NOTORNIS FAECES AS EVIDENCE ON FOODS AS A FACTOR IN CHICK REARING SUCCESS

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INTRODUCTION: Since the re-discovery of *Notornis* in 1948, work on this bird has usually aimed at determining the chances of its continued survival through the study of reproduction and natural loss, so knowledge of its food requirements, from a promising beginning, has advanced only slowly.

The first ecological paper (Falla, 1949), in describing the feeding habits of the takahe, mentioned the lack of attractive foods among the wiry scrub and coarse grasses of the alpine region in which the birds have persisted, and it was, in fact, the unusual poverty in mammalian food resources which set the form of the present study in February, 1953.

The vegetation of the district is a fairly typical montane one, dominated by slightly stunted tussock snow grass (*Danthonia flavescens*) with the many subordinate herbs and shrubs, but some of the least favoured areas carry only a sparse vegetation characterized by the sedge, *Carpha alpina,* a small shrub, *Dracophyllum densum,* and brown *Rhacomitrium* moss. These latter places held no resident takahe or deer, but the evidence of rather evenly spread faecal pellets or droppings indicated a light utilization by takahe of the remaining and larger part of the region.

Nesting occurred only in occasional small areas. These were marked by differences in the vegetation, by the number of fine grasses and small herbs, and by the location of sites, which suggested a soil fertility distinctly higher than found on the general range.

There was, however, also a wide degree of variation among nesting sites, or territories, which graded down to a level which was little different from general range. Further, there appeared to be a positive correlation between assessed quality of territory and recorded success in chick rearing, although, irrespective of other considerations, incompleteness of data on past nesting success left conclusions in doubt.

'Quality' is of course a relative term, for little is known of the food requirements of wild animals or of the capacity of vegetation to supply those needs.

Overseas feed studies on wild plants, which are of low average value by agricultural standards, have shown that *nutritional* rating is very complex, and, of course, the requirements of animal species differ in many ways, particularly in the proteins which have to be obtained from food. However, in New Zealand, field observations and analysis of stomach contents have shown that, except for understandable exceptions, *palatability* rating of plants is very similar for a relatively wide range of animals.

In the absence of precise data, it becomes necessary to bridge the gap between *nutrition* and *preference,* and assume that the staple foods which wild animals take in greatest amount, are those which are of high food value. This may not be universally accepted, but it must be evident at least that foods which are rejected, or taken in only small amount, can be of little use as basic energy resources.

Notoris foods differ from deer foods mainly in that acceptable plant species are much fewer, and it seems unlikely that a bird whose faeces are composed of little-altered vegetable material, could extract nourishment with efficiency equalling that of a ruminant with an alimentary system specialised for microbial digestion and protein synthesis.

Takahe have a poor record of breeding success. The proportion of the birds which pair is not known, but many pairs fail to produce chicks; one or two eggs are laid, but there is no record of two chicks being reared from one nest in Takahe Valley*; so in an environment which is poorly stocked

*H. B. Wisely found a pair of chicks near Waterfall Creek, South Fiord, but comparison of the vegetation of the two areas has not been possible.

with deer foods, it seems that an explanation for observed takahe breeding failures could be sought in the low availability of adequate foods for a ground-feeding bird.

The obvious line of investigation would be a detailed comparison of the composition of droppings from general range and territories respectively, followed by similar comparisons of droppings taken from territories whose chick rearing success records could be classified as 'consistent success', 'occasional success' and 'consistent failure'.

Time would not permit this, either in the field or in the subsequent laboratory work. Differences between general range and territory could be distinguished macroscopically, for fine textured faeces, which were not uncommon on territories, were rarely found on general range. (However, field evidence should be considered with caution, because 'fine' components are effectively masked in the presence of 'coarse' ones in proportions as low as 30%.)

For these reasons, droppings were collected from only two territories, those commonly designated A and B, and located respectively along the northern side of the lake, and on the summit of the adjacent North Bluff.

These two territories were well defined but it cannot be assumed that they are occupied by identical pairs in different years, or that they can always be maintained by single pairs. Territory A has the most successful record and is judged to have the best food resources in Takahe Valley. Territory B has not been credited with the production of a chick, although resident pairs nest and lay successfully. Its food resources are considered to be better than those of other unsuccessful territories. Territory B somewhat resembles A in essentials, but effective areas is less, due in part to encroachment of smothering *Dracophyllum uniflorum* scrub.

