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Foods of the Red Deer as Determined by Rumen Content Analyses*

[With 9 Tables]

The composition of red deer (*Cervus elaphus* L i n n a e u s, 1758) diet was analyzed on the basis of 110 rumen samples collected in three forest environments of lowland Poland during autumn and winter, 1964 to 1968. Of the 49 plant species found in deer rumens there were 11 trees, 8 shrubs, 4 dwarfshrubs, 5 grasses, sedges, and rushes, 4 mosses, 1 lichen, 2 ferns, 1 horsetail and 13 dicotyledonous forbs. Distinct differences were found between the composition of autumn (September—November) and winter (December—February) diets. The winter diet was characterized by a low diversity and a remarkable predominance of browse. No marked variations were noted in the diet of calves, hinds, and stags, but there were differences in food selection among the environments. The consumption of Scotts pine (*Pinus silvestris* L.) bark was a common phenomenon. The five most important food plants of red deer were *Pinus silvestris, Juniperus communis, Calluna vulgaris, Salix cinerea,* and *Vaccinium myrtillus.* They are suggested as indicator plants concerning the status and developmental trends of habitat.

I. INTRODUCTION

Studies on the composition of natural diet and food habits of animals provide an important part of research in animal ecology. When concerned with game animals the investigations are of additional significance for game management and the related fields of forest, farm, and range management.

The studies reported here characterize the composition of autumn and winter foods of red deer (*Cervus elaphus* L i n n a e u s, 1758) inhabiting managed forests in the lowland part of Poland. They also describe seasonal variations in food selection in relation to sex and age of animals, and to their environment.

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The rumen content analyses technique has been used to study the diet composition for numerous species of game: pronghorn antelope (*Antilocapra americana*) — Dirschl, 1962; 1963; elk (*Cervus canadensis*) — Murphy, 1963; mule deer (*Odocoileus hemionus* Raf.) — Wilkins, 1957; Lovaas, 1958; Taber & Dasmann, 1958; McCulloch, 1964; Anderson, Snyder & Brown, 1965; Klebenow, 1965; white-tailed deer (*Odocoileus virginianus* Zim.) — Harlow, 1961; Korschgen, 1962; Chamrad & Box, 1964; McCulloch, 1964; caribou (*Rangifer tarandus* L.) — Bergerud & Russell, 1964; and the red deer — Fišer, Hanuš & Lochman, 1958; Jensen, 1958; Eygenraam (after Crombrugghe, 1964); Brügermann, Giesecke & Kärst, 1965; Rijcken, 1965.

II. STUDY AREAS AND PROCEDURES

Samples of rumen contents were obtained from 110 deer killed during the hunting season, September 1 until the 10th or 20th of February from 1964 to 1968.

The origin of the study material is illustrated in Table 1. The sampling areas included three state forest districts in different regions of Poland.

Józefów forest district (Lublin province, 50°23′—50°32′ N and 22°56′—23°10′ E) occupies a portion of the Biłgoraj Plain in the eastern part of the Middle-Poland

Table 1.

Origin of rumen content samples.

Sampling area	Number of samples taken during the hunting season of:					Total
	1964/65	1965/66	1966/67	1967/68	1968/69	
Józefów	4	2	5	11	—	22
Pszczyna	9	1	3	5	5	23
Smolniki	34	30	—	1	—	65

Uplands. The prevalent forest site types are the fresh pine forest of pine, fir, and alder, or the boggy coniferous forest of pine and alder. The stands have a sparse understory and a scant herb layer dominated by *Calluna vulgaris, Vaccinium vitis idaea, V. myrtillus, Entodon Schreberi, Dicranum undulatum, Polytrichum commune,* and *Hylocomium splendens.*

Pszczyna forest district (Katowice province, 49°05′—50°03′ N and 18°33′—19°08′ E) is in the Oświęcim Basin of southeastern Silesia. Pine, spruce-pine, and oak-pine stands prevail. The understory layer is poorly developed, but the herb layer dominated by tall grasses and sedges is well developed.

Smolniki forest district (Olsztyn province, 53°32′—53°36′ N and 19°29′—19°31′ E) is in the Iława Lakeland area between the Vistula and Pasłęka River valleys in the western part of Mazury—Podlasie. This region has a high percentage of forest area. Within the range of moraine strips, the forests have a rather rich specific

composition. The fresh coniferous forest is the most common of the coniferous types. It occurs mainly on patches of moraine-surrounded outwash. A moist coniferous forest occupies places with a shallower level of groundwater. In the close-to-moraine portions and on moraine elevations there is a mixed coniferous and a deciduous forest. Stands in the Smolniki district are distinguished by an understory and regeneration which, when dense, eliminates the growth of herbaceous vegetation.

Botanical samples were taken from different parts of the rumen. The sample volume was 1 litre, except when the rumen volume was less than 1 litre. Samples were preserved with a 10% aqueous solution of formaldehyde. After taken into the laboratory the samples were rinsed on sieves with 2 and 4 mm mesh size. The fraction that passed through was classed as »unidentifiable remainder«. Its volume was measured in graduated cylinders. The fraction retained on both sieves was manually segregated into specific fractions. In numerous cases specific identification was impossible and then the material was classified into one of the following groups: 1) trees and shrubs, 2) dwarf-shrubs, 3) grasses, sedges, and rushes, 4) mosses and lichens, 5) ferns, lycopods, and horsetails, 6) mushrooms, 7) dicotyledonous forbs, 8) other plant material, and 9) non-plant material such as stones, insects and sand.

Table 2.

Confidence intervals for frequencies of individual plant groups in the autumnal and winter diet of red deer.

Group of food plants	Limits of confidence interval with the coefficient P = .95	
	Autumn	Winter
Trees and shrubs	0.901 — 1.000	0.903 — 1.000
Dwarf-shrubs	0.582 — 0.835	0.795 — 0.953
Grasses, sedges, and rushes	0.767 — 0.957	0.591 — 0.842
Mosses and lichens	0.309 — 0 586	0.173 — 0.422
Ferns, lycopods, and horsetails	0 284 — 0.580	0.078 — 0.292
Forbs	0.790 — 0.968	0.464 — 0.783
Mushrooms	0.000 — 0.101	0.000 — 0.066

For the portion of the red deer population taking definite types of food, the confidence interval limits for frequency of occurrence were calculated (Table 2) with the coefficient P = 0.95 (G r e ń, 1968).

Segregated food fractions were dried at 65°C for 48 hrs, and then weighed to an accuracy of 0.1 g. Volume was measured in graduated cylinders. Data were compiled according to weight percentage, volume percentage, and the percent occurrence of definite food items in a series of rumen samples.

