

DANISH REVIEW OF GAME BIOLOGY Vol. 5. no. 3

Edited by Anders Holm Joensen

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by Examination of the Rumen Content

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POUL VALENTIN JENSEN
(Zoological Museum, Copenhagen)

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Выбор пищи благородного оленя
(*Cervus elaphus*) в Дании.

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Introduction

As a result of complaints about the damage done by foraging red deer (*Cervus elaphus*) in forest plantations and crops in certain areas of Jutland, a reduction in populations was carried out during the years 1954–1956.

The Directorate of State Forestry carried out the shooting of red deer in the Buderupholm State Forest District in the Rold Forest area in the northern part of Jutland, and the Dune Directorate did the shooting in the dune plantations south of Ringkøbing Fjord, West Jutland.

This made it possible to remove rumen samples from a large proportion of the red deer killed.

The examination of the samples was entrusted to Jagtfondens Vildtbiologiske Undersøgelser, Copenhagen, while the remainder was handed over to the Game Biology Station, Kalø.

The following investigation is based solely on this material and is virtually pure laboratory work. Preliminary reports on the investigations have been published (JENSEN 1958 a, 1958 b).

Knowledge of the natural food selection of an animal is an important requirement for understanding the ecology of the species, i.e., its dependence on, and influence on its environment. Among other things, the food it selects will explain the preference of the animal for certain biotopes and the movement of the single individual in the terrain, during the course of both a single day and of a year.

In the case of modern wildlife management, it is, moreover, very important to have a basis on which to judge the ecolo-

gical capacity of a particular territory in relation to a given animal species, i.e. the number of individuals for which the given territory can provide optimal living conditions. It is obvious that a whole combination of factors plays a role here, e.g. climatic conditions, cover, and also purely psychological factors. However, one of the most important conditions for the maintenance of an animal population is that the available food should be sufficient both in amount and nourishment value, so that the adults are not only healthy themselves but capable of producing healthy offspring.

If the food selection of an animal species – or a particular animal population – in some way or another interferes with man's economic interests, it is also important to have a firm basis on which objectively to evaluate possible damage in order to improve one's chances of being able to take suitable counter-measures.

Many references to the food of different kinds of game are to be found in the literature. Until recent years these examples were largely based on observations made by various people – mainly foresters and hunters – and the views they themselves had formed. This kind of personal opinion is, of course, easily influenced by the observer's interests and preformed opinions. This is particularly true in the case of animals suspected of causing damage of economical significance. Again, there will be a strong tendency to generalize on the basis of a few more or less accidental observations which may very often be quite atypical of the feeding habits of the animal in question.

It is, therefore, of real importance to seek a truly objective evaluation of the feeding habits of various species of game, based on a scientific examination of as large and representative a material as possible. At the start of the investigation in 1954 work of this nature was unknown in Europe, whereas several papers had been published in the U.S.A., e.g. HOSLEY & ZIEBARTH (1935), DE NIO (1938), NORRIS (1943), DUSI (1949), DASMANN (1950), and FERREL & LEACH (1950 a, 1950 b). It was, however, necessary to find a method which was practical under more modest research conditions and which would provide a sufficient degree of accuracy for the purpose.

Since then, similar investigations have been undertaken in other European countries, and some of them have been published, e.g., EYGENRAAM (1959), NEUMAN (1963) and HEGG (1961). The latter based his analyses on excrement alone.

Apart from stomach investigations proper, the food selection of red deer and other species of deer have, in recent years, been investigated by direct observation (AHLÉN 1961, 1964, 1965 a, 1965 b) and by tracking in the snow. The latter method in particular may provide valuable information about winter food in areas with longlasting snow cover (NASIMOVICH 1948, HAGEN 1958 a and 1958 b, AHLÉN 1965 a, 1965 b).

Problems in connection with the examination of rumen content

When judging the value of rumen content examinations it is especially important to note that the food consumed by the deer always enters a stomach already containing considerable quantities of partly digested plant matter from earlier foraging, and gradually becomes mixed with this. It is also important to note that while easily digestible food – because of the ability of the rumen-reticulum system to sort the contents – will pass this section more rapidly the coarser, less digestible food will remain in the rumen for as long as is necessary for its decomposition.

In the case of domestic ruminants this situation has been known for a long time. With respect to sheep, NORRIS (1943) made a direct comparison between the composition of the food intake and that of the rumen-content. He found that the rumen-content gives an inexact picture of the food eaten by the animal immediately before slaughtering; in particular, the calcu-

lated amount of browse (shoot tips of woody plants), will be larger than that actually consumed because remains of browse from earlier intakes will still be present. NORRIS found that 32.1 % of the solid food in the rumen had been digested after 3 hours, 48.5 % after 6 hours, and 58.8 % after 9 hours, and that the food started to enter the omasum 2–5 hours after intake. It was also seen that various amounts of coarse food, e.g. straw and barley grains, remained in the rumen for at least 4 days. Furthermore, it appeared that there was a pronounced difference in the ability of different sheep to digest the food, making it impossible to introduce a corrective calculation for eliminating the effects of digestion and of food remaining from earlier intakes.

With regard to red deer, GILL (1962) investigated the length of time necessary for food to pass through the entire digestive system. He mixed the food with a

known quantity of dyed hay and oats, and noted the time taken for coloured particles to appear in the excrement. The first particles appeared at different times with different experimental animals – from 11 to 24 hours after feeding – while the main amount appeared in the excrement from the 2nd to the 4th day. The last remains were still appearing 5 to 12 days after feeding.

This was, more or less as expected, the same kind of result found in similar experiments with cattle. It is, however, important to note that these experiments with deer were undertaken in Zoos (Plock, Danzig and Warsaw), and thus under the totally unnatural environmental and dietary conditions of captivity. Thus, with respect to the present problem, the significance of this experiment has certain limitations. On the other hand it is quite clear that the whole digestive system is extraordinarily sensitive to the immediate mental state of the animal. Thus, GILL particularly mentions the influences of the rutting season and of change of surroundings, e.g. transfer of animals from one enclosure to another or isolation of one individual from the herd. Furthermore, sudden changes in feeding conditions themselves were seen to have a pronounced effect on time of retention in the stomach.

It has been suggested that by using the known average retention times for the various foods, it might be possible to adjust the amounts found for various food items in the stomach to correspond more closely to the relative amounts in the food intake. However, when one considers the variations that may occur during the time of passage and the multiplicity of food items (each varying in digestibility with season, age of plant, actual fragment of the plant in question, and often the proportion between the various parts of the

same plant, e.g. leaves and woody tips), any adjustment of this sort is seen to be quite unrealistic. The whole process would become so complicated and give rise to so many new sources of error that the final result would hardly be any improvement.

If one is to decide whether the value of stomach-content investigations merits the time spent one must first clearly ascertain what can be learned of practical value from these investigations, and whether it is possible for the given material to furnish that information.

The first question is, what plant species appear in the food at all.

The main problem is, to what degree is it possible to identify the plant remains found in the rumen, and how certain is it that more fragile and easily digestible matter is not overlooked – possibly because this has been completely decomposed? It is obvious here that as the rumen contains an average of 12 kg of food, and some hold as much as 20 kg, consisting of millions of minute plant fragments, it is possible in practice to examine only a small sample. Thus a plant species of which only a few specimens have been eaten may quite easily be in that part of the rumen content not forming part of the sample. Such a plant, however, can hardly be of great importance as a food item, and may possibly have been taken accidentally with neighbouring food plants.

Plant remains in the rumen may often be surprisingly well preserved and whole, and even at an advanced stage of digestion may still show characteristic details. Starting from the best preserved plant portions one can, by continual comparison, work towards fragments which, from their condition, might otherwise be quite hopeless to identify. In most cases it is at least possible to decide whether the

material is one of the common, well-known food plants, or whether it belongs to a main group such as herbs, graminaceous plants, lichens, mosses, etc. Apart from plant matter which can at least be referred to these groups, one may also find veins and finely divided tissues separated by digestion, and completely barkless, more-or-less splintered wood particles from shoots and smaller branches. As mentioned above, even these may often be put into definite species or groups by comparison, but as their condition shows them to have been in the rumen for some time, and thus not come from the latest food intakes, it would be most correct to disregard them completely.

A special problem arises with graminids, which as a group constitute the most important food for deer throughout the year. Here, it is usually possible to distinguish between grasses proper (*Graminaeae*), sedges (*Carex*) and woodrushes (*Luzula*). The individual species within this group, which can be difficult enough to identify when whole and in flower, are naturally even more difficult, or even impossible, to identify in fragmentary form. However, the leaf structure of some is so characteristic that they can easily be identified, and luckily this is true of some of the most important food plants. One advantage is that even small fragments usually show the full width of the leaf.

Herbaceous plants are also very difficult to determine, especially as the fragments form only very small parts of the complete leaf, providing little information as to its form and structure. Here, it is often necessary to call them »unidentified herbs«. But they are relatively unimportant, particularly in the winter food of the red deer.

In all cases it is important to have plants from the feeding ground for comparison, and a stomach investigation will

be easier to undertake if carried out in or near the area where the material originates.

The next question is whether it is possible to judge the percentage and importance of the individual plant species or plant groups as food for deer on the basis of stomach analyses.

By giving the percent occurrence for the individual food items, the percentage of the total number of samples in which a particular plant is found can be seen. From this it may be ascertained whether the plant has particular importance in a certain season, or whether it was only taken on single occasions – and then perhaps incidentally, with other food.

The big problem is the question of the relative amounts of various plant species. As mentioned above, it is only possible to examine a small sample of the total rumen content. Again, the relative amounts in the rumen will not correspond to the relative amounts in the food intake because of the complex ruminatory process. We must, therefore, assume that it is impossible to show the relative amounts of each plant species or group with any degree of accuracy. However, the matter must be regarded in a practical light; it cannot be of decisive importance if a plant species which actually forms 37 % of the food intake is judged to constitute 30 %, 35 % or 40 % on the basis of a rumen sample. The essential point must be that this plant forms about $\frac{1}{3}$ of the food intake, and is therefore important for the animal. If this is supported by examination of other samples, and if the percent occurrence is again high, it must be an important food plant.

With regard to estimation of relative amounts, the best method of reducing erroneous judgements must be to use the least digested plant fragments as a basis,



Photo P. VALENTIN JENSEN.

Fig. 1. Old stand of *Fagus sylvatica* (Rold 18.2.1965). This kind of growth does not give much food to the red deer.

i.e. that part of the food last consumed. Where browse is part of the food it will be particularly important not to take into

consideration the strongly digested particles which, as previously mentioned, may have been several days in the rumen.

Material

The present investigations are all based on laboratory tests of samples of rumen content received.

The material originates from two localities in Jutland, The Rold Forest of Himmerland and the dune plantations in West Jutland south of Ringkøbing Fjord. Herds of red deer roam freely in both these areas.

The Rold Forest is Denmark's largest forest area (about 8,300 hectares). The soil largely consists of gravel, and the forest originally consisted largely of rather stunted beeches (*Fagus sylvatica*). Two thirds of the area has now been planted with conifers, mainly Norway spruce

(*Picea abies*). Deciduous trees constitute the remainder, with beech dominating.

Of the 46 samples analysed from this area, 41 are from the Buderupholm State Forest District, (sent in by Mr. JENS HVASS, forest supervisor). Three samples from Nørlund Estate, and one from Seem Forest on the Lindenberg Estate, were taken by the author.

Buderupholm State Forest District (2,210 hectares) houses a native population of red deer. In 1955, when most of these samples were collected, the total number of individuals was given as around 25 (ALEX-HANSEN 1956). However, one's experiences with census-taking

of deer make one regard this figure with great reserve. It is quite possible that there could have been interchanging between this population and the population from the Lindenberg area, as at this time the border was only partly fenced.

It is reported by Mr. R. SØRENSEN, forest keeper that red deer from this area, which at that time had a very large population – the total number for the Rold area was given as 435 (ALEX-HANSEN 1956) – made regular nightly journeys to certain preferred foraging places in the northern part of the State Forest.

At the end of the 1920s fences were erected along the outer edges of the forest in order to prevent red deer from wandering out into the fields in search of food.

In the winter, food, mostly oats (*Avena sativa*) is put down in special feeding places.

The dune plantations include plantations, sand dunes and heath, between Ringkøbing Fjord and Ho Bugt (approx. 9,500 hectares).

The planting of the dune areas began in 1853, and was originally intended as a means of preventing sand drift. The dominating tree is mountain pine (*Pinus mugo*); on better soil and older plantations a number of other conifers and even deciduous trees may be found.

In between the individual plantations there are extensive areas of open dune and heath terrain, with unhampered access to the neighbouring fields. The actual area planted comprises approximately 7,500 hectares while approximately 2,000 hectares are heath and dune (THAARUP 1953).

Table 1. The number of samples distributed on year, month and district.

