Discrimination between grass species and nitrogen-fertilized vegetation by young Barnacle Geese

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Introduction

Many studies have indicated that wild geese are selective grazers and that their preferences are related to the nutritional characteristics of their foods (e.g. Owen 1973, 1975a; Harwood 1975). In a series of tests with captive Snow Geese *Anser caerulescens* and Canada Geese *Branta canadensis*, Lieff *et al.* (1970) found highly significant differences in the selection of six plant species. They suggested that selection became more efficient as the experiment proceeded, i.e. the geese could ultimately recognize their preferred foods. Their tests included grasses, sedges and spike-rush, which varied in height from 1–2 cm to 30–60 cm and were of varying degrees of coarseness. There were, however, no relationships between the preferences shown by the geese and the height, nutritional characteristics of the plants, or soil pH. Wild geese grazing winter pastures face a situation where there is a very limited height range and where all the grass species could be described as 'fine'. Even in this situation, Owen (1976) demonstrated consistent preferences in White-fronted Geese *Anser albifrons* for certain plant species in mixed swards, although no relationship with nutritional composition was demonstrated. In an experiment on the same sward, however, geese were shown to select nitrogen fertilized vegetation (Owen 1975a).

This paper describes an experiment to test whether young Barnacle Geese *Branta leucopsis* reared in isolation from their parents discriminate between four grass species clipped to a standard height and between trays of one of the species treated with different levels of nitrogen fertilizer.

Materials and methods

Ten goslings, hatched in an incubator, on 14th and 15th June 1976, were reared for the first two weeks in wire-floored brooders and fed on poultry pellets and greenfood (lettuce and duckweed *Lemna* sp.). They were then transferred to a wire enclosure where poultry pellets, later mixed with grain, and flint grit were always available. The goslings were marked at a day old with monel foot web-tags and at four weeks with coloured plastic leg rings for individual recognition. They were weighed periodically and visited frequently so that they were familiar with the experimenters.

The four grass species, perennial ryegrass *Lolium perenne*, bent *Agrostis tenuis*, red fescue *Festuca rubra* and meadow grass *Poa pratensis*, were grown from commercial seed in a 3:1 mixture of soil and peat in 36 × 21 cm seed trays. The soil was thoroughly mixed and 16 trays (4 for each species) filled from the same sample. A further 12 trays were sown with *Lolium* and four fertiliser treatments applied just after emergence of the shoots: (0) control, (1) 1·5 gm/tray, (2) 3 gm, and (3) 4·5 gm of fertilizer. The fertilizer used as Nitrochalk (25% N) and the levels corresponded approximately to 0, 200, 400 and 600 kg/ha. The trays were sown 3–5 weeks before they were presented to the geese and were clipped to a standard 5 cm above soil level prior to the tests.

The original intention was to present grasses in pairs to geese in pairs in a small holding pen, but because the geese became nervous and did not attempt to peck at the vegetation under these circumstances, this proved unworkable. Two *groups* of four geese (A and B) were eventually separated, and kept in contiguous pens, into which test trays were introduced. Trays were presented in *combinations* of two species (or nitrogen treatments) and two combinations presented consecutively constituted a *round*, which thus included each of the four species or treatments. A *replicate* consisted of three rounds, and included the six possible combinations of four treatments, e.g. for species Replicate 1: round 1—*Agrostis*/*Festuca*, *Lolium*/*Poa*; round 2—*A*/*L*, *F*/*P*; round 3—*A*/*P*, *L*/*F*. Three replicates were carried out on species and four on fertilizer treatments.

In the evening before the test little supplementary food was given (which was consumed very quickly), and the tests were carried out between 08.00 and 10.00. There was little grass available in the pen due to a severe drought. The trays were placed 20 cm apart in the centre of the pen (Figure 1), and positions with respect to the geese, which