A similar procedure of sampling, preparation, and analysis was used by: W i l k i n s, 1957; F i š e r *et al.*, 1958; J e n s e n, 1958; T a b e r & D a s m a n n, 1958; H a r l o w, 1961; D i r s c h l, 1962; K o r s c h g e n, 1962; D i r s c h, 1963; M u r p h y, 1963; B e r g e r u d & R u s s e l l, 1964; M c C u l l o c h, 1964; A n d e r s o n *et al.*, 1965; and K l e b e n o v, 1965.

III. RESULTS

1. Red Deer Diet During the Autumn and Winter

Autumn Diet

The characteristics of red deer diet during the autumn (September—November) were based on the content of 54 rumen samples (Table 3). Trees and shrubs were the most important group. They constituted more than 40% of the weight and above 39% of the volume of identified food. They were found in all samples. The most important tree species were: Scots pine, oak, and birch. Prevalent shrubs were willow, alder buckthorn, and *Berberis vulgaris*. Dwarf-shrubs comprised nearly 9% of weight and slightly above 9% of the volume of identified food. They occurred in 39 samples (72% frequency). Heather and whortleberry were most important.

Table 3.

Composition of red deer food during autumn (IX—XI) as determined on the basis of analyses of 54 samples of rumen content.

No	Plant group Genus or species	Parts consumed	Fraction > 2 mm					
			Weight		Volume		Occurrence	
			g	(%)	ml	(%)	pieces	(%)
	Trees and shrubs							
1	*Pinus silvestris* L.	bark	39.9		96.7		30	
		needles	30.0		116.0		49	
		twigs	0.8		2.6		7	
		buds	0.1		0.2		1	
			70.8	(9.2)	215.5	(8.2)	52	(96.3)
2	*Quercus* sp.	leaves	40.1		168.6		16	
		acorns	9.0		33.8		9	
		twigs	1.5		5.3		6	
			50.6	(6.6)	208.0	(7.9)	22	(40.7)
3	*Betula* sp.	leaves	6.1		39.1		7	
		twigs	3.3		12.9		11	
		bark	0.7		3.6		4	
		seed	trace		trace		1	
			10.2	(1.3)	55.6	(2.1)	16	(29.6)
	including:							
	B. verrucosa Ehrh.	leaves	(2.5)		(10.8)		(1)	
		twigs	(2.0)		(6.5)		(5)	
			(4.5)	(0.6)	(17.3)	(0.7)	(6)	(11.1)
4	*Populus* sp.	leaves	5.0		7.6		2	
		twigs	0.6		2.1		1	
			5.6	(0.7)	9 7	(0.4)	2	(3.7)
	including:							
	P. tremula L.	leaves	(0.2)	(trace)		(trace)	(1)	(1.8)

5	*Aesculus hippocastanum* L.	fruits	4.1	(0.5)	3.1	(0.1)	2	(3.7)
6	*Fagus silvatica* L.	leaves	2.2		13.3		2	
		buds	0.9		3.6		2	
			3.1	(0.4)	16.9	(0.6)	3	(5.5)
7	*Picea excelsa* (Lam.) Lk.	needles	2.1		27.9		16	
		twigs	1.0		4.5		14	
			3.1	(0.4)	32.4	(1.2)	21	(38.9)
8	*Malus silvestris* (L.) Mill.	fruits	1.0	(0.1)	3.2	(0.1)	4	(7.4)
9	*Carpinus betulus* L.	fruits	0.4	(trace)	1.1	(trace)	1	(1.8)
10	*Abies* sp.	needles	0.1	(trace)	0.5	(trace)	2	(3.7)
11	Unidentified trees	leaves	27.7		116.0		35	
		twigs	18.6		70.5		34	
		bark	12.0		36.4		21	
		needles	0.1		0.2		1	
		phloem	0.7		3.6		1	
		scales	0.1		0.3		1	
			59.2	(7.7)	227.0	(8.6)	51	(94.4)
12	*Salix* sp.	bark	33.0		62.3		3	
		twigs	4.1		12.4		8	
		leaves	3.9		3.7		2	
		phloem	1.2		5.8		1	
			42.2	(5.5)	84.2	(3.2)	13	(24.0)
13	*Frangula alnus* Mill.	seed	6.7		15.2		4	
		bark	3.7		11.9		5	
		twigs	2.6		9.2		4	
14	*Berberis vulgaris* L.	seed	11.8		23.8		7	
		twigs	0.4		1.6		3	
		bark	0.1		0.3		4	
			12.3	(1.6)	25.7	(1.0)	10	(18.5)
15	*Padus serotina* Ehrh.	leaves	5.1		14.9		1	
		fruits	0.6		2.5		1	
			5.7	(0.8)	17.4	(0.7)	1	(1.8)
16	*Juniperus communis* L.	needles	3.8		10.5		9	
		twigs	0.9		3.7		7	
			4.7	(trace)	14.2	(0.5)	12	(22.2)
17	*Cornus* sp.	leaves	0.9	(0.1)	1.8	(0.1)	1	(1.8)
18	*Cytisus* sp.	twigs	0.6		2.4		1	
		seed	0.2		0.4		1	
			0.8	(0.1)	2.8	(0.1)	1	(1.8)
19	Unidentified shrubs	twigs	11.2		40.9		20	
		bark	6.2		18.6		7	
		leaves	2.9		10.0		8	
		seed	trace		0.1		1	
			20.3	(2.7)	69.6	(2.6)	23	(42.6)
	Subtotal		309.2	(40.3)	1026.8	(39.1)	54	(100.0)
	Dwarf-shrubs							
1	*Calluna vulgaris* (L.) Salisb.	twigs	36.0		131.4		28	
		flowers	2.9		8.8		10	
		fruits	0.1		0.9		2	
			39.0	(5.1)	141.1	(5.4)	32	(59.2)

