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Foraging behaviour and habitat use in corvids wintering on farmlands in northern Italy

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Abstract - Foraging behaviour and habitat use of corvids (Hooded and Carrion Crows, Rooks, Magpies) wintering on farmlands have been studied in the western Padana Plain (northern Italy). All species foraged prevalently on meadows and maize stubbles. Differences in the proportions of use of crops were not significant between Hooded and Carrion Crow, whereas they were significant in every other comparison between species. Foraging techniques were opportunistically used according to the foraging habitat choosed. Surface pecking was the commonest technique for every species, while digging was often displayed by the Rook only. Feeding rates varied according to the crop types used. Rooks fed significantly quicker than others on dunged meadows and harrowed fields, whereas Magpies fed slower than others on maize stubbles. The highest feeding activity of the Rook was obtained by means of an unremitting pecking activity and a wide use of all the different foraging techniques. No significant difference in feeding rates was found between Hooded and Carrion Crows. Both habitat use and foraging behaviour changed from area to area, suggesting that foraging ecology of corvids largely depends upon local environmental conditions. Flocks of Hooded Crows and Rooks were significantly more numerous when Carrion Crows and Hooded Crows were present, respectively. However, these data may be interpreted without assuming that interspecific competiton affects flock size.

Introduction

All over Central and Southern Europe sympatric species of corvids coexist during winter on the same farmlands. Species involved are the Crow *Corvus corone*, the Rook *Corvus frugilegus*, the Magpie *Pica pica*, the Jackdaw *Corvus monedula* (Prinzinger and Hund 1981, Waite 1984a, Bossema *et al.* 1986, Rolando and Giachello 1992) and, to a lesser extent, the Chough *Pyrrhocorax pyrrhocorax* (Soler *et al.* 1993). Interspecific aggressions leading to dominance hierarchies have been frequently observed (Vines 1981, Waite 1984b, Bossema *et al.* 1986, Eden 1987, Saino and Scatizzi 1991). Mixed-species flocking is usually avoided; however, when in mixed flocks, the degree of integration between species is rather poor (Rolando 1988). Heterotypic flocking is even avoided by the Hooded Crow *Corvus corone cornix* and the Carrion Crow *C. c. corone*, although they are races of the same species (Saino 1992, Rolando and Laiolo 1994).

According to the tenets of the niche theory (Cody 1974, Schoener 1974), separation by habitat selection could act to reduce overlap between species. However, farmlands represent a rather structurally simple environment compared to, for instance, woodlands, and possibilities for interspecific segregation might be low. Previous data from England suggested, in fact, that overlap in habitat use was mostly high (Waite 1984a). Hooded and Carrion Crow showed sharply different winter foraging habitat preferences in a north-western Italian area within the Alpine hybrid zone (Saino 1992), but they did not show appreciable differences in another area (Rolando and Laiolo 1994). Foraging behaviour and diet may differentiate species as well. Significant differences between species have been indeed pointed out in foraging behaviour (Waite 1984a) and diet (Soler and Soler 1991).

Interspecific interactions have been often considered to affect behaviour and ecology of syntopic corvids. It is well known, for instance, that foraging behaviour can be modified by aggressiveness and dominance between species (Eden 1987, Saino and Scatizzi 1991). Habitat selection and species distributions have also been considered partly to depend upon interspecific competition and predation (Fasola and Brichetti 1983). However, there is also the possibility that differences in habitat selection reflect solely species-specific preferences (Saino and Meriggi 1990).

This paper analyses foraging ecology of flocks of Carrion Crows, Hooded Crows, Rooks and Magpies

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wintering on farmlands in an area located in northwestern Italy.

The main aims were: 1) to describe habitat use and foraging behaviour showing eventual differences between species; 2) to assess to what extent habitat use and foraging behaviour were constant and species-specific or depending upon local environmental conditions; 3) to compare flock sizes of every species in homospecific and heterospecific flocks to evaluate the effect of interspecific interactions upon flocking.

A special aim was to assess differences (particularly in habitat use) between Hooded and Carrion Crows, given that previous studies had produced contrasting results (Saino 1992, Rolando and Laiolo 1994).