		Dune plantations	Rold Forest	Total
January	1954		1	
	1955		10	
	1956	10		
	Total	10	11	21
February	1954		1	
	1955		11	
	1956	4		
	Total	4	12	16
March	1954			
	1955			
	1956	3		
	Total	3		3
April	1954			
	1955			
	1956	1		
	Total	1		1
May	1954			
	1955		1	
	1956	2		
	Total	2	1	3
June	1954			
	1955	1		
	1956			
	Total	1		1
July	1954			
	1955	3		
	1956			
	Total	3		3
August	1954			
	1955	2	8	
	1956			
	Total	2	8	10
September	1954			
	1955	4	9	
	1956	2		
	Total	6	9	15
October	1953		1	
	1955	1	3	
	1956	15		
	Total	16	4	20
November	1954	2		
	1955	3	1	
	1956	10		
	Total	15	1	16
December	1954	7		
	1955			
	1956	3		
	Total	10		10
Total		73	46	119



Photo P. VALENTIN JENSEN.

Fig. 2. Moorland (Rold 18.2.1965). Open, grass-grown areas with young spruces are often frequented by the red deer.

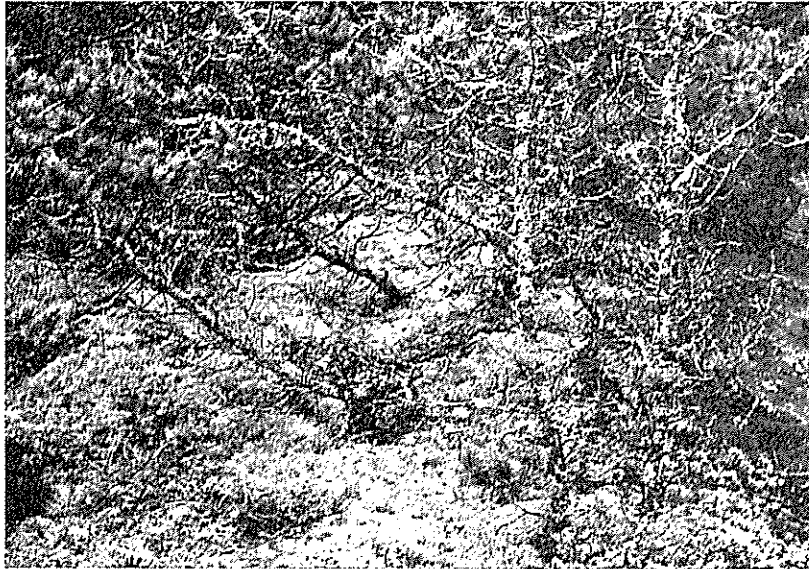


Photo P. VALENTIN JENSEN.

Fig. 3. Scrub of *Pinus mugo* with a dominating cover of lichens. The dune plantations (Vejers Plantation 10.5.1962).



Photo P. VALENTIN JENSEN.

Fig. 4. Heath area. The dune plantations (Kallesmærsk 10.5.1962). The vegetation is dominated by *Calluna*, mixed with *Empetrum*, lichens, *Deschampsia flexuosa*, and mosses.

The red deer population in this area is, naturally enough, quite recent, and must have been established from the deer populations in the northern and eastern parts of Jutland during the last 50 years. At the present time a large and hardy population exists; in 1955, when most of the samples were taken after 136 animals

had been shot, it appears to have consisted of at least 250 individuals (CHRISTOFFERSEN 1967).

A total of 73 samples has been analysed from this area, all originating from the shoots undertaken by the Dune Directorate in cooperation with the Game Biology Station.

Stomach weights

Whenever possible the weighing of rumen-reticulum with contents was taken immediately after it was removed from the animal in order to obtain an impression of the food amount.

The average weight for all stomachs was 12 kg. In 28 calves shot between September and March the average weight was 6½ kg. The lowest weight here was 3 kg (Oksby Plantation, 9.10.1956, ♂)

and the highest 10 kg (Bordrup Plantation, 23.3.1956, ♂).

For twelve 1½ year-old hinds the average stomach weight was 10½ kg (8–13 kg), while for 22 males of the same age it was 13½ kg (10–17 kg). For 51 hinds aged 2½ years or more the average weight was 13 kg (7–20 kg) as was also the average weight of 38 stags of the same age (5–22 kg).



Photo F. CHRISTOFFERSEN.

Fig. 5. Removing rumen samples.

Even though most of the stags appeared to be fairly young animals, it is obvious that stomach weight values are remarkably low from the end of September until the middle of October. It would

seem natural to connect this with the rutting period. Apart from these stomachs from the rutting period, the average of the remaining stags aged $2\frac{1}{2}$ years or more is 16 kg.

Method employed

The samples were taken out of the stomach as quickly as was practicably possible after the animal had died, and as often as possible by the same person. In all cases instructions were sent to the examiner in question.

The rumen and reticulum were cut free as a whole and weighed. The sample was then taken from the rumen itself, and in order to ensure that samples were as representative as possible, smaller samples were taken from ten different parts of the food mass, constituting about 500 cm^3 in

all (Fig. 5). Formalin was then added and the sample was sent off with as much information as possible (date, time of death of animal, age, sex, locality, etc.), to be examined at Jagtfondens Vildtbiologiske Undersøgelser in Copenhagen.

For the actual examination the following method was employed which was believed to give a sufficient degree of accuracy and to be practical within a reasonable period of time. Approximately a third of the sample was set aside for possible control or for later supplementary investiga-

tions – the rest was washed in a fine-meshed sieve for closer examination. The material was examined and sorted under water, using a binocular microscope with 5 x magnification. To ensure that no part of the material was overlooked, a larger petri dish was sometimes used, divided into two parts by plastic strips and provided with a small »lock-chamber« in the middle, the width of which corresponded to the field of vision of the microscope (Fig. 6). As the material was gradually pulled from the one part to the other through the lock it could be ascertained that nothing essential was overlooked. The fragments from the different species or groups were collected in small piles in a large petri dish, and the respective amounts estimated in percentage by volume. The results of a suitable number of subsamples – dependent on how complex and »difficult« the sample was – were compared, and the final percentage given, taking into account whether part of the content was difficult-to-digest food which had been for a longer period in the rumen.

It seems natural to state the relative

amounts of each plant species as percent volume, and owing to the wide margin of error (especially with larger amounts), it was thought preferable to give a »round« figure. It must be strongly emphasized that percentage indications for the individual samples cannot be taken as an exact measure of the percent volume, but are only intended as a measure for evaluation. Indications given in percentages have the advantage of being easier to work with and provide average values for given periods. This kind of mean value can, however, when published to several decimal places as one often sees in similar papers, give an erroneous impression of accuracy. It must be constantly remembered that these values are produced from somewhat uncertain figures, and it is, therefore, preferable to delete the decimals in the final result. It is obvious that with the average of a large number of figures a certain degree of equalization will appear and that on the whole, a large material investigated by the same person will give the best possible picture of food selection.

Considering the uncertainty in estim-

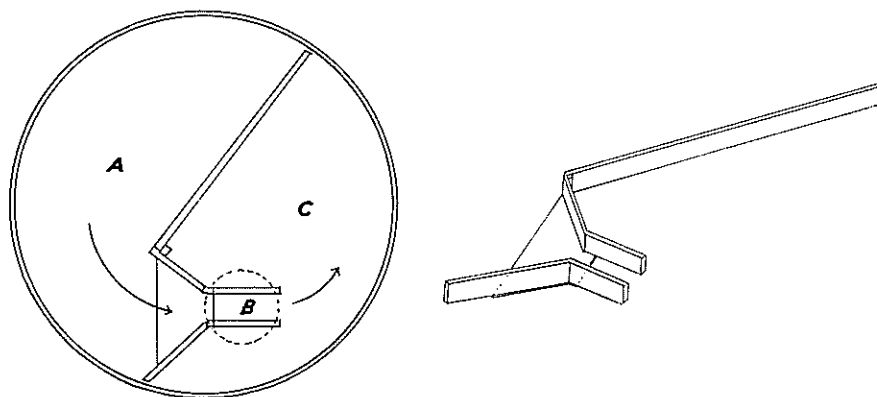


Fig. 6. The material to be investigated is put in room A and is drawn through B into room C. Dotted line: field of vision of the microscope.

ating amounts, another representation of the results has been tried. Visually, at least, this should show the importance of each individual plant species or group as food items without giving the impression of exaggerated accuracy (Figs. 8, 12, 13, 14, 18, 19).

On the basis of an estimate of the relative amount of each food item as percent volume, the items are classified into four groups.

If a food item is present in an amount estimated to be under 1 % of the total amount, or only as traces, it is put into the first group, shown as open columns in the diagrams. This may then be taken to be unimportant to the particular animal in question – possibly taken accidentally with other food. The second group includes food items present in small amounts only and presumed to have limited food value. This includes food in amounts from 1 % – 5 %, and is shown as diagonally-lined (hatched) columns. If food is present in

amounts exceeding 5 % it must be considered to be of real value to the animal and is put into the third group, which includes amounts from 5 % to 50 % and is shown by crosshatched columns. Food in amounts of 50 % or more must be considered to dominate and to be of great importance. This group is shown by filled-in (black) columns.

By this method of representation the height of the columns shows the actual number of samples in the case of a small material whereas for a larger material it is more convenient to have the columns indicate the percentage of the total number of samples. At the same time, the diagrams give a direct impression of how many samples were completely dominated by a certain food item, and in what cases this formed an important part, a small part, or only a trace of the total. In this way, a direct visual impression of the quantitative value of each food item is obtained.

The importance of the individual plant species or plant group as food item for red deer

It has been found necessary to divide the separate food items into groups which are

practical to work with and consequently to do away with the stricter systematics.

BARK

The fact that bark occupies a special position as a food item for red deer, is first and foremost because the deer, by »stripping« the bark from living trees, cause considerable damage to forests.

As »bark-stripping« damage is an obvious and permanent sign of foraging

deer, there can be no doubt when bark is part of a certain deer population's food.

One might expect »bark-stripping« to be a decided winter phenomenon, and that bark, which is always easily available (irrespective of snow and ice-cover) always has a certain value as a source of

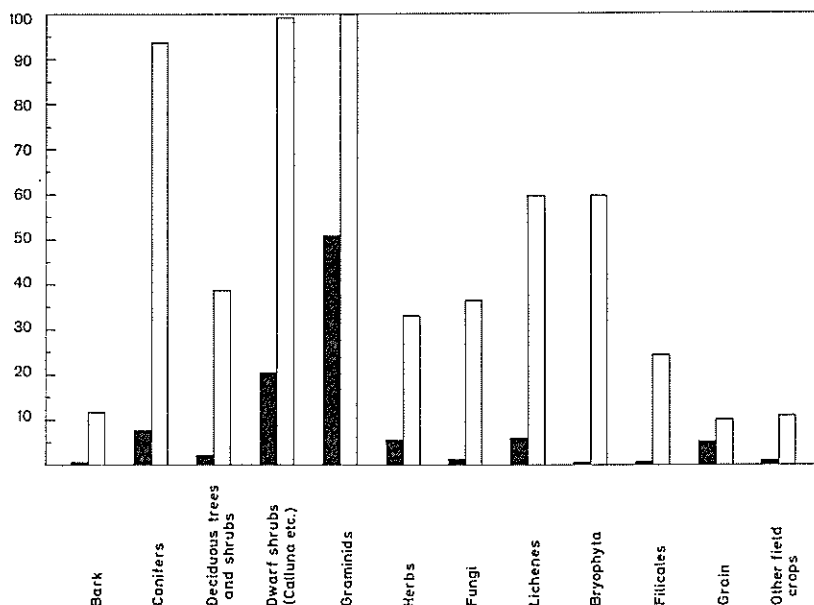


Fig. 7. The share of the single food group of the total amount of food for the whole year (119 samples). Volume percentage: black columns. Frequency of occurrence: open columns.

emergency food, when food from plants and herbs is scarce or unavailable. It is common knowledge that all herbivores, e.g., deer, small rodents, hares (*Lepus europaeus*), and rabbits (*Oryctolagus cuniculus*), gnaw bark in the winter, and it is also in this period that deer eat the shoot tips of woody plants (browse). However, direct observation alone has shown that »bark-stripping« goes on during spring and summer, and that during this time the damages are definitely more extensive.

Bark is taken from the tree with the lower front teeth; these are set into the bark, and with an upward, chisel-like movement the bark is torn from the tree. In the winter months, when the bark is more firmly attached to the trunk, it is gnawed off in smaller particles. In these cases the individual toothmarks can often

clearly be seen; they penetrate right through to the lighter part of the trunk and are often edged by small stripes in the brown, inner bark. In the summer – and not least in the first part of the sap-rising period – the bark is more easily detachable, and it is possible for deer to loosen whole strips or flakes on rather large surfaces. Thus, large portions of the trunk may be completely bared, and for this reason alone, summer-stripping is much more damaging than winter-stripping.

The more practical side of the »bark-stripping« problem has been investigated by the Game Biology Station, Kalø. For the results of these investigations see STRANDGAARD (1967).

