On the autumn food of Barnacle Geese at Caerlaverock National Nature Reserve

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Introduction

Most British species of geese now feed on agricultural land or on pastures which have been extensively changed by man. The Barnacle Goose *Branta leucopsis* on the Solway Firth spends much of its time on the merseland of Eastpark Farm at Caerlaverock National Nature Reserve (Roberts 1966). The term 'merseland' is applied to pasture subject to tidal flooding and includes low level terraces and high level grazed salting. It is a type of habitat which, although affected by agricultural practice, was in existence before man and his grazing animals modified much of the British lowlands.

The amount of information on the food of Barnacle Geese is extremely small, the only quantitative data published on winter feeding in Britain being those of Campbell (1936, 1946). His results relate to gut analyses of 27 birds shot in the Outer Hebrides in January and February. The most important foods eaten by these birds were grasses, and the most important species red fescue *Festuca rubra*. This species is also eaten by Barnacle Geese elsewhere, and droppings collected by D. Cabot from the islands of Inishkea, Co. Mayo, Ireland, and examined at Slimbridge contained predominantly fragments of *F. rubra*. These droppings were collected from '*Plantago* swards' and also contained remains of the leaves of plantains *Plantago* spp. Recent work at Gotland, Sweden (Bjarvall and Samuelsson 1970) describes Barnacle Geese feeding on saltings in spring. The geese here graze in *Juncus gerardii-Agrostis stolonifera* (mud rush-bent) zones as well as in *Festuca rubra* areas. Stomachs examined contained only leaf and stem material, in which the genera *Festuca* and *Agrostis* were well represented. *Festuca rubra* is the predominant plant species over most of the merseland at Eastpark (Marshall 1962) and has been assumed to be a preferred food of the Solway Barnacle Goose flock. For example Kear (1963) states that 'The Barnacle Goose feeds exclusively on grass, in particular saltmarsh grass *Festuca rubra*, and pasture plants, *F. ovina*, clover, etc.'

The situation at Caerlaverock affords an opportunity of studying a goose in a semi-natural habitat. The technique of faecal analysis allows feeding studies to be carried out without killing the animals under investigation, and is extremely useful in studying a protected species. As part of a study by Kerbes of the movements and feeding habits of Barnacle Geese at Caerlaverock, a number of samples of droppings were collected in 1969 and 1970. This paper is an account of an analysis made by Owen of the droppings samples collected on Eastpark merse on 8th and 9th October 1970. The fact that grazing of the merse was unusually light in 1970 may have caused seed to become abundant and may have affected the habits of the geese. The extent of this effect is not known, but no foods were available in 1970 which are not normally found on the merse.

Method

The technique of faecal analysis to study the composition of the food of herbivores is well known and is reviewed in detail by Stewart (1967). The basic assumptions are that the cuticle and parts of the epidermis of most plants, and particularly grasses, pass unchanged through the alimentary tract of grazing animals and that genera or species of plants can be identified in the faeces by the different patterns of their epidermal cells. It is, however, difficult to make the complete identification of all fragments in a sample which is necessary for quantitative analysis. Stewart (1967) concluded that when the grazed sward had a large number of plant species, accurate quantitative estimation was impossible, but it could be attempted where the diet had few components.

Salting pastures contain relatively few plant species, especially in winter, and in the present study an attempt was made to identify all the components of the droppings. Some foods could only be identified as far as families or larger groupings but these were in the minority (see below). Some species can be eliminated by examination of the sward. For example, *Festuca rubra* fragments in faeces cannot always be distinguished from those of sheep's fescue *F. ovina* but the latter species was not found on the merse. The epidermal characteristics of the two most abundant species are shown in Figure 1, and those of seed and stolon fragments in Plate Va, (facing page 56).