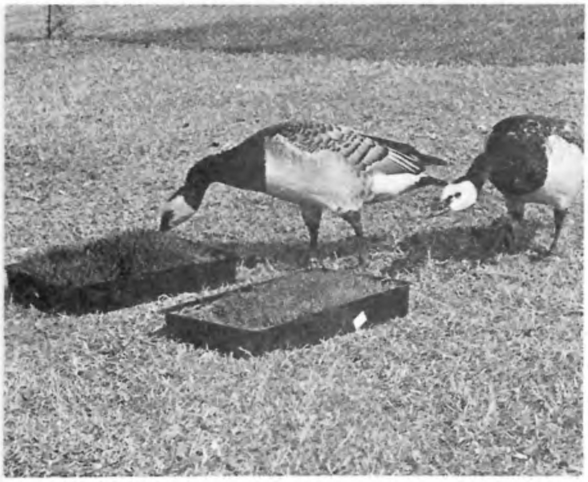

Figure 1. Two goslings of Group A approaching trays of two different species. Before the actual tests the grass was clipped to the same height in all trays.

retreated to one side of the pen, continually changed, so that one species was not always on the left or the right.

Recordings were started when the first goose pecked at the grass (Figure 2), and continued for five minutes. Two observers recorded on tape (a) the number of pecks, and (b) the time spent pecking on each tray by each of the four birds. A sample of grass was clipped from each tray on two dates in early September, the water content assessed and the nitrogen content of pooled trays of each species determined. After the replicate trials had been completed, trays of single species and treatments were presented to the geese and droppings collected so that the breakdown index (Owen 1975b) could be determined. One hundred faecal fragments were examined for each treatment.

Results and discussion

Species selection

The total number of pecks, time spent feeding (in seconds), and the feeding rate (pecks per minute of feeding time, calculated from total pecks and time) were subjected to analyses of variance. As an example, the full analysis for total pecks in the grass species tests, is given in Table 1. In order to reduce computation time the full bird by bird analysis was not carried out on all tests, in some cases the group totals were used. A summary of the species preference is given in Figure 3, where significant differences are shown by all three measures of feeding. Also shown is the number of tests in which a species was first selected (by any goose). This 'first choice' is not related to subsequent preference, and was not different from chance selection (X^2 test against 1:1:1:1

Figure 2. Three of the goslings feeding on the preferred *Festuca* tray.