In Rold, J. HVASS, forest supervisor, states that bark-stripping began to be serious around 1940, and that since that

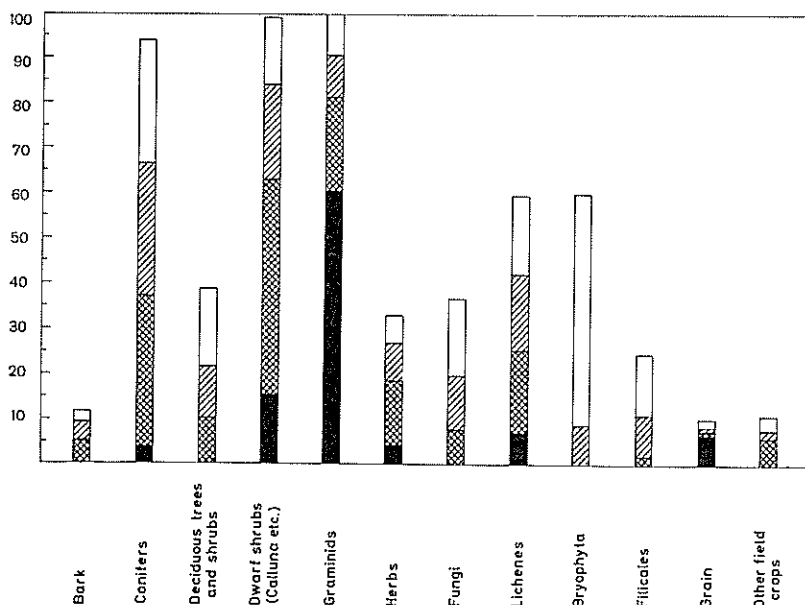


Fig. 8. The quantitative importance of the various food groups for the whole year. The single columns show the percentage of rumens where the food item comprises respectively a dominating (> 50 per cent, black), main (5-50 per cent, cross hatched), sparse (1-5 per cent, hatched), or very small (< 1 per cent, open) part of the rumen sample.

time it had reached really serious dimensions. However, the problem now appears to be less important, since during recent years the deer population has been reduced and has been separated by a fence from the adjoining forest of the Lindenberg Estate.

During the serious bark-stripping period it appears that the tree suffering the most damage was Norway spruce (*Picea abies*) between the ages of 30-45 years, with a trunk diameter of 10-15 cm. Younger spruces are difficult to approach owing to the dense lower branches. It is often observed that stripping begins immediately after the first thinning of a spruce culture.

In the dune plantations stripping did not begin until later. It takes place here

to a small extent, and as it is concerned mostly with mountain pine (*Pinus mugo*), has slight economic significance. In recent years, however, it seems that deer have developed a taste for the bark of lodgepole pine (*Pinus contorta*), which is now used greatly in the founding of new plantations.

In the present investigation only the bark of conifers was found. Even after a long period in the rumen this is easy to recognize. It is found as small flakes of a few centimetres or, where the bark is stripped in summer, as shorter or longer strips, up to 170 mm long and 10-15 mm wide in the present material. It is almost always found in its full thickness, irrespective of size; the outside is formed by the cork itself into a hard, scaly layer

and the inside by the remaining bark layer which, after being some time in the rumen, appears as a thick, stringy and somewhat spongy layer.

In some samples scales of about 1 mm were found from the cork layer itself. When these scales were found on single occasions they were not regarded as »traces« from actual barkstripping but as chance finds of loose bark. This kind of fallen or torn-off bark is found in large quantities in the vegetation of the forest bed.

Bark was found in 15 samples of the material examined, corresponding to 12% of the samples as a whole.

From the winter months proper, December, January, February, bark was present in only two samples out of a total of 48. Of these, one showed only a trace of bark, while the other showed 5% (Rold, 14.1.1955). From the spring months, March, April and May (7 samples in all) approximately 5% bark was found in the two samples from May. From the summer months, June, July and August (14 samples), bark was found in no less than 5 samples, all from August, and varying in amounts from 1% to 8%. From the autumn months, September, October, November, there were 51 samples, of which bark was found in only four samples. Of the latter, three samples from September showed only traces in one and about 1% in the other two. The

last of the four autumn samples containing bark is from October, and contains only traces.

Bark found in the samples was, in all cases, bark from conifers, and of these the most important tree appears to be *Picea abies*. In all the samples from Rold in which bark was found, spruce bark was present, and only this type exceeded amounts of 1%.

The bark of silver fir (*Abies sp.*) was found in very small particles in the Rold samples. This was not obtained by »stripping«, but was from thicker shoots, consumed as »browse«. J. Hvass, forest supervisor, states that the first tree the deer began to »strip« was the silver fir.

Bark of the pine (*Pinus sp.*) was only found in samples from the dune plantations, and in all cases only in very small amounts – in four cases as traces, and only in one case in an amount of about 1%.

It appears that in recent years deer have begun to »strip« bark from the *Pinus contorta* in the dune plantations.

Despite the fact that the present material, especially from the spring and summer months, is rather limited, it does seem to show that bark is normally relatively unimportant as a winter food, whereas bark from the spruce, particularly where this three appears in large stands, can occur in the food from May to August in rather large amounts.

BROWSE OF CONIFERS

Norway spruce (*Picea abies*)

Remains of spruce were found in 34 of the 45 samples from Rold from August right up to February, i.e. in 75% of the samples. Apart from a single sample from October with a content of 30%,

spruce in dominating amounts was first found in the February samples (particularly from the last part of the month). It was found in two samples from 24th and 25th February in amounts of 75% and 80% respectively.

Silver fir (*Abies sp.*)

Silver fir was almost exclusively found in the samples from Rold. Of the 45 samples from August to February, silver fir was found in 18 of the samples (40 %). Larger amounts, up to 35 %, were found only in January and February, and only in one instance in samples also containing other conifers. A few needles were found in only one sample from the dune plantations (Vrøgem 22.1.1956).

Scotch pine (*Pinus silvestris*)

Particles of Scotch pine were found only in one January sample from Rold, where they made up 2 % of the sample; and it was possibly present, in a few cases, together with *Pinus mugo* from the dune plantations.

Mountain pine (*Pinus mugo*)

Mountain pine occurred only in samples from the dune plantations. Withered needles were found in samples from all 12 months—often in rather large amounts—up to 5 %—6 %. Green needles and whole shoots were, on the other hand, found only from November to April, but these were often mixed with withered needles.

It is assumed that the many withered needles were taken by chance, together with other food. Owing to the length of pine needles (particularly where the twin needles still remain on their dwarf shoot), they very easily become attached to herb plants after withering and falling from the tree. As these needles do not easily disintegrate they are found in large amounts throughout the year. Only in cases of fresh needles—fragments, whole needles, pairs attached to their dwarf shoot, or year-old shoots with or without dwarf shoots with needles—can there be any suggestion of actual browse, i.e. shoots taken directly from the tree as food. As

mentioned above, browse is only found from November to April. Of the 43 samples from the dune plantations during this period, green fir needles were found in 29 (57 %), and if withered needles are included, the figure reaches a percent occurrence of 98. The largest amount of fir found in a sample was 60 % (Vejers Plantation 29.1.1956), and the average for the November to April period was 5 %.

Juniper (*Juniperus communis*)

Juniper was found in 8 samples from the winter months. Of these two were from the dune plantations, one in an amount of 5 %. In addition to a few samples with single needles from Rold, samples with amounts of 1 %, 5 %, 20 % and no less than 95 % were found (Rold 24.2.1955). In the latter sample a few berry-cones were found. From this picture it is evident that deer on occasion can fill the rumen almost completely with *Juniperus communis*.

Hence browse of conifers plays an important role during the winter months, particularly during the latter part. All evergreen food plants are, naturally, of great importance in the winter, as their leaves remain green and without essential loss of food value throughout this period. With evergreen bushes or trees there is also the further advantage that the branches and leaves are easily accessible, irrespective of how severe snow conditions may be with respect to depth or ice-cover.

Of the species mentioned above, it appears that deer will eat any of them which happen to be easily obtainable. In the Rold area *Picea abies* and *Abies sp.* are the preferred species, and in the dune plantations *Pinus mugo*.

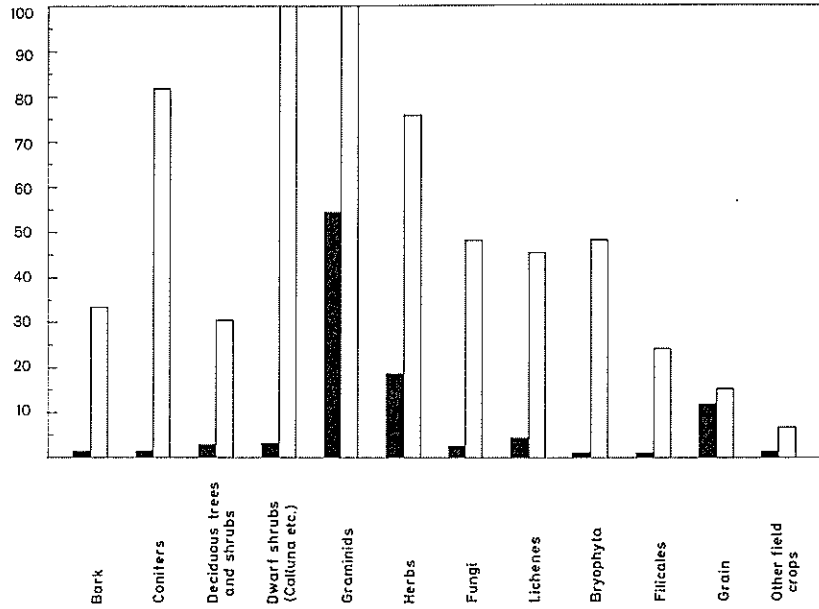


Fig. 9. The part of the individual food groups of the total food mass in the summer months (April-September), total 33 samples. Percentage of volume: black columns. Frequency of occurrence: open columns.

BROWSE FROM DECIDUOUS TREES AND SHRUBS

Shoots and leaves of deciduous trees and shrubs do not appear to be particularly important as food for red deer. Even though remains are found in over a third of the samples (38 %), these comprise only 2 % of the total food amount. As material during the actual summer months is particularly scarce, however, it is difficult to say with any certainty what importance shoots with leaves may have in this period.

Broom (*Sarothamnus scoparius*)

Broom occupies a special place among food plants as, although it is deciduous, its twig-like branches remain green throughout the winter. It was found in

single samples from both Rold and the dune plantations from December to March. It usually occurred in small amounts, but one sample from Rold (20.1. 1955) contained 10 %, and one from the dune plantations (Veiers Plantation, 12.3. 1955) contained as much as 40 %.

It was easy to recognize *Sarothamnus* in the samples because the branches are provided with 5 wings, and in a more digested state are very strongly shredded.

Creeping willow (*Salix repens*)

Creeping willow was rather common in samples from the dune plantations most months, but had special significance in September and October. Of the 22 samp-

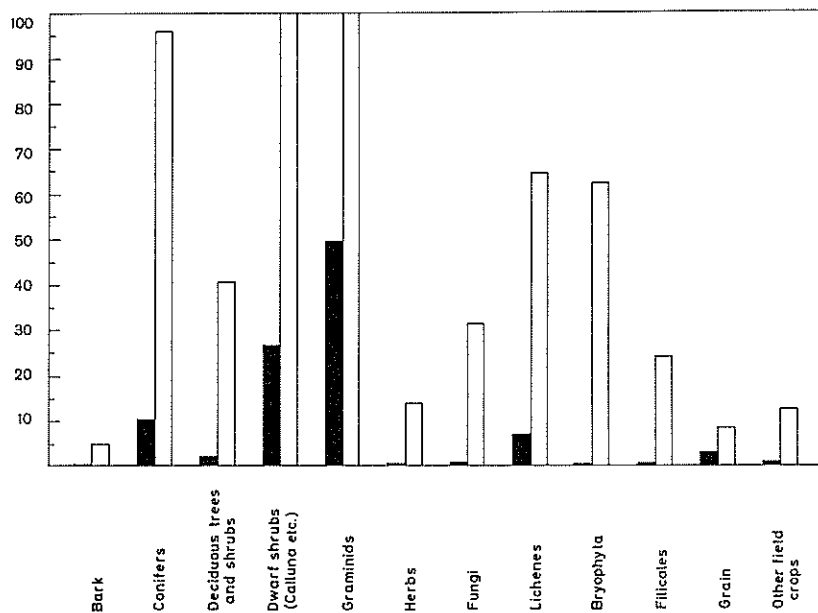


Fig. 10. The part of the individual groups of the total feed mass in the winter months (October-March), total 86 samples. Percent of volume: black columns. Frequency of occurrence: open columns.

les from these months, willow was found in 16 (73 %), comprising 5 % of the total food mass for this period. The largest amount in a sample was 45 % (Sølager Plantation, 26.6.1955), also containing a number of seed capsules.

Salix repens varies greatly, but it appeared that the type occurring most frequently was the wide-leaved form (*Salix repens arenaria*) – often with almost circular leaves – which grows particularly on dry, sandy soil.

The most remarkable fact about the present analyses is that *Salix repens* is of definite significance to the dune plantation population, especially in the autumn, and that broom can be taken in rather large amounts in both areas – at least on occasion.

Other deciduous trees were found in insignificant amounts during the winter months. In one sample from July (Kærgaard Plantation, 19.7.1955) about 20 % of different deciduous tree leaves were found. Otherwise, even during the summer months, the amounts were insignificant in the few samples available.

