with consumption of leaves.

Variation	Sums of squares	No. of degrees of freedom	S^2	F test	
3-directional biased classification	$SS_2=224777.63$	175			
Error	$SS=96231.73$	257	374.44		
General	$SS_1=321009.36$	432			
For seasons and moose from estimation of parameters	$SS_4=80457.05$	4			interaction seasons \times moose
Interaction seasons \times moose	$SS_5=10961.54$	3	3653.85	9.76*	
Bias of variation seasons \times moose	$SS_3=91418.59$	7			
For seasons (biased)	$SS_{11}=28401.57$	1	—	—	for moose
For moose (unbiased)	$SS_{12}=52055.48$	3	17351.83	46.34*	
For seasons and moose from estimation of parameters	$SS_4=80457.05$	4			
For moose (biased)	$SS_6=76746.26$	1	—	—	for seasons
for seasons (unbiased)	$SS_7=3710.79$	3	3710.79	19.91*	
For seasons and moose from estimation of parameters	$SS_4=80457.05$	4	—	—	
For seasons and moose from estimation of parameters	$SS_9=156696.82$	24	—	—	interaction moose \times plants
Interaction moose \times plants	$SS_{10}=18149.38$	63	288.08	1	
Bias of variation moose \times plants	$SS_8=174846.20$	87			
For moose (biased)	$SS_6=76746.26$	3	—	—	for plants
For plants (unbiased)	$SS_{14}=79950.56$	21	3807.17	10.17*	
For moose and plants from estimation of parameters	$SS_9=156696.82$	24			
For seasons and plants from estimation of parameters	$SS_{16}=113951.26$	22	—	—	interaction seasons \times plants
Interaction seasons \times plants	$SS_{17}=23425.73$	21	1115.99	2.98*	
Bias of variation seasons \times plants	$SS_{15}=137376.98$	43	—	—	

* Statistically significant differences at 0.05 level.

3.2. Seasonal Preference

The relative selectivity of browse twigs varied significantly between seasons. Moose consumed more twigs, and the number of browse species in the preferred group was significantly greater during winter and spring than in the summer and autumn.

Winter and spring: Browse twig selectivity by moose was fairly similar during these two seasons, although the degree of use slackened towards summer. At the peak of highest use during the winter 10 species were included in the highly preferred group. The list includes *Vaccinium vitis-idaea*, *Salix cinerea*, *Rubus idaeus*, *Pirus communis*, *Carpinus betulus*, *Alnus glutinosa*, *Vaccinium myrtillus*, *Salix caprea*, *Populus*

Table 6

Comparison of annual food preferences of red deer and moose.

Red deer		Moose	
Plant	%	Plant	%
HIGH		HIGH	
<i>Rubus idaeus</i>	60.3	<i>Vaccinium vitis-idaea</i>	84.0
<i>Vaccinium vitis-idaea</i>	59.6	<i>Vaccinium myrtillus</i>	79.4
<i>Salix caprea</i>	55.4	<i>Rubus idaeus</i>	79.4
<i>Sorbus aucuparia</i>	52.9	MEDIUM	
<i>Corylus avellana</i>	50.7	<i>Salix caprea</i>	70.1
MEDIUM		<i>Carpinus betulus</i>	68.6
<i>Calluna vulgaris</i>	46.6	<i>Vaccinium uliginosum</i>	68.4
<i>Carpinus betulus</i>	42.3	<i>Frangula alnus</i>	62.6
<i>Frangula alnus</i>	39.1	<i>Sorbus aucuparia</i>	62.3
<i>Vaccinium uliginosum</i>	38.1	<i>Calluna vulgaris</i>	57.8
<i>Vaccinium myrtillus</i>	31.2	<i>Corylus avellana</i>	56.6
LOW		<i>Pinus silvestris</i>	46.3
<i>Pinus silvestris</i>	6.1	<i>Juniperus communis</i>	30.8
<i>Juniperus communis</i>	0.0		

tremula and *Ledum palustre*. All of the above species except the latter four remained in the highly preferred group during the spring.

The number of species in the moderately preferred group increased from 11 in winter to 16 in spring — further evidence of a decline in preference with an advance in season.

Species eaten least by moose during the winter were *Oxycoccus quadripetalus*, *Fraxinus excelsior*, *Tilia cordata*, *Sarothamnus scoparius*, and *Evonymus verrucosa*. The latter three species and *Ribes nigrum* were in the low preference group during the spring.

Summer and autumn: The relative low preference of moose for browse twigs during these seasons was illustrated by the fact that only two or three plant species were classed as highly preferred whereas 6 to

9 were in the low preference group. These seasons of generally low selectivity of browse coincides with an abundance of available herbaceous and aquatic vegetation in the forest habitat.

Vaccinium uliginosum was classed as a highly preferred species only during the summer season. Other species preferred in the summer and autumn also had a high preference rating on a yearlong basis.