2	*Vaccinium* sp.	twigs	12.2		58.1		25	
		leaves	9.6		29.4		20	
			21.8	(2.8)	87.5	(3.3)	31	(57.4)
	including:							
	V. myrtillus L.	twigs	(12.0)		(53.1)		(24)	
		leaves	(4.0)		(10.7)		(8)	
			(16.0)	(2.1)	(63.8)	(2.4)	(25)	(46.3)
	V. vitis-idaea L.	leaves	(4.9)		(15.5)		(16)	
		twigs	(trace)		(0.2)		(1)	
			(5.0)	(0.6)	(15.7)	(0.6)	(16)	(29.6)
3	*Ledum palustre* L.	twigs	trace	(trace)	0.1	(trace)	1	(1.8)
4	Unidentified dwarf-shrubs	twigs	4.6	(0.6)	19.2	(0.7)	11	(20.4)
	Subtotal		65.4	(8.6)	247.9	(9.4)	39	(72.2)
	Grasses, sedges, and rushes							
1	*Avena sativa* L.		2.3	(0.3)	5.7	(0.4)	2	(3.7)
2	*Secale cereale* L.		trace	(trace)	trace	(trace)	1	(1.8)
3	Unidentified grasses		90.8	(11.9)	436.0	(16.6)	47	(87.0)
4	*Juncus* sp.		1.3	(0.2)	4.5	(0.2)	4	(7.4)
	Subtotal		94.4	(12.4)	450.2	(17.2)	48	(88.8)
	Mosses and lichens							
1	*Dicranum undulatum*		0.7	(0.1)	0.4	(trace)	3	(5.5)
2	*Entodon Schreberi*		0.7	(0.1)	0.4	(trace)	3	(5.5)
3	*Polytrichum* sp.		0.6	(0.1)	3.3	(0.1)	6	(11.1)
4	*Sphagnum* sp.		0.2	(trace)	0.7	(trace)	1	(1.8)
5	Unidentified mosses		1.4	(0.2)	4.7	(0.2)	11	(20.4)
6	*Cladonia* sp.		2.3	(0.3)	6.1	(0.2)	3	(5.5)
	Subtotal		5.9	(0.8)	15.6	(0.6)	24	(44.4)
	Ferns, lycopods, and horsetails							
1	*Pteridium aquilinum* (L.) Kuhn.		trace	(trace)	0.2	(trace)	1	(1.8)
2	Unidentified ferns		22.3	(2.9)	115.4	(4.4)	19	(35.2)
3	*Equisetum* sp.		0.2	(trace)	0.3	(trace)	6	(11.1)
	Subtotal		22.5	(2.9)	115.9	(4.4)	20	(37.0)
	Mushrooms							
1	Unidentified mushrooms		1.5	(0.2)	5.4	(0.2)	1	(1.8)
	Dicotyledonous forbs							
1	*Solanum tuberosum* L.		126.1	(16.5)	219.9	(8.4)	9	(16.7)
2	*Trifolium* sp.		7.5	(1.0)	22.0	(0.8)	2	(3.7)
3	*Ornithopus sativus* L.		3.5	(0.4)	17.5	(0.7)	7	(13.0)
4	*Lupinus polypjyllus* Ldl.		2.2	(0.3)	8.6	(0.3)	1	(1.8)
5	*Polygonum dumentorum* L.		1.2	(0.2)	4.6	(0.2)	7	(13.0)
6	*Polygonatum odoratum* (Mill.) Druce		0.2	(trace)	0.5	(trace)	2	(3.7)
7	*Papilionaceae*		0.2	(trace)	0.5	(trace)	1	(1.8)
8	*Cirsium* sp.		0.1	(trace)	1.1	(trace)	1	(1.8)
9	*Veronica* sp.		trace	(trace)	0.2	(trace)	1	(1.8)
10	*Compositae*		trace	(trace)	0.4	(trace)	1	(1.8)
11	*Hieracium pilosella* L.		trace	(trace)	0.3	(trace)	1	(1.8)
12	*Stellaria* sp.		trace	(trace)	trace	(trace)	1	(1.8)
13	*Bidens* sp.		trace	(trace)	trace	(trace)	1	(1.8)
14	Unidentified forbs		125.0	(16.3)	486.7	(18.6)	47	(87.0)
	Subtotal		266.4	(34.8)	762.3	(29.1)	49	(90.7)
	Total fraction > 2 mm		765.3	(100.0)	2624.1	(100.0)	54	(100.0)
	Unidentified remainder > 2 mm		301.9		1507.2		43	(79.6)
	Grant total		1067.2		4131.3		54	

Grasses, sedges, and rushes were above 12% by weight and above 17% by volume of the food identified. They occurred in 48 samples (89% frequency). Because of difficulties in identification the majority of material in this group was classed as »unidentifiable grasses«.

Mosses and lichens were only 0.8% by weight and 0.6% by volume of the food identified. They were found in 24 rumen samples (44% frequency). Ferns, lycopods, and horsetails were almost 3% by weight and more than 4% by volume of the material identified. They occurred in 20 rumen samples (37%). Unidentified ferns constituted the greatest fraction. Mushrooms occurred in one sample to the extent of 1.5% by weight and 0.2% by volume of the whole material identified.

Forbs were an important contribution to autumn diet as shown by the following values: almost 35% by weight, 29% by volume, and 91% frequency. Potato tubers from farm land and, to a slight extent, from artificial feeding, were the main components of this group.

In general, the autumn diet of red deer was composed mainly of trees and shrubs, dicotyledons, grasses, sedges, and rushes, and dwarf-shrubs. In total they comprised above 96% by weight and 95% by volume of the material identified.

Winter Diet

The composition of red deer diet during winter (December—February) was based on the content of 56 rumen samples (Table 4). As in autumn, the trees and shrubs were the dominant group of red deer food plants. They represent not less than 78% by weight and 78% by volume of the identified material, and they occurred in all 56 samples. The main tree

Table 4.

Composition of red deer diet during winter (XII—II) as determined on the basis of analyses of 56 samples of rumen contents.

No	Plant group Genus or species	Parts consumed	Fraction > 2 mm					
			Weight		Volume		Occurrence	
			g	(%)	ml	(%)	pieces	(%)
	Trees and shrubs							
1	*Pinus silvestris* L.	needles	249.3		861.2		55	
		bark	73.2		209.3		53	
		twigs	28.4		115.1		43	
		buds	2.0		7.4		15	
			352.9	(34.8)	1193.0	(34.3)	56	(100.0)
2	*Betula* sp.	twigs	26.4		118.6		15	
		bark	6.6		25.9		11	
		phloem	0.2		1.0		1	
		seed	0.1		0.2		3	
		leaves	trace		0.2		1	
		flowers	trace		0.2		1	
			33.3	(3.3)	140.1	(4.2)	18	(32.1)