While leaves of *Salix repens* were always very well preserved in the samples, larger leaves of most other deciduous trees and shrubs were so fragmented and damaged that they were extremely difficult to identify with any accuracy. The following species were established:

Oak (*Quercus sp.*)

In the above mentioned sample from July (Kærgaard Plantation, 19.7.1955) a large proportion of the 20 % deciduous leaves

were *Quercus*, and the rest unidentifiable. In addition, in two samples from the dune plantations from October a few shoot fragments with buds were found. In Rold, remains of oak leaves were believed to be found in an August sample.

Beech (*Fagus silvatica*)

A single bud was found in a winter sample from Rold. In addition a number of bud fragments were found in a sample

from May (Rold, 17.5.1956), but these were definitely loose, fallen particles taken with other food from the forest bed.

Birch (*Betula sp.*)

Single fragments of shoots with buds were found in samples from the dune plantations (Bordrup Plantation, 17.9.1955, Ho Plantation, 18.11.1956 and Oksby Plantation 19.11.1956).

BROWSE FROM DWARF SHRUBS

Common heather (*Calluna vulgaris*)

Heather was found in all samples except one (with an occurrence of 99 %), and constituted no less than 20 % of the total food amount. There is, however, an obvious variation in the amount taken during the course of the year. If an average of the samples is taken from October to March (86 samples) the percentage is 26, while the average for the remaining months, April to September (33 samples) is down to 3 %. If an average is taken for the very few samples (14) from the summer months, June to August, the average is down to 1 %.

Thus, in the winter months *Calluna* plays an important role in the food of the red deer, constituting $\frac{1}{4}$ of all food. During the summer months it is of no importance, although still taken in small

amounts. The only sample in which *Calluna* was not found was from Rold (27.9.1955); here, the content consisted almost entirely of grasses.

If the samples from Rold and the dune plantations are compared it will be seen that there is no great difference for either the summer or the winter months, in that the average for the winter months is 28 % and 25 %, and for the summer months, 2 % and 3 %.

In the winter months the average values for the months of January and February are about 30 % while the average for December goes right down to 15 % (again reaching approximately 30 % in January and February, declining to about 20 % in March, and down to a few percent in April). The low December figure, compared to the other winter months, must

	Total yearly samples	%	Total winter samples	%	Total summer samples	%
Rold Forest	47	18	28	28	19	2
Dune Plantations	72	21	58	25	14	3
Totals	119	20	86	26	33	3

Table 2. The average share of *Calluna* of the samples (volume percentage).



Photo H. V. CHRISTENSEN, Zool. Mus.

Fig. 11. Rumen sample No. 30 from Roldskov 18.2.1955. 95 per cent *Calluna*, 5 percent *Abies*.

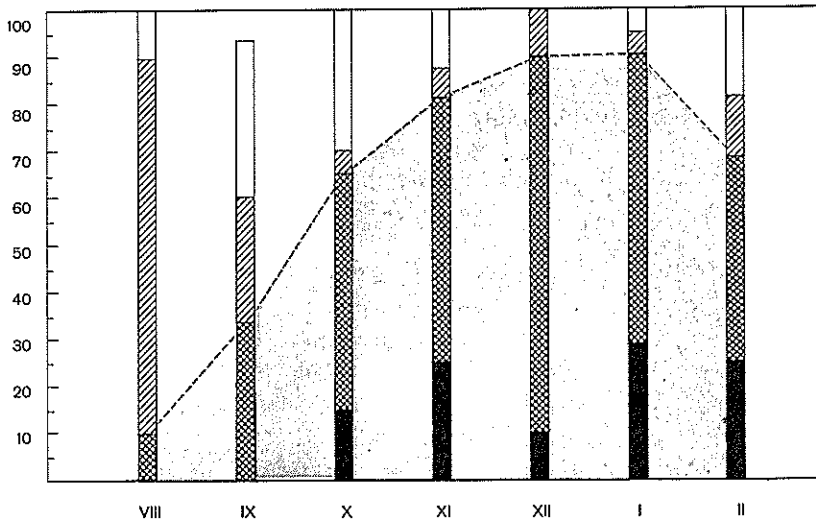


Fig. 12. The importance of *Calluna* as a food item in the months August to February (VIII-II) in the dune plantations and Roldskov. The grey part shows its increasing part of the food in the winter months. Black columns mean that the food subject forms a dominating (> 50 per cent, black), main (5-50 per cent, cross hatched), sparse (1-5 per cent, hatched), or very small (< 1 per cent) part of the rumen content.

supposedly be attributed to accidentally coinciding samples with low values in this very small material, which comprises only 10 samples.

With regard to individual samples the content varies in the winter months from rather small amounts (traces) to a maximum of around 95 % (Rold, 18.2.1955). Only in October to February are samples found containing 50 % or over – in altogether 13 samples, or 21 % of the samples. For red deer as a whole, it can thus be seen that *Calluna* is of great importance as a winter food.

Other dwarf shrubs

Other typical heath plants found were *Empetrum nigrum*, *Vaccinium myrtillus*, *Vaccinium vitis-idaea*, *Erica tetralix*, and *Myrica gale*. None of these plays a particularly decisive role as a food item, but they are found – especially in the winter months – in small amounts in some of the samples.

Crowberry (*Empetrum nigrum*)

Crowberry was found in no less than 52 of the samples (44 %), but mostly as traces. Only in six cases were amounts found of about 1 %, and in one case 4 % (Rold, 12.2.1955). It appears to be most frequently taken in the winter months, and was somewhat more common in the samples from the dune plantations than those from Rold.

Bilberry (*Vaccinium myrtillus*)

Bilberry grows, in particular, on north-

facing hillsides of the heath, but it is also found on humus soil in both coniferous and deciduous forests (beech forests). Bilberry was only found in samples from Rold, in altogether 16 samples (36 %). In one case it was found in an amount of 5 % (8.1.1955) but was otherwise, apart from one other sample with 1 %, only seen as traces.

Cowberry (*Vaccinium vitis-idaea*)

Cowberry was found in 14 of the samples (12 %), of which two were from Rold (8.1.1955 and 26.10.1955) in amounts of 3 % and 7 % respectively. One from the dune plantations appeared in an amount of 1 %, and the rest as traces.

Cross-leaved heather (*Erica tetralix*)

Cross-leaved heather was found in 24 samples (20 %), most of them from the dune plantations. Only in five samples from the dune plantations was the amount in the region of 1 %; otherwise it occurred only as traces.

Bog myrtle (*Myrica gale*)

Bog myrtle was found only in samples from the dune plantations, 11 samples in all (16 %), and only in one case in an amount of approximately 1 %. It otherwise occurred only as traces.

Bearberry (*Arctostaphylos uva ursi*)

Remains of bearberry were found in one sample from the dune plantations (Bordrup Plantation, 1.10.1956).

GRASSLIKE PLANTS (GRAMINIDS)

Apart from grasses proper (*Graminaceae*) this group includes for purely practical reasons other monocotyledonous plants with narrow grass-type leaves, e.g. sedges

(*Carex*) and wood-rushes (*Luzula*). In the decomposed state these plants are almost impossible to distinguish from each other, but can nearly always be separated from

plants outside the group. For the same reason, leaves of cultivated grasses – grains – have been included in this group.

It is conceivable that leaves from young plants of winter crops, especially rye (*Cecale cereale*) could be among the indeterminate items in this group. On the other hand, kernels of mature grain are not included under this group. These are always easy to recognize, and have a different kind of nutritive character from the green leaves themselves.

Among herbaceous plants graminids play a dominating role; they form the larger part of the field layer and often occur as a continuous cover over large areas. Several species have green leaves throughout the winter and are therefore particularly valuable as a food plant.

When considering graminids as a whole the result obtained is that food items from this group make up approximately half (51 %) of all food taken throughout the year, and that they occur in all stomachs (percentage occurrence 100). Thus, taken together, graminids form the most important food group for red deer.

Comparison between the winter months (October–March) and the summer months (April–September) shows that the figures for the winter are 50 % compared to 54 % for the summer. It is thus evident that graminids are, generally speaking, just as important a food item in the winter as in the summer, it being emphasized that only green, fresh leaves were found in the present material.

When conditions in Rold and the dune plantations are compared it appears that winter samples from the dune plantations show larger amounts of graminids (about 54 %) than samples from Rold (about 42 %). During the summer months the situation is reversed; the content of graminids is greater for Rold (about 65 %) while that for the dune plantations is

only about 40 %. This difference would be equalized if ripe grain, partly taken directly from the fields and partly from the feeding places, were included with the graminids.

Thus in the winter samples from Rold about 8 % grain was found which must originate from laid-out fodder, whereas the amount of grain in samples from the dune plantations was practically negligible (< 1 %). If these figures are added to the figures for graminids as a whole the difference for the two localities is not very great, the total content for Rold being around 50 % and that for the dune plantations around 54 %. In the summer months grain was not found in the Rold samples, but no less than 25 % green oats (*Avena sativa*), taken directly from the fields, was found in the samples from the dune plantation. Accordingly, the figure for Rold would be about 65 % and that for the dune plantations around 66 %.

Grasses (Graminaceae)

Wavy hair grass (Deschampsia flexuosa)

Wavy hair grass, which is a pronounced humus plant, is common in both localities. It is found – often in large, continuous growths – in the forest, in clearings, and on the open heath. It is fresh and green throughout the year, and will only become temporarily inaccessible in the event of heavy snow cover.

In Denmark it has been stated to be »without particular value as a food grass« (MENTZ 1935, but is said to be taken by sheep on the heath. In Northern Sweden, however, according to local farmers it is said to be one of the best food plants, the milk of cows grazing on this grass having a high fat content.

MANKER (1964) states that certain grasses, e.g. *Deschampsia flexuosa* and fescue

grasses (*Festuca*), known to the Lapps as sitno, are an important green food for reindeer at the beginning of the winter when the reindeer can paw them out of the snow.

Dutch investigations (EYGENRAAM 1959) on the food of red deer have also shown *Deschampsia flexuosa* to be a very important feeding plant. It has been observed here that, given a choice of different grasses sown on experimental plots, the red deer much preferred this plant to all others (personal communication).

AHLÉN (personal communication 1964), during the heavy snow falls of 1962–1963, had occasion to compare red deer populations in two different areas in Skåne – an area of coniferous trees on sandy soil (Vombs fure) and an area of deciduous trees on morain clay (Fjällfota, in the locality of Björkesåkra). The deep snow, together with ice-cover, prevented the deer from seeking their customary food from the open fields, forcing them instead to find it in the forest. In the deciduous tree area, snow and ice-cover also prevented the animals from taking food from the field layer, and they were, almost without exception, reduced to eating browse from the bush layer. At the end of the winter the animals were in a poor condition and a number died of starvation. In the coniferous area, however, the

ice-cover was not severe enough to prevent the deer from scraping holes in the loose snow in many places. In addition, there were snow-free areas under many of the large, more isolated spruces whose dense branches reached almost to the ground. Here it was possible for the deer to reach the bottom vegetation itself, which to a large extent consisted of *Deschampsia flexuosa*. In this area the deer were able to remain in good condition throughout the winter.

In the present material, *Deschampsia flexuosa* was found in no less than 101 samples, i.e. a percentage occurrence of 84. At the same time it constituted $\frac{1}{3}$ of the total food mass for the whole year, and $\frac{4}{5}$ (84 %) of the grasses. *Deschampsia flexuosa* is thus the most important food item for red deer, and is on the whole of equal importance throughout the year.

In individual samples the amounts of *Deschampsia flexuosa* varied from traces to 95 % of the content. In no less than 46 samples, i.e., around $\frac{1}{3}$ (39 %) of all samples, *Deschampsia flexuosa* was found to dominate, occurring in amounts of 50 % or over; of these, 25 samples (21 %) had 75 % or more, and a further 11 samples (9 %) had 90 % or more. The highest amount found was 95 %.

For the summer months, *Deschampsia*

	Total yearly samples	%	Total winter samples	%	Total summer samples	%
Rold Forest	47	29	28	16	19	48
Dune Plantations	72	36	58	38	14	27
Totals	119	33	86	31	33	39

Table 3. The average share of *Deschampsia flexuosa* of the samples (volume percentage).

flexuosa constituted 39 % of the total food mass, and 31 % for the winter months. At the same time, the same difference exists between the two areas as for graminids as a whole; samples from the dune plantations contained more *Deschampsia flexuosa* in the winter months (38 %) than the samples from Rold (16 %). In the summer months the opposite was the case; the content was greater for Rold (48 %), and for the dune plantations considerably less (27 %).

Deschampsia flexuosa is easy to recognize, even in very small fragments. The almost thread-like leaves are pentagonal in cross-section, with faint longitudinal grooves, and a somewhat oily gloss. Along one surface there is a distinct light-coloured furrow.

Other grasses

Apart from *Deschampsia flexuosa* there was only a relatively small amount of grass in the samples, forming altogether about 6 % of the total food mass. In stomachs from the Rold area the figures for both summer and winter were around 3 % (4 % and 3 %), and for the dune plantations around 8 % (9 % and 8 %).

