A C T A T H E R I O L O G I C A

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Food Preference of Roe Deer in Relation to Principal Species of Forest Trees and Shrubs

[With 6 Tables]

The food preference of roe deer, *Capreolus capreolus* (Linnaeus, 1758) reared in enclosures was studied in respect of 27 principal species of forest trees and shrubs. The animals were supplied, both in summer and in winter, with 100 g weighing bunches of twigs of various tree and shrub species. After 4 hours the bunches were weighed again. Taking into account the results of statistical analysis (*F* test, Gupta test) three types of plants were distinguished separately for the vegetation period and for winter: (1) species particularly preferred, (2) species of mean attractivity, (3) species poorly consumed. In winter the most preferred species were among others: *Fagus silvatica* L., *Evonymus europea* L., *Carpinus betulus* L., while to the least consumed species belonged among others: *Tilia cordata* Mill., *Betula verrucosa* Ehrh., *Sambucus nigra* L., *Pinus silvestris* L. In the vegetation period to the first group belonged among others: *Quercus robur* L., *Evonymus europea* L., *Sorbus aucuparia* L., and *Salix* sp., while to the least consumed species in that period belonged: *Abies alba* Mill, *Picea abies* Karst., *Pinus silvestris* L., *Sambucus nigra* L., and others. Moreover, the results of preliminary investigations indicate that food preference of roe deer may vary, for example in relation to the availability or abundance of different species of trees and shrubs.

I. INTRODUCTION

Review of literature on composition of natural feed of roe deer indicates that this problem has not been accurately analysed. Food quantity and quality influences not only individual properties of the game or population dynamics, but also damages inflicted to forests, which only in forest plantations include over 50 thousand ha in area (Szukiel, 1971). The food preference partly established in the present study is a complex problem, as correctly pointed out by Eiberle (1969). It should be regarded not only from the side of attractivity of consumed feed but also should take into account its value, distribution, availability, variability, *etc.* Roe deer can consume a great number of plant species but definitely prefer only some of them in particular seasons of the year, or even con-

sume only some parts of plants (Smidt, 1961; Brown & Mandery, 1962; Ambroz, 1963; Pielowski, 1970).

Knowledge of food preference of roe-deer in relation to particular trees and shrubs is an important indicator for introducing the most attractive natural feed to their habitats. Roe deer, similarly to red deer (Dzięciołowski, 1967), consume preferably plant twigs. According to Melichar (Kurt, 1970) twigs of trees and shrubs constitute in roe deer 62% of the total food, and in winter the share of this browse increases above 80% covering not only energy requirements but also, according to Szczerbiński (1964), some water requirements. In summer this fibrous feed amounts to 50% of the total food intake and is physiologically important for the regulation of digestive processes (Bubenik, 1959).

For these reasons the proper species composition of shrub and tree plantations for browsing, as well as newly established replacements, and especially brushwoods, may become an important element of biological protection of forest plantations against damages caused by deer.

II. METHODS

From among a few methods utilized in the investigations on the composition of feed of game (Dzięciołowski, 1967) the experiments with fenced rearing were selected as the most useful for the establishment of food preference.

The studies lasted with interruptions from 1971 to 1974 and included 5 roe deer *Capreolus capreolus* (Linnaeus, 1758), captured as kids or one-year old individuals. They were placed singly or in pairs (♀ and ♂) in *ca* 6-are plots fenced with wired net in the region of Zielonka Forest Inspectorate.

The attractivity of browse was established by simultaneous administration to the tested individuals of bunches of freshly cut twigs of different tree and shrub species growing in well insolated places. In summer 100 g bunches of twigs were placed in jars filled with water in order to prevent a significant loss of twig weight caused by drying, while in winter they were attached to the fence. One series of experiments included a set of randomly selected trees and shrubs. After 4 h exposure to the animals the bunch was weighed again to establish the amount of consumed browse from the weight difference. Each series included 4 repetitions, and one weight difference most deviating from the mean was discarded. This was in order to eliminate rare and unexpected situations which could deformate the results of particular experiments, such as violent storm or passing by a tractor in the vicinity of the fenced plot. Frightened animals did not browse for a long time. In Tables only the total values of consumed feed in three repetitions are given. Before and during the experiments the animals were supplied with feed in excess, in summer in the form of herb plants and substantial food (oats, chestnuts) and in winter as hay and substantial food.