	including:						
	B. verrucosa Ehrh.	twigs	(16.4)		(57.6)	(8)	
		bark	(2.7)		(8.6)	(5)	
		flowers	(trace)		(0.2)	(1)	
			(19.1)	1.9	(66.4)	(1.9)	(9) (16.1)
3	*Quercus* sp.	acorns	5.2		19.5	2	
		leaves	1.1		3.5	5	
			6.3	(0.6)	23.0	(0.7)	7 (12.5)
4	*Picea excelsa* (Lam.) Lk.	needles	2.9		10.2	8	
		twigs	2.5		8.6	8	
		bark	0.1		trace	1	
			5.5	(0.5)	18.8	(0.5)	11 (19.6)
5	*Carpinus betulus* L.	fruits	0.5	(0.1	1.2	(trace)	1 (2.0)
6	*Fraxinus excelsior* L.	phloem	0.4	(trace)	2.0	(0.1)	1 (2.0)
7	*Abies* sp.	needles	0.1	(trace)	0.3	(trace)	1 (2.0)
8	Unidentified trees	twigs	56.4		214.4	33	
		bark	13.7		42.7	12	
		needles	1.5		4.5	4	
		leaves	0.3		0.7	9	
		roots	trace		0.1	1	
			71.9	(7.1)	262.4	(7.5)	38 (67.8)
9	*Juniperus communis* L.	needles	206.7		610.2	48	
		twigs	48.6		182.8	33	
		bark	2.8		8.6	12	
			258.1	(25.4)	801.6	(23.0)	50 (89.3)
10	*Salix* sp.	bark	17.0		79.4	6	
		phloem	5.1		34.0	1	
		twigs	1.1		6.5	1	
			23.2	(2.3)	119.9	(3.4)	7 (12.5)
	including:						
	S. cinerea L.	bark	(13.2)		(68.0)	(4)	
		twigs	(1.1)		(6.5)	(1)	
			(14.3)	(1 4)	(74.5)	(2.1)	(5) (8.9)
11	*Frangula alnus* Mill.	bark	0.6		2.0	4	
		twigs	0.3		1.0	4	
			0.9	(0.1)	3.0	(0.1)	6 (10.7)
12	*Berberis vulgaris* L.	seed	0.2		0.5	1	
		twigs	trace		trace	1	
			0.2	(trace)	0.5	(trace)	2 (3.6)
13	*Corylus avellana* L.	catkins	0.1		0.4	1	
		buds	0.1		0.3	2	
			0.2	(trace)	0.7	(trace)	3 (5.4)
14	Unidentified shrubs	twigs	35.7		125.9	26	
		bark	4.6		12.5	4	
		needles	1.0		3.0	3	
		seed	0.6		1.7	3	
		roots	trace		0.1	1	
		leaves	trace		0.1	1	
			41.9	(4.1)	143.3	(4.1)	28 (50.0)
	Subtotal		795.5	(78.5)	2715.8	(78.0)	56 (100.0)

	Dwarf-shrubs							
1	*Calluna vulgaris* (L.) Salisb.	twigs	43.8		181.6		34	
		flowers	4.3		19.4		15	
		seed	0.2		0.9		1	
			53.3	(5.3)	201.9	(5.8)	34	(60.7)
2	*Vaccinium* sp.	twigs	44.3		162.5		33	
		leaves	3.6		15.7		23	
			47.9	(4.7)	178.2	(5 1)	40	(71.4)
	including:							
	V. myrtillus L.	twigs	(41.4)		(151.7)		(31)	
		leaves	(0.4)		(2.3)		(3)	
			(41.8)	(4.1)	(154.0)	(4.4)	(31)	(55.4)
	V. vitis-idaea L.	leaves	(2.4)		(12.5)		(21)	
		twigs	(0.1)		(0.3)		(2)	
			(2.5)	(0.2)	(12.8)	(0.4)	(22)	(39.2)
3	*Ledum palustre* L.	twigs	trace	(trace)	0.2	(trace)	1	(2.0)
4	Unidentified dwarf-shrubs	twigs	14.1		56.3		11	
		fruits	0.1		0.3		1	
			14.2	(1.4)	56.6	(1.6)	11	(19.6)
	Subtotal		115.4	(11.4)	436.9	(12.6)	50	(89.3)
	Grasses, sedges, rushes							
1	*Avena sativa* L.		9.8	(1.0)	41.8	(1.2)	8	(14.3)
2	*Hordeum vulgare* L.		0.2	(trace)	1.0	(trace)	1	(2.0)
3	*Festuca* sp.		trace	(trace)	trace	(trace)	1	(2.0)
4	Unidentified grasses		35.5	(3.5)	115.5	(3 3)	41	(73.2)
5	*Juncus* sp.		1.9	(0.2)	7.1	(0.2)	2	(3.6)
	Subtotal		47.4	(4.7)	165.4	(4.8)	41	(73.2)
	Mosses and lichens							
1	*Entodon Schreberi*		0.3	(trace)	0.7	(trace)	3	(5.4)
2	*Polytrichum* sp.		0.3	(trace)	0.8	(trace)	2	(3.6)
3	*Dicranum undulatum*		0.2	(trace)	0.5	(trace)	4	(7.1)
4	*Sphagnum* sp.		trace	(trace)	0.1	(trace)	1	(2.0)
5	Unidentified mosses		1.0	(0.1)	3.9	(0.1)	15	(26.8)
6	*Cladonia* sp.		23.6	(2.3)	62.0	(0.8)	8	(14.3)
	Subtotal		25.4	(2.5)	68.0	(2.0)	16	(28.6)
	Ferns, lycopods, horsetails							
1	*Dryopteris spinulosa* (Müll.) O. Kuntze		1.4	(0.1)	11.2	(0.3)	1	(2 0)
2	*Pteridium aquilinum* (L.) Kuhn.		0.3	(trace)	1.1	(trace)	1	(2.0)
3	Unidentified ferns		6.7	(0.7)	20.9	(0.6)	9	(16.1)
	Subtotal		8.4	(0.8)	33.2	(1.0)	9	(16.1)
	Dicotyledonous forbs							
1	*Brassica* sp.		7.4	(0.7)	21.8	(0.6)	1	(2.0)
2	*Solanum tuberosum* L.		trace	(trace)	0.1	(trace)	2	(3.6)
3	*Melampyrum pratense* L.		trace	(trace)	trace	(trace)	2	(3.6)
4	Unidentified forbs		14.5	(1.4)	38.9	(1.1)	31	(55.4)
	Subtotal		21.9	(2.2)	60.8	(1.8)	34	(60.7)
	Total fraction > 2 mm		1014.1	(100.0)	3480.1	(100.0)	56	(100.0)
	Unidentified remained > 2 mm		314.1		1418.1		44	
	Grand total		1328.2		4898.2		56	

species were Scots pine and birch. The most important shrubs were juniper and willow (mainly osier). Dwarf-shrubs comprised 11% by weight and almost 13% by volume. They occurred in 50 rumen samples (89%) from the winter series. Thus, their use in winter was greater than in autumn. Heather and whortleberry were again the most important species.

The proportion of grasses, sedges, and rushes in red deer diet decreased, when compared with autumn, to less than 5% by weight and 5% by volume of the material identified. They occurred in 41 rumen samples (73%). The majority of material in this group was »unidentified grasses«.

