

The foraging behaviour of the Chough *Pyrrhocorax pyrrhocorax* in two contrasting habitats

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Abstract – The foraging behaviour of the Chough *Pyrrhocorax pyrrhocorax* was compared between Alpine and coastal environment at the same time of the year (summer).

Choughs in both study areas (Aosta valley in northwestern Italy and the isle of Islay in western Scotland) took a wide range of arthropods but the diet appeared more diverse in the Alpine area. The Aosta Choughs had more variable feeding methods than the Islay ones. Such differences might merely reflect the prey species diversity of the two sites, perhaps in turn depending on the environmental diversity. The length of stay at any one patch was considerably shorter at Aosta, and this might be related to the lower cost of moving in the Alps, by being able to glide along steep slopes. Pecking rates were similar in the two areas, although slightly faster at Aosta. Observations carried out on Islay on colour-ringed individuals suggested that foraging techniques were age-dependent.

Introduction

The Chough *Pyrrhocorax pyrrhocorax* is a corvid whose populations all over Europe are declining considerably (Bignal and Curtis 1988). This species feeds mainly on soil and soil-surface invertebrates, changing its diet according to the availability of prey species (Cowdy 1973, Roberts 1982 and 1983, Garcia-Dory 1983, Warnes and Stroud 1988, McCracken *et al.* 1992, Soler and Soler 1993). In Scotland birds show seasonal variation in the use of vegetation patch types (Warnes and Stroud 1988) and display different activities in different patches (Curtis *et al.* 1988).

However, the Chough occurs in two dramatically different environments, high Alpine continental areas and low coastal maritime ones. Since the food items available to the Chough will differ widely between the two habitats, it seemed likely that the birds' foraging behaviour might also be very different as they coped with divergent conditions. The aim of the present study was to compare the foraging behaviour of the Chough in both Alpine and coastal environments at the same time of year (summer).

Study areas and Methods

The Alpine study area was near Aosta, Italy, in the upper (southern) part of the Val di Rhêmes, an area of

cliffs and Alpine pastures at an altitude of 1,950-2,500 m (Fig. 1), which was visited from 11 June to 12 July 1991, following preliminary observations in July 1990. The coastal area was the island of Islay, Argyll, UK, on the west coast of Scotland. Two study sites were established on Islay, one on a sandy peninsula at Ardnave at the north end of the island and the other at Kilchoman, a bay on the west coast (Fig. 2). Both were areas mainly of short grazed grassland with fields of improved grassland (some cut for hay and silage) and sand dunes. Field observations on Islay were carried out from 26 June to 17 July 1991.

Observations on the Choughs in both areas were made using binoculars and 15X-45X telescopes from vantage points. Flock size was determined whenever the whole group could be seen clearly and detailed observations of foraging behaviour and feeding rates were made opportunistically whenever flocks were close enough to the observers. The tameness of the Choughs on Islay allowed observation from 50-100 m while the birds at Aosta were observed from 100-300 m. On Islay we could determine the age of many individuals since the population was colour-ringed (Bignal *et al.* 1987)

The duration of the Choughs' stay in each patch of pasture was measured by selecting one bird in the middle of a landing group and recording the time for which it foraged before flying up and moving to a new patch (over 50 m away). In similar observations



Fig. 1. Location of the Val di Rhêmes in northern Italy and that of the study area in the southern part of the Val di Rhêmes (in the Aosta Valley).



Fig. 2. Location of the isle of Islay in Scotland and that of the two study sites (Ardnave and Kilchoman) in the western part of Islay.

Table 1. Prey species found in faeces at Aosta and on Islay and the percentages of samples in which each was found. When not specified, individuals were adults.