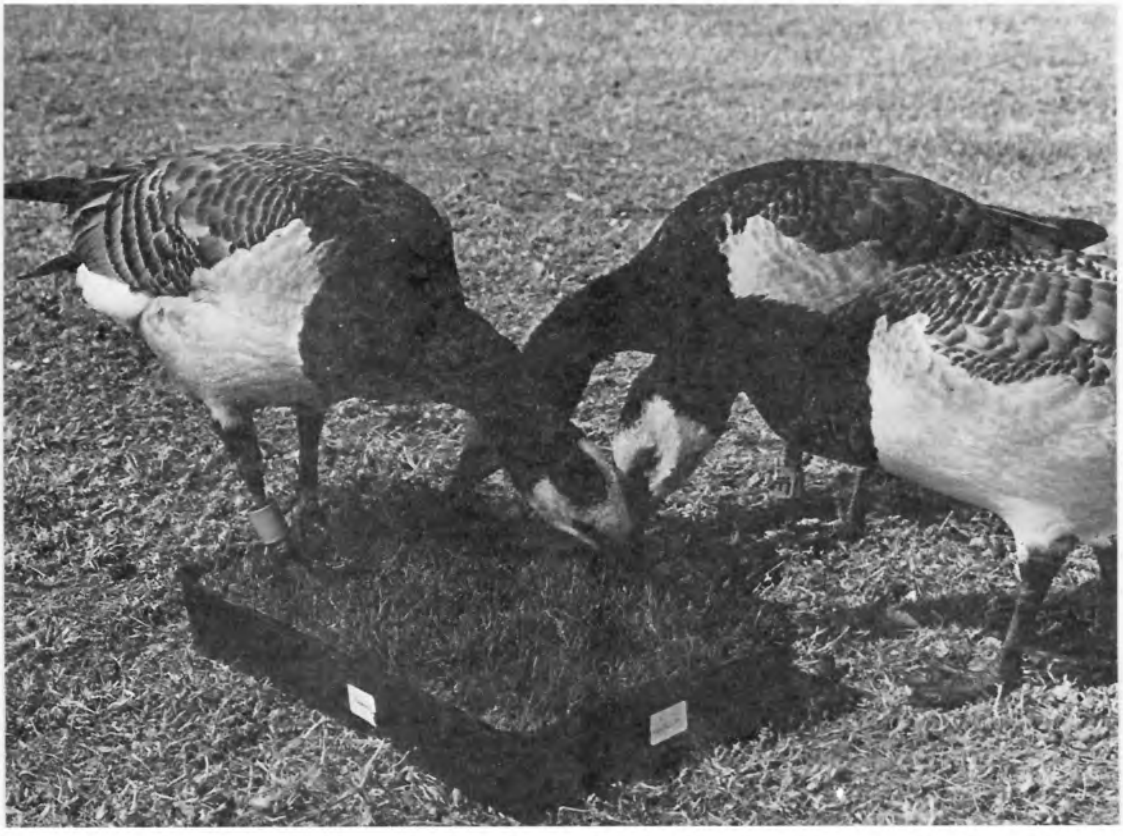

Table 1. Overall analysis of variance for the number of pecks in the species tests.

Source	Degrees of fredom	SS[2]	Variance	F	P
Total	287	1493705·3			
Treatments	95	806692·7	8491·5	2·35	<0·001
Species	3	27253·5	90841·2	25·16	<0·001
rounds	2	33931·1	16965·6	4·70	<0·05
birds	7	144181·2	20597·3	5·70	<0·001
S × R	6	98185·1	16364·2	4·53	<0·01
S × B	21	106381·6	5065·8	1·4	NS
R × B	14	40743·2	2910·2	<1	NS
S × R × B	42	110747·1	2636·8	<1	NS
Replicates	2	963·2	481·6	<1	NS
Error	190	686049·5	3610·8		

NS = not significant.

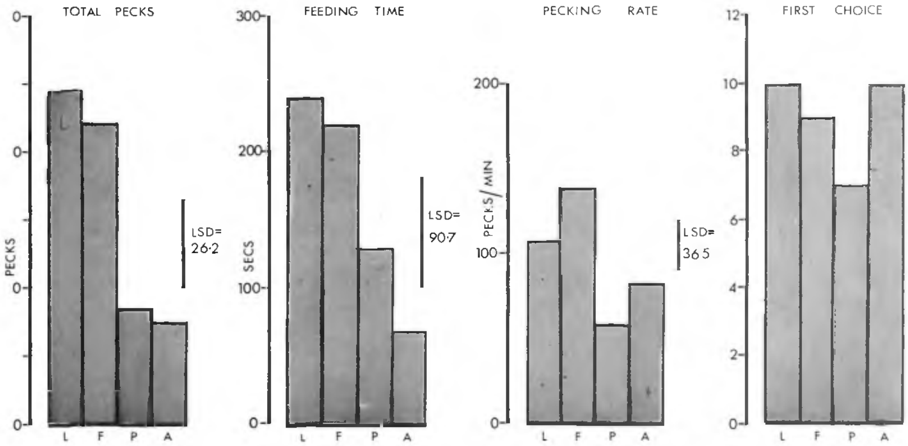

Figure 3. The selection of species by Barnacle Geese as assessed by four measures. L = *Lolium perenne*, F = *Festuca rubra*, P = *Poa pratensis*, A = *Agrostis tenuis*. L.S.D. = Least Significant Difference (at the 5% level).

ratio: $X^2 = 0{\cdot}66$, $P > 0{\cdot}750$). Although the grasses were clipped to a standard height they were very different in colour and tiller density, and easily distinguishable to the human eye. The absence of consistency in 'first choice' even at the end of the experiment indicates that the geese did not learn to recognize at a distance their preferred species. There were significant differences between the combinations presented, the lowest, as expected, being *Agrostis/Poa*. Thus the geese not only preferred the other two species but fed less heavily on these two when presented together.

Selection of fertilized vegetation

The selection of fertilized *Lolium* is summarized in Figure 4. Although each feeding measure gives a significant difference between treatments this is always between the unfertilized and one or more of the fertilizer treatments. There were highly significant differences between the activity of different birds (see Table 1), and there was a significant interaction between individual birds and nitrogen level, i.e. individuals were selecting different treatments. It became obvious, especially towards the end of the experiment, that the more aggressive individuals were preventing others from feeding on the preferred trays. The analysis was carried out using only three and only two birds from each group and the variance ratios were thereby increased. There were still, however, no significant differences between any fertilizer treatments.