The use of mosses and lichens increased in winter. They constituted 2.5% by weight and almost 2% by volume of the diet and were found in 16 rumen samples (29% frequency). Lichens from the genus *Cladonia* were most important in this group. Ferns, lycopods, and horsetails were eaten less in winter than in autumn. They contributed only 0.8% by weight and 1% by volume of the material identified and they occurred in 9 rumen samples (16% frequency). Unidentified ferns comprised the greatest fraction. Mushrooms were absent in the winter samples.

Forbs showed the greatest decline in their proportion of winter diet when compared with autumn. Their contribution in winter was only 2% by weight and 2% by volume of the material identified. They occurred in 24 rumen samples (61%).

Generally, the winter diet of red deer consisted principally of trees and shrubs and dwarf-shrubs. These two groups comprised 90% by weight and 91% by volume of the material identified. This shows a marked reduction in the diversity of winter food when compared with the autumn diet and is obviously a result of phenological changes. Browse was decidedly the main component in the winter diet of red deer.

2. Red Deer Diet in Relation to Sex and Age

The results of rumen content analyses for red deer calves of both sexes (21 samples), hinds (58 samples), and stage (31 samples) are shown in table 5.

Red Deer Calves

Trees and shrubs were the most important group of food plants for red deer calves. They comprised above 57% by weight and by volume of the material identified and they occurred in all samples (100% frequency). The most important tree species were: Scots pine, oak, and horse chestnut. The predominant shrubs were juniper, *Berberis vulgaris*,

and alder buckthorn. Dwarf-shrubs comprised over 16% by weight and almost 17% by volume of the identified food in 19 rumen samples (above 90% frequency). Heather, whortleberry, and *Vaccinium vitis-idaea* were the most important plants.

Grasses, sedges, and rushes were more than 7% by weight and almost 7% by volume of the food identified in 15 rumen samples (above 71% frequency).

Mosses and lichens contributed nearly 3% of diet by weight and over 2% by volume. They were found in 8 rumen samples (38% frequency). Lichens from the genus *Cladonia* were the most important plants from this group. Ferns, lycopods, and horsetails were found in trace quantities (0.1% by volume) in 3 rumen samples (14% frequency).

Table 5.

Comparison of diet composition in red deer according to the percentual proportion of individual plant groups in rumen content samples.

Group of plants	Group of red deer								
	Calves			Hinds			Stags		
	Wt.	Vol.	F*	Wt.	Vol.	F*	Wt.	Vol.	F*
Trees and shrubs	57.1	57.2	100.0	65.0	66.4	100.0	58.3	52.4	100.0
Dwarf-shrubs	16.5	16.7	90.5	10.8	12.1	91.4	5.7	7.0	54.8
Grasses, sedges, rushes	7.4	9.5	71.4	6.0	7.9	82.7	12.5	14.9	83.9
Mosses and lichens	2.6	2.4	38.1	1.7	1.3	25.9	1.1	1.0	54.8
Ferns, lycopods, horsetails	trace	0.1	14.3	1.3	2.2	22.4	3.5	3.9	41.9
Dicotyledonous forbs	16.4	14.1	80.9	15.2	10.1	69.0	18.6	20.5	84.0
Mushrooms	—	—	—	—	—	—	0.3	0.3	3.2
Total	100.0	100.0	—	100.0	100.0	—	100.0	100.0	—

*) F — frequency

Forbs were an important source of food for red deer calves. Their contribution to diet was more than 16% by weight and 14% by volume. Their frequency of occurrence was 81%. The most important plants were farm crops such as potatos, clover, and bird's-foot.

Generally, the diet of calves consisted mainly of trees and shrubs, dwarf-shrubs, and forbs. In total they comprised 90% by weight and 88% by volume of the material identified.

Red Deer Hinds

Trees and shrubs were the most important food plants for hinds. They made up 65% by weight and above 66% by volume of the material identified, and occurred in all 58 samples. The most important tree species

were Scots pine, birch (mainly common birch), and oak. The main shrubs were juniper and willow (50% gray willow). Dwarf-shrubs comprised nearly 11% by weight and over 12% by volume of the material identified. They were found in 53 samples (91% frequency). Heather and whortleberry were the most prevalent.

Grasses, sedges, and rushes comprised 6% by weight and nearly 8% by volume of the material identified. They occurred in 48 samples (83% frequency). Oats were most common among the identified items.

Mosses and lichens comprised less than 2% by weight and slightly more than 1% by volume of the material identified. They were found in 15 samples (26% frequency). The genus *Cladonia* was the only important item in this group. Ferns, lycopods, and horsetails contributed slightly more than 1% by weight and 2% by volume of the material identified, and were found in 13 rumen samples (22% frequency).

Forbs were more than 15% by weight and 10% by volume of the material identified. They occurred in 40 rumen samples (69% frequency). Potatoes, clover, and lupine were the most important items in this group.

Generally, the diet of hinds, as in the case of calves, consisted mainly of trees and shrubs, dwarf-shrubs, and dicotyledons. Together they provided for 91% by weight and 89% by volume of the identified material.

Red Deer Stags

Trees and shrubs were also the most important group of food plants for stags. This group comprised over 58% by weight and over 52% by volume of the material identified. It occurred in all 31 rumen samples (100% frequency). The Scots pine and oak trees and the juniper and willow shrubs were the most important food plants. Dwarf-shrubs comprised almost 6% by weight and 7% by volume of the material identified. They occurred in 17 samples (55% frequency). Heather and whortleberry were the most important.

Grasses, sedges, and rushes provided for 12% by weight and nearly 15% by volume of the material identified. They occurred in 26 rumen samples (84% frequency). Oats, as with the hinds, was the most common of the few identified items.

Mosses and lichens contributed little more than 1% by weight and 1% by volume of the material identified. They were found in 17 samples (55% frequency). Ferns, lycopods, and horsetails comprised almost 4% by weight and 4% by volume of the material identified, and were found in 13 rumen samples (42% frequency).

Fragments of mushrooms were found in only one sample. When compared with the total series, the proportion of mushrooms was negligible

(0.3% by weight, 0.3% by volume, 3% frequency). Forbs ranked second to trees and shrubs as a source of food for red deer stags. Their proportion in diet was 19% by weight and 20% by volume of the material identified. They occurred in 26 rumen samples (84% frequency). As with calves and hinds, farm crops were the most important foods in this group.

In general, the red deer stag diet consisted mainly of trees and shrubs, grasses, sedges, and rushes, and forbs. These plants comprised over 89% by weight and almost 88% by volume of the material identified in the 31 rumen samples. In contrast to the diet of calves and hinds, the dwarf--shrubs were not the most important component of stag diet. Usually they were replaced by grasses and graminids.