METHOD

As far as possible, the whole of the two territories was covered. Sampling was not strictly random; all very old and all isolated droppings were taken, but judgment was used in the sampling of aggregations in order to avoid over-representation of droppings from the congested nesting areas, and from the large clocker droppings which are produced by sitting birds. Further, as age of droppings was important, faeces were excluded if found in particularly damp situations where a black mould disintegrated droppings rapidly. However, such decayed droppings were not numerous and did not appear to be restricted to any one type or to any season, so their exclusion should not significantly influence results.

A two-inch section was taken from each dropping, classified according to apparent age, wrapped individually, and packed away for later examination. This length was judged to constitute a reliable sample, and as subsequent analysis was done by relative proportions, size of droppings did not influence results.

Age was assessed by appearance. New droppings were a bright green colour. They changed to yellow or brown in a few days, rate and nature of change being determined by air humidity, exposure to rain, and to sunshine.

In the collected droppings, following loss of a fine matrix, two weathering processes were apparent. Bleaching with loss of both colour and weight was most important. In the older specimens, black deposits, probably algal, seemed to be associated with later decay.

Fresh droppings (Class 4) were distinguished by matrix and colour. Usually some green remained in at least a few protected parts, but the shade of brown (found by test to result from early exposure to hot sunshine) was almost equally distinctive.

In the next older class (3) droppings had lost fine non-fibrous material, and were slightly bleached.

Very old droppings (Class 1) were decayed to the point of commencing to lose form, and another class (2) intermediate between Classes 1 and 3 was distinguished. For working convenience, these classes have been labelled

as 'Pre-nesting' (1), 'Nesting' (2 and 3), and 'Post-nesting' periods.

Chick droppings were distinguished by size and shape. An adult occasionally may produce small droppings, but these can readily be distinguished from the series of small compact droppings which grow in size as the chick ages, and so give concrete evidence of rearing success on a territory.

The laboratory examination was first done by Miss E. M. Stevens, but it was subsequently repeated completely under slightly different standards and checked against the first classification by Miss A. Percival and myself working in conjunction. Each of the 323 samples was sorted volumetrically by tenths. The full tabulation is not presented here, but frequencies and totals of each food class are given by respective periods in Table I.

Class		Grass seed		Grass leaves		Grass base		Celmisia		Other plants	
	No.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.
1A	28	46.4	24.3	17.9	10.7	57.1	41.1	0	0	53.6	23.9
2A	9	66.7	58.9	0	0	33.3	12.2	11.1	7.8	55.6	21.1
3A	45	82.2	68.5	2.2	2.2	44.4	19.1	0	0	26.7	10.2
4A	85	96.5	84.7	35.3	0.8	14.1	4.5	0	0	22.4	10.0
1B	21	9.5	3.3	0	0	76.2	47.6	47.6	16.7	52.4	32.4
2B	35	11.4	5.1	0	0	88.6	73.4	31.4	10.9	25.7	10.6
3B	35	60.0	45.4	8.6	0.9	22.9	9.4	31.4	15.7	45.7	28.6
4B	33	90.9	62.7	3.0	1.2	21.2	6.4	6.1	3.0	60.6	26.7
Chick	32	87.5	56.3	3.1	1.6	28.1	7.5	0	0	68.8	34.7

TABLE 1. *Frequency columns show the respective percentages of samples which contained food of each class. Volume columns show the percentage which each food class comprised during respective periods.*

RESULTS

Complete accuracy is impossible, and some overlap is unavoidable in any continuous series, but significant errors seem unlikely in the 'Nesting' and 'Post-nesting' periods.*

Time-scale inaccuracies are unlikely to affect the validity of comparisons between the two territories.

Considerable error is to be expected in the 'Pre-nesting' series. Here disintegration is advanced, but the main complication is caused by winter snow providing a period when at least some droppings would virtually cease weathering for several months. Accordingly, some late autumn and early spring droppings could be readily classified alike.

The 'Pre-nesting' droppings, however, are not important in this study, because they represent a period of the year marked by regression of breeding activity, when territoriality should be least in evidence, and it is not even certain that the birds represented were the respective territory holders.