The larger part of the present material has not yet been identified down to family or species. Strongly digested material, which must be included in the collective graminid group, comprised altogether about 7 % of the total food mass.

The following species have been identified:

Tufted hair grass (*Deschampsia caespitosa*)

Deschampsia caespitosa is the species most often encountered after *Deschampsia flexuosa*. This was found in 23 cases (19 %), of which 20 (17 %) were from Rold, and all from the months August to Fe-

bruary. In one sample (Rold, 15.9.1955), *Deschampsia caespitosa* was found in very large quantities (20 %), but was otherwise seen only as traces, or in amounts of 1 % - 2 %.

Grey hair grass (*Corynephorus canescens*)

Corynephorus canescens was found in 12 cases (10 %), all from the dune plantations. In one instance it was found in very large amounts comprising half the entire stomach contents (Oksby Plantation, 7.11.1956), and in another case an amount of about 10 % was found (Bordrup Plantation, 20.11.1955). In one sample from March 12th, 1956, from Vejers Plantation, the amount was estimated at about 4 %, comprising a whole tuft complete with roots.

Leaf fragments of *Corynephorus canescens* are difficult to distinguish from *Deschampsia flexuosa*. Like the latter plant, the leaves are almost thread- or brushlike, in that they are tightly inrolled. However, the edges of the leaves are not closely joined but leave an obvious, rather deep fissure. In cross-section the leaf is completely rounded, without corners, and the underside is provided with dense, short spines, the tips of which are directed towards the tip of the leaf itself.

Sheep's fescue (*Festuca ovina*)

Sheep's fescue, against expectation, was found in only a few cases. Owing to the state in which this plant was found in the stomach samples it is difficult to distinguish it from *Deschampsia flexuosa*. The threadlike leaves are, however, more compressed, and the furrow between the edges of the leaf is deeper and not so strongly closed. On each side of the tip there is a row of fine spines, which can, however, only be seen under magnification.

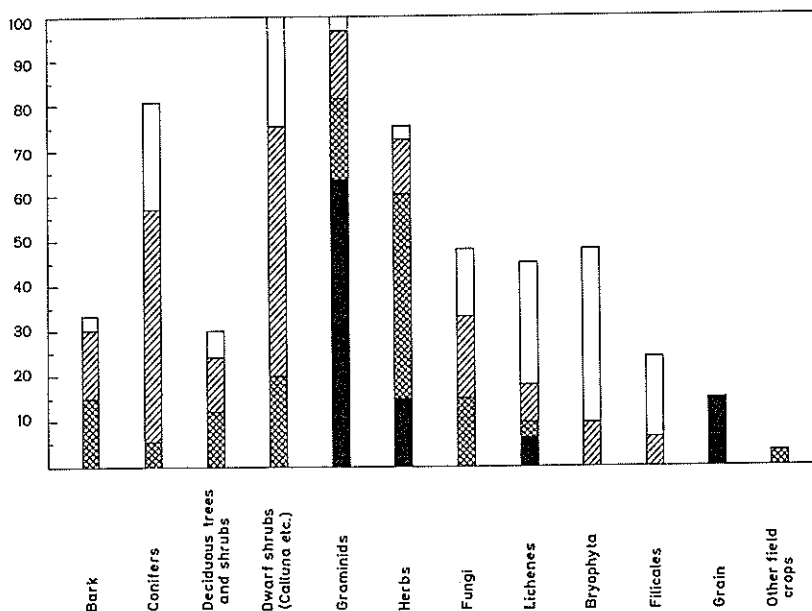


Fig. 13. The quantitative importance of the various food groups in the summer months (April-September). Each column shows the percentage of rumen, where the food item forms a dominating (> 50 per cent, black), a main (5-50 per cent, cross hatched), a sparse (1-5 per cent, hatched) or a very small (< 1 per cent, open) part of the rumen content.

Red fescue (*Festuca rubra*)

Red fescue was found only as traces in two samples from August and September.

Marsh foxtail (*Alopecurus genicalatus*)

In one case marsh foxtail was found in rather large amounts (8%) in a sample from the dune plantations (Vrøgum Plantation, 3.9.1956).

Yorkshire fog (*Holcus lanatus*)

Yorkshire fog was found in three samples – and in rather large amounts – from Rold, 15th September and 7th October (25% and 5%), and from the dune plantations (Vejers Plantation) 29th January.

Cocksfoot (*Dactylis glomerata*)

Cocksfoot was found in one sample from Rold (17th May) in a considerable amount (20%).

Wood-rush (*Luzula pilosa*)

Wood-rush belongs to the family *Juncaceae*, but its leaves so resemble grass leaves that a certain amount of practice is needed to distinguish between the two groups.

Luzula pilosa remains green and fresh throughout the year and is in particular found in forests.

This plant constituted a very small part of the total food mass (around 2%), but apart from the single sample from the dune plantations (1%) and in five other cases as traces, it was found to occur more frequently in the Rold samples – mostly as winter food. Even though the average for all samples from the winter months was only around 3%, *Luzula pilosa* did appear in dominating amounts in a few samples.

In January, when there were 11 samples from Rold, wood-rush occurred in all

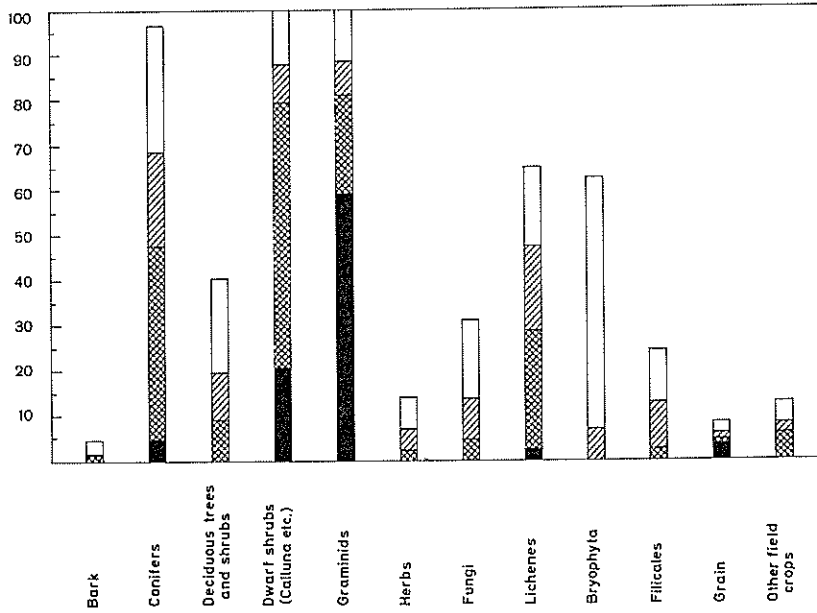


Fig. 14. The quantitative importance of the various food groups in the winter months (October-March). Each column shows the percentage of rumens, where the food item forms respectively a dominating (> 50 per cent, black), a main (5-50 per cent, cross hatched), a sparse (1-5 per cent hatched), or a very small (< 1 per cent, open) part of the rumen content.

varying from single leaf fragments to amounts of no less than 70%, the average for 11 samples being 15%. In the months of October and November, around 50% wood-rush was found in a single sample (Seem Forest, 7.10.1953) but was apart from this only found in small amounts in a further three samples. In February, *Luzula pilosa* was found in three samples, of which one was 5% and another 20%. Unfortunately, there was no samples from Rold from December, but as most samples with high values were from 8th - 22nd January, it would be reasonable to assume that *Luzula pilosa* would have appeared in December samples had any been taken.

It may be said that *Luzula pilosa* is a rather important food plant in Rold, where it appeared on occasion in dominating amounts in the winter.

Sedge (*Carex sp.*)

Leaves of narrow-leaved sedges were found in a number of samples. These constituted about 2% of the total food mass for the whole year. *Carex* does not appear to be of any importance in the summer months, constituting less than 1% (0.4%), but occurred in much larger amounts in the winter (3%).

A comparison between the two areas showed that *Carex* formed a slightly larger proportion, in both summer and winter, in the Rold samples than in those from the dune plantations.

In single samples, *Carex* occurred in very varying amounts, from traces to around 50% (Oksby Plantation, 6.10.1956).

Characteristic of *Carex* are the vacuolations which gradually appear between the vascular bundles. *Carex* leaves found



Photo H. V. CHRISTENSEN, Zool. Mus.

Fig. 15. Rumen sample No. 52 from Roldskov 15.9.1955. 80 per cent *Deschampsia flexuosa*, 5 per cent indefinable grasses, 1 per cent *Oxalis acetosella*, 8 per cent other herbs, 1 per cent *Calluna*, 1 per cent bark, 2 per cent *Abies*, 2 per cent *Fungi*.

in these samples are of two different types. The first is easy to distinguish from grasses as each half-leaf has a more or less clear longitudinal fold. The second type is more difficult to distinguish; the leaves are definitely thick, but the thick-

ness of the individual half-leaf decreases both towards the edge and towards the middle. A number of leaves of the first type were assumed to originate from sand sedge (*Carex arenaria*).

HERBS

In this group are included all herbs except the narrow-leaved graminids which, for the purpose of this paper, have been put into a separate group.

As most herbs have green leaves only in summer, the group naturally plays a more important role during that period. The group constituted around 5% of the yearly total food mass, and while the figure for the winter months was insignificant (0.24%), it was 18% for the summer months, i.e. almost $\frac{1}{5}$ of the food, and therefore of considerable importance.

From the Rold area, herbs were found in all the 17 samples from August and September (no samples from July), in amounts up to 90% (25% on average). Herbs were found in the dune plantations in 7 out of 11 samples from July, August and September, (65%) or almost $\frac{2}{3}$, and in amounts of up to 86% (17% on average).

Wood sorrel (*Oxalis acetosella*)

Despite its thin, fragile leaves, wood sorrel was very easy to recognize in the samples. Even in a rather decomposed condition, when practically only the cu-



Photo H. V. CHRISTENSEN, Zool. Mus.

Fig. 16. Rumen sample No. 41 from the dune plantations (Ho Plantation 27.9.1955). 31 per cent *Fungi*, 60 per cent lichens, 5 per cent *Deschampsia flexuosa*, 1 per cent bark, 1 per cent *Calluna*, 2 per cent other grasses.

ticle was left, this remained intact in large flakes.

Oxalis acetosella is the herb found in the largest amounts. It constituted half of all herbs found throughout the year, or 3 % of the total food mass. However, while in the summer months *Oxalis acetosella* formed a good 9 %, it barely constituted 1 % in the winter. In addition, *Oxalis acetosella* was only important as a food item in the Rold area where it was common both in *Picea* and *Fagus* forests. It comprised here no less than 17 % of the food in the summer months and is therefore, much more important than all the other herbs taken together, which constituted only 6 %.

From the Rold area apart from a single sample from May, there were samples from August and September only, but in 17 samples from these two months *Oxalis acetosella* was present in 14, of

which three were dominating, with amounts of 50 %, 75 % and 90 %. The average amount for August was 22 % and that for September 15 %. *Oxalis acetosella* seed was frequently found in these samples.

Other herbs

As already mentioned, the amount of other herbs constituted in all the same quantity as *Oxalis acetosella* alone e.g. barely 3 %. Other herbs constituted 9 % of the food in the summer months, but were without importance in the winter (0.15 % in both localities).

With regard to the summer months it was noted that while other herbs formed about 6 % in the Rold area, they constituted 12 % for the dune plantations, or twice as much. However, this figure comprised the whole content of herbs for the dune plantations, whereas in the Rold



Photo H. V. CHRISTENSEN, Zool. Mus.

Fig. 17. Rumen sample No. 87 from the dune plantations (Vrøgum Plantation 3.9.1956). 75 per cent *Avena sativa*, 8 per cent *Alopecurus geniculatus*, 1 per cent herbs, and 16 per cent cabbage.

area there was a further amount (around 17 %) of *Oxalis acetosella*, making the total amount of herbs almost double in Rold.

Spurrey (*Spergula arvensis*)

At one time spurrey was cultivated as cattle fodder, but is now only found growing wild. It was found in two samples from the dune plantations, and in one of them (Kærgaard Plantation, 21.7.1955), dominating in an amount of 75 %.

Shepherd's purse (*Capsella bursa-pastoris*)

Shepherd's purse was found in one sample from the dune plantations from December (Vrøgum Plantation, 14.12.1954) in about 2 %.

Common tare (*Vicia hirsuta*)

Common tare was found in a few samples from the Rold area as traces, 10th

February, 1955, and in 2 % on 7th August 1955.

Mountain speedwell (*Veronica montana*)

Found in one sample from the Rold area, 6th August, 1955, in 5 %.

Common cow-wheat (*Melampyrum pratense*)

Found in one sample from the dune plantations (Kærgaard Plantation, 19.7.1955), in no less than 10 %.

Heath bed straw (*Galium hercynicum*)

Heath bed straw was found in several samples from the Rold area, and in one sample from the dune plantations as traces.

In addition to these herbs a number impossible to identify were found, especially from July and August. They amount, however, to only about 2 % of the total food mass.

FUNGI

Mushrooms are important as food for red deer during the autumn months, being found in samples from August to November, the largest amounts being found in September and October.