3. Red Deer Diet in Relation to Environment

Trees and shrubs were the most important food plants in all three environments. They constituted 62% of weight and over 61% of volume of the material identified and they occurred in all of the 110 rumen samples (Table 6). The highest proportion of food from trees and shrubs was in the poorest environment of Józefów, the intermediate proportion was in the richest environment of Smolniki, and the lowest was in moist sites of Pszczyna. In general the group shows a moderate variation among environments in its proportion of red deer diet. Dwarf-shrubs varied slightly between environments in their contribution to red deer diet. As with trees and shrubs the highest proportion of dwarf-shrubs was in the poorest environment of Józefów, the mean proportion in Pszczyna, and the lowest was in the rich environment of Smolniki. Their mean frequency of occurrence was 81%.

Grasses, sedges, and rushes varied widely among environments in their contribution to red deer diet. Their proportion was high in the moist environment of Pszczyna, where they ranked second in importance to trees and shrubs as a deer food. Their proportion was intermediate in the fertile sites of Smolniki, and low in the poor environment of Józefów. Their mean frequency, in spite of the variation mentioned, was high (81%).

The contribution of mosses and lichens to deer diet also varied considerably among environments. The proportion was relatively very high in the poor environment of Józefów but low in the other environments. Their average frequency was 36%. The inconsistency among environments was likewise shown in the red deer diet of ferns, lycopods, and horsetails. Their proportion of diet was highest at Pszczyna. The proportion was low at Smolniki. Occasionally, one was found in samples from Józefów. The average frequency of these plants in rumen samples was

Table 6.

Comparison of diet composition in red deer from the three habitats based on the percentual proportion of individual plant groups in rumen content samples.

Group of plants	Józefów			Pszczyna			Smolniki			General		
	Wt.	Vol.	F.*	Wt.	Vol.	F.*	Wt.	Vol.	F.*	Wt.	Vol.	F.*
Trees and shrubs	73.5	77.7	100.0	53.3	47.2	100.0	60.5	59.2	100.0	62.0	61.3	100.0
Dwarf-shrubs	12.3	11.2	86.4	10.4	11.0	73.9	9.4	11.3	81.5	10.2	11.2	80.9
Grasses, sedges, rushes	4.6	4.3	68.2	17.9	22.9	91.3	6.7	8.7	81.5	8.0	10.1	80.9
Mosses and lichens	7.5	5.1	54.5	0.4	0.4	52.2	0.2	0.2	24.6	1.8	1.4	36.4
Ferns, lycopods, horsetails	0.0	0.0	9.1	7.6	10.4	4.3	0.9	1.1	24.6	1.7	2.4	26.4
Dicotyledonous forbs	2.1	1.7	68.2	9.8	7.6	69.6	22.3	19.5	80.0	16.2	13.5	75.4
Mushrooms	0.0	0.0	0.0	0.6	0.5	4.3	0.0	0.0	0.0	0.1	0.1	0.9
Total	100.0	100.0	—	100.0	100 0	—	100.0	100.0	—	100.0	100.0	—

*) F — frequency.

low (26%). Mushroom consumption was negligible, and confined exclusively to the moist environment of Pszczyna.

Forbs were second in importance to trees and shrubs as food plants in the cross-section of the three environments. The proportion of forbs in red deer diet varied considerably between environments, being highest at Smolniki, intermediate at Pszczyna, and negligible at Józefów. The mean frequency of forbs in the rumen samples was 75%.

IV. DISCUSSION

Botanical, chemical, and microbiological techniques have been used jointly or separately in stomach content analyses. The botanical method is most frequently used, and has been the subject of numerous papers (Norris, 1943; Martin, 1960; Dirschl, 1962; Bergerud & Russell, 1964; Chamrad & Box, 1964). The two remaining techniques are still at the introductory stage (Klein, 1962; Brügermann, Giesecke & Kärst, 1965).

The botanical method of rumen content analysis gives a reliable qualitative characteristic of food composition, and provides data for a listing of species consumed. This is especially important in the case of tiny plants which are often overlooked in other techniques of sampling such as animal observation.

Diet estimates from botanical analysis have been shown to differ considerably from known rumen contens of animals experimentally fed and sacrified (Norris, 1943; Bergerud & Russell, 1964). The differences were attributed to variation in digestion of several kinds of food. Rates of digestion cause two serious errors in determining the quantitative composition of food in the rumen: plants are not proportionately represented in the greater (identified) and smaller (unidentified) fractions, and the identifiable fragments of certain plants disappear more rapidly than others. Thus, the quantitative comparison between plant groups are only rough indications and should be complemented with other techniques.

Labor is another serious drawback of botanical analysis (Jensen, 1958). In my studies the analysis of one rumen sample required more than 50 man-hours. To reduce the labor of segregating samples into fractions, Dirschl (1962) tested sieves of three mesh sizes: 5.66 mm, 4.00 mm, and 2.83 mm. He concluded that mesh size did not affect the results of the analysis but the larger mesh reduced time consumption by more than 50% when compared to the sieve with the smallest mesh. Dirschl (1962) also found that collective percents for volume and weight of specific food fractions were quite similar in the botanical ana-

lyses. However, the analyses of rumen samples showed that the volumetric measure gave slightly more variable results than the weight measure and tended to underestimate the proportion of plants occurring in small quantities. My experience confirms these conclusions. Martin (1960) suggests the joint use of three measures in stomach content analyses: volumetric percents, representation of important food components, and occurrence of all individual food components.

When food is consumed by deer under conditions of free choice, it can be assumed that the food component of greatest proportion in the rumen represents a preferred food. The analysis of rumen contents prove the usefulness of maintaining a diversity of life forms of plants available for red deer. No single kind of food (except trees and shrubs as a group and Scots pine as an individual plant) was dominant during autumn and winter.

Table 7.

Comparison of the ten most important components of the autumnal and winter diet according to their percentual proportion in the weight of rumen sample series examined.

Autumn		Winter	
Food component	Wt., %	Food component	Wt., %
Solanum tuberosum	16.5	*Pinus silvestris*	34.8
Pinus silvestris	9.2	*Juniperus communis*	25.4
Quercus sp.	6.6	*Calluna vulgaris*	5.3
Salix sp.	5.5	*Vaccinium myrtillus*	4.1
Calluna vulgaris	5.1	*Betula* sp.	3.3
Vaccinium myrtillus	2.1	*Cladonia* sp.	2.3
Frangula alnus	1.8	*Salix* sp.	2.3
Berberis vulgaris	1.6	*Avena sativa*	1.0
Betula sp.	1.3	*Brassica* sp.	0.7
Trifolium sp.	1.0	*Quercus* sp.	0.6
Total	50.7	Total	79.8

A comparison, by weight, of the 10 most important components of deer food show that the autumn diet was relatively much more diversified than the winter diet (Table 7). The ten most important autumn foods comprised slightly more than half of the identified material, whereas, the 10 most important winter foods provided nearly 80 % of the identified material. Red deer food during these two seasons was not too diversified. Out of 14 species providing red deer with fundamental food, not less than 6 occurred in both the autumn and winter diet. In descending order of importance they were *Pinus silvestris, Calluna vulgaris, Salix* sp., *Quercus* sp., *Vaccinium myrtillus,* and *Betula* sp. The autumn diet con-

tained numerous deciduous species (oak, willow, alder buckthorn, *Berberis*, birch) and farm crops (potatoes, clover). The winter diet was mainly twigs of coniferous trees and shrubs (pine, juniper), dwarf-shrubs, and artificial fodder (oats, cabbage).