Figure 1 illustrates the fundamental differences between the two territories. Fine foods, shown in the left column for each season, are characteristic of territories, while, in contrast, coarse foods are characteristic of general range.

The nine samples which make up the early 'Nesting' column for Territory A are too few to be statistically significant, but interpolation between the adjacent 'Pre-nesting' and late 'Nesting' periods gives an essentially similar result. The two 'Nesting' periods are the ones considered most likely to be important. Probably the early 'Nesting' droppings represent the season before laying when the hen bird accumulates sufficient reserves to permit the later production of eggs, although shortage at this time might not have serious consequences if adequate food became available in the late 'Nesting' period.

*This could be tested in later work, when fresh samples should be taken at the appropriate times.

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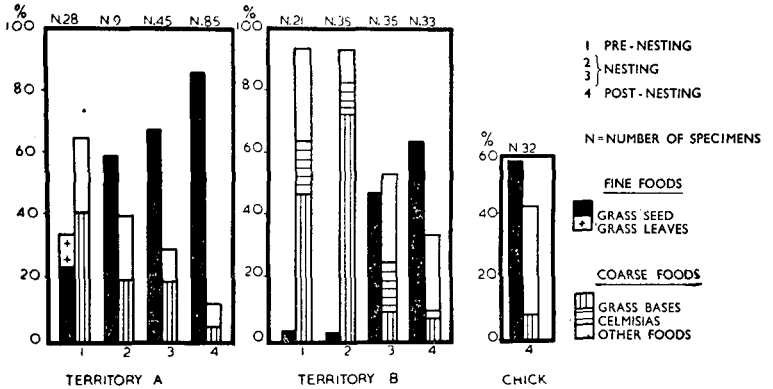

FIG. 1 – Comparison of fine (left) and coarse (right) foods of successful (A) and unsuccessful (B) territories. Total number of droppings is 323.

It is for these two periods that Territories A and B should be compared in Figure 1. In the early 'Nesting' stage, A has 58.9 per cent of fine foods*, while B has only 5.1 per cent. In the later 'Nesting' stage A rises another 12 per cent up to 70.7 per cent, and B climbs quickly to 46.3 per cent.

The rise of fine foods continues on both territories through the summer 'Post-nesting' period to 85.5 per cent and 63.9 per cent respectively. Although territory B is still inferior to A, favoured foods are likely to be in excess of requirements in both places, but the nesting period has passed so successful breeding then depends upon chick requirements.

Chick food differs from that of the adults; instead of being nearly all fine grass seed, it is comprised of more equal proportions of fine and coarse foods. It is an open question whether this difference from the adult feeding pattern is determined by deliberate choice, or whether it is an attribute of lack of experience or skill, and chance would influence results based on only 32 samples.†

If chicks take 'coarse' foods by choice, it does not seem that a very high availability of grass seed would be necessary for them, but the situation would be reversed if inexperience limited the amount of this type of food which could be gathered by young birds.

There are minor differences shown between the food resources of the two territories. Celmisias are a staple food on Territory B except during the summer, but they do not appear in the A droppings, although the discarded white leaves, found in the area, indicate that a few bases are eaten on Territory A even in the summer. Faeces suggest that field signs may sometimes over-emphasize the degree of celmisia utilization, as possibly also that of the

*Fine foods consisted of seed (and flowers?) of the small grasses *Poa, Festuca, Hierochloe,* etc., which were not identified as to species in the droppings. There was very little *Danthonia* seed. Fine grass leaves were fairly frequently taken but occurred in sufficient volume to show in Figure 1, only in the 'Pre-nesting' class of Territory A.

†These droppings probably represent a period for the chick following diversion from the initial animal foods, although insect remains made up 20 per cent volume in one sample. Faeces composed of predominantly insect remains would lack bulk and durability. K. Miers points out (oral communication) that chick and adult faeces are not directly comparable, because the outer sheaths are rejected before leaf bases are fed to the chick by parents.

large danthonia species, *D. rigida* and *D. flavescens*. In contrast, the 'Other Foods' class consisted mainly of unidentified stalks. These were a summer food. The 'Leaf Bases' class included all grasses and some sedges, but did not include celmisias or other broad leafed plants.

