

Food of the Roe Deer and Red Deer in the Białowieża Primeval Forest

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Analysis was made of the rumen contents of 91 roe deer and 93 red deer shot in the Białowieża Primeval Forest. It was established that herbs form 80% of the roe deer's food in spring and summer, and about 65% in autumn and winter. Leaves buds, and small twigs of trees and shrubs form 11—12% of their food in spring and early summer, and 23% in autumn and winter. Frequency of occurrence of different plant species in samples varied with the season. No differences were found in the quality of food consumed by young and adult roe deer. Comparison of the red deer's food in the Białowieża Primeval Forest during the autumn and winter seasons showed that there are some, although not significant, differences between males and females. Red deer preferred leaves, small twigs and the bark of trees. Among species most readily eaten is *Populus tremula* in autumn (24.5% of all tree species eaten). In winter *Picea excelsa* and *Pinus silvestris* dominate. It was also found that the method used for analysis of rumen contents, particularly the methods consisting in examining feeding traces, underestimates the percentage of herb plants, grasses, sedge and herb layer plants in the food of the roe deer, and this is even more the case in respect of red deer.

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1. INTRODUCTION

The roe deer, *Capreolus capreolus* (Linnaeus, 1758), and red deer, *Cervus elaphus* (Linnaeus, 1758) are game animal species of importance in respect of the food they consume, and the way it is obtained, to forest management by man. For this reason observation have been carried out for many years on the food relations of the above two species. Two methods are employed for determining the diet of these mammals: (1) by analysing the stomach contents in animals shot during hunts or killed specially for research purposes, (2) by means of direct observations of feeding animals, or recording traces of their feeding («contacts»). Determination of food preferences in captive animals constitutes a variant of this second method.

Both the above methods are burdened by serious disadvantages. In the case of the first method the main disadvantage is that a large part,

sometimes more than half, of the rumen contents cannot be accurately identified, in view of the very small particles to which the food has been reduced. With the second method observations of feeding roe or red deer are possible only in a small number of cases, or in relation to individuals accustomed to the presence of humans. Thus recording of »contacts« is a laborious task which does not guarantee accuracy in establishing a list of the species consumed and the respective amounts.

Feeding by the above two species in different types of habitat makes it necessary to take into account, when determining full food preferences, their natural plasticity of feeding habits depending on the habitat, season, etc. In Poland the roe deer's diet has been analysed on the basis of rumen contents by Siuda *et al.* (1969). Food preferences have also been evaluated (Szmidt, 1975), in relation to a large number of tree and bush species. A list of species consumed by the red deer has been drawn up (Dzięciołowski, 1970a) after analyzing rumen contents. In addition when calculating the supply of twig food available for roe and red deer, an estimate was made of their food preferences (Bobek *et al.*, 1972). When estimating food relations in the ecosystems of the Białowieża Primeval Forest, however, Borowski & Kossak (1975) drew up lists of species most readily eaten. Similar lists for young red deer were drawn up by Malinovskaja (1972), using the preference test termed »the cafeteria test«, in the Soviet part of the Białowieża Primeval Forest.

The purpose of the present study was: (1) to establish a list of plant species consumed by roe and red deer on the basis of rumen contents; (2) to compare this list with diets of these species determined previously for other regions of Poland and, (3) to compare the results obtained by this method with data obtained by the method of counting »contacts«. Such comparison was possible because the earlier studies on feeding traces (Borowski & Kossak, 1975) were also carried out in the Białowieża Primeval Forest.

2. MATERIAL AND METHODS

Analysis was made of 91 roe deer rumens, 20 of which were obtained from young animals and 71 from adult males and females, and 93 red deer rumens, 42 of which belonged to fawns and the remainder to adult animals of both sexes (Table 1). These animals were shot during the shooting season which, in the case of roe deer, lasts from 21st May to 30th September (bucks); and from 1st October to 31st January (does and fawns); for red deer from 21st August to 28th February (stags and fawns), and from 1st September to 31st January (hinds) in the Białowieża Primeval Forest. This forest occupies an area extending

over approximately 1250 km² and lies between 23°31' and 24°21'E and 52°20' and 52°57'N. The flora of the Forest includes 990 species of vascular plants, 26 of which are tree species, 55 shrub species and — 1 semi-bush and 14 species of dwarf shrubs; 254 species of mosses and liverworts and 200 species of lichen (Faliński, 1968).

Samples weighing 0.5 kg were taken from the thoroughly mixed rumen contents, fixed in 4% formalin and then rinsed through a 2 mm mesh sieve. The mass which passed through the sieve was then strained through filter paper and dried to constant weight. Particles larger than the mesh were analyzed, identifying as accurately as possible (to species or genus, sometimes to family)

Table 1
Number of roe and red deer rumens obtained in different seasons.