The investigations were carried out both in the vegetation period and in winter. The food preference of roe deer was tested in respect of 27 species of forest trees and shrubs. Moreover, preliminary comparative experiments were carried out on the preference of particular individuals, and differences in preference depending on habituation to a definite type of browse. The credibility of the obtained results

was evaluated statistically on the basis of mean values for each of three repetitions. To demonstrate the significance of differences (for the data in Tables 1 and 2) between the mean values of browsing the analysis of variance for the totally varied system was carried out (F test). The division into groups of tree and shrub species in respect of their browsing attractivity was carried out according to the test of Gupta. For the data presented in Table 4 and some of the data in Table 2 (June 1973 ♀ ♂) the two-factor analysis of variance was carried out (the first factor — tree species, the second one — examined individuals ♀ ♂) for a completely randomized system. The division into groups of species was in this case also carried out by means of Gupta test.

III. RESULTS AND DISCUSSION

1. Food Preference in Summer and in Winter

Since the main damages to the forest by roe deer are inflicted in winter, their food preference in that period is more interesting. For this reason the highest number of experiments was carried out between November and March in the years 1972 and 1973. From the data shown in Table 1 it appears that *Fagus silvatica* L. is the most attractive food species in winter (jointly 684 g consumed). To the least consumed species in winter belong *Pinus silvestris* L. and *Sambucus nigra* L.

The beech is treated by some authors as willingly consumed species (W a g e n k n e c h t, 1969), or periodically browsed species (K l ö t z l i, 1965), but its twigs were never most preferred by roe deer in our experiments.

Sambucus nigra is in some cases regarded as the species of low attractivity (P i e l o w s k i, 1970), which was confirmed in this study, but other authors classify it, jointly with pine, with strongly or periodically browsed species (K u r t, 1970).

Since the accurate establishment of the order of attractivity of particular species of examined trees and shrubs would be very difficult, division into three groups is proposed: (1) species particularly preferred, (2) species of mean attractivity, (3) species least consumed. This division is based on the establishment of significant differences between the groups on the basis of statistical analysis of the data given in Tables (F test = 63.28, and Gupta test: $D_{0{\cdot}05} = 9.02$).

To the first group of particularly preferred species belong apart from *Fagus silvatica* L. also *Alnus glutinosa* Gaertn., *Carpinus betulus* L. and *Robinia pseudoacacia* L.

The second group of species of mean attrictivity includes *Sorbus aucuparia* L., *Quercus robur* L., *Rhamnus cathartica* L., *Crataegus monogyna* Jacy., *Salix* L., *Larix decidua* Mill., *Acer pseudoplatanus* L., *Ulmus laevis* Pall., *Pseudotsuga taxifolia* Britt., *Rhus typhina* L., *Corylus avellana* L. and *Picea abies* Karst.

To the third group of species least consumed in winter belong: *Fraxinus excelsior* L., *Prunus padus* L., *Populus tremula* L., *Abies alba* Mill., *Betula verrucosa* Ehrh., *Tilia cordata* Mill., *Prunus spinosa* L. and *Populus* L., as well as two already mentioned and least attractive species — *Sambucus nigra* L. and *Pinus silvestris* L.

The mentioned above discrepancies in the evaluation of attractivity in some plant species may be further extended. For example *Alnus* in

Table 1

Intensity of browsing of twigs of principal species of trees and shrubs in winter period.