Seasonal differences in red deer diet coincided with the relative availability of food. This is shown by the decline in the proportion of deciduous species in red deer diet from autumn to winter. Jensen (1958) found a high proportion of coniferous tree twigs but a low percentage of deciduous tree twigs in the winter diet of red deer in Denmark. Willow (*Salix repens*) was important in autumn. Heather was a fundamental food (30%) throughout autumn and winter. Mushrooms were important in autumn. Lichens were found in almost all rumens during the autumn--winter period, averaging 10% of diet. *Cladonia* sp. was the most important lichen. Ferns occurred in quite low quantities in a few rumen samples during autumn. Grasses and graminids were important as red deer foods, but were frequently impossible to identify. Grasses constituted an average 50% of rumen contents. The most important was *Deschampsia flexuosa* (33%). Other grasses were *D. caespitosa*, *Holcus lanatus*, and *Festuca ovina*. *Carex* sp. and *Luzula pilosa* were the main graminids. Jensen's results from the poor heathland and coniferous forest sites of Jutland indicate similar seasonal trends to those shown in Tables 3 and 4. McCulloch (1964) indicated that seasonal differences in white-tailed and mule deer diet do not reflect the relative availability of food. During late autumn and at the end of winter, grasses were consumed in quantities unrelated to their abundance in the environment. High shrubs provided the most available food in the annual cycle, but they were neglected by deer when other kinds of food were readily accessible. In each season, an average of not more than 3 to 4 species provided the major bulk of the rumen contents. In New Mexico, Anderson *et al.* (1965) found that juniper had the highest total frequency and smallest variation and was the most important food item in mule deer diet from January until March. Oaks were the main source of food from April until December. Deer showed a distinct preference for leaves over the shoots of oak (*Quercus undulata*). Until recently, however, the measurement of shoots was a commonly used index of woody plant utilization.

There were no significant differences in the selection of major food items according to the age and sex of red deer (Table 8). Food selection by calves was almost identical to that of hinds. The stags' diet varied slightly from that of hinds and calves. Among 15 plant species providing the staple food of red deer not less than 6 occurred in the diet of all sex and age classes. In descending order of importance they were *Pinus silvestris*, *Juniperus communis*, *Solanum tuberosum* (tubers), *Calluna vul-*

garis, Vaccinium myrtillus, and *Quercus* sp. Stag diet was more diversified than diet of females and calves.

F i š e r *et al.* (1958) studied the diet of red deer stags during and after the rut. The rumen content of males in rut was small and unusual. The major part (53%) constituted materials with very low or no nutritive value (dry grass, dead needles, dry spruce twigs, dried leaves), or pebbles and sand. In red deer killed during the rut, but not taking part in it, green material was 93% of the total contents. The authors concluded that males in rut restrict their food consumption, and the content in rumens is taken exclusively as a ballast. In my study a negligible filling of stomachs was frequently observed in red deer stags killed during the rut.

Table 8.

Comparison of the ten most important components in the diet of red deer according to their percentual share in the weight of rumen contents identified.

Calves		Hinds		Stags	
Component	Wt., %	Component	Wt., %	Component	Wt., %
Pinus silvestris	21.5	*Pinus silvestris*	27.3	*Pinus silvestris*	17.3
Juniperus communis	15.2	*Juniperus communis*	14.8	*Juniperus communis*	14.4
Calluna vulgaris	8.6	*Solanum tuberosum*	9.2	*Salix* sp.	6.8
Solanum tuberosum	7.0	*Calluma vulgaris*	5.3	*Quercus* sp.	4.6
Vaccinium myrtillus	5 4	*Betula* sp.	3.5	*Calluna vulgaris*	3.2
Cladonia sp. div.	2.6	*Vaccinium myrtillus*	3.4	*Solanum tuberosum*	2.5
Berberis vulgaris	2.1	*Salix* sp.	3.0	*Vaccinium myrtillus*	1.8
Quercus sp.	2.0	*Quercus* sp.	2.8	*Brasica* sp.	1.5
Frangula alnus	1.7	*Cladonia* sp. div.	1.7	*Avena sativa*	1.0
Aesculus hippocastanum	1.6	*Frangula alnus*	0.9	*Betula* sp.	0.9
Total	67.7	Total	71.9	Total	54.0

The bark of Scots pine occurred in 30 rumen samples from autumn and in 53 winter samples. This contribution is very high, especially in winter, and differs from values reported by J e n s e n (1958) and R i j c k e n (1965). J e n s e n (1958) found only small quantities of bark in rumens of Danish red deer despite the occurrence of bark peeling in the sampling area. In a rumen analyses of red deer from Veluve (Netherlands) R i j c k e n (1965) showed that very few individuals consumed bark even in areas where bark peeling was severe. He suggested the possibility that a few animals specialize in peeling the bark off trees. M c C u l l o c h (1964) compared the rumen contents of two mule deer calves and two white-tailed deer calves with a large series of samples from adults. The content of calf rumens appeared similar to the majority of adult deer killed in late autumn. The volumetric proportion of herbs

was more than twofold greater than the fibrous foods in rumens of does at the beginning stage of pregnancy.

A comparison, by weight, of the 10 most important components in the autumn and winter diet of red deer in the three environments is shown in table 9. Qualitative differences in food selection were slight and concerned mainly those species with minor quantitative significance. In descending order of importance the five species most important to red deer in all the three environments were *Pinus silvestris*, *Juniperus communis*, *Calluna vulgaris*, *Salix* sp. (mainly *S. cinerea*), and *Vaccinium* sp. *Vaccinium vitis-idaea* was the most frequently eaten *Vaccinium* in Józefów, but in Pszczyna and Smolniki it was replaced by whortleberry.

Table 9.

Comparison of the ten most important components in the diet of red deer from the three environments according to their percentual share in the weight of rumen contents.