The 'first choice' test was again not related to preferences and there was no significant differences from the expected 1:1:1:1 ratio ($X^2 = 4{\cdot}08$, $P > 0{\cdot}25$), despite the fact that colour differences between the control and fertilized trays were obvious to the human eye.

Characteristics of the test vegetation

The selection of species and fertilized vegetation is related to its water and protein content in Figure 5. In both the species and the nitrogen tests the preference of the geese more closely relates to water content than to protein content, in terms of fresh weight. The protein content of *Festuca* was 46% higher than that of *Lolium* but the geese had more pecks at *Lolium*. Experimental variability was high, however, and nitrogen was determined on pooled samples, so statistical analysis of these relationships cannot be carried out. The fragmentation index (Figure 5b) relates closely to water content and if the index gives a good indication of the availability of nutrients (Owen 1976), this may indicate the reason for the apparently closer relationship between water content and preference. Figure 6 shows the relationship between preference (total pecks)

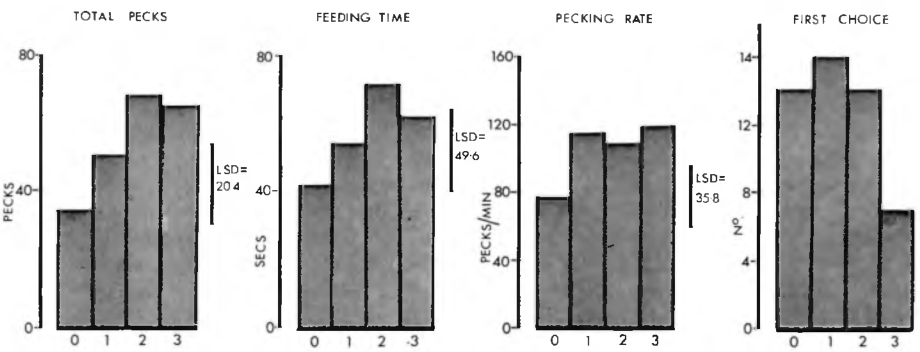

Figure 4. The selection of *Lolium perenne* treated with different levels of Nitrogen fertilizer. 0 = control, 1 = 1·5 gm/tray, 2 = 3·0 gm/tray, 3 = 4·5 gm/tray.

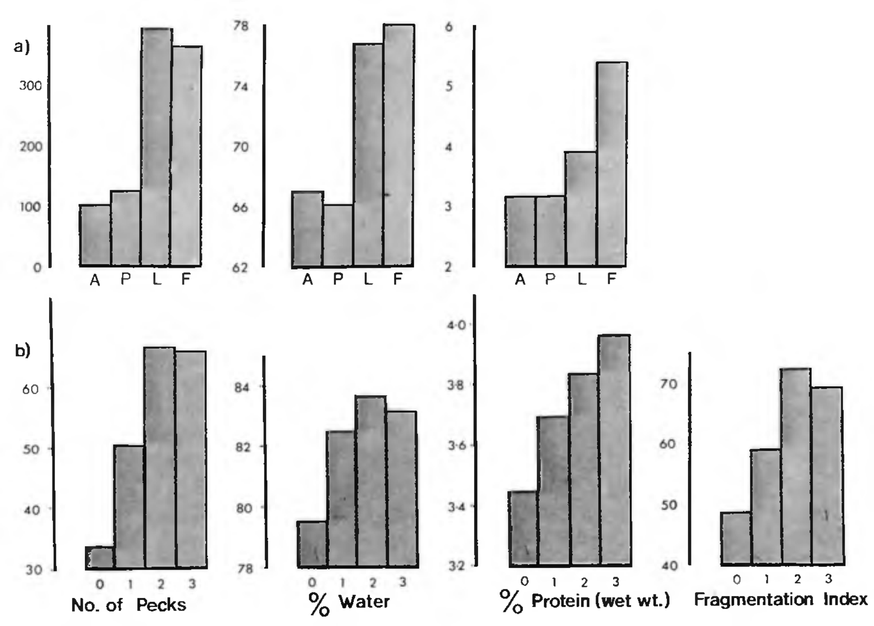

Figure 5. The relation between preference and the water and protein content (%N × 6·25) of vegetation; (a) species tests, (b) fertilizer tests. The fragmentation index is the percentage of fragments that appear in droppings with only a single surface intact (Owen 1975b).

and the 'available protein index', which is calculated from % protein (wet weight) x fragmentation index/100. Although this correlation is very close (r = 0·998) a large amount of experimental error is not taken into account and it cannot be regarded as a precise relationship.