Except for the leaf bases, the several *Danthonia* species were represented only rarely and in very small amount as seeds, and were not observed at all in green leaf material. It is also remarkable that although the fine grass seeds (or flowers) were taken in large quantities during the summer, this class of food was represented to some extent in the droppings at *all* seasons. Seeds in the 'Pre-nesting' series are easily explained as a carry-over from the previous autumn, but this cannot account for 'seeds' in the 'Early-nesting' period. It is possible that ageing of samples has been incorrect, but if columns Nos. 2, A and B, in Figure 1 are consulted, it will be seen that the paucity of grass seed on Territory B at that time would conform to expectation for that higher and poorer territory, so error in ageing would apply to A but not to B.

It seems that the small grasses are of great importance because of their heavy utilization in the 'Nesting' period, but it is desirable that the suggested extent of their *early* use should be confirmed by observation of the flowering period of the small grasses.

The analysis of droppings was an empirical one, designed mainly to separate out the broad categories of 'Breeding Ground' and 'General Range' foods, so it is not surprising that forbs, or broad leafed herbs, were not recorded.

Forbs were recorded as taken (C. A. Fleming, 1950) and plants of this form are characteristic of the most successful takahe territories. They are taken by the deer and by the strongly selective opossum, so it seems probable that they are an important food for takahe, but special treatment of fresh droppings would be required to demonstrate the presence of these.

At this point, the general differences between A and B Territories should be considered.

Territory A is favoured by situation. The water table, consequent upon levelling of slope, becomes higher with progression downhill until it breaks ground surface as the lake itself is reached. Soil condition has in this instance outweighed climate, and there has been an inversion in the normal order of plant communities. Here grassland passes upwards through scrub to beech forest; and these three plant formations are telescoped into a narrow belt giving a maximum of biological 'edge' effect.

On this teritory the usual snow-grass tussock (*Danthonia flavescens*) is completely displaced by the red tussock (*D. rigida*). Growth of the latter species on the moderately drained soil is restrained enough to be favourable for takahe (thus differing from the same plant species on the congested Point Burn Flat), and also the scrub is open. Here the association is the *Olearia lineata - Coprosma rigida* (affine) one, with a varied herbaceous understory.

This plant community appears to be superior to any other in Takahe Valley, although the snow-grass communities of the higher valley heads, and the *Coprosma ciliata - C. pseudocuneata - Aristotelia fruticosa - Hymenanthera alpina* associations of the north side of the main valley flat have many possibilities.

All these associations, with their variety of foods of moderate general (ruminant-marsupial) palatability must be contrasted with the scrub association which occupies the greater part of the south of the main valley flat, a *Dracophyllum uniflorum - Dacrydium biforme* one. This is so low-lying in habit that there is no lower herb stratum, and the consequently limited food resources cannot be effectively supplemented either from the adjacent sphagnum-influenced forest, or from the stunted *Danthonia rigida - Oreobolus - Donatia* grass-sedge community of the central flat.

Territory B occupies a position which is intermediate in regard to its plant communities between those of Territory A and the poorer ones carrying the associations described in the preceding paragraph. In herbaceous species, it

somewhat resembles A Territory, but *Dracophyllum uniflorum* occupies a large proportion of the main (western) portion of the area, and the eastern section of the grassland is occupied by an almost pure association of *Danthonia teretefolia* and *D. crassiuscula* – grasses which showed no signs of utilization by either takahe or deer.

Spatially, this territory appears to be adequate, but the area contains too high a proportion of plants which are not associated with smaller herbs and which are themselves unpalatable to all the wildlife animal species of which I have had experience.

A somewhat varied plant community, probably calcophilous and characterized by *Danthonia ouria* (affine) and *Anisotome capillifolia,* occurs at the foot of the bluff, but does not appear to be used by takahe (although deer and opossums utilize its superior resources). The beech forest appears to add little food, and the stunted plants of the higher leached soil (*Dracophyllum uniflorum, D. densum, Carpha alpina* sedge, and brown *Rhacomitrium* moss) can give no appreciable supplement.

DISCUSSION

The field work of this paper is very limited, and it is obvious that faeces from general range as well as from additional territories should have been included.