Prey item	Percentage of faeces				
	Aosta Rhêmes	Ardnave	Islay Kilchoman		
Orthoptera	15.2	1.1	—		
Coleoptera	Scarabaeidae	adults	33.3	100.0	38.0
		larvae	21.2	89.0	64.0
	Geotrupidae	3.0	—	—	
	Curculionidae	24.2	57.1	68.0	
	Elateridae	adults	36.4	—	4.0
		larvae	9.1	—	—
	Carabidae	adults	27.3	17.6	24.0
		larvae	6.1	—	—
	Cerambycidae	6.1	—	—	
	Birridae	12.1	1.1	16.0	
	Lathridiidae	3.0	3.3	—	
	Staphylinidae	adults	9.1	—	9.3
		larvae	3.0	—	4.0
	Coccinellidae	3.0	—	—	
	Chrysomelidae	3.0	1.1	2.0	
Silphidae	—	1.1	2.0		
Dermaptera	Forficulidae	15.2	17.6	14.0	
Heteroptera		24.2	1.1	—	
Lepidoptera	eggs	3.0	—	—	
	larvae	72.7	86.8	36.0	
	pupae	3.0	—	—	
Diptera	Tipulidae	adults	—	6.6	8.0
		larvae and pupae	9.1	57.1	64.0
	Other Nematocera	adults	—	1.1	—
		larvae and pupae	—	5.5	56.0
	Brachicera	adults	—	—	8.0
Hymenoptera	Formicidae	3.0	20.9	26.0	
	Others	36.4	2.2	2.0	
Diplopoda		18.2	3.3	—	
Diplopoda		12.1	28.6	24.0	
Isopoda		—	—	16.0	
Arachnidae		39.4	4.4	16.0	
<i>Gagea fistulosa</i>		33.3	—	—	
N. samples		33	91	50	

on the Alpine Chough *Pyrrhocorax graculus*, there was no significant difference between stay times which ended in the whole flock moving and those when the "focal bird" moved with only some of the flock, nor between measurements made by two different observers (Rolando and Patterson unpublished).

Individual birds were selected at random and watched for at least three minutes to determine the foraging techniques being used. The peck rate was measured by timing a bird while it pecked and apparently swallowed 25 items (if possible; minimum 10 items), although, even using a telescope at close range it was not always easy to see if a prey item had been obtained. Faeces were collected from areas where the Choughs had been seen feeding or resting and at

Aosta were taken only if a Chough (rather than an Alpine Chough) had been seen defecating. The birds were observed in different feeding habitats as opportunities occurred; there was no attempt to observe all habitats equally (or proportionally to their relative areas) and no measurements of the areas of different habitats could be made in the time available.

Results

a) Diet

The mean dry weight of faecal deposits on Islay (0.198 ± 0.016 g, $n=30$) was significantly higher than that at Aosta (0.083 ± 0.018 g, $n=22$; $t=4.72$, $P<0.005$). The Choughs in both areas took a wide

Table 2. Feeding techniques used on grass by Choughs of different age on Islay in different areas and time periods

	Percentage using			N
	Probing	Surf. Pecking	Both	
Adults (Ardnave)				
1 - 5 July	97.2	0.0	2.8	71
6 - 10 July	90.9	1.8	7.3	55
11 - 17 July	81.3	3.1	15.6	64
All date	90.0	2.6	7.4	190
Seasonal variation: $\chi^2=9.7$, $P<0.05$				
Adults (Kilchoman)				
26 - 30 July	100.0	0.0	0.0	15
1 - 5 July	100.0	0.0	0.0	10
6 - 10 July	75.0	15.6	9.4	32
11 - 17 July	76.9	15.4	7.7	13
All dates	84.3	10.0	5.7	70
Seasonal variation: $\chi^2=7.3$, $P>0.05$				
First-year (Kilchoman)				
26 - 30 June	100.0	0.0	0.0	21
1 - 5 July	100.0	0.0	0.0	7
6 - 10 July	9.1	81.8	9.1	11
11 - 17 July	40.0	60.0	0.0	5
All dates	70.5	27.3	2.3	44
Seasonal variation: $\chi^2=34.6$, $P<0.001$				
- Juveniles (Ardnave)	0.0	100.0	0.0	35

Adults: Ardnave vs Kilchoman; $\chi^2=6.4$, $P<0.05$

Kilchoman: Adults vs First Year (1st & 2nd periods); $\chi^2=6.2$, $P<0.05$

Arndave: Adults vs Juveniles (1st & 2nd periods); $\chi^2=191.6$, $P<0.001$.