Study area and methods

Observations were carried out during the winters of 1994-95 (from December to February) in an area of northwestern Italy (southwestern Piedmont). The study area, about 60 km^2, was located near Cuneo, encompassed between Mondovì and Cuneo, and ranged in altitude from 390 to 540 m a.s.l. Nearly all the surface, except small woods along rivers and canals and poplar plantations, was arable land.

Pre-dominant crops were meadows and pastures, cereals and maize. Six broad habitat categories were considered: i.e. undunged meadows (UM), dunged meadows (DM), ploughed fields (large clods of earth) (PF), harrowed fields (earth crumbled and livelled) (HF), cereal crops (wheat and barely) (CC), and maize stubbles (MS). Other minor habitats (soy bean stubbles, gardens, untilled land etc.) were not considered.

Habitat use was analysed considering each flock as an observation. All the birds in a particular field were considered to belong to the same flock, in keeeping with Patterson *et al.* (1971) and Waite (1981). In cases when flocks contained individuals of different species we scored 1 for each species. Given that a special aim of the study was to assess differences between Hooded and Carrion Crows, hybrids were excluded from analyses. We decided not to consider each individual as an observation because the probability that some of the individuals were observed in two or more surveys was high, hence producing inflated samples made up of dependent observations. Moreover, the choice to consider each individual as an observation was unjustified from a purely biological standpoint since the movements of a bird were strictly tied to those of the other birds of the flock. Hence, the habitat use of an individual could not be properly separated from that of the other individuals of the flock.

For studying foraging behaviour, birds within flocks were randomly selected arbitrarily and watched for a maximum of four minutes. The same individual was never recorded twice during the same session. We tried also to select groups which were different for size and location, in order to avoid dependent foraging observations. Records lasting less than 60 seconds were discarded. Observations on birds were made using a vehicle as a hide with a 15-45 telescope at ranges not exceeding 100 m. Foraging behaviour was timed with a stopwatch and continuously described with a tape-recorder.

Data regarding foraging techniques were presented as percentages of occurrence and frequency percentages. Percentages of occurrence were calculated by dividing the number of observations during which a certain technique was recorded by the total number of observations made (O%). Frequency percentages were calculated by dividing the number of times a certain technique was recorded during observations by the total number of times all techniques were recorded during observations (F%). Only in this latter case the sum of the percentages was equal to 100. There were some differences in the use of foraging techniques across the different crop types. Accordingly, in order to compare the use of the foraging techniques between the different species, for each technique we calculated an average O% and F% value from the % values assessed for the different foraging habitats. Hence, for each species, every foraging habitat was equally weighted, independently from its sample size. Six foraging techniques were observed:

1) surface pecking (SP): the bird collected (or tried to collect) items on the surface of the meadow or crop while walking;

2) relocation pecking (RP): the bird collected items which were relocated and hided in another site;

3) turning objects (TO): the bird, after removing stones, clods of earth or dung pieces, looked for food under them;

4) digging (D): the bird, staying in the same spot, repeatedly drove its beack underground;

5) hitting (H): the bird hit items (nuts, maize-cob) heavy blows until the food item could be collected and swallowed;

6) surface touching (ST): the bird gently touched with one quick peck the surface without apparently catching anything.

The feeding rate (number of swallows/min) was measured by timing a bird while it swallowed items. A pecking rate (number of pecks/min) independent from the act of swallowing was also measured. Since foraging behaviour may be modified by interspecific influences, only homospecific flocks were considered. Foraging (feeding and pecking) rates and flock sizes were often contagiously distributed and, hence, for parametric tests (one-way ANOVA), they were trans-

formed by changing counts to logarithms (base 10) (Sokal and Rohlf 1981). After log-transformations the assumptions of the parametric tests were fulfilled.

Results

Habitat use

All species foraged prevalently on meadows (dunged and undunged) and maize stubbles, with percentages of observation ranging from 19 to 36% for every habitat type (Table 1). Cereal crops, ploughed and harrowed fields were frequented to a lesser extent, with percentages usually lower than 10%. In particular, Hooded and Carrion Crows were found mostly on maize stubbles and dunged meadows, whereas Rooks on maize stubbles and undunged meadows. Magpies foraged prevalently on meadows, both dunged and undunged (Table 1). Differences in the frequencies of use of crop types were not significant between Hooded and Carrion Crow ($X^2 = 6.9$, P= 0.22, N.S.), whereas they were significant in every other comparison between species ($P<0.01$).