Species	Mass of browse consumed, g						Total
	Nov. 1972	Dec. 1972	Jan. 1973	Febr. 1973	Febr. 1973	March 1973	
	Plants tested — group 1						
Fagus silvatica L.	116	134	100	137	107	90	684
Sorbus aucuparia L.	105	83	61	68	62	56	435
Alnus glutinosa Gaertn.	102	105	63	112	78	72	532
Evonymus europaea L.	93	96	91	101	92	78	551
Prunus padus L.	65	43	26	38	37	30	239
Rhus typhina L.	72	51	42	68	45	31	309
Ulmus laevis Pall.	42	70	50	83	49	45	339
Prunus spinosa L.	34	27	13	46	30	16	166
Sambucus nigra L.	12	14	6	11	6	15	64
	Plants tested — group 2						
Carpinus betulus L.	119	97	72	68	88	62	506
Robinia pseudoacacia L.	107	87	67	65	77	56	459
Crataegus monogyna Jacq.	102	71	55	64	45	59	396
Quercus robur L.	95	86	72	71	54	57	435
Salix L.	85	58	49	105	46	47	390
Acer pseudoplatanus L.	80	78	42	61	32	47	340
Betula vèrrucosa Ehrh.	64	29	31	51	34	23	232
Tilia cordata Mill.	63	41	20	58	24	9	215
Populus tremula L.	52	51	38	51	31	14	237
	Plants tested — group 3						
Rhamnus cathartica L.	96	76	52	110	45	51	430
Picea abies Karst.	66	54	41	18	44	45	268
Corylus avellana L.	60	46	40	81	27	19	273
Fraxinus excelsior L.	55	54	39	46	31	26	251
Larix decidua Mill.	67	69	52	65	43	49	345
Populus L.	33	34	28	51	16	17	179
Abies alba Mill.	35	37	41	40	35	32	220
Pseudotsuga taxifolia	61	79	49	41	43	45	318
Pinus silvestris L.	0	7	9	0	0	8	24

our investigations belong to particularly preferred species, similarly as found by Schütte (Wagenknecht, 1959), but other authors regard it as species never browsed in winter (Ueckermann, 1960; Pielowski, 1970), jointly with birch, which in our studies was not consumed. A further example of discrepancy concerns fir, which according

to Smidt (1961) is browsed in winter more willingly than beech, while in our investigations it occupied the terminal part of the winter list.

The data on food preference of roe deer in summer (from June to August) are given in Table 2. In this case none of the plants is significantly preferred, although among 25 examined species *Q. robur* L. leads the list (766 g consumed leaved twigs). This considerable browsing

Table 2

Intensity of browsing of twigs of principal species of trees and shrubs in summer period.

Species	Mass of browse consumed, g				Total
	July 1971	Aug. 1972	June 1973	June 1972	
	Plants tested — group 1				
Rhus typhina L.	122	121	119	131	493
Carpinus betulus L.	119	156	96	63	434
Salix L.	170	172	170	158	670
Quercus robur L.	158	171	221	216	766
Tilia cordata Mill.	84	30	69	27	210
Fraxinus excelsior L.	49	76	78	99	302
Populus tremula L.	94	80	123	155	452
Populus L.	59	68	58	133	318
Alnus glutinosa Gaertn.	164	159	178	136	637
Betula verrucosa Ehrh.	133	140	130	132	535
Fagus silvatica L.	87	90	62	23	262
Sambucus nigra L.	34	10	4	11	59
Prunus spinosa L.	165	165	166	152	648
Crataegus monogyna Jacg.	156	126	116	132	530
	Plants tested — group 2				
Pinus silvestris L.	11	20	11	18	60
Abies alba Mill.	31	77	10	18	136
Larix decidua Mill.	44	58	26	53	191
Picea abies Karst.	16	31	18	25	90
Pseudotsuga taxifolia Britt.	24	48	19	21	112
Sorbus aucuparia L.	171	195	166	154	686
Evonymus europaea L.	202	200	159	157	718
Rhamnus cathartica L.	110	125	117	88	440
Prunus padus L.	42	42	34	58	176
Acer pseudoplatanus L.	100	127	114	133	474
Robinia pseudoacacia L.	90	91	95	98	374

of the oak by roe deer and red deer was confirmed by many authors (Ueckermann, 1964; Wagenknecht, 1969; Siuda *et al.*, 1969; Dzięciołowski, 1970). The beech, which is liked in winter occupies a distant place in summer.

On the basis of statistical analysis (test $F=32.15$, Gupta test: $D_{0.05}=5.64$) the following species are included to the first group of plants most attractive in summer: *Q. robur* L., *E. europea* L., *S. aucuparia* L. and *Salix* sp.

The second most numerous group of intermediate attractivity includes *P. spinosa* L., *A. glutinosa* Gaertn., *B. verrucosa* Ehrh., *C. monogyna* Jacy., *R. typhina* L., *A. pseudoplatanus* L., *P. tremula* L., *R. cathartica* L., *C. betulus* L., *R. pseudoacacia* L., *Populus* L., *F. excelsior* L., *F. silvatica* L., *T. cordata* Mill., *L. decidua* Mill. and *P. padus* L.