Table 3. Length of time spent at one place by Chough flocks at Aosta on four categories of pastures: A) wet pastures with a slope minor than 13° comprised between 2200 and 2300 m a.s.l., B) rather dry pastures with a slope major than 26°, C) pastures with a slope minor than 19° and an altitude comprised between 2400 and 2500 m, often covered with snow in June-July and D) pastures with a slope minor than 18° and lower than 2100 m. The four type of pastures were also characterized by different vegetation.

Meadow Category	Mean Stay (min)	SE	N
A	6.98	0.91	60
B	6.57	0.74	135
C	2.12	0.44	10
D	6.68	0.57	154
Overall	6.56	0.40	359

$F_{3,355} = 1.21, P = 0.306$

Category C vs A, B and D combined; $t = 7.61, P < 0.001$

range of arthropod groups but the number of taxa was higher in the alpine area, where birds were also observed feeding on bulbs of *Gagea fistulosa*. Among Scarabaeidae, *Aphodius* adults were commonly observed in faeces of Choughs both at Aosta (21.2%) and at Islay (Ardnave 97.8%, Kilchoman 36.0%), *Onthophagus* (6.1%) occurred only at Aosta whereas *Serica brunnea* (Ardnave 25.3%, Kilchoman 2.0%) only at Islay. Some seasonal variations were observed: Curculionidae and Diptera, for instance, were most frequent at Kilchoman in early July, and a shift to *Aphodius* was recorded later. (Table 1).

b) Feeding habitats and feeding techniques.

At Aosta almost all of the groups observed feeding were on pastures. On Islay most birds were seen foraging on grazed grassland, many of them feeding by probing in cow pats. Some also fed in the sand

Table 4. Time (min) spent at one site by feeding flocks of Choughs on Islay

Flock Size	Ardnave			Kilchoman		
	Mean	SE	N	Mean	SE	N
1 - 5	8.41	1.14	25	11.12	1.22	77
6 - 10	18.37	3.60	16	16.56	2.83	16
Over 10	22.84	9.65	5	9.36	2.14	34
All sizes	13.44	1.87	46	11.33	1.01	127

All sizes, Ardnave vs Kilchoman; $t = 0.99, P > 0.05$

Table 5. Mean feeding rate (items ingested per min) of Choughs at Aosta. Pasture categories as in Table 3.

Meadow Category	Mean Rate	SE	N
A	2.14	0.26	39
B	1.97	0.14	43
C	2.61	0.49	8
D	2.39	0.15	75
Overall	2.23	0.10	165

$F_{3,161} = 1.20, P = 0.310$

dunes, occasionally probing in the soil above the buried carcasses of sheep. When grass cutting began, many birds were seen on cut fields at Kilchoman but few at Ardnave, although cutting also occurred commonly there.

At Aosta most birds (84%) used a continuous mixture of surface searching, digging and stone-turning, with a minority using only one technique during a period of observation. No bird was seen to use stone-turning as a sole technique. In contrast, on Islay most birds used only one feeding method during an observation period. At the start of the study period, almost all of the birds fed by probing but they changed later (significantly for adults at Ardnave and first-year birds at Kilchoman) towards more surface pecking or a mixture of both methods (Table 2). Overall, adults at Kilchoman used significantly more surface pecking than those at Ardnave and first-year birds (at Kilchoman, up to 5 July) used significantly more than adults at the same site and period. Juveniles used only surface-pecking.

c) Stay times

The Aosta Choughs' stay times averaged 6.56 ± 0.40 min, with no significant variation among habitat categories (Table 3). However, stay times in high areas with snow patches (category C) were significantly shorter than those in the other categories. There was no significant difference in stay time between morning and afternoon, or between different flock sizes.