Foraging techniques

Foraging techniques were opportunistically used by species according to the crop type choosed, but surface pecking was the most frequently used technique for every species on every crop type, with F% values ranging from 55 to 89%. Turning objects prevailed for every species on dunged meadows, where birds removed continuously the dung pieces scattered over the grass. F% values relative to this foraging habitat for Hooded Crow, Carrion Crow, Rook and Magpie were 55%, 57%, 46% and 51%, respectively. Analogously, hitting was mostly observed on maize stubbles (32%, 37%, 40% and 62%). Digging was especially used by Rooks, mostly on harrowed fields (45%).
Considering average O% values, surface pecking clearly resulted to be the commonest foraging technique, being recorded for every species in 94-95% of foraging observations. Digging, as stated above, was often displayed by the Rook (27%), but it was rarely displayed by the Crows and the Magpie. The Rook resulted to be the most active species with percentages which were higher than those of the other species (with the noticeable exception of relocation pecking, which scored last), whereas the Magpie was the least active species. Hooded and Carrion Crows presented quite similar occurrence percentages (Fig. 1).
Average frequency percentages confirmed the prevalence of surface pecking over the other techniques (from 65 to 77% of records). Digging (with the noticeable exception of the Rook) and surface touching were poorly used (less than 2%). Relocation pecking (low in the Rook), turning objects and hitting scored intermediate values (from 2 to 11%) (Table 2).

Feeding rates

Total feeding rates (i.e. rates calculated pooling all habitats) of all species were rather close, i.e. less than two items/min for every species (Hooded and Carrion Crows scored the same rate at 1.5 items/min). Feeding rates, however, varied a lot, from 0.95 items swallowed/min for the Magpie feeding on maize stubble to 4.7 items/min for the Rook feeding on ploughed fields (Table 3). Profitability cannot be properly calculated without considering the kind and the size of items collected. However, considering feeding rates only, harrowed fields might be the most profitable foraging habitat (average feeding rates for all species combined= 3.8 items/min), whereas maize stubbles might be the less profitable (1.36 items/min). Significant interspecific differences occurred in certain foraging habitats. In particular, Rooks fed significantly quicker than others on dunged meadows and harrowed fields, and Magpies fed slower on maize stubbles. Hooded-Carrion Crow was the only species pair for which no significant differences between feeding rates were

Table 1. Percentages of use of the different foraging habitats. Nr.=number of observations.

Habitat		Species			
		Hooded Crow	Carrion Crow	Rook	Magpie
undunged meadows	UM	19.3	21.9	27.5	29.1
dunged meadows	DM	29.1	28.9	18.7	36.3
ploughed fields	PF	8.4	7.3	3.7	3.6
harrowed fields	HF	2,3	4.1	7.9	0.8
cereal crops	CC	12.2	9.7	8.8	6.9
maize stubbles	MS	28.7	28.1	33.4	23.4
Nr.		1197	463	353	333