In the total food mass for the whole year mushrooms constituted only about 1 %, but in September and October they were found in 30 out of 35 samples (86 %), with an average value of 3 %. Amounts in single samples varied from tra-

ces to about 30 % (Ho Plantation, 27.9.1955).

Mushrooms appear to be of equal importance in both localities. In September and October they appeared in amounts of about 3 % in both places.

It is remarkable that wholly undamaged caps and stalks were found among this very fragile material in the rumen content.

LICHENS (*Lichenes*)

Lichens constituted about 6 % of the total food mass, but only had any real importance as a food in the dune plantations, where throughout the year they constituted almost 10 % of all food, i.e. a very significant proportion. In Rold lichens were only found in 9 samples, and only in small amounts – in two cases 1 %, otherwise only as traces.

In samples from the dune plantations lichens were found in most of the samples in varying amounts (percentage occurrence 82). When the summer months are considered to be from April to September, it is seen that the quantity of lichens in the food is about the same for both periods, barely 10 %. The large amount of lichens during the summer months appears, however, to be solely due to the large amount found in September. If this month is considered together with the winter months, i.e. September to March, this is the period when lichens are very important for red deer in the dune plantations. During this period lichens were found in 86 % of the samples, and formed about 11 % of the total food mass.

In the remaining months – April up to and including August – from which there are only 9 samples from the dune planta-

tions, lichens were found in 7 (78 %), but only in very small amounts (0.6 %).

Thus lichens are an important food for red deer in the dune plantations from September to March. In most cases they dominated in the rumen content. The highest percentage was 75 (Bordrup Plantation, 9.10.1956), and two other samples contained 65 % and 60 % (Kærgaard Plantation, 28.9.1955 and Ho Plantation, 27.9.1955).

The largest amounts of lichens found were of reindeer moss (*Cladonia rangiferina* and *C. silvatica*), then *Cetraria tenuissima* and in a few cases *Parmelia physodes*.

Parmelia grows on tree trunks and branches and also occurs on twigs of heather. Thus it can be taken accidentally with »browse« from trees, bushes or heather.

Characteristically, lichens were very well preserved in the samples. This was particularly striking when an occasion arose to compare the present samples with the stomach contents of wild reindeer from Norway (Dovre) and West Greenland, in which lichens – and the rumen contents as a whole – were extremely finely disintegrated.

MOSSES (*Bryophyta*)

Mosses occurred very frequently in the samples (percentage occurrence 58), but usually only as traces (yearly average 0.1 %). Only in 9 cases were amounts found over 1 %.

There are no indications that moss has any significance as a food proper, and

it would be reasonable to assume that this is taken accidentally with other food. It would, in fact, be impossible for animals to forage in low plants in the field layer without a certain amount of moss being taken as well.

FERNS (*Filicales*)

Ferns constituted only an extremely small proportion of the total food mass (0.3 %), and occurred almost only in samples from the dune plantations, where they constituted just over one half percent of the food mass. From Rold they were found only in three cases, as traces.

In the dune plantations ferns formed about one half percent of the food mass for the whole year, constituting hardly anything of significance for the summer months (0.2 %), but a good half percent (0.6 %) for the winter months. They occurred in the largest amounts in samples from November to December, where in two cases they were found in amounts of

5 % and 12 % respectively. Ferns were otherwise found only as traces, or in amount of very few percent (1-3).

In almost all cases the fern in question was polypody (*Polypodium vulgare*). This little fern occurs both in forests (plantations) and out on the heath itself – often in small patches – and remains green throughout the winter months. In one case other species were found (*Dryopteris sp.*).

Even in very small fragments it is possible to recognize ferns; the vascular bundle, which is often black, ends in a characteristic small club-shaped swelling some distance from the leaf-edge.

FIELD CROPS

Of particular interest in any investigation of the food selection of a herbivore is the question of cultivated plants being taken directly from the fields, giving grounds for suspecting direct damage of greater or lesser significance.

Grain

In respect to grain, grazing may occur on the young plants, or as the biting or tearing off of the ears of more-or-less ripe »grain«.

Damage to winter seed

Firstly, and in the case of the dune plantations only, this concerns rye (*Ceale cereale*). Rye is sown here at the end of September or at the beginning of October; it sprouts, and remains green throughout the winter.

Leaves of grain plants have not with certainty been found in any samples. However, there is a possibility that these could have been present among the unidentified grasses, which, particularly

from the dune plantations (where the possibilities of crop damage are larger) were found in rather large amounts from November to March.

Since in strongly digested food it is hardly possible to distinguish *Cecale cereale* plants from other grasses, it would be natural to include possible grain plants in the graminid group – not least as in the case of red deer these must be »grasses« to the same extent as wild grasses.

The question is whether grazing on winter crops can, in general, be as damaging as is commonly supposed.

In places where wild geese have their resting or overwintering areas, there have likewise been complaints of damage. Here, where the geese often occur in flocks of many hundreds, damage is considered to be caused partly by the grain plants being bitten off, and partly by the plants being trodden down. However, closer examination has revealed that grain does not necessarily suffer from being eaten off in this way, and that this thinning out of the leaves is in many cases an advantage. Even though, after repeated visits from a flock of geese, a field may appear to be severely damaged, the grain plants will quickly regenerate during the growth period in spring and early summer. At harvesting time the grain will be equally as good as grain untouched by geese, and »the crop will in no way be less« (MARKGREN 1963).

The same results have been obtained in Holland (VAN DOBBEN 1953) and England (KEAR 1963), amongst other places.

In Denmark too, sheep used to be put out to graze on the sprouting winter crops in certain areas of West Jutland.

It is doubtful, therefore, whether foraging by red deer on exposed fields has any serious effect, unless there should be any question of direct tearing out of the plants, e.g. in sandy areas.

Damage to ripe grain

Damage to ripe grain has a slightly different character. In this respect it is not the leaves that are under consideration, but the ears of ripe or almost ripe »grain«. These are always easy to recognize in stomach samples, and it is natural enough that they should form a special group, especially as this will also include winter fodder laid out on purpose.

Grain from the summer months is of particular interest in this respect, as this can only be taken straight from the fields.

Grain constituted about 5 % of the yearly total food mass. During the summer months it formed no less than about 12 %, while for the winter months the figure was only around 3 %.

In the summer months grain was found only in samples from the dune plantations, but of the 14 samples from this period, it constituted no less than $\frac{1}{4}$ (26 %) of the food intake. »Grain« was found in 5 of the 14 samples (36 % – Kærgaard Plantation, 19.7.1955 and 15.8.1955; Sølager Plantation, 22.8.1955, and two samples from Vrøgum Plantation, 3.9.1956). In these areas of Jutland the crops are often out in the fields until around the middle of September. In the five samples mentioned above, grain, which consisted exclusively of oats (*Avena sativa*), constituted from 65 % to 90 % in individual samples, or an average of 73 %. These figures show that when an ample supply of suitable fodder is available, red deer can fill the stomach almost completely with this.

Laid-out fodder

Grain found during the winter months, can, as stated, only originate from laid-out fodder. In the Rold area this constituted 9 % of the food intake, while that for the dune plantations occurred only as traces. Along with the »grain« itself there

is naturally an amount of straw from the ears, and this is the only kind of »dry plant food« occurring in the samples.

Oats (*Avena sativa*) formed the greater part of the laid-out fodder, but in addition, both wheat (*Triticum sativum*) and rye (*Secale cereale*) were found in smaller amounts.

Other field crops

Remains of turnips or swedes (*Brassica sp.*) were found in one case, but comprised only about 1/2 ‰ of the total food amount. These were found in two samp-

les from February in small amounts, and in somewhat larger amounts in November and December (4 ‰, 12 ‰, 18 ‰ and 25 ‰).

Potato (*Solanum tuberosum*) was found in two samples from the dune plantations in August and December, in amounts of 27 ‰ and 7 ‰ respectively.

Leaves of cabbage, turnip or swede were found in a single sample from the dune plantations from September (16 ‰), and »traces« of carrot (*Daucus carota*) were found on a few occasions in October and December.

NON-FOOD ITEMS

Apart from the food proper found in the rumen samples, a few other occasional items can also be mentioned. Hair of red deer, which was assumed to have been swallowed by the animal during coat-licking, was of common occurrence (45 ‰ of samples). Hair was usually found in rather small amounts, but during the moulting season it often occurred in large amounts, e.g. in samples from 11th and 17th May (spring moult), and 27th, 28th September and 9th October (autumn moult).

Insects and other *arthropoda* occurred quite frequently. In some cases these were animals which had been swallowed when the deer was engaged in coat-licking, e.g., deer-keed (*Lipoptena cervi*) in three cases, wood tick (*Ixodes ricinus*) in six cases and bird louse (*Mallophaga*) in one case. Others, probably also swallowed accidentally together with food, included larvæ of fungus gnat (*Mycetophilidae*), ant (*Myrmica ruginodis*), moth (*Tineidae* (e.g. *Tineola biselliella*)), and centipede (*Lithobius*), and so on.

Summary

As a result of the present rumen analyses it can be seen that of the plant groups considered in this study graminids are the most important. Not only does this group constitute half of the total food mass, but it has practically the same importance in the two areas during both summer and winter.

Browse of dwarf shrubs – nearly always common heather (*Calluna vulgaris*)

– is the second important food group. This can be found in the food throughout the year, but it is of particular significance in the winter (Fig. 12). Of the total food mass it forms 20 ‰ for the whole year, and 27 ‰ for the winter months.

Browse of conifers is of great importance during the winter months, particularly during the latter part. This constitutes 8 ‰ of the total food mass for the

whole year, and 10 % of the food mass for the winter months.

Browse of deciduous trees and bushes is mostly significant in the summer months and does not appear to have any great importance as a food.

Herbs are an important food in the summer months, but even then constitute only $\frac{1}{3}$ of the graminaceous plants (18 %).

Lichens play an important role as winter food in the dune plantations, comprising 7 % of the food.

In the case of individual plant species it is seen that there can be a rather large difference in their occurrence in the two areas investigated. However, in most cases this difference can be explained by difference in composition of vegetation. It is to be assumed that red deer prefer to eat plants that are easily accessible and occur in ample amounts on the spot. It can also be expected that food selection in other areas might vary considerably in detail from that of the present investigation, depending on the composition of the vegetation in the area in question.

One characteristic of the present samples is that in almost all of them an individual plant or plant group dominates in the content. This indicates that red deer are inclined to »fill up« on one type of food alone, when this occurs in sufficient quantities.

It must be further assumed that there is a certain »order of preference« between the individual food species according to taste and nutritional value, as shown by experimental plots with different types of food plants (STRANDGAARD 1967). Chemical analyses of food plants can give information on their content of nutrients, but it must be strongly emphasized that, unlike a fodder material or a fodder mixture, it is not possible to state a definite and constant content of the individual

food items. A plant is a living organism, its content of nutrients will vary according to where it grows, the time of year, age, the part of the plant in question and presumably the time of day or night. There may also be considerable differences from year to year. Additionally, with regard to food selection, individual differences can presumably make themselves felt. There are examples to show that when deer are given the choice of two plant species they will choose one plant in one area and the second in the other area, even though both plant species are present in large quantities in both areas (AHLÉN 1965).

Among the individual plant species found as food in the present samples, wavy hair grass (*Deschampsia flexuosa*) appears completely to dominate in both areas during both the summer and the winter months.

Common heather (*Calluna vulgaris*) is the second important fodder plant, and is of great importance in the winter months in both areas.

Browse of conifers constitutes, as a group, the third place and the individual species play an important role in the winter. In the Rold area the most important tree is Norway spruce (*Picea abies*), followed by silver fir (*Abies sp.*) and juniper (*Juniperus communis*), while browse in the dune plantations is almost exclusively from mountain pine (*Pinus mugo*).

Apart from mountain pine other plants chiefly – or only – eaten in the dune plantations are reindeer moss (*Cladonia rangiferina* and *C. silvatica*), and to a lesser degree *Cetraria tenuissima*, creeping willow (*Salix repens*), polypody (*Polypodium vulgare*) and bog myrtle (*Myrica gale*).