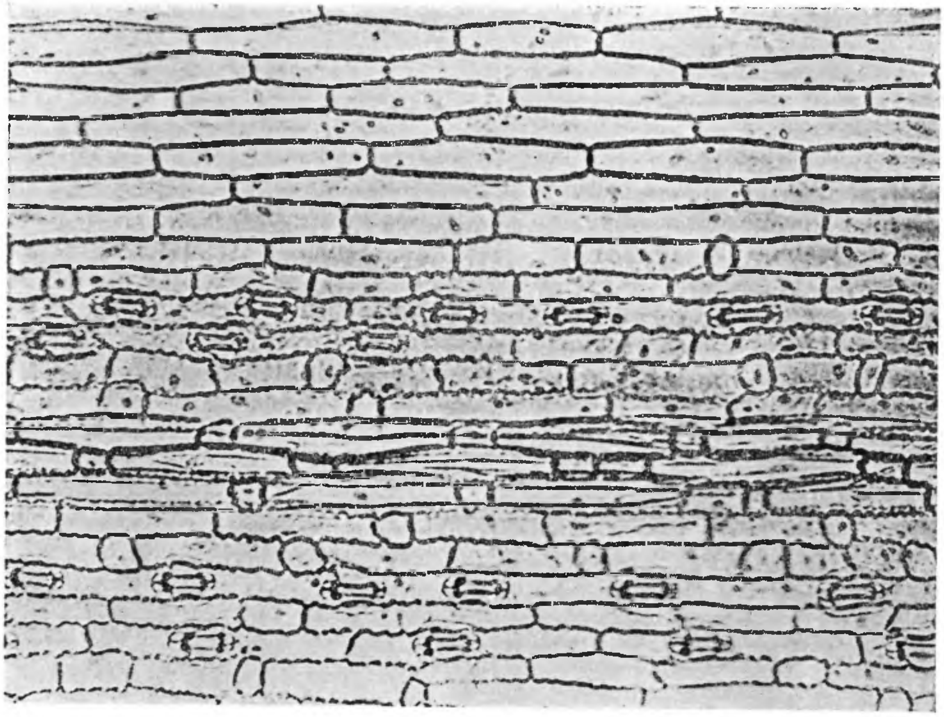
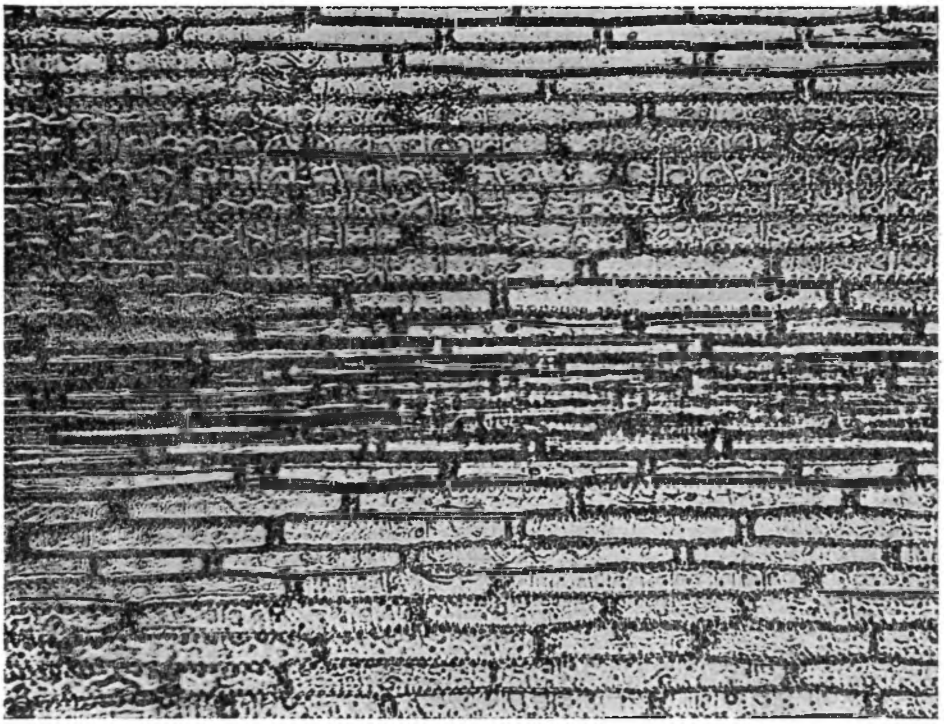


Figure 1. Epidermal preparation of two grass species, *Puccinellia maritima* (above) and *Festuca rubra* (below). The drawings were prepared from photographs by tone destruction. (Magnification × 220.)