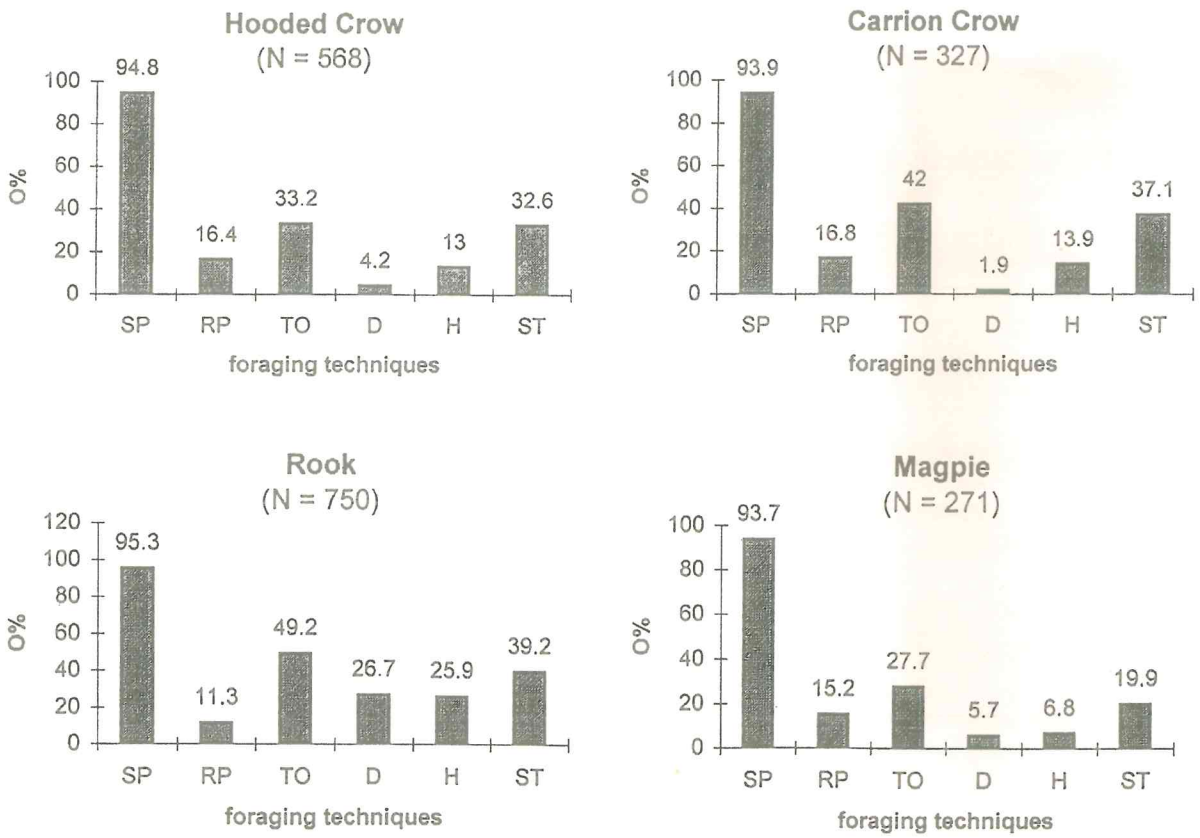

Fig. 1. Average percentages of occurrence (O%) of the different foraging techniques, calculated by dividing the number of observations during which a certain technique was recorded by the total number of foraging observations (N).

Table 2. Frequency percentages (F%) of foraging techniques calculated by dividing the number of times a certain technique was recorded by the total number of times all techniques were recorded during observations. Nr.=total number of times all techniques were recorded.

Foraging technique		Species			
		Hooded Crow	Carrion Crow	Rook	Magpie
surface pecking	SP	75.9	72.1	64.5	76.9
relocation pecking	RP	8.9	9.7	4.7	10.7
turning objects	TO	6.9	8.4	10.2	7.4
digging	D	0.9	0.4	9.8	1.3
hitting	H	5.1	6.3	8.2	2.3
surfage touching	ST	2.3	3.1	2.6	1.4
Nr.		11,922	6,972	20,133	5,214

pointed out. Rates regarding undunged meadows and cereal crops were similar for all species (Table 4).

To assess costs associated with the foraging activity, peck rates were calculated taking into account all pecks independently of the collection and swallowing of the items. Peck rates ranged between 6.1 to 14.3 peck/min (Table 5). On average, the Rook was markedly the most active species (10.1 pecks/min, total peck rates), whereas the Magpie was the less active (6.9). Rooks, in fact, pecked significantly quicker than others in all habitats except in undunged meadows. Peck rates of Hooded and Carrion Crows were usually not significantly different: the only exception regarded harrowed fields, where Hooded

Table 3. Mean feeding rates (number of swallows/min) of Crows, Rooks and Magpies on crop types. Number of observations are given in brackets. No feeding rates are given for samples with less than ten foraging observations. All samples, however, were considered to compute total rates.