Finally, the trees and shrubs least consumed in summer are: *A. alba* Mill., *P. taxifolia* Britt., *P. abies* Karst., *P. silvestris* L. and *S. nigra* L.

The presented summer list of preference of examined trees and bushes is not always in full agreement with the data of literature. Ueckermann (1960) includes beech and lime to the most preferred group, while in our studies these species were numbered in the second group. On the other hand, the most willingly browsed oak was classified by Ueckermann (1960) in the second group. Even more controversial species can be mentioned, such as birch, which according to Ueckermann belongs to the third, least consumed group, while Siuda *et al.* (1969) regarded it as the intermediate position. However, also some considerable similarities in the estimation of summer attractivity of browsed species are observed. For example rowan and willow are most willingly browsed both in our observations and those reported by Ueckermann (1960). When comparing winter and summer attractivity of examined plants (Tables 1 and 2) it should be stated that the lowest number of common species was found in the first group (only *Evonymus europea* L.), and the highest number in the second group (5 species). Moreover, coniferous species constitute the least attractive browse in winter, and especially in summer.

2. Preference of Various Willow Species

A specific problem raised by some authors depends on apparently exceptional utilization of some willow species as the principal food. In fact willows are willingly browsed in winter, and particularly in summer (cf. Tables 1 and 2). However, since in those observations accurate species determination of willows was not made an additional series of experiments was carried out. For this purpose 6 willow species were selected: *Salix daphnoides* Vill., regarded as not consumed species, *Salix viminalis* L. — as poorly consumed species, *Salix amygdalina* L. as belonging to the intermediate group, and *Salix hastata* L. which are regarded as very willingly consumed (Bukiewicz, 1960; Skotnicki, 1967). According to the data of foreign authors (Ueckermann, 1964; Wagenknecht, 1969) the most attractive willow species include: *Salix smithiana* Willd., *Salix americana, Salix aquatica* Sm., *Salix purpurea* (*viminalis*) and *Salix caprea* L.

After 4 h exposure of cut bunches of willows the degree of con-

sumption was estimated not by weighing but in optical way by employing an arbitrary scale from 1 to 6. The bunch most consumed in each series of experiments was classified in the first place in respect of attractivity. The final order of a given willow species was established on the basis of mean results from three series of experiments. The obtained results (Table 3) did not confirm suggested by the literature exceptional attractivity for roe deer of two willow species: *S. adenophyla* and *S. hastata*, since they were classified only on 4 and 6 (last) place, while *S. amygdalina* and *S. cinerea* belonged to the most willingly consumed species.

Hence it can be suggested that food preference of roe deer, and perhaps other animals as well, is conditioned only to some degree by

Table 3

Browsing attractivity of different willow species in examined roe deer (♀ and ♂).

Species	Order of browse attractivity in consecutive repetitions; series			Final order of attractivity
	I	II	III	
Salix amygdalina L.	1	1	1	1
Salix daphnoides Vill.	5	6	6	6
Salix cinerea L.	2	2	2	2
Salix hastata L.	6	5	5	5
Salix viminalis L.	3	3	3	3
Salix adenophyla	4	4	4	4

nutritive, morphological or taste properties of particular plants, but that it changes as demonstrated above in relation to the season and moreover in relation to some other factors difficult to define: *e.g.* stillness in the habitat, distribution of browse, percentage share of particular plants, and perhaps also in relation to the content of micro-elements in the soil, or individual properties of the game, and even habituation of animals to particular browse.

3. Individual Variations in the Food Preference

In order to shed some light on individual liking or food habits two adult individuals (♀ and ♂), kept in neighbouring enclosures, were supplied simultaneously with identical set of plants. The results of these observations are shown by some data in Table 2 and Tables 4, 5 and 6. Comparison of numerical data from Table 2 (June 1973, ♀ and ♂) indicates a considerable similarity of food habits in both examined individuals. For 25 tested trees and shrubs significant differences (F test$=2.81$, Gupta test: $D_{0.05}=13.99$) were found for 4 species only. Alder belonged to the first group for the male and to the second

for female, lime and beech belonged to the first group for male and the third group for female, and *Prunus serotina* was numbered in the group III for male and group II for female. However, in no case the same species was browsed most willingly (group I) or least willingly (group III).