Field sampling

It was apparent to the naked eye that there were several different types of droppings present on the merse in October. Some were identified as containing seed remains and others had fragments of clover *Trifolium repens* stolons. Five different classes of droppings were separated in the higher merse and an assessment made of the frequency of occurrence of each class. Samples of twenty dropping of each class were collected for more detailed analysis. These are the 'droppings samples' referred to below.

Coarse separation

Goose droppings which contain clover stolons usually have a number of relatively unbroken stolon fragments, up to 10 mm. in length and 2 mm. in diameter. These are difficult to deal with on microscope slides and have a weight/area ratio much diffierent from that of the other foods. Each droppings sample was thoroughly mixed and two subsamples separated. These subsamples were scanned and all stolon fragments were removed, dried overnight at 90°C., weighed and expressed as a percentage of the subsample dry weight.

Microscopical analysis

This was carried out on subsamples which had had the main stolon pieces removed.

Ten subsamples were taken from each droppings sample and spread on glass slides so that each covered an area of 22 × 50 mm. An attempt was made to spread the fragments so that they covered as much of the area as possible without overlapping. In practice fragments covered just over 50% of the total area.

The sampling of plant fragments on a microscope slide is analagous to field-sampling a plant community with quadrats. An estimate of the area covered by each component is obtained by using a quadrat of no area, i.e. a point (Levy and Madden 1933). Sampling was carried out on two transects along the glass slide, and at points (indicated by cross wires) at 5 mm. intervals. The presence of species was recorded at each point, and if fragments overlapped only the uppermost was recorded. Systematic sampling has the advantage over random sampling in that it is quick and easy, using the microscope stage manipulators. It has no disadvantages provided the interval between points is large in relation to the average dimension of fragments. Duplicate samples analysed by the present systematic method and by a random scatter of points gave exactly similar results. Twenty points were taken on each of ten subsamples, giving 200 points analysed. As overall cover was around 50%, about 100 presence values were usually recorded.

Results

Droppings examined on the high level *Festuca rubra* sward were placed in one of five classes in the field, depending on whether they contained seed fragments, stolons, predominantly grass or were of mixed composition. The frequency of occurrence of each class in 155 droppings classified is shown in Table I. In addition droppings were collected from the lower terraces on the estuary side of the merse which have a sward consisting of predominantly sea poa grass *Puccinellia maritima.* These form a sixth class.

The results of the laboratory analysis of these six droppings samples are shown in Table II. The term 'seed' is used here in a broad sense, to include fragments of rachis, bracts, capsule walls and other parts of the inflorescence, as well as the true seeds.

The composition of the droppings confirms the subjective classification (Table I), although 'stolon' faeces contained substantial amounts of non-stolon material, much of which was clover *Trifolium repens* leaf and petiole fragments. The 'combined composition' is

Table I. The frequency of occurrence of different classes of droppings on *Festuca rubra* merse at East Park, October 1970.

Class	*Description*	*Frequency*	%
1	over 90% seed	37	23.8
2	non-stolon, seed	36	23.3
3	stolon, seed	29	18.7
4	stolon, non-seed	12	7.7
5	non-stolon, non-seed	41	26.5
		155	100.0

Table II. The analysis of droppings samples from six classes collected on Eastpark Merse, October 1970.