The Islay birds' stay times averaged 13.44 ± 1.87 min at Ardnave and 11.33 ± 1.01 min at Kilchoman, with no significant or consistent variation over the study period (Table 4).

d) Peck rate

At Aosta, the peck rate averaged 2.23 ± 0.10 pecks per min with no significant variation between habitat categories (Table 5), or between morning and

Table 6. Mean feeding rates (items ingested per min) of Choughs on Islay in different areas and time periods

Age group; Area; Dates	Grass (probing)			Habitat Cut Grass			Dung		
	Mean	SE	N	Mean	SE	N	Mean	SE	N
- Adults, Ardnave									
1 - 5 July	2.16	0.12	69						
6 - 10 July	1.40	0.10	50						
1 - 17 July	1.55	0.88	52						
All dates	1.75	0.07	171				13.20	1.40	18
- Adults, Kilchoman									
26 - 30 June	1.36	0.16	15						
1 - 5 July	1.12	0.25	10	1.30	0.26	7			
6 - 10 July	0.61	0.07	24	1.38	0.10	47			
11 - 17 July	0.83	0.15	10	1.83	0.22	22			
All dates	0.92	0.08	59	1.50	0.10	76	24.34	4.32	12
- First Year, Kilchoman									
26 - 30 June	1.64	0.21	21						
1 - 5 July	1.44	0.23	7	1.56	0.82	3			
6 - 10 July	0.41	-	1	1.45	0.70	32			
11 - 17 July	0.47	0.31	2	1.04	0.12	7			
All dates	1.48	0.16	31	1.39	0.11	42	22.99	1.83	32
- Juveniles, Ardnave									
All dates							5.61	0.80	35

Seasonal variation (grass):

Adults, Ardnave; $F_{2,168} = 12.54$, $P < 0.001$ Adults, Kilchoman; $F_{3,35} = 6.48$, $P < 0.001$ 1st Year, Kilchoman; $F_{3,27} = 2.52$, $P > 0.05$

Cut grass vs Grass:

Adults, Kilchoman; $t = 4.53$, $P < 0.001$ First Year, Kilchoman; $t = 0.46$, $P > 0.05$

Dung vs Grass:

Adults, Ardnave; $t = 8.17$, $P < 0.001$ Adults, Kilchoman; $t = 5.42$, $P < 0.001$ 1st Year Kilchoman; $t = 11.71$, $P < 0.001$

afternoon. On Islay the peck rate varied between 0.92 ± 0.08 and 1.75 ± 0.07 pecks per min on grass and cut grass; there was no significant difference between the rates on these two habitat categories in adults, but first-year birds had significantly higher peck rates on cut grass than on grazed grass (Table 6). There was a tendency for peck rates to decrease during July, significantly so for adult birds on grass. Peck rates on dung pats were significantly higher than those on grass for both first-year and adult birds (Table 6). Juveniles were an exception to this having a very low peck rate on dung pats (Table 6). There was a slight but significant tendency for peck rate to be faster in larger flocks ($r=0.202$, $P < 0.05$, $n=166$).

Discussion

The Choughs in both areas fed on similar types of invertebrates, those living on or near the soil surface, although of course the species were different in the two places. In summer the diet of the Choughs at Aosta

seems to be more diverse than that on Islay. This might depend on a greater prey species diversity in the Alps, perhaps due to the greater environmental diversity (for instance the four categories of meadows of Table 3). However analysis of the diet on Islay demonstrated that, throughout the year, the Chough there also feeds on a great variety of items (McCracken *et al.* 1992). Both populations took Lepidopteran larvae but apparently very few grasshoppers, which were a main food of Alpine Choughs at Aosta (Rolando and Patterson 1993) and in the Pyrenees (Dendaletche and Saint-Lebe 1987). Invertebrate larvae found in cow dung were an important component of the Islay birds' diet, in keeping with the findings of Warnes and Stroud (1988) and McCracken *et al.* (1992). Only old dry dung (after the winter period) with no remaining fauna was available at Aosta in June but nevertheless proportions of Scarabeidae were about 30% (adults) and 20% (larvae).

Choughs showed to take advantage of the local availability of food items. Birds at Aosta, for instance,

fed on bulbs of *Gagea fistulosa* which is a typical Alpine flower, whereas at Islay they fed on Nematocera (especially at Kilchoman) since carcasses of sheep and cows buried in the sandy soil produced a lot of these insects.