Sex, age	Spring 11 Apr.-1 June	Summer 2 June-10 Aug.	Autumn 11 Aug.-21 Dec.	Winter 21 Dec.-10 Apr.	Total
<i>Capreolus capreolus</i>					
Males					
Ad.	15	16	3	—	34
Juv.	—	3	7	2	12
Females					
Ad.	—	—	21	16	37
Juv.	—	—	2	6	8
<i>Cervus elaphus</i>					
Males					
Ad.	—	—	17	15	32
Juv.	—	—	14	9	23
Females					
Ad.	—	—	7	12	19
Juv.	—	—	9	10	19

the plants found there and dividing them into different species (groups), after which they were dried to constant weight and weighed. The weights of identified particles and filtered residue (not identified) made up the weight of dry mass of the whole sample. The percentage of weight of different species in the whole of the sample was next calculated.

The beginning and end of the different growing seasons in which tests were carried out was taken after Falińska (1973), this division taking into account the actual growing phases in the Białowieża Primeval Forest.

3. RESULTS

3.1. Food of the Roe Deer over the Yearly Cycle

The roe deer's food, for identified species, includes 16 species, of tree, 18 species of shrub and dwarf shrub, 101 species of herbs, 3 species of moss, 3 species of fern, 7 species of grass and sedge, and also fungi, lichens and liverworts, the amount being subject to certain variations in different seasons.

About 60% of the roe deer's rumen contents are formed by the particles which passed through the sieve and were too fine to permit of identification to species or genus. Examination of these particles, however, indicated that the greater part, estimated as about 9/10, certainly consisted of herb plants, grasses and sedge. It was therefore taken, in further calculations, that they form 54% in spring, summer and winter, and 49% in autumn. Since herb plants form the largest percentage in the identifiable part of the food mass, then this kind of food forms the basic food of the roe deer. In spring and early summer herb plants and grasses form about 80% of the roe deer' food. In autumn and winter their percentage greatly decreased, and was about

Table 2
Percentage of different kinds of food of the roe deer in different seasons
(% dry mass).

Kind of food	Spring	Summer	Autumn	Winter
Trees	8.8	9.4	18.6	18.3
Shrubs and dwarf shrubs	3.4	1.6	3.9	5.0
Herb layer plants	24.5	25.4	18.5	10.9
Grasses and sedges	3.6	2.9	3.5	3.8
Mosses	0.0	0.0	0.0	0.1
Ferns	0.2	0.2	0.4	1.2
Fungi and lichens	0.0	0.5	1.4	0.7
Particles < 2 mm ¹	59.5	60.0	53.7	60.0

¹ This is that part of the food which cannot be identified to species or genus. General analysis of its composition indicates that 90% consists of herbs, grasses and sedges and the remainder leaves and buds of trees and shrubs.

65% (Table 2). Trees and shrubs, from which the roe deer prefers leaves, buds and small twigs, satisfy about 11—12% of its food requirements in spring and early summer, and about 23% in autumn and winter. If we accept that leaves and buds of trees and shrubs also form part of the unidentified part, in addition to herb plants, it becomes clear that these two kinds of food form over 90% by weight of the roe deer's diet. The remainder is made up by different species of grasses, mosses, ferns, and also fungi and lichens (Table 2).

The frequency of occurrence of different plant species also varies in samples from different seasons (Fig. 1). In spring, for instance, the trees most frequently cropped are *Carpinus betulus*, *Quercus robur* and *Picea excelsa*, and *Betula* sp., *Populus tremula* and *Acer platanoides*. In respect of shrubs and dwarf shrubs by far the greater number of these animals browse on *Corylus avellana*; and among herb plants — *Ranunculus repens*, *Anemone nemorosa* and *Caltha palustris*.