3.3. Animal Variation

Selectivity of a particular browse species was not always consistent among animals (Table 5). *Vaccinium vitis-idaea* was the only species preferred by all four moose. *Pirus communis* and *Vaccinium myrtillus* were preferred by three moose, *Salix cinerea*, *S. caprea* and *Carpinus betulus* by two moose, and *Rubus idaeus* by one moose. At the other end of the preference scale all four moose displayed low selectivity for twigs of *Oxyccoccus quadripetalus*, *Evonymus verrucosa*, and *Fraxinus excelsior*, three moose for *Ribes nigrum*, *Tilia cordata* and *Sarothamnus scoparius*, and two animals for *Picea excelsa* and *Juniperus communis*.

On a yearlong basis all four moose consumed 25 to 74 percent of the browse twigs from 12 to 21 species.

3.4. Comparison of Browse Preferences Between Moose and Red Deer

Data from the present study on browse preference by moose were compared to results of an investigation conducted by Dzieciolowski (1970) on browse preferences by red deer (*Cervus elaphus* L.).

Twelve browse species were common to both tests (Table 6). *Rubus idaeus* and *Vaccinium vitis-idaea* were in the preferred group for both animal species. *Salix caprea*, *Sorbus aucuparia*, and *Corylus avellana* were highly preferred by red deer and were important second choice browse for moose, whereas *Vaccinium myrtillus* was highly preferred by moose and second choice for red deer.

Calluna vulgaris, *Carpinus betulus*, *Frangula alnus*, and *Vaccinium uliginosum* were second choice, and *Pinus silvestris* and *Juniperus communis* were low choice species for both red deer and moose.

The similarity in browse preference by red deer and moose indicates that these animal species may be in direct competition for food where their ranges overlap, particularly during winter and spring.

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DOBÓR PĘDÓW ROŚLIN DRZEWIASTYCH PRZEZ ŁOSIE

Streszczenie

Wybiórczość pokarmową łosi (*Alces alces* L.) w stosunku do pędów drzew, krzewów i krzewinek 26 gatunków (Tabela 1) badano na 4 oswojonych osobnikach (3 ♂♂ i 1 ♀). Stosowano metodę jednoczesnego podawania pojedynczym zwierzętom w zagrodzie zestawów pędów trzech gatunków. W okresie od czerwca 1971 do marca 1973 r. przeprowadzono 541 testów. Wyniki opracowano metodą analizy wariancji w trójkierunkowym układzie klasyfikacji: 4 łosie × 4 pory roku × 26 gatunków roślin. Analizę przeprowadzono metodą wyznaczania stałych w drodze rozwiązania odpowiedników układów równań normalnych. Rachunki wykonano na maszynie cyfrowej ODRA 1304.

Analiza (Tabela 2) dowiodła istotnego wpływu pór roku i gatunków roślin na dobór zjadanych pędów oraz istotnego współdziałania: pory roku × łosie, łosie × rośliny oraz pory roku × rośliny. W przypadku liści (Tabela 3) analiza dowiodła statystycznie istotnego wpływu zwierząt doświadczalnych, pór roku i gatunków roślin na dobór zjadanych liści oraz istotności dwóch współdziałań: pory roku × łosie oraz pory roku × rośliny.

Spśród 26 gatunków roślin żerowych pięć (borówka brusznica, dzika jabłoń, borówka czarna, malina i wierzba szara) należało do grupy roślin wysoce preferowanych przez łosie w ciągu całego roku (Tabela 4). Grupę roślin drugiego wyboru

stanowiły: osika, wierzba iwa, grab, borówka łochynia, olsza czarna, lipa drobnolistna, kruszyna, jarzębina, bagno, brzoza omszona, wrzos, leszczyna, sosna zwyczajna, dąb szypułkowy, jałowiec pospolity i świerk (w sumie 16 gatunków). Pokarm głodowy stanowiło 5 gatunków roślin, mianowicie: jesion, żarnowiec, porzeczką czarna, żurawina i trzmielina brodawkowata.

Stwierdzono statystycznie istotną sezonową zmienność preferencji żerowych łosi w stosunku do żeru pędowego. Wiosną preferowane są: borówka brusznica, bagno, borówka czarna, olsza czarna, grab i malina, latem — jabłoń, borówka czarna i borówka łochynia, jesienią — jabłoń i borówka brusznica, natomiast zimą — borówka brusznica, wierzba szara, malina, jabłoń, grab, olsza czarna, borówka czarna, wierzba iwa, osika i bagno.

Zimą i wiosną łosie zjadają dużo pędów i preferują wiele roślin drzewiastych i krzewiastych, natomiast w okresie lata i jesieni zjadają mało pędów i ograniczają się do najbardziej smakowitych, jak borówki i dzika jabłoń.

Testowane cztery łosie charakteryzują się indywidualnymi upodobaniami żerowymi (Tabela 5), których rozmiar, jednak, nie przekreśla przydatności metody, lecz nakłada wymóg operowania kilkoma osobnikami zwierząt doświadczalnych.

Układ preferencji żerowych jelenia szlachetnego i łosia jest dość podobny (Tabela 6) i, w związku z tym, może między nimi dochodzić do bezpośredniej konkurencji o dostępne zasoby żeru pędowego.

Ustalenie szeregów preferencyjnych roślin żerowych jest traktowane jako krok wstępny do wytypowania kluczowych roślin wskaźnikowych, rozmiar użytkowania których w środowisku otwartym pozwoli na ustalenie stopnia wykorzystania potencjalnej pojemności wyżywieniowej tych środowisk.