The analysis of food preference of two other individuals (Table 4) permits to conclude even better similarity of food preference in the some conditions (F test=1.52). In this case among 15 species no statistically significant differences were found in the orded of browsing by two individuals. Even more similarities in the food attractivity among 9 tested plants were found for 2 individuals in April 1973 (Table 5). On the other hand, in the studies of individual selectivity

Table 4

Comparison of browsing preference for two individuals (♀ and ♂) in winter period.

Species	Jan. 1974, ♀		Jan. 1974, ♂		Total mass, g	Average rank
	Mass of browse, g	Rank	Mass of browse, g	Rank		
Pseudotsuga taxifolia Brit.	184	1	198	1	382	1
Pinus silvestris L.	106	4	174	2	280	2
Abies alba Mill.	101	5	76	5	177	5
Tilia cordata Mill.	69	7	62	7	131	7
Fagus silvatica L.	112	2	92	3	204	3
Alnus glutinosa Gaertn.	108	3	83	4	191	4
Sorbus aucuparia L.	71	6	68	6	139	6
Corylus avellana L.	36	10	36	11	72	10
Picea abies Karst.	29	11	44	10	73	9
Larix decidua Mill.	44	9	5	15	49	12
Evonymus europaea L.	47	8	48	8	95	8
Prunus serotina Ehrh.	18	13	12	14	30	15
Populus L.	25	12	46	9	71	11
Rhamnus cathartica L.	17	14	15	13	32	14
Sambucus nigra L.	13	15	26	12	39	13

in respect of coniferous trees carried out in summer 1973 one individual (♀) consumed very little Douglas spruce, whereas the second one (♂) preferred it among other plant species (Table 6).

Summarizing the results on individual preference is particularly difficult since relatively small number of experiments was completed. However, a hypothesis may be put forward that individual food preference, although exists, is not important because it concerns only some individuals and few plant species which are browsed.

Some preliminary conclusions on the interesting aspect of food preference related to food habits can be drawn from the comparison of data in Table 1 and 4, concerning the experiments from January 1973 and January 1974. These data refer to the same individuals which were

kept in a pen from summer 1972 till January 1973. In the pen they could eat only herb plants but were regularly supplied with substantial food and sporadically with various species of deciduous trees and shrubs. Starting from summer 1973 till January 1974 when the second series of experiments was carried out they stayed in a fenced dense pine thicket where they also could eat herb layer plants and were supplied with substantial food. Hence in the latter case they had in excess an easily available browse in the form of fresh pine twigs, and they utilized it permanently as indicated by numerous twig cuts.

Table 5

Comparison of browsing preference for two individuals (♀ and ♂) in spring period.

Species	April 1973, ♀		April 1973, ♂	
	Mass of browse, g	Rank	Mass of browse, g	Rank
Carpinus betulus L.	71	1	81	1
Acer pseudoplatanus L.	46	2	42	3
Rhus typhina L.	42	3	29	6
Robinia pseudoacacia L.	41	4	45	2
Salix L.	41	5	31	4
Prunus serotina Ehrh.	25	6	24	7
Ulmus laevis Pall.	23	7	30	5
Tilia cordata Mill.	23	8	19	9
Populus tremula L.	20	9	19	8

Table 6

Comparison of browsing preference for two individuals (♀ and ♂) in summer, in relation to coniferous trees only.

Species	June 1973, ♂		June 1973, ♀	
	Mass of browse, g	Rank	Mass of browse, g	Rank
Pinus silvestris L.	40	5	16	5
Abies alba Mill.	76	3	74	1
Larix decidua Mill.	101	2	71	2
Picea abies Karst.	51	4	63	3
Pseudotsuga taxifolia Britt.	106	1	23	4

Comparison of the numerical data of these two series of January experiments (Tables 1 and 4) points to a change in food habits of the studied individuals. First of all attractivity of the pine was altered: in January 1973 and in the whole winter period of that year it occupied but the last 26 place (Table 2), while in January 1974 was promoted suddenly to the second place among 25 species (Table 4). It is difficult to find out any other cause than habituation during a few month

period to browsing of the always available pine twigs. The shift of other poorly consumed species of coniferous trees (Douglas spruce, fir) to the most attractive group can be also explained by close relationship of these species and pine.