	Class					
COARSE SEPARATION	*1*	*2*	*3*	*4*	*5*	*6*
Stolon	0.0	0.2	5.8	12.1	0.8	0.0
Non-stolon	100.0	99.8	94.2	87.9	99.2	100.0
MICROSCOPICAL ANALYSIS	*Class*					
Food group[1]	*1*	*2*	*3*	*4*	*5*	*6*
Juncus gerardii seed	68.6	65.3	38.9	4.2	8.1	0.9
Plantago maritima seed			0.9			
Unidentified seed[2]	12.7		0.9	1.1		
Trifolium repens stolon		4.1	31.8	71.3	0.8	0.9
Festuca rubra	3.4	7.1	1.8	1.1	4.1	4.7
Agrostis ?stolonifera	0.9		0.9		7.3	5.6
Puccinellia maritima	5.9		0.9	1.1	58.5	85.1
? Spartina sp.				1.1		
Trifolium repens	1.7	12.3	13.3	10.6	4.9	
Trifolium petiole		2.0	7.0	7.4	3.3	
Dicotyledon sp.						0.9
Cyperaceae sp.		4.1	1.8		4.1	1.9
Unidentified non-stolon, non-seed[3]	6.8	5.1	1.8	2.1	8.9	
COMBINED COMPOSITION	*Class*					
Food	*1*	*2*	*3*	*4*	*5*	*6*
Stolon	81.4	65.2	38.3	4.6	8.1	0.9
Seed		4.3	35.8	74.8	1.5	0.9
other	18.6	30.5	25.9	20.6	90.4	98.2

1. Leaf fragments unless otherwise stated.
2. Probably mostly unidentified portions of *J. gerardii* seed.
3. Possibly unidentified material, sheath, ligule or other part of species already listed.

calculated on the assumption that the separations by weight (coarse separation) and by area (microscopical analysis) are similar, for which there is good evidence (see below).

If the frequency of droppings type (Table I) and the detailed analysis of droppings composition are combined we have the following proportions of the main components of the food taken by Barnacle Geese on the *Festuca rubra* merse: seeds 44.0%, stolons 14.1%, other material 41.9%. Thus at this particular time more than half of the Barnacle Goose diet on the high level merse at Eastpark consists of materials which cannot be obtained by the normal grazing behaviour as described by Markgren (1963).

Discussion

Efficient field sampling is one of the main problems in an analysis of this kind, since only a very small part of the total droppings on the feeding grounds is actually analysed. For example it would be misleading to analyse droppings from 5% of a goose population while the other 95% were feeding elsewhere.

In the present study no attempt was made to estimate accurately the proportion of the droppings on the two sward types, i.e. *Puccinellia* and *Festuca*, except to note that the density of droppings, where they occurred, was similar on both swards. The emphasis has been placed on the composition of the droppings from the *Festuca* sward where the geese have a choice of several food sources. These droppings were collected at random and are thought to be representative.

The initial classification of droppings, although not sufficient in itself, gives a useful guide to droppings content and markedly increases the efficiency of sampling. The proportion of stolons removed in the coarse separation gave a good guide to the stolon content but it was still necessary to make microscopical analysis for stolon material.

The technique of faecal analysis has many limitations as discussed by Stewart (1967), and some of these are relevant when considering the validity of the present results.

(a) *Identifiability*

Plant species or groups may occur in forms which are difficult to identify because of the differential effects of digestion. This is not very important in geese because most fragments pass through the digestive tract relatively unchanged, there being little, if any, cellulose digestion (Mattocks 1971). Most errors are likely to arise when comparing the relative abundance of grasses and the more succulent saltmarsh dicotyledonous plants. Most succulents, however, are annuals or overwinter underground and are not present in quantity in October.

(b) Differential fragmentation

Species may be over- or under-recorded in droppings because of differences in the extent to which they break up in the gizzard. This is overcome by using point sampling, as this estimates the area occupied by each species, irrespective of the number of fragments.

(c) Weight/area ratio

The weight of food is the important measure, and only an estimate can be obtained by measuring area of fragments. Serious errors are encountered if the weight/area ratios of the different plant components are markedly different. In the present analysis these errors were minimised by removing the main stolon items before microscopical analysis, and by breaking up any whole fruit capsules of mud rush *Juncus gerardii* which were present. In the final analysis all the fragments recorded were of approximately similar thickness.