The work was done as a pilot study, in the time available after completion of the primary object of the trip, to indicate whether the method of faecal examination was worth full development in order to test a hypothesis suggested by study of vegetation.

However, as no further work has been presented on this aspect in the two seasons since the original report was written, it may be profitable to consider implications of the present results.

There is an observed difference between the availability of 'fine' and 'coarse' foods on territories and open range, and the presence of 'fine' foods appears to be an important attribute of any territory.

The paper does not discuss present open range data, but, based upon two examples, it considers differences in grading of territories, and suggests that local territories fall progressively from the A territory standard down towards that of general range below that of territory B.

It seems that, quite apart from other requirements, food deficiencies in spring limit the number of effective territories.

There would be an annual difference in food resources, for a favourable season would improve the grading of territories, although it would not increase the available number of territories unless the *establishment* of territories were purely food dependent – which is *not* suggested.

Figure 1 shows the differences in the resources of Territories A and B during the 1953 - 54 season, and for that year the food standard indicated for B probably was near the threshold for successful hatching and chick rearing.

The accuracy of the earlier recorded failures on Territory B could be open to question, but in the year under consideration, although the result of incubation is not established, the absence of a chick-dropping series in association with the adult series showed that the pair did not retain a chick, and a hatch cannot well be assumed in light of the observations of other seasons.

The question of the nutritional standards of territories is an important one. The wide distribution of droppings suggests that there are birds living on open range, which would be available to occupy territories rendered vacant by loss (or removal for special purposes) of birds from an established territory – whether or not such territory were a chick producing one.

Alterations to the general range would appear to be beneficial only if they provided new territories, and do not appear to be practicable, but, on the other hand, improvement of deficient territories could involve only minor alterations

on very small areas – if the implications of this paper are accepted or established by later full-scale investigation. The main requirement would be the cutting of dense unproductive growth. Number of territories would not be increased, but takahe production would be greater on improved areas. Unless present territories have deficiencies which are not evident, effective habitat improvement would probably be a relatively simple undertaking, involving only a few acres.

On Territory B, effective feeding ground is limited by the increasing encroachment of dracophyllum scrub which could be thinned with a slasher to allow increase of existing herbs, including the small grasses.

Probably the additional application of a fertilizer to stimulate growth would be beneficial, but there would remain for consideration the question of permanence, although annual maintenance upon this scale would not be onerous.

A longer term improvement would be the replacement of the dracophyllum by an open shrub community, such as the *Olearia - Coprosma* one of A Territory, or the *Coprosma - Aristotelia* one of Territory B, but such changes would require a better understanding of local ecology than is yet available.

Dracophyllum scrub, although it influences all territories of the floor of Takahe Valley, is not the only form of vegetation that can restrict the favoured food plants; the *Danthonia teretefolia - D. crassiuscula* community lying immediately east of Territory B is an example of unpalatable grasses smothering other plants. Such a closed association would normally be attributed to an edaphic factor, but in this case the complete dominance could possibly have resulted in part at least from takahe browsing pressure on the more palatable species.

The clearing of narrow lanes and fertilizing would probably result in an invasion of the finer grasses among the unpalatable tussocks which would shelter new growth, although probably the territory standard could be raised sufficiently by attention to the dracophyllum portion alone.

Deer represent a direct threat. The unpalatable red tussock of Territory A is not subject to destruction as is the snow grass, which is being killed in the valley head, but if, as this study suggests, seed heads of small grasses are important, only moderate grazing by deer will eliminate these. The situation can be illustrated by the comparison of a pasture and a hay paddock; grass flower heads are absent in the first case, but they grow in profusion in the second.

The restriction of sampling to only two territories is a weakness of the present study, and in any full-scale planned project, age of droppings should be established beyond question by the collection of fresh droppings at appropriate seasons. Such samples should be treated in order to preserve traces of soft herbs which would otherwise be lost.

However, the marked differences in availability and utilization of food types that are shown between the two nesting areas compared here, correspond to success and failure in chick rearing. They suggest that management of the takahe is governed by the same basic requirements of game birds and mammals, in fertile soil and available food plants, and that, further, in view of the smallness of the areas concerned, practical difficulties of improvement should not be great.

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