Harwood (1975) found that the application of nitrogenous fertilizer to a grass sward increased the water content as well as the protein content of the vegetation. Moreover, the water and protein content were

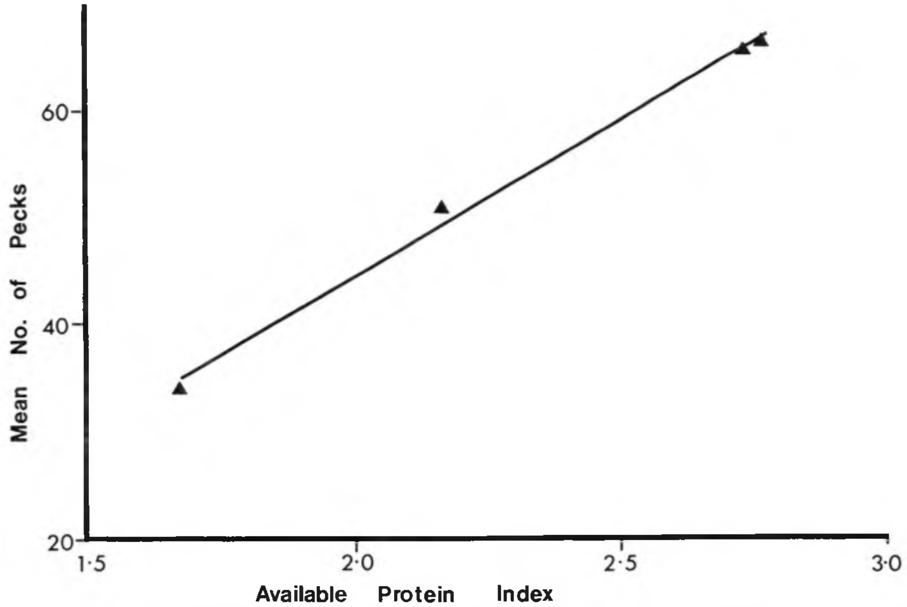

Figure 6. The relationship between preference (No. of pecks) and the 'available protein index' for the fertilizer tests. 'Available protein index' = % protein (wet wt.) x breakdown index/100.

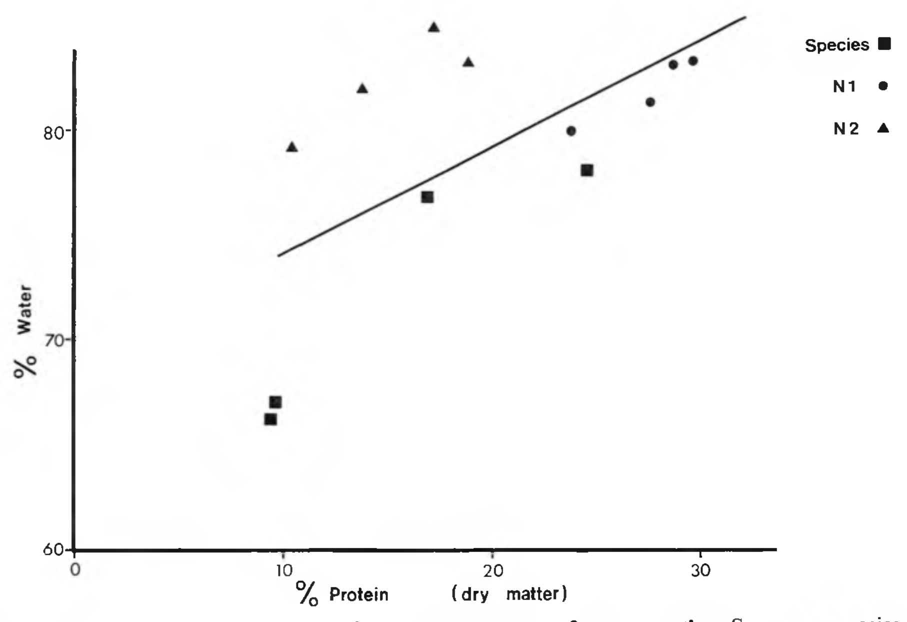

Figure 7. The relationship between protein and water content of test vegetation. Squares = species, circles = N_1 (fertilizer tests sampled 6.9.76), and triangles = N_2 (fertilizer tests sampled 14.9.76).