The lower mean weight of Chough faeces at Aosta may indicate that the diet there was less bulky, with a lower proportion of undigestible matter.

Both populations fed mainly on short-grass meadows, but exploited other feeding sites available in their areas, especially at Islay (cut grass, dung pats and buried carcasses).

The Aosta Choughs had more variable feeding methods, with most birds switching frequently between digging, surface-searching and stone-turning, whereas the Islay birds tended to use one method at one time (chiefly digging at the start of the study period with more surface-searching later). The greater diversity of feeding methods at Aosta might be correlated with the prey species diversity, which might be greater at Aosta than on Islay. Lovari (1976) described Choughs in Abruzzo catching insects in flight near the ground, but we never saw this either at Aosta or at Islay. Digging activity at Islay was greatly facilitated by the sandy soil and by the apparent facility with which birds caught *Tipula* larvae. It is worth noting that even though the peck rates in cow dung were significantly higher than those in meadows, birds continued to dig in meadows until mid July when presumably *Tipula* were scarcer or more difficult to catch (deeper in the soil because of the lack of rain). In the same period birds readily shifted (only at Kilchoman) to cut grass where peck rates on *Tipula* were significantly higher for 1st year birds. It was not possible to estimate the size of the items taken by the birds, so the rate of food intake could not be compared between the different feeding situations. The length of stay at any one patch was considerably shorter at Aosta than on Islay (about half the duration). This may be related to the lower costs of moving at Aosta, by being able to glide along steep slopes. Choughs of both population had stay times longer than those observed in the Alpine Chough (Rolando and Patterson 1993).

Pecking rates were similar in the two areas, although slightly faster at Aosta. The estimated intake per stay at a feeding patch (adults on grass) was 14.63 items at Aosta, 23.52 at Ardnave and 10.42 at Kilchoman. Observations carried out at Islay on colour-ringed individuals (Bignal *et al.* 1987) suggested that foraging techniques were age-dependent. In particular juveniles (2-3 months old) had to learn a lot and did not dig at all; moreover their peck rates were very

low. They were observed many times to beg from adults, with fights between adults and juveniles in some occasions.

There was some evidence of a possible social influence on peck rates (faster in larger flocks). These data are in keeping with those from other corvids. It was suggested, for instance, that magpies in flocks have a higher average feeding rate than birds alone or in pairs (Vines 1981).

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Riassunto - In Europa il Gracchio corallino (*Pyrrhonorax pyrrhonorax*) si rinviene in ambienti anche nettamente diversi tra loro, quali le coste atlantiche e le aree montuose alpine. Lo scopo del presente lavoro è stato quello di paragonare, nello stesso periodo dell'anno (estate), il comportamento trofico di questo corvide nei due habitat. Lo studio è stato quindi condotto contemporaneamente in alta Val di Rhêmes, Val d'Aosta, e sull'isola scozzese di Islay. Lo spettro alimentare, desunto dall'analisi delle deiezioni, è risultato ampio in entrambe le zone con una maggior diversificazione nell'area alpina, dove la specie si alimenta frequentemente di larve di Lepidotteri, Formicidi e Coleotteri Elateridi mentre ad Islay utilizza perlopiù Coleotteri Scarabeidi e larve di Ditteri (principalmente Tipulidi). Le tecniche di ricerca del cibo riflettono il differente grado di diversificazione della dieta nei due siti: sulle Alpi è di solito utilizzata una tecnica mista che prevede l'alternarsi di sonde, scavi, catture in superficie e rimozione di sassi mentre ad Islay si osserva con maggior frequenza l'uso di una sola tecnica alimentare. I tempi di stazionamento sono risultati inferiori in ambiente alpino, probabilmente in relazione al minor costo degli spostamenti, prevalentemente effettuati sfruttando le correnti ascensionali che risalgono le pareti rocciose. Le osservazioni condotte ad Islay su animali marcati hanno permesso di appurare che il comportamento trofico cambia significativamente a seconda dell'età dell'individuo.

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