In summer *Carpinus betulus* continues to form the most frequently

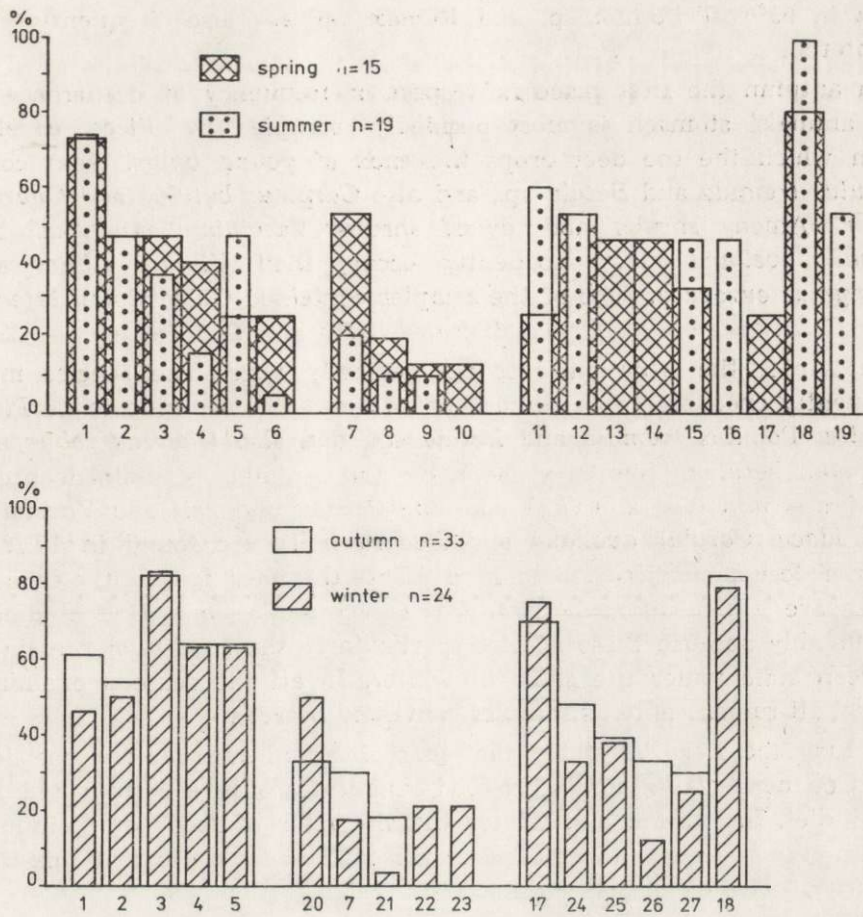


Fig. 1. Frequency of occurrence of plant species in the stomach of *Capreolus capreolus* in four seasons of the year.

Trees: 1 — *Carpinus betulus*, 2 — *Quercus robur*, 3 — *Picea excelsa*, 4 — *Betula* sp., 5 — *Populus tremula*, 6 — *Acer platanoides*.

Shrubs and dwarf shrubs: 7 — *Corylus avellana*, 8 — *Evonymus europaea*, 9 — *Sorbus aucuparia*, 10 — *Rubus* sp., 20 — *Vaccinium myrtillus*, 21 — *Viscum album*, 22 — *Calluna vulgaris*, 23 — *Vaccinium vitis idaea*. Grasses: 18 — *Gramineae*.

Herb layer plants: 11 — *Lathyrus vernus*, 12 — *Ranunculus repens*, 13 — *Anemone nemorosa*, 14 — *Caltha palustris*, 15 — *Rumex* sp., 16 — *Trifolium* sp., 17 — *Galeobdolon luteum*, 19 — *Chamaenerium angustifolium*, 24 — *Oxalis acetosella*, 25 — *Urtica dioica*, 26 — *Stellaria holostea*, 27 — *Stachys silvatica*.

cropped tree, then in turn *Populus tremula*, *Quercus robur* and *Picea excelsa*. The animals browse on shrubs far less often in this season. Only 21% of the animals chose *Corylus avellana* and 10% *Evonymus europaea* and *Sorbus aucuparia*. *Lathyrus vernus* occurs in 60% of

their stomachs, and *Ranunculus repens* and *Chamaenerium angustifolium* in 53%. *Trifolium* sp. and *Rumex* sp. are also frequently encountered.

In autumn the first place in respect of frequency of occurrence in the animals' stomach is most decidedly occupied by *Picea excelsa*, from which the roe deer crops the ends of young twigs. Next come *Populus tremula* and *Betula* sp., and also *Carpinus betulus* and *Quercus robur*. Among shrubs and dwarf shrubs *Vaccinium myrtillus* and *Corylus avellana* most frequently occur, then *Viscum album* and *Evonymus europaea*, 70% of the samples contained *Galeobdolon luteum*, 48% *Oxalis acetosella*, *Urtica dioica* — 39% and *Stellaria* sp. — 33%.

In winter the situation does not radically alter. The species most frequently encountered in rumen contents samples continue to be *Picea excelsa*, *Populus tremula* and *Betula* sp., and also *Quercus robur* and *Carpinus betulus*. Similarly 50% of the animals examined prefer *Vaccinium myrtillus* and 21% consume *Calluna vulgaris* and *Vaccinium vitis idaea*. *Corylus avellana* and *Hedera helix* are found in 17% of the roe deer stomachs. Among herb plants the most frequently encountered are *Galeobdolon luteum*, *Oxalis acetosella* and *Urtica dioica*, presumably because these species (particularly the first two) remain in a green state under the snow in winter. In all the seasons examined almost all rumen contents samples contained grasses.