The overall composition of the droppings analysed in this study indicates a greater flexibility of winter feeding behaviour in Barnacle Geese than had hitherto been suspected. The use of clover stolons as a source of food by grazing geese had been recorded in European White-fronted Geese *Anser a. albifrons* (Owen in press) and in other species (unpublished data). The use of seeds on the scale found was, however, surprising as seeds, apart from agricultural grain, are not generally regarded as being important foods of short-billed geese. *Juncus gerardii* has very small seeds (approximately 0.5 × 0.3 mm.), but is an abundant constituent of the merse sward. The Barnacles were probably stripping fruit capsules off the inflorescence, which accounts for the pieces of rachis, bracts, and capsule walls present in droppings as well as the seeds. Although other seed heads, for example those of sea plantain *Plantago maritima* and sea arrow-grass *Triglochin maritima*, were abundant in the sward they were little used by the geese.

Whereas winter grass has 20% dry matter content and 10% soluble carbohydrate, most seeds contain 85% and over 50% respectively (Evans 1960). Thus, although the digestion of seeds by Barnacle Geese is inefficient (many seeds survive the process completely), the potential value of this food as an energy source is much greater than that of winter grass. Although Evans provides no data on clover stolons, similarly starchy materials such as couch grass *Agropyron repens* rhizomes, and bracken *Pteridium aquilinum* roots have more than double the carbohydrate content of grass. The use of these high energy foods may allow the birds to replace fat reserves after migration and before the onset of winter.

The composition of the leafy material in droppings indicates that there was some selection within the sward by geese. Thus *Puccinellia maritima* was by far the most important component of non-stolon non-seed droppings (class 5) although *Festuca rubra* is the most abundant plant on the higher parts of the merse. It may be argued that droppings deposited here contained material ingested on *Puccinellia* swards, but although some movement between feeding stations does occur it is not sufficient to produce such a marked difference. For example, the droppings collected on *Puccinellia* terraces (class 6) contained only 1.8% of foods which are not found on this sward (seeds and clover). Clover and seeds do accompany *Puccinellia maritima* in the class 5 droppings. The number of droppings on the *Puccinellia* terraces, although not accurately counted, seemed much more abundant than would occur by chance since the terraces make up a relatively small proportion of the total merse area. This may indicate some preference for the terraces although their distance from disturbance and their closeness to the roost may play a part. Similar preference for *Puccinellia* has been noted in Wigeon *Anas penelope* and European White-fronted Geese at Bridgwater Bay N.N.R., Somerset (Owen unpublished).

Many workers investigating feeding preferences of birds have equated the abundance of a certain food item in the viscera, or on the feeding grounds, with preference for that food. It has been shown that European White-fronted Geese move in sequence through the winter from one vegetation zone to another on salting pasture (Owen 1971) Observations made or droppings samples taken at any one stage during such a cycle would indicate an apparent 'preference' for particular food plants. However, real preference can only be claimed when food was available on all zones, i.e. in early winter, and the birds concentrated on one zone.

The present paper answers only a few questions relating to food selection in the Barnacle Goose. A more thorough study has been started which might help to establish some of the habitat and food requirements of this interesting species. This includes investigations of the movements of the wintering population on agricultural land as well as feeding behaviour and food composition studies on merseland.

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Summary

An analysis of droppings of Barnacle Geese *Branta leucopsis* was made to identify the food of those birds on a wintering area of the Solway Firth in 1970. Their diet consisted of 44% seed, mainly of *Juncus gerardii*, mud rush; 14% *Trifolium repens*, clover, stolons, and 42% grass and other leaf material.

Barnacle Geese are flexible in their feeding behaviour, and their ability to use seeds and stolons, which have much higher energy value than grass, probably allows them to lay down fat before the onset of winter. There are indications that the geese select sea poa grass *Puccinellia maritima* in preference to red fescue *Festuca rubra* from the merse sward.

The technique of faecal analysis as applied to geese is briefly discussed, and it is concluded that the method used here is a promising one for use in feeding studies on wildfowl.

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