Józefów		Pszczyna		Smolniki	
Component	Wt., %	Component	Wt., %	Component	Wt., %
Pinus silvestris	39.4	*Pinus silvestris*	16.9	*Pinus silvestris*	20.5
Juniperus communis	15.6	*Salix* sp.	9.2	*Juniperus communis*	17.9
Calluna vulgaris	10.5	*Vaccinium* sp. (mainly *V. myrtillus*)	5.5	*Solanum tuberosum*	11.1
Cladonia sp. div.	7.0	*Calluna vulgaris*	4.8	*Vaccinium* sp.(mainly *V. myrtillus*)	4.3
Salix sp.	5.6	*Aesculus hippocastanum*	1.6	*Quercus* sp.	4.0
Betula sp.	4.3	*Picea excelsa*	1.4	*Calluna vulgaris*	3.5
Vaccinium sp. (mainly *V. vitis-idaea*)	1.7	*Junus* sp.	1.2	*Betula* sp. (mainly *B. verrucosa*)	2.4
Padus serotina	1.5	*Fungi* sp. div.	0.6	*Salix* sp. (mainly *S. cinerea*)	1.8
Avena sativa	1.5	*Dryopteris spinulosa*	0.5	*Berberis vulgaris*	1.1
Frangula alnus	0 8	*Juniperus communis*	0.2	*Frangula alnus*	1.0
Total	87.9	Total	41.1	Total	67.6

The composition of red deer diet in Józefów was similar to that in Smolniki. *Betula* sp. (mainly *B. verrucosa*) and *Frangula alnus* constituted a staple food in both environments. From among the 19 most important species, not less than 7 were common components of deer diet. Plants consumed in quantities exclusively in Józefów were: *Cladonia* sp. div., *Padus serotina*, and *Avena sativa* (artificial feeding). *Aesculus hippocastanum* (fruits), *Picea excelsa* (needles), *Juncus* sp., and *Dryopteris spinulosa* comprised the specific food of red deer in Pszczyna. In Smolniki the main foods were *Solanum tuberosum* (tubers from feeding places), *Quercus* sp. (leaves), and *Berberis vulgaris* (fruits).

The fundamental framework of the autumn and winter diet of red deer is composed of the five species consumed in all three environments. Józefów and Smolniki indicate great similarity in diet composition. The diet of red deer in Pszczyna shows the greatest distinctions, but, even here, five species constitute the fundamental items. Within environments, the least differentiation in red deer diet was in Józefów. Here the 10 most important items comprised not less than 86% by weight of the whole material identified. In Smolniki 10 items comprised 68% of the material identified. The greatest differentiation of food was found in Pszczyna where the 10 most important items comprised only 42% of the material identified in rumens. *Pinus silvestris, Juniperus communis, Calluna vulgaris, Salix cinerea,* and *Vaccinium myrtillus,* the five species most frequently consumed in various habitats, might be considered as indicatory plants according to Korschgen's (1962) concept. The degree of use for these species may reveal the condition and trends of change in vegetation. Excessive utilization would indicate an unfavourable trophic situation for the herbivore population.

The diet of red deer in poor habitats of Veluve (Crombrugghe, 1964) does not deviate much from that of red deer in this study. Among the plant species listed by Crombrugghe, four occurred in each of my three diet lists. In Florida, Harlow (1961) found entirely different proportions of fruits, twigs of trees and shrubs, herbs, mushrooms, grasses and sedges in each of three habitats. Of the plant species occurring in the area of sampling only 18% were found in deer rumens by McCulloch (1964). Some of the most common plants were seldom or never found in deer rumens, whereas certain rare plants occurred frequently or in large quantities.

The ratio between the unidentified and identified material in fractions greater than 2 mm was 28% by weight and 36% by volume for the autumn rumen samples, and 24% by weight and 29% by volume for the winter samples. These are considered far better ratios than those cited by Jensen (1958).

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POKARM JELENI SZLACHETNYCH USTALONY METODĄ ANALIZ TREŚCI ŻWACZY

Streszczenie

Na terenie trzech obwodów leśnych położonych w nizinnej Polsce zebrano w ciągu 4 sezonów polowań (wrzesień — luty) materiał 110 próbek treści żwaczy jeleni szlachetnych (*Cervus elaphus* L.) (Tabela 1). Starano się doprowadzić oznaczenie roślin pokarmowych do gatunku, lecz w wielu przypadkach możliwe było jedynie zaklasyfikowanie do jednej z następujących grup: 1) drzewa i krzewy, 2) krzewinki, 3) trawy, turzyce i sity, 4) mchy i porosty, 5) paprocie, widłaki i skrzypy, 6) grzyby, 7) dwuliścienne zioła (w tym rośliny uprawne), 8) inne.

Charakterystykę składu pokarmu jeleni opartą na analizach próbek treści żwaczy przeprowadzono w trzech klasyfikacjach, mianowicie w zależności od: 1) pór roku (jesień i zima) (Tabele 3, 4, 7), 2) płci i wieku zwierząt (cielęta, łanie i byki) (Tabele 5 i 8) oraz 3) środowiska (Józefów, Pszczyna, Smolniki) (Tabele 6 i 9).

Analiza botaniczna 110 próbek treści żwaczy jeleni wykazała występowanie 49 rodzajów i gatunków roślin, w tym 11 drzew, 8 krzewów, 4 krzewinek, 5 traw, turzyc i sitów, 4 mchów, 1 porostu, 2 paproci, 1 skrzypu i 13 dwuliściennych roślin zielnych.

Stwierdzono istotne zróżnicowanie w składzie pokarmu jeleni pomiędzy dwoma porównywanymi porami roku (Tab. 2). Zimowy pokarm w odróżnieniu od jesiennego odznaczał się małą rozmaitością i znaczną przewagą żeru włóknistego.

Dobór pokarmu przez cielęta i łanie był niemal identyczny, natomiast skład pokarmu samców wykazywał nieznaczne różnice.

Dwie grupy roślin: 1) drzewa i krzewy oraz 2) krzewinki wykazują stosunkowo niewielką zmienność udziału w pokarmie jeleni w zależności od środowiska. Udział pozostałych grup wykazywał znaczną zmienność w obrębie trzech porównywanych środowisk.

Stwierdzono, że zjadanie kory sosny zwyczajnej było zjawiskiem powszechnym wśród zbadanej próbki populacji jeleni (83 próbki żwaczy spośród 110 zawierały korę sosny).

Pięć gatunków roślin (*Pinus silvestris, Juniperus communis, Calluna vulgaris, Salix cinerea* i *Vaccinium myrtillus*) stanowiących w okresie jesienno-zimowym najważniejsze składniki diety jeleni w trzech badanych środowiskach uznać należy za rośliny wskaźnikowe informujące o stanie i tendencjach dynamiki rozwojowej środowiska.