It may therefore be stated that in spring and summer the roe deer feeds on herb plants, and twig food constitutes only a certain addition to its diet. In autumn and winter the character of food composition is similar, but the percentages of trees and shrubs double and at this time form 1/4 — 1/5 of all plants consumed.

3.2 List of the Most Important Plant Species in the Roe Deer's Diet

A list of the most important species forming the roe deer's diet (Table 3) shows that there are differences in different seasons. In spring and summer the trees most preferred are *Carpinus betulus* and *Quercus robur*. In autumn and winter *Populus tremula* and *Picea excelsa* are added to these species, and in winter, *Betula* sp. also. In the case of shrubs and dwarf shrubs there is marked difference in the extent of feeding on the various species, e.g., in winter *Calluna vulgaris* and *Vaccinium myrtillus* are browsed on to a considerable degree. Seasonal use of herb layer plants is manifested to an even greater extent, since they periodically occur in great abundance, which encourages their consumption by roe deer. An example of this is *Anemone nemorosa*, eaten only in spring and summer, or *Lathyrus vernus* — eaten in

Table 3

Proportion of particular plant species in the food of roe deer in different seasons. Calculations made separately for trees, shrubs, herb layer plants and grasses and sedges, taking that each of these groups of plants forms 100%.

Species	Spring	Summer	Autumn	Winter
TREES:				
<i>Carpinus betulus</i> L.	31.8	41.1	8.1	7.2
<i>Quercus robur</i> L.	18.4	16.8	54.4	2.2
<i>Betula</i> sp.	16.2	8.0	4.2	17.9
<i>Acer platanoides</i> L.	12.8	2.7	4.9	2.1
<i>Picea excelsa</i> Lk.	8.7	6.0	6.4	26.4
<i>Populus tremula</i> L.	4.1	17.2	13.8	29.7
<i>Tilia cordata</i> Mill.	2.8	1.5	3.0	1.8
<i>Alnus glutinosa</i> Gaertn.	2.2	0.4	0.6	0.3
<i>Betula pubescens</i> Ehrh.	0.7	0.8	0.6	0.1
<i>Betula verrucosa</i> Ehrh.	1.4	2.8	1.7	1.4
<i>Fraxinus excelsior</i> L.	0.0	2.7	2.4	0.9
<i>Salix caprea</i> L.	0.8	2.8	0.6	1.6
<i>Salix cinerea</i> L.	—	1.5	—	—
<i>Ulmus campestris</i> L.	—	—	—	2.8
<i>Pinus silvestris</i> L.	—	—	—	5.6
SHRUBS AND DWARF SHRUBS:				
<i>Evonymus europaea</i> L.	28.2	14.9	7.9	3.7
<i>Corylus avellana</i> L.	27.7	41.8	38.3	11.7
<i>Rubus</i> sp.	18.8	8.5	—	0.9
<i>Sorbus aucuparia</i> L.	13.2	14.6	2.1	—
<i>Prunus padus</i> L.	5.9	—	—	—
<i>Ribes nigrum</i> L.	—	4.4	7.2	—
<i>Rhamnus frangula</i> L.	—	7.7	0.1	—
<i>Hedera helix</i> L.	—	7.5	—	2.6
<i>Vaccinium myrtillus</i> L.	—	—	12.5	48.3
<i>Calluna vulgaris</i> Sal.	—	—	28.0	19.9
<i>Viscum album</i> L.	—	—	9.0	1.7
<i>Rubus fruticosus</i> L.	—	—	—	3.8
<i>Vaccinium vitis idaea</i> L.	—	—	—	6.4
HERB LAYER PLANTS:				
<i>Ranunculus repens</i> L.	11.1	3.0	1.9	0.9
<i>Anemone nemorosa</i> L.	7.2	3.2	0.4	—
<i>Caltha palustris</i> L.	5.4	0.1	—	—
<i>Geum rivale</i> L.	4.7	0.4	1.6	1.5
<i>Lathyrus vernus</i> Bernh.	3.5	6.4	2.2	—
<i>Aegopodium podagraria</i> L.	3.2	—	2.5	2.0
<i>Cardamine amara</i> L.	3.1	0.8	0.5	0.2
<i>Ficaria verna</i> Huds.	3.1	1.5	0.1	—
<i>Chamaenerium angustifolium</i> Scop.	2.9	7.6	1.5	0.4
<i>Campanula persicifolia</i> L.	2.8	2.5	—	—
<i>Mycelis muralis</i> (L.), Dum.	2.4	2.8	1.6	0.6
<i>Filipendula ulmaria</i> Max.	2.4	3.3	3.1	—
<i>Viola silvestris</i> Rchb.	2.4	0.6	0.6	0.8
<i>Rumex</i> sp.	2.2	3.1	2.6	3.6
<i>Taraxacum officinale</i> Web.	2.0	1.2	—	—
<i>Isopyrum thalictroides</i> L.	1.9	1.1	—	—
<i>Genista tinctoria</i> L.	1.9	2.4	—	0.9
<i>Impatiens noli-tangere</i> L.	2.0	1.9	3.4	—
<i>Asperula odorata</i> L.	1.2	—	2.6	2.5
<i>Majanthemum bifolium</i> Schm.	0.9	3.6	1.2	—
<i>Stellaria holostea</i> Vill.	1.6	0.5	2.1	3.7