Simultaneously other changes in the attractivity of deciduous species occurred, such as lime and buckthorn. The remaining coniferous species — larch, was classified in January 1974 in the group of less attractive plants. Drawing final conclusions will be possible after some additional observations. Acceptation of the hypothesis on the significant effect of habituation to the browse which occurs in excess is in opposition to the widespread idea that roe deer consume mainly plants which are rare in a given biotope. Moreover, even assuming habituation of roe deer to a definite browse in artificial conditions where in the fenced area they can eat only some plant species this cannot be directly extrapolated to natural conditions, where almost always (even in pine forests) there exists a chance of finding small amounts of different types of browse (admixture of birch in pine forests).

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WYBIÓRCZOŚĆ ŻEROWA SARNY EUROPEJSKIEJ W ODNIESIENIU DO WAŻNIEJSZYCH GATUNKÓW DRZEW I KRZEWÓW LEŚNYCH

Streszczenie

Przedstawiona praca dotyczy wybiórczości żerowej saren, znajomość której szczególnie w odniesieniu do drzew i krzewów leśnych posiada duże znaczenie gospodarcze. Doświadczenia żywieniowe prowadzono w hodowli zamkniętej na 5 sarnach. Łącznie testowano wybiórczość żerową na 27 gatunkach drzew i krzewów i to zarówno w okresie zimowym jak i letnim.

Na podstawie analizy statystycznej otrzymanych wyników ustalono, że w okresie zimowym zdecydowanie wybijającym się swą atrakcyjnością żerową okazał się buk pospolity, natomiast wyraźnie najsłabiej żerowanymi gatunkami była sosna pospolita oraz bez czarny.

Ostateczny podział badanych gatunków (w okresie zimy) na 3 grupy atrakcyjności wygląda następująco:

I. gatunki najchętniej zgryzane: buk pospolity, trzmielina pospolita, olsza czarna, grab pospolity i robinia akacjowa,

II. gatunki o średniej atrakcyjności żerowej: jarząb pospolity, dąb szypułkowy, szakłak pospolity, głóg jednoszyjkowy, wierzby, modrzew europejski, klon, jawor, wiąz szypułkowy, jedlica Douglasa, sumak octowiec, leszczyna pospolita, świerk pospolity,

III. gatunki najsłabiej żerowane: jesion wyniosły, czeremcha późna, topola osika, jodła pospolita, brzoza brodawkowata, lipa drobnolistna, śliwa tarnina, topole, bez czarny, sosna pospolita (Tabela 1).

W okresie lata nie stwierdzono roślin wyjątkowo wyróżniających się swą atrakcyjnością żerową. Natomiast podział na 3 grupy atrakcyjności (latem) przedstawiał się następująco:

I. Gatunki najchętniej zgryzane: dąb szypułkowy, trzmielina pospolita, jarząb pospolity, wierzby.

II. Gatunki o średniej atrakcyjności żerowej: śliwa tarnina, olsza czarna, brzoza brodawkowata, głóg jednoszyjkowy, sumak octowiec, klon jawor, topola osika, szakłak pospolity, grab pospolity, robinia akacjowa, topole, jesion wyniosły, buk pospolity, lipa drobnolistna, modrzew uropejski, czeremcha późna.

III. Gatunki najsłabiej żerowane: jodła pospolita, jedlica Douglasa, świerk pospolity, sosna pospolita, bez czarny (Tabela 2).

Jak wynika z powyższych zestawień gatunki iglaste zarówno zimą, a szczególnie latem ustępują zwykle swą atrakcyjnością żerową gatunkom drzew i krzewów liściastych.

Poza tym wyniki wstępnych badań nad wybiórczością indywidualną saren (Tabele 4, 5, 6) pozwalają przypuszczać, że tego rodzaju wybiórczość żerowa wprawdzie istnieje ale nie posiada większego znaczenia, dotycząc tylko niektórych osobników i niewielu gatunków drzew lub krzewów. Również w oparciu o wstępne badania można postawić hipotezę, że co najmniej w warunkach hodowli zamkniętej może zachodzić zmiana upodobań żerowych u tych samych osobników jako rezultat dłuższego przyzwyczajania się do znajdującego się w nadmiarze, łatwo dostępnego pokarmu.