In addition to *Picea abies*, *Abies sp.* and *Juniperus communis* other plants chiefly – or only – eaten in the Rold

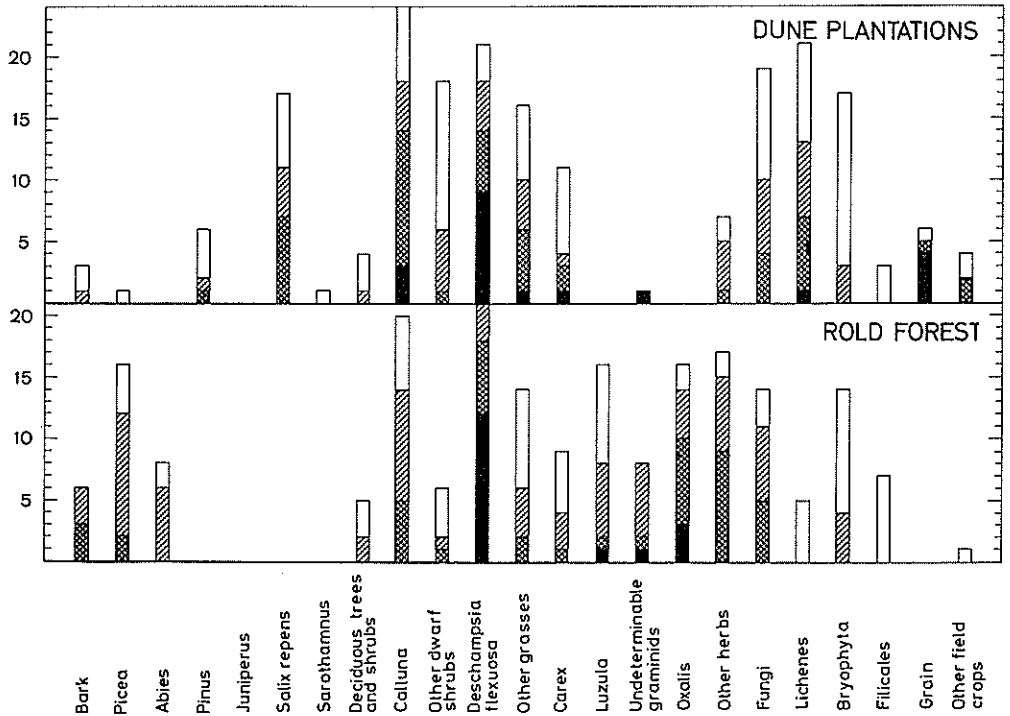


Fig. 18. Comparison of the importance of the food items in the dune plantations (24 samples) and Roldskov (21 samples) in the months August–October. Black columns show that the food item comprises a dominating (> 50 per cent), cross hatched a main (5–50 per cent), hatched a sparse (1–5 per cent), and open columns a very small (er cent) part of the rumen content.

area are broom (*Sarothamnus scoparius*), wood-rush (*Luzula pilosa*) and wood sorrel (*Oxalis acetosella*).

It is established that despite the complicated process of food digestion in the rumen-reticulum system, valuable information on the food selection of investigated animals can be obtained from an examination of their stomach contents.

However, the value of future investigations will be considerably increased if they can take place in the area where the animals in question live, and are coupled with direct observations of the daily wanderings and habits associated with foraging. In addition a thorough investigation of the vegetation should be made, in order to get an impression of which plant species are preferred as food amongst the many species available.

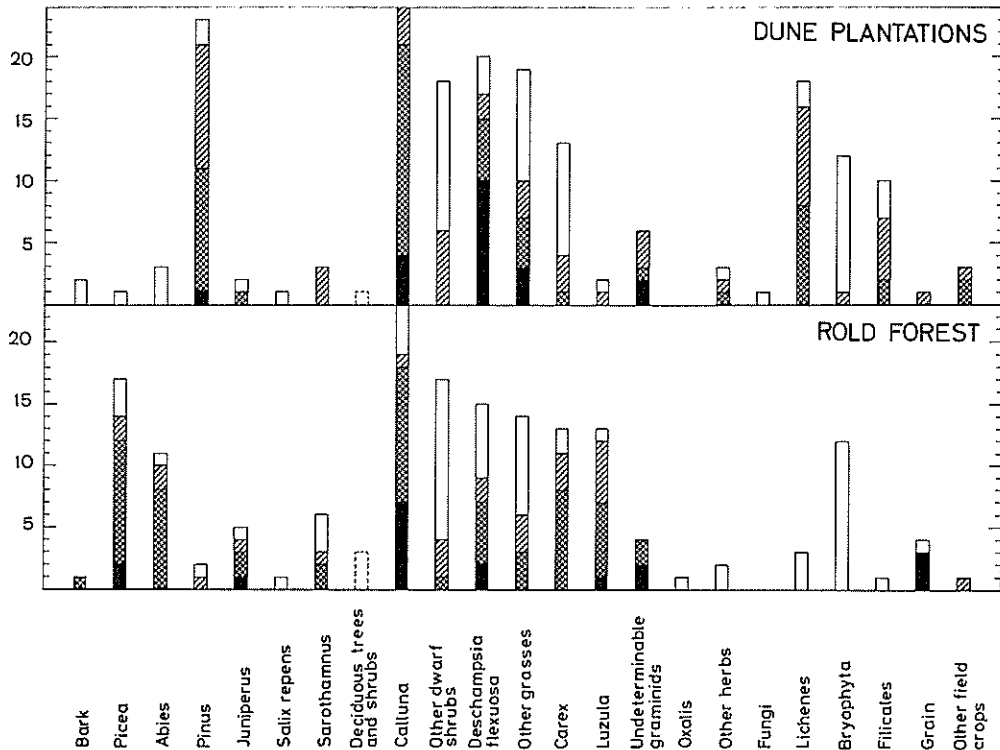


Fig. 19. Comparison of the importance of the food items in the dune plantations (24 samples) and Roldskov (23 samples) in the months December–February. Black columns show that the food item comprises a dominating (> 50 per cent), cross hatched a main (5–50 per cent) hatched a sparse (1–5 per cent), and open columns a very small (< 1 per cent) part of the rumen content.

Literature

- AHLÉN, I., 1961: Från Skånes kronvildtsmarker. – Skånska jägareselekskaps årsbok: 9–16.
- AHLÉN, I., 1964: Hur den skånska kronhjorten undersökes. – Skånes Naturs Årsskrift 51: 107–123.
- AHLÉN, I., 1965 a: Studies on the red deer, *Cervus elaphus* L., in Scandinavia I–III. – Viltrevy 3: 1–376.
- AHLÉN, I., 1965 b: A comparison between the winter feeding behaviour of the red deer and the moose. – Trans. 6th. Congr. Int. Union Game Biol.: 117–126. London.
- ALEX-HANSEN, B., 1956: Jyllands kronvildt 1955–1956. – Dansk Jagttidende 73: 13–14, 215–219, 237–240.
- CHRISTOFFERSEN, F., 1967: Bestandsoptællingen og beskyddingen af kronvildtet i de vestjyske klitplantager. – Danske Vildtundersøgelser 13: 107–119.
- DASMANN, W. P., 1950: Basic deer management. – Calif. Fish Game 36: 251–284.
- van DOBBEN, W. H., 1953: De landbouwschade door wilde ganzen. – Landbouvoorlicht 10: 263–268.
- DUST, J. L., 1949: Methods for the determination of food habits by plantmicrotechniques and histology and their application to cottontail rabbit food habits. – J. Wildlife Mgmt. 13: 295–298.

- EYGENRAAM, J. A., 1959: Over het Beheer van de Edelhertenbevolking in Nederland. – ITBON-Mededeling 42/1959 and Ned. Bosbouw Tijdschrift 32: 1–20. 1960.
- FERREL, C. M. & LEACH, H. R., 1950a: Food habits of the pronghorn antelope of California. Calif. Fish Game 36: 21–26.
- FERREL, C. M. & LEACH, H. R., 1950b: Food habits of a California deer herd. – *Ibid.* 36: 235–240.
- GILL, J., 1962: Die Durchgangszeiten der Nahrung durch den Verdauungskanal und die physischen Eigenschaften des Kotes beim Rothirsch (*Cervus elaphus* L.). – Trans. 5th. Congr. Int. Union Game Biol.; Supplemento alle Ric. Zool. app. Caccia 4: 161–174.
- HAGEN, Y., 1958a: Litt om undersøkelser over vinterernæringen hos rådyr og elg. – *Ieger og Fisker* 87: 453–464.
- HAGEN, Y., 1958b: Orientering om påbegyndte undersøkelser over vinterernæringen hos elg og rådyr i Norge. – Statens Viltundersøkelser. Oslo. (Stencil rap.).
- HEGG, O., 1961: Analysen von Grosswildkot aus dem schweizerischen Nationalpark zur Ermittlung der Nahrungszusammensetzung. – *Rev. suisse Zool.* 68: 156–165.
- HOSLEY, N. W. & ZIEBARTH, R. K., 1935: Some winter relations of the whitetailed deer to the forest in north central Massachusetts. – *Ecology* 16: 535–553.
- JENSEN, P. V., 1958a: Stomach contents of Danish red deer. – Trans. 3rd. Congr. Int. Union Game Biol.; Dan. Rev. Game Biol. 3, 3: 141–143.
- JENSEN, P. V., 1958b: Panseninhalt dänischen Rotwildes. – *Z. Jagdwiss.* 4: 164–167.
- KEAR, J., 1965: The Assesment of goose damage by grazing trials. – Trans. 6th. Congr. Int. Union Game Biol.: 333–339. London.
- MANKER, E., 1964: De åtta årstidernas folk. Göteborg.
- MARKGREN, G., 1963: Studies on wild geese in southernmost Sweden. – *Acta Vertebr.* 2: 299–418.
- MENTZ, A., 1935: Danske græsser. København.
- NASIMOVITSCH, A. A., 1948: Et forsøg på at udforske pattedyrenes økologi ved vintersporing – *Zool. Zh.* 27: 371–378. (*in Russian*).
- NEUMANN, A., 1963: Wilddicte und Winteräsung von Rotwildgebieten nach der reduzierten Winteräsungskapazität im Kiefernrevieren. – *Beitr. Jagd Wildforsch.* 3: 69–79. Tagungsberichte nr. 61.
- de NIO, R. M., 1938: Stomach analyses of deer and elk in northern Idaho and Montana. – Univ. Idaho School of Forestry Bull.
- NORRIS, J. J., 1943: Botanical analyses of stomach contents as a method of determining forage consumption of range sheep. – *Ecology* 24: 244–251.
- STRANDGAARD, H., 1967: En undersøgelse over kronvildtets tilpasning til det danske kulturlandskab. – *Danske Vildtundersøgelser* 13: 9–75.
- THAARUP, P., 1953: Klitplantagerne 100 år efter plantningens begyndelse. Landbrugsministeriet. København.

Резюме на русском языке
Выбор пищи благородного оленя (Cervus elaphus) в Дании

Выбор пищи благородного оленя в Дании выяснен исследованием содержания *gutten* 119 оленей, убитых в двух районах, содержащих самые значительные в настоящее время популяции оленей в Дании.

46 проб получены из лесного района Ролдскоу в приблизительно 8300 га, в восточной Ютландии (фиг. 1 и 2), где почва главным образом составляется

песчаными и галечными моренами, и 2/3 леса состоят из хвойных деревьев, преимущественно *Picea abies*, а остальная часть из лиственных, преимущественно *Fagus sylvatica*. 73 пробы получены из района прилб. 9500 га засаженных лесом дюн у западного морского берега Ютландии (фиг. 3 и 4). Засаженная площадь здесь составляет прилб. 7500 га, и преобладающим видом деревьев

является *Pinus mugo*, а припл. 2000 га занимают пустошь и дюны, главным образом поросшие *Calluna vulgaris* и другими малорослыми кустами. Распределение собранного материала по годам, месяцам и районам показано в табл. 1.

Из каждого *rumen* взята проба в припл. 500 см³ (фиг. 5), припл. 2/3 пробы исследованы. Остатки растений сортированы и определены, а затем их количественное взаимоотношение оценено и указано в процентах по объему. Состав по предметам пищи у отдельных особей показан в приложении 1, стр. 40–44.

В фиг. 7, 9 и 10 показаны по целым годам, по летним и по зимним полугодиям, количества желудков, в которых обнаружены предметы пищи (белые колонны), и проценты по объему, составляемые этими предметами пищи (черные колонны). Кроме того, количественный удел разных предметов пищи наглядно представлен в фиг. 8, 13 и 14, соответственно по всему году, по летнему и по зимнему полугодью. Эдесь показано, в каком проценте желудков предмет пищи составлял преобладающую (> 50 проц., черные столбы), значительную (5–50 проц., столбы, штрифованные наперекрест), малую (1–5 проц., просто заштрифованные колонны) или очень малую (< 1 проц., белые колонны) часть содержания желудка. Соответствующим образом, фиг. 18 и 19 показывают значение предметов пищи в двух районах исследования, в период от августа до ноября, и в период от декабря до февраля.

В зимнее полугодие, важную роль как предмет питания играют ростки хвойных деревьев, составляя в этот период припл. 10 проц. всей пищевой массы. Древесной коры в пробах обнаружено мало, но облуплением деревьев олени приносят лесоводству значительный вред.

Судя по результатам исследований, ростки лиственных деревьев и кустов значительной роли не играют, во всяком случае в зимнем полугодии. Из малорослых кустов, очень важным предметом пищи является *Calluna vulgaris*, составляя 1/5 всей пищевой массы, и 1/3 пищевой массы зимнего полугодия (фиг. 12 и табл. 2).

Травоподобные растения, т.е. *Graminaceae*, *Carex*, *Luzula*, составляют половину всей пищи, и играют одинаково большую роль как летом, так и зимой. Они обнаружены только в виде свежих, зеленых листьев. *Deschampsia flexuosa* преобладает, составляя 1/4 всей пищи.

В качестве пищи, роль трав во время зимнего полугодия незначительна, так как они составляют только 1 проц. В летнее полугодие можно считать, что их роль несколько более значительна.