Table 3, concluded.

Species	Spring	Summer	Autumn	Winter
<i>Epilobium hirsutum</i> L.	1.6	0.0	0.5	—
<i>Ranunculus lanuginosus</i> L.	1.4	—	0.7	0.6
<i>Urtica dioica</i> L.	0.8	1.7	3.2	10.2
<i>Galeobdolon luteum</i> Huds.	0.8	0.6	18.3	23.1
<i>Oxalis acetosella</i> L.	0.8	0.2	3.3	3.9
<i>Asarum europaeum</i> L.	0.0	0.0	1.3	5.4
<i>Stachys silvatica</i> L.	—	0.3	2.6	4.5
<i>Pulmonaria obscura</i> Dum.	—	1.0	1.8	6.1
<i>Ajuga reptans</i> L.	0.1	—	1.5	8.3
<i>Lathyrus silvester</i> L.	0.3	2.1	0.4	—
<i>Hepatica nobilis</i> Garsault	0.3	—	2.4	2.8
Gramineae	69.6	84.4	78.7	65.2
<i>Dactylis glomerata</i> L.	7.7	—	9.4	6.2
<i>Calamagrostis arundinacea</i> Roth.	—	4.4	5.5	10.6
<i>Milium effusum</i> L.	8.2	4.2	—	7.0
<i>Carex</i> sp.	14.9	6.8	6.4	9.0

summer, while *Urtica dioica* and *Galeobdolon luteum* form an important part of the roe deer's winter food (Table 3).

3.3. The Red Deer's Food (Autumn and Winter)

The analyses made show that 14 species of trees, 17 species of shrubs and dwarf shrubs, 56 herb layer species, 9 species of grasses and sedges, 2 species of lichens, 6 species of mosses, 6 species of ferns and fungi are included in the red deer's food in the Białowieża Primeval Forest in the seasons examined. These proportions are subject to some variation during the growing seasons.

There are certain differences between males and females in respect of their food composition in both autumn and winter. Although these differences are not very distinct, results have been given separately for the two sexes in tables, in order to obtain a clear picture. The greatest preference is shown for leaves, twigs and the bark of trees. If the fact is taken into account that in autumn, in the unidentified part of rumen contents, 70% is also formed by different species of trees, it can be seen that altogether this forms more than half of their food. As the percentages of shrubs and dwarf shrubs play an important part (Table 4), in autumn not more than 1/3 of the whole is formed by the other kinds of food, and of this remaining part herb plants and grasses are present in considerable quantities, particularly if we take into consideration the fact that in the unidentified mass their percentage is supplemented by the percentage of tree food. The other kinds of food form only a negligible addition (Table 4). In winter the percentage of ligneous species increases even more, although the amount of grasses consumed is in no way reduced in comparison with autumn (Table 4).

In autumn the species most often encountered in the samples of rumen contents examined are *Picea excelsa* and *Carpinus betulus* (res-

Table 4
Seasonal variation in components of the red deer's food (% dry mass).

Kind of food	Autumn		Winter	
	M	F	M	F
Trees,	30.7	19.7	28.0	27.7
Shrubs and dwarf shrubs	9.6	13.1	9.9	9.7
Herb layer plants	12.5	6.4	5.1	3.0
Grasses and sedges	4.0	4.1	14.0	5.3
Lichens	0.5	0.4	0.4	1.4
Mosses	0.9	0.5	0.7	0.8
Ferns	1.2	1.2	0.8	1.5
Fungi and liverworts	0.3	0.8	0.6	0.9
Tree roots	0.2	—	—	0.2
Grass roots	0.1	0.1	—	0.2
Particles <2 mm ¹	40.0	53.7	40.5	49.3

¹ This is that part of the food which cannot be identified to species or genus.

pectively 72 and 70% of the samples), and *Quercus robur* and *Populus tremula*. Among dwarf shrubs *Vaccinium myrtillus* occurs in 51% of the red deer stomachs, while *Gramineae* species are encountered in 87% of the stomachs.