significantly and positively correlated. He suggested that the birds were responding to changes in water content but the correlation made it impossible for the two factors to be separated. Figure 7 shows the relationship between protein and water content of the present test vegetation. The overall relationship is significant ($r = 0{\cdot}62$, $P < 0{\cdot}05$) but within each set of samples the relationship is much closer (r for Species = $0{\cdot}932$, for $N_1 = 0{\cdot}947$, for $N_2 = 0{\cdot}873$). The protein content of vegetation in the fertilizer tests decreased from 23–30% (of dry weight) at the first sampling to 10–19% at the second, but water content remained the same. This was because fertilizer was leached out of the shallow trays by watering. Towards the end of the experimental period fertilized trays were obviously a brighter green than controls. Unfortunately, because comparisons cannot be made between groups of tests, the effect of differences in protein and water content on selection cannot be separated in the present experiment. The closer concordance between preference and water content (Figure 5) than with protein content may, however, suggest that the birds are really responding to changes in water content.

The results of the present experiment suggest that geese would fare better if they selected vegetation on the basis of its water content than its protein content. This is because water content is correlated with, (a) protein content, and (b) the fragmentation index which affects the availability of that protein. It seems likely that the brittleness of leaves would be related to their water content, and changes in such mechanical properties may be detectable by geese. It has been suggested (Owen 1976) that geese select vegetation by exerting a certain pressure or 'pull' so that more brittle leaves break off and are ingested while the tougher ones slip through. The fact that geese in this experiment did not appear to select trays visually, and that there is an apparent relationship between water content and selection, is consistent with this hypothesis. In order to test this further, more experiments are needed where the nitrogen and water content of vegetation are varied independently (the change in protein content between N_1 and N_2 (Figure 7) suggests that this is possible), and where the mechanical properties of leaves (e.g. tensile strength) are related to their water content.

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Summary

An experiment is described which tested the ability of young Barnacle Geese *Branta leucopsis* to discriminate between grass species and between trays of a single species treated with different levels of Nitrogen fertilizer.

The geese showed significant preferences for perennial ryegrass *Lolium perenne* and red fescue *Festuca rubra* against bent *Agrostis tenuis* and meadow grass *Poa pratensis*, and they significantly preferred fertilized to unfertilized *Lolium*, although they did not select either species or fertilized trays visually. The preferences were correlated with both the water and nitrogen content of the vegetation, and these were themselves positively correlated. Water content seemed to relate better to the preferences shown than did protein content.

It is suggested that geese would ingest more protein by selecting leaves on the basis of their water rather than their protein content. This was because water content was not only correlated with protein content but with the ease with which vegetation was broken up in the gizzard, which in itself controls the availability of nutrients to the bird.

Although not conclusive the results of this experiment were consistent with the hypothesis put forward earlier that geese select grass leaves and species on the basis of their mechanical not their visual properties.

References

Harwood, J. 1975. Grazing strategies of Blue Geese *Anser caerulescens*. Ph.D. thesis, University of Western Ontario.

Lieff, B. C., MacInnes, C. D. & Misra, R. K. 1970. Food selection experiments with young geese. *J. Wildl. Mgmt.* 34: 321–7.

Owen, M. 1973. The management of grassland areas for wintering geese. *Wildfowl* 24: 123–30.

Owen, M. 1975a. Cutting and fertilizing grassland for winter goose management. *J. Wildl. Mgmt.* 39: 163–7.

Owen, M. 1975b. An assessment of faecal analysis technique in waterfowl feeding studies. *J. Wildl. Mgmt.* 39: 271–9.

Owen, M. 1976. The selection of winter food by White-fronted Geese. *J. Appl. Ecol.* 13: 715–29.

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