Lichenes в районе засаженных лесом дюн играют значительную роль, особенно в зимнем полугодии, когда они составляют припл. 10 проц. пищевой массы.

Полевые культурные растения обнаружены в нескольких пробах, и в окрестностях района засаженных лесом дюн олени приносят довольно много вреда полям, в особенности культурам *Avena sativa*.

Что касается отдельных видов растений, оказалось что содержание их в пище оленей двух районов исследования может показывать довольно значительные различия. Однако, такая разница в большинстве случаев может объясняться различным составом растительности определенных мест. Для исследованных проб характерно, что почти во всех преобладает только один вид – или одна группа – растений, что может считаться признаком того, что олени склонны наполняться подходящим предметом пищи, если он встречается в изобилии.

APPENDIX 1.

Food items in volume percentage in all red deer investigated.

Rold Forest		January										February										May			
Date		8	8	8	8	8	14	20	21	21	22	26	3	10	11	12	12	12	17	18	22	24	24	25	17
Nr.		1	4	2	3	5	6	11	13	12	14	18	19	÷	÷	÷	25	30	35	36	39	40			
Bark		5																				5			
Conifers	<i>Picea</i>	+ + 6 2 + 15 6										20 5 5 6 5 10 10 2 75 80													
	<i>Abies</i>	10 25 6 35 2 18 1 5										+ 5 20													
	<i>Pinus</i>	2										+													
	<i>Juniperus</i>	1										+ 5 95 20													
	Total	10 25 6 35 2 6 5 18 16 5 6										20 5 5 6 5 10 5 5 30 97 95 80													
Deciduous trees and shrubs	<i>Salix</i>	+																							
	<i>Sarothamnus</i>	+ + 1 10										+ 5													
	Other	+ + +										+										+			
	Total	+ + + 1 10 +										+ 5 +										+			
Dwarf shrubs	<i>Calluna</i>	10 + 18 5 55 50 60 2 70 10 15										10 + 80 45 45 40 85 95 + + 5 20										+			
	Other	5 + 3 + + 1 + + +										+ + + 4 + + + +													
	Total	15 + 21 5 55 51 60 2 70 10 15										10 + 80 49 45 40 85 95 + + 5 20										+			
Graminids	<i>Deschampsia flexuosa</i>	50 8 70 5 30 35 25 + 1 2										+ + + + +										50			
	Other graminids	4 32 + + + + 4 +										+ 15 10 + 3 +										20			
	<i>Carex</i>	1 10 1 20 10 1 10 8 5										20 + 30 +													
	<i>Luzula</i>	20 25 2 35 2 2 + 70 1 10 2										5 20													
	Undeterminable	75 70										20 40										25			
	Total	75 75 73 60 42 38 25 80 14 85 79										+ 15 45 50 50 + + + 3 + +										95			
Herbs	<i>Oxalis</i>	+																							
	Other herbs	+										+													
	Total	+ +										+													
Cryptogams	Fungi																								
	Lichenes	+										+													
	Bryophyta	+ + + + + +										+ + + + +													
	Filicales	+																							
Field crops and fodder	Grain											70 95 70 +													
	Other field crops											5													

The Food of the Danish Red Deer (*Cervus elaphus*)

Rold Forest		August							September							October			Nov.				
Date		5	6	7	10	11	25	25	30	7	15	15	27	28	28	28	28	30	7	26	26	26	3
Nr.		43	44	45	46	47	48	49	51	52	53	54	55	56	57	58	59	÷	60	61	62	63	
Bark		1 8 6 5 1							1														
Conifers	<i>Picea</i>	1	+	2	2	5	+	1	+	2	2	1	1	1	2	+	30	+					
	<i>Abies</i>	+		+				1	1		2	1	3	1									
	<i>Pinus</i>																						
	<i>Juniperus</i>																						
	Total	1	+	+	2	2	5	+	2	1	2	2	3	2	4	2	+	130	+				
Deciduous trees and shrubs	<i>Salix</i>																						
	<i>Sarothamnus</i>																						
	Other	+		3				1						+	+								
	Total	+		3				1						+	+								
Dwarf shrubs	<i>Calluna</i>	1	+	1	1	5	1	1	1	+	1	+	+	+	25	1	5	+	20	13	2	35	
	Other	+		+					1	+	+			7	+								
	Total	1	+	1	1	5	1	1	1	1	1	+	+	+	+	25	1	5	+	27	13	2	37
Graminids	<i>Deschampsia flexuosa</i>	85	20	70	2	50	30	84	85	90	80	20	5	70	62	1	40	70	15	60	190	50	
	Other graminids				2	+	+	+	+	1	45	+	1	+	+	15	2	+					
	<i>Carex</i>	+		+	+			2	1	+	6	2		+									
	<i>Luzula</i>	+	+	1		5	+	+	+	1	1	1	3	+	+	60	+	1	3				
	Undeterminable			7		10	45	5	10	86			42	55									
	Total	85	20	78	4	60	80	84	87	92	85	76	92	78	67	1	82	70	90	62	56	91	55
Herbs	<i>Oxalis</i>	5	75	90			2	+	1	1	15	5	20	30	50	5	10	3	+	5			
	Other herbs	8	5	20		25	7	4	4	8	5	+	1	20	8	1	1	+	2				
	Total	13	80	20	90	25	7	6	+	5	9	20	5	20	31	70	13	11	4	+	2	5	
Cryptogams	Fungi	+					3	8	1	2	2	+	2	+	1	14	6	10	5	3			
	Lichenes								+				+	+	+	+							
	Bryophyta	+				1	1	+	+	+	+	+	+	1	+	+	1	+	+				
	Filicales	+							+			+		+	+	+	+						
Field crops and fodder	Grain														+	+	+						
	Other field crops														+								

Dune Plantations		January					February				March			April	May		June					
Date		21	22	22	23	24	24	25	27	29	29	4	6	6	11	12	12	23	6	11	24	26
Nr.		70	71	72	73	74	75	1	2	76	77	78	3	4	79	80	81	82	83	84	85	33
Bark															5		1					
Conifers	<i>Picea</i>	+													+							
	<i>Abies</i>	+ +										+										
	<i>Pinus</i>	2	2	10	2	+	10	35	22	15	60	40	1	8	28	10	10	+	4	1	2	1
	<i>Juniperus</i>	5										+										
	Total	2	2	10	2	5	10	35	22	15	60	40	1	8	28	10	10	+	4	1	2	1
Deciduous trees and shrubs	<i>Salix</i>													+		3		45				
	<i>Sarothamnus</i>	1										1		40								
	Other																					
	Total	1										1		40		+		3		45		
Dwarf shrubs	<i>Calluna</i>	30	40	10	22	5	70	45	35	85	35	50	2	1	5	40	15	10	1	1	2	1
	Other	+ 1 + + + + +										+ 1 1 +		+ +				+				
	Total	30	40	10	23	5	70	45	35	85	35	50	3	2	5	40	15	10	1	1	2	1
Graminids	<i>Deschampsia flexuosa</i>	35	20	75	50	4	+	30	+	1	90	50	10	1	50	+	95	95	70	1		
	Other graminids	3	+	+	+	5	10	+	2	+	+	55	4	+	60	+	+	14				
	<i>Carex</i>	2	+	+	2	15	+	1	+	+	25	+	+	1								
	<i>Luzula</i>	+										1		+								
	Undeterminable	75 40 4										3 1						50				
	Total	38	22	75	75	90	10	20	40	+	2	4	92	51	65	5	75	60	95	96	84	51
Herbs	<i>Oxalis</i>															+						
	Other herbs											+				2						
	Total											+				2						
Cryptogams	Fungi																					
	Lichenes	30	35	5	10	2	+	3	3	2	38	1	5	+	30	+	2	2	1			
	Bryophyta	+ 1 +										+		+ +		+		+				
	Filicales	+										3 1 1										
Field crops and fodder	Grain																					
	Other field crops											1										

The Food of the Danish Red Deer (*Cervus elaphus*)

Dune Plantations		July	Aug.	September	October													
Date		19 21 27	15 22	3 3 17 24 27 28	1 1 1 6 7 9 9 9 9 9 10 10 10 11 14 17													
Nr.		34 35 36	37 38	86 87 39 40 41 42	88 89 90 93 94 96 97 98 100 101 102 103 104 105 106 51													
Bark				1 +														
Conifers	<i>Picea</i>	+		+														
	<i>Abies</i>																	
	<i>Pinus</i>	+ + 2	+ 1	+ 6 + +	1 + 1 + + + + + 2 + + + + + + +													
	<i>Juniperus</i>																	
	Total	+ + 2	+ 1	+ 6 + + +	1 + 1 + + + + + 2 + + + + + + +													
Deciduous trees and shrubs	<i>Salix</i>		1	12 5	2 10 2 5 25 + 12 + + 45 + 2 + +													
	<i>Sarothamnus</i>			+														
	Other	20		1	2 +													
	Total	20	1	13 5	4 10 2 5 25 + 12 + + 45 + 2 + +													
Dwarf shrubs	<i>Calluna</i>	+ 8 1	1 1	3 + 5 5 1 15	+ 70 20 20 50 + 25 + 40 5 55 5 + + 20 10													
	Other	+ +		+ 1 5 + +	+ + 1 + 1 + + 1 + + + 2 +													
	Total	+ 8 1	1 1	3 + 6 10 1 15	+ 70 21 20 51 + 25 + 41 5 55 5 + + 22 10													
Graminids	<i>Deschampsia flexuosa</i>	+ 8 10	3 1	30 + 50 5 3	95 3 + 95 20 20 45 95 + 90 90 95 75 80													
	Other graminids			+ 8 25 75 2	2 15 25 2 + 40 + 4 + + +													
	<i>Carex</i>	+		1 +	+ 50 + 5 + + 5 + +													
	<i>Luzula</i>																	
	Undeterminable	7			60													
	Total	+ 15 10	3 1	31 8 75 75 7 3	95 5 75 75 2 100 60 20 49 95 + 95 90 95 75 80													
Herbs	<i>Oxalis</i>																	
	Other herbs	10 75 86	3 6	1 1	2 + +													
	Total	10 75 86	3 6	1 1	2 + +													
Cryptogams	Fungi	+		+ 5 31 12	+ 10 + + + + 2 1 2 + + + 1 2 1 10													
	Lichenes	+ +	+	+ 10 60 65	+ 5 1 + 20 + 1 75 5 + + + 2 2 2 +													
	Bryophyta			+ +	+ + + + + + + 4 1 + + + + 1 + +													
	Filicales	2 1		+ +														
Field crops and fodder	Grain	70	65 91	65 75	+ 5 +													
	Other field crops		27	16	+ +													

(continued p. 44)

Dune Plantations		November																December																																								
Date		3	5	7	7	13	13	14	14	14	15	16	18	19	20	28	2	3	4	4	4	5	7	13	14	15																																
Nr.		107	108	109	61	2	3	110	111	112	113	66	114	115	67	117	118	119	10	12	13	120	14	16	17	18																																
Bark																																																										
Conifers	<i>Picea</i>																											+																														
	<i>Abies</i>																																																									
	<i>Pinus</i>	+	7	+	4	5	2	+	2	+	+	+	3	+	35	+	6	10	1		1	+	6	1	1	1																																
	<i>Juniperus</i>																																																									
	Total	+	7	+	4	5	2	+	2	+	+	+	3	+	35	+	6	10	1		1	+	6	1	1	1																																
Deciduous trees and shrubs	<i>Salix</i>	+					+																						+																													
	<i>Sarothamnus</i>																																										1															
	Other																									1	1																															
	Total	+					+																		1	1																																
Dwarf shrubs	<i>Calluna</i>	45	20	+	40	55	60	+	20	5	3	10	80	75	20	40	30	20	8	5	65	5	10	5	1	5																																
	Other	1	+	1	+	+	+	+	+	+	+	2	4	1	+	2	+	1	2	+	+	+																																				
	Total	46	20	1	40	55	60	+	20	5	3	10	82	79	21	40	32	20	8	6	67	5	10	5	1	5																																
Graminids	<i>Deschampsia flexuosa</i>	50	70	+	+	50	65	80	85	90	5	4	45	55	65	85					90	70	+	10	86																																	
	Other graminids	+	+	90	+	+	+					+	1	2	12	5	5	5	50	+	+	+	75	+	1																																	
	<i>Carex</i>	+	+	8	3	+	2	5	+					4	2	3				+	+	+	+	+																																		
	<i>Luzula</i>																									+																																
	Undeterminable																									10	10																							80								
	Total	50	70	98	3	10	10	52	70	80	85	90	10	4	19	50	60	70	85	50	+	90	70	75	90	87																																
Herbs	<i>Oxalis</i>																											+																														
	Other herbs																																								1	7																
	Total																											+																1	7													
Cryptogams	Fungi	+	1	+					+	+	+					+																+																										
	Lichenes	+	2	1	50	5	10	45	6	12	7	4	16	25	10	2	2	4	4	31	+	2	5																																			
	Bryophyta	+	+	3					+	+	+	2	+	+																																												
	Filicales					3	2	3	3	+																																																
Field crops and fodder	Other field crops																																																									
	Grain	4					25	18																		+																13	7															

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