In winter *Picea excelsa* is most frequently found in 87% of the samples, then *Pinus silvestris* and *Carpinus betulus*. *Vaccinium myrtillus* is preferred by 72% of the animals examined, and *Gramineae* is encountered in 84% of the rumens (Fig. 2).

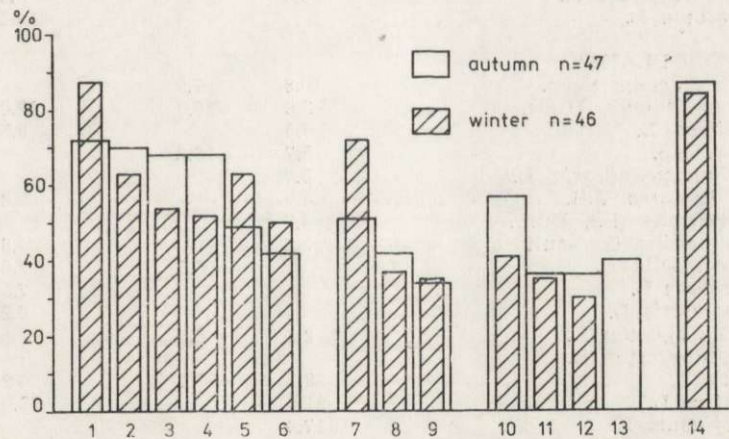


Fig. 2. Frequency of occurrence of plant species in the stomach of *Cervus elaphus*.

Trees: 1 — *Picea excelsa*, 2 — *Carpinus betulus*, 3 — *Quercus robur*, 4 — *Populus tremula*, 5 — *Pinus silvestris*, 6 — *Betula verrucosa*.
Dwarf shrubs: 7 — *Vaccinium myrtillus*, 8 — *Vaccinium vitis idaea*, 9 — *Calluna vulgaris*.
Herb layer plants: 10 — *Galeobdolon luteum*, 11 — *Oxalis acetosella*, 12 — *Stellaria holostea*, 13 — *Cirsium oleraceum*. Grasses: 14 — *Gramineae*.

3.4. List of Plant Species of Greatest Importance in the Red Deer's Diet

In autumn *Populus tremula* is one of the most preferred species and in the case of males forms 24.5⁰/₀, and females 20.5⁰/₀, of all trees on

Table 5

Proportion of different plant species in the food of *Cervus elaphus* in different seasons. Calculations made separately for trees, shrubs and dwarf shrubs, herb layer plants, grasses and sedges and mosses.

Species	Autumn		Winter	
	M	F	M	F
TREES:				
<i>Populus tremula</i> L.	24.5	20.5	11.1	10.6
<i>Alnus glutinosa</i> Gaertn.	16.2	2.1	1.3	2.7
<i>Quercus robur</i> L.	9.8	12.3	8.9	15.7
<i>Carpinus betulus</i> L.	15.3	20.5	4.5	8.3
<i>Pinus silvestris</i> L.		12.0	27.5	17.5
<i>Picea excelsa</i> Lk.,		9.5	27.1	21.5
<i>Fraxinus excelsior</i> L.		6.0	4.4	
<i>Betula verrucosa</i> Ehrh.	5.0	4.2	4.7	6.4
SHRUBS AND DWARF SHRUBS:				
<i>Calluna vulgaris</i> Sal.	64.1	36.2	20.0	39.4
<i>Vaccinium myrtillus</i> L.	10.7	22.5	28.0	20.4
<i>Rubus (idaeus, fruticosus, saxatilis)</i>	7.2	12.5		
<i>Vaccinium vitis idaea</i> L.,	5.4	12.5	8.2	
<i>Corylus avellana</i> L.		7.4	22.9	6.8
<i>Evonymus europaea</i> L.	3.4		3.0	9.9
<i>Viscum album</i> L.			13.2	2.3
HERB LAYER PLANTS:				
<i>Cirsium oleraceum</i> Scop.	10.8	7.9		
<i>Galeobdolon luteum</i> Huds.	8.6	25.0	22.0	27.8
<i>Urtica dioica</i> L.	6.6		8.5	14.5
<i>Ranunculus</i> sp.	5.7	16.3		
<i>Aegopodium podagraria</i> L.	5.7			
<i>Stellaria holostea</i> Vill.	4.9		5.8	15.9
<i>Mycelis muralis</i> (L.), Dum.	4.7			
<i>Hepatica nobilis</i> Garsault	3.2		4.8	
<i>Oxalis acetosella</i> L.		18.5	8.0	11.6
<i>Ajuga reptans</i> L.			7.5	14.0
<i>Caltha palustris</i> L.			6.2	
<i>Asarum europaeum</i> L.	2.1	8.6		
<i>Solanum tuberosum</i> L.				18.2
Gramineae	38.1	77.4	23.2	27.8
<i>Avena sativa</i> L.	21.0		73.9	61.0
<i>Milium effusum</i> L.	17.4			
<i>Dactylis glomerata</i> L.		4.8	0.9	1.1
<i>Festuca</i> sp.	4.4	11.1		
<i>Carex</i> sp.	5.4			5.9
<i>Calamagrostis arundinacea</i> Roth.			1.4	
MOSESSES:				
<i>Aorchynchium zetterstedti</i>	40.8		37.0	
<i>Mnium</i> sp.	38.3		36.6	
<i>Polytrichum commune</i>	8.6		26.5	

which the animals browse; next in turn are *Quercus robur*, *Carpinus betulus* and *Alnus glutinosa*. In winter *Picea excelsa* and *Pinus silvestris* clearly predominate, followed by *Populus tremula*, *Carpinus betulus* and *Quercus robur* (Table 5). In these seasons oak acorns are readily consumed. In the case of shrubs and dwarf shrubs it is a striking fact that the list of preferred species is approximately constant. In autumn and winter the preferred species are *Calluna vulgaris*, *Vaccinium myrtillus*, *Vaccinium vitis idaea* and *Corylus avellana*. The list of herb layer species consumed is subject to relatively considerable variations, although in this case also species most readily eaten in autumn and winter are *Galeobolon luteum* and *Urtica dioica* (Table 5).

4. DISCUSSION

When comparing the composition of the roe deer's diet by the method of analysing rumen contents in the Pisz Forest (Siuda *et al.*, 1969) and the Białowieża Primeval Forest (this study) significant differences are apparent between them. Although in both these areas the list of plant species consumed is long, the fundamental difference consists in the fact that in the first case it was considered that the basic food of the roe deer consists of leaves and twigs of trees and shrubs and dwarf shrubs, and that herb layer plants come second in order. In the second place it was found that the roe deer is an animal which feeds chiefly on herb layer plants, and although the percentage of trees and shrubs consumed increases in autumn and winter, herb layer plants continue to form its basic food in these seasons also (Table 2). The reason for these differences may be the different habitats in which these animals live.

Preference for different species of ligneous plants estimated on the basis of rumen contents (Siuda *et al.*, 1969; this study) is similar. The preference test (Szmidt, 1975) points to a slightly different arrangement of the list of most preferred species consumed, which should perhaps be explained by the fact that in the test assortments the number of species given was greater than that which the animal encounters in its natural habitats in north-eastern Poland.

The data given by Sablina (1970) on the roe deer's food in the Soviet part of the Białowieża Primeval Forest differ distinctly from the above findings. In this area roe deer feed on a total of 71 plant species, 28 of which are trees and shrubs, and 43 — herb plants. According to the above author herb plants and grasses form the animal's basic food only from April to September, while during the winter months roe deer pass completely to food composed of the twigs of

trees, shrubs and dwarf shrubs. The author did not, unfortunately, give the method which she used to obtain the above results.

It is estimated that in the south of Poland the ligneous species most preferred by roe and red deer are: *Populus tremula*, *Frangula alnus*, *Quercus sessilis* and *Salix caprea* (Bobek et al., 1972). The red deer's preferences in relation to trees (Dzięciołowski, 1970b), established on the basis of the »cafeteria test« showed that the trees on which this animal most readily browses are *Quercus sessilis*, *Salix caprea*, *Sorbus aucuparia* and *Corylus avellana*. Jamroz (1920) found by means of observations of feeding deer that in the Carpathian forests, the red deer browse in winter on trees and shrubs (about 90% of their diet), chiefly in the form of twigs, and also strip off and consume bark. *Abies alba* and *Salix caprea* dominated among the 36 cropped or 27 barked species. Species for which the greatest preference was shown for their twigs are *Salix* sp., *Juniperus communis*, *Pinus silvestris*, *Acer pseudoplatanus* and *Fraxinus excelsior*. Malinovskaja (1972), on the basis of the »cafeteria test« established that during the spring-summer and autumn periods in the Białowieża Primeval Forest young red deer prefer *Populus tremula*, *Salix caprea*, *Betula* sp., and *Fraxinus excelsior*. In winter their favourite species include: *Populus tremula*, *Pinus silvestris* and *Salix caprea*. There is a decided predominance of tree and shrub food over grasses and herb plants in the food of young red deer throughout the whole year, although the percentages of grasses and herb plants are considerable in May, June and August. According to Sablina (1970) the list of plant species eaten by red deer in the same area includes 80 species, 21 of which are tree, 16 shrub and dwarf shrub species, while the remainder consists of herb plants. This author states in addition that in summer red deer consume chiefly leaves and the non-ligneous shoots of trees. In winter, however, twigs and bark are eaten. Irrespective of this they also readily eat bark in spring, when the sap is rising in the trees. Their favourite food consists of leaves and twigs of *Sorbus aucuparia*, *Salix caprea*, *Fraxinus excelsior*, the leaves of *Acer platanoides* and in winter the bark of *Fraxinus excelsior* the leaves and twigs of the oak, and also its acorns. Red deer browse on the upper parts of herb plants, and also shrubs and dwarf shrubs, and in summer the flowers. To sum up — the percentage of herb plants and grasses in the red deer's diet is very small, although constantly present, and thus these animals may be considered as consuming tree and bush food. Borowski & Kossak (1975) showed that the species most readily eaten by red deer include: *Carpinus betulus*, *Fraxinus excelsior*, *Quercus robur* and *Salix caprea*. The same species are again found when estimating diet by the method of analysing rumen contents

(Tables 3 and 5). It must, however, be emphasised that estimates so far made of the food preferences of roe and red deer in different parts of Poland, in different habitats, point to their diversification. Although the list of tree species in this geographical zone is relatively short, it reveals a different order, although some species are repeated in all lists (e.g., *Quercus* sp. and *Carpinus betulus*). When comparing the percentages formed by the various groups of plants (trees, shrubs and dwarf shrubs, herb plants etc.) in the food of the red deer examined in different parts of the Polish lowlands (Dzięciołowski, 1970a) and the Białowieża Primeval Forest (Table 4) considerable agreement is found. It may therefore be said that in autumn and winter the red deer, despite its slightly different preferences, satisfies its requirements in a similar way, regardless of the type of habitat. Nevertheless data obtained by analysis of rumen contents differ from information obtained by the »contact« method (Borowski & Kossak, 1975), when it was found that 85—95% of the winter food of roe and red deer consists of ligneous plants.

It must therefore be concluded that the method of examining feeding traces overestimates the percentage of tree food in the diet of roe and red deer, and consequently underestimates the percentage of herb plants. A second serious disadvantage of this method is the fact that only in a few cases is it possible to distinguish between the feeding traces left by different species of animals. When using this method it is therefore usual to speak of the feeding of deer (Bobek *et al.*, 1972; Borowski & Kossak, 1975). Analysis of rumen contents may also, as shown by experiments made by Bergerud & Russell (1964) and Gaare *et al.*, (1978), cause underestimation of the amount and species composition of the most digestible parts of the diet (herb plants, tree leaves). It may thus be concluded that the percentage of herb layer plants has, in the majority of the studies so far made on the roe, and particularly the red, deer been greatly underestimated.

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POKARM SARNY I JELENIA W PUSZCZY BIAŁOWIESKIEJ

Streszczenie

Poddano analizie 91 żwaczy sarny i 93 żwacze jeleni (Tabela 1). Wiosną i wczesnym latem zioła stanowią około 80% pokarmu sarny a jesienią i zimą około 65% (Tabela 2). Udział drzew i krzewów w diecie tego gatunku wynosi odpowiednio 11—12% i 23%. Wyraźny cykl sezonowy wykazuje udział poszczególnych gatunków w diecie (Ryc. 1, Tabela 3). U jelenia stwierdzono pewne, choć niewielkie, różnice pomiędzy samcami a samicami. Najchętniej zjadane były liście, gałązki i kora drzew (Tabela 4). Jesienią dominuje udział *Populus tremula* a zimą *Picea excelsa* i *Pinus silvestris* (Tabela 5).

Dane uzyskane poprzez analizę treści żwaczy odbiegają od informacji uzyskanych przez innych autorów metodą badania śladów żerowania, gdzie stwierdzono, że w skład zimowego żeru sarny i jelenia wchodzi w 85—95% rośliny drzewiaste. Nasuwa się wniosek, że ta metoda zawyża udział drzew w pożywieniu sarny i jelenia, zaniżając przy tym udział roślin zielnych. Ponieważ analiza treści żwaczy może także spowodować zmniejszenie ilości oraz składu gatunkowego najłatwiej strawialnych części diety (rośliny zielne, liście drzew) można wnioskować, że udział roślin runa jest w większości dotychczasowych badań pokarmu sarny, a szczególnie jelenia wyraźnie niedoceniany.