Habitat		Species				
		Hooded Crow	Carrion Crow	Rook	Magpie	total
undunged meadows	UM	1.56 (75)	1.21 (32)	1.36 (186)	1.53 (49)	1.41 (342)
dunged meadows	DM	1.35 (119)	1.54 (45)	1.84 (137)	1.57 (64)	1.59 (365)
ploughed fields	PF	1.3 (55)		1.91 (50)		1.58 (111)
harrowed fields	HF	3.1 (20)	1.9 (11)	4.65 (54)		3.8 (89)
cereal crops	CC	1.89 (49)	1.83 (16)	2.4 (93)	2.46 (18)	2.21 (176)
maize stubbles	MS	1.46 (105)	1.62 (53)	1.42 (169)	0.95 (81)	1.36 (408)
total		1.55 (423)	1.54 (160)	1.91 (689)	1.41 (219)	

Table 4. Comparisons between mean feeding rates (ANOVA). *=P<0.05, ***=P<0.005; N.S.=not significant. No comparisons have been carried out for samples with less than ten observations.

Habitat		Comparisons between species					
		Hooded Crow Carrion Crow	Hooded Crow Rook	Hooded Crow Magpie	Carrion Crow Rook	Carrion Crow Magpie	Rook Magpie
undunged meadows	UM	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
dunged meadows	DM	N.S.	*	N.S.	*	N.S.	*
ploughed fields	PF		N.S.				
harrowed fields	HF	N.S.	*		***		
cereal crops	CC	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
maize stubbles	MS	N.S.	N.S.	*	N.S.	***	*

Table 5. Mean pecking rates (number of pecks/min) of Crows, Rooks and Magpies on crop types. Number of observations are given in brackets. No pecking rates are given for samples with less than ten foraging observations. All samples, however, were considered to compute total rates.

Habitat		Species				
		Hooded Crow	Carrion Crow	Rook	Magpie	total
undunged meadows	UM	6.76 (75)	6.52 (32)	7.4 (186)	6.84 (49)	7.1 (342)
dunged meadows	DM	7.81 (119)	7.92 (45)	11.62 (137)	7.47 (64)	9.19 (365)
ploughed fields	PF	6.79 (55)		9.54 (50)		8.06 (111)
harrowed fields	HF	12.53 (20)	8.52 (11)	14.25 (54)		10.28 (89)
cereal crops	CC	7.74 (49)	7.94 (16)	11.07 (93)	8.79 (18)	9.6 (176)
maize stubbles	MS	7.05 (105)	7.32 (53)	10.03 (169)	6.11 (81)	8.13 (408)
total		7.52 (423)	7.44 (160)	10.07 (689)	6.95 (219)	

Crows pecked significantly quicker than Carrion Crows (Table 6).

Flock size

Flock size of Crows and Magpies were rather small, i.e. 2-3 birds on average. To the contrary, Rooks were more numerous, average flock sizes ranging from 10 to 20 birds. Mean number of birds of each species in homospecific and heterospecific flocks are given in Fig. 2. Flocks of Hooded Crows were significantly larger when the Carrion Crow was present (3.73 versus 2.2, F=24.2, P<0.001). Analogously, Rooks were more numerous when Hooded Crows were present (20.9 versus 13.97, F=8.42, P<0.005). Conversely, Hooded Crows and Rooks were less numerous when in presence of the Magpie, and Magpies were less numerous when in presence of Rooks and Hooded Crows, but these differences were not significant.

Table 6. Comparisons between mean pecking rates (ANOVA). *=P<0.05, **=P<0.01, ****=P<0.001; N.S.=not significant. No comparisons have been carried out for samples with less than ten observations.

Habitat		Comparisons between species					
		Hooded Crow Carrion Crow	Hooded Crow Rook	Hooded Crow Magpie	Carrion Crow Rook	Carrion Crow Magpie	Rook Magpie
undunged meadows	UM	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
dunged meadows	DM	N.S.	****	N.S.	****	N.S.	****
ploughed fields	PF		**				
harrowed fields	HF	*	**		****		
cereal crops	CC	N.S.	****	N.S.	**	N.S.	*
maize stubbles	MS	N.S.	****	N.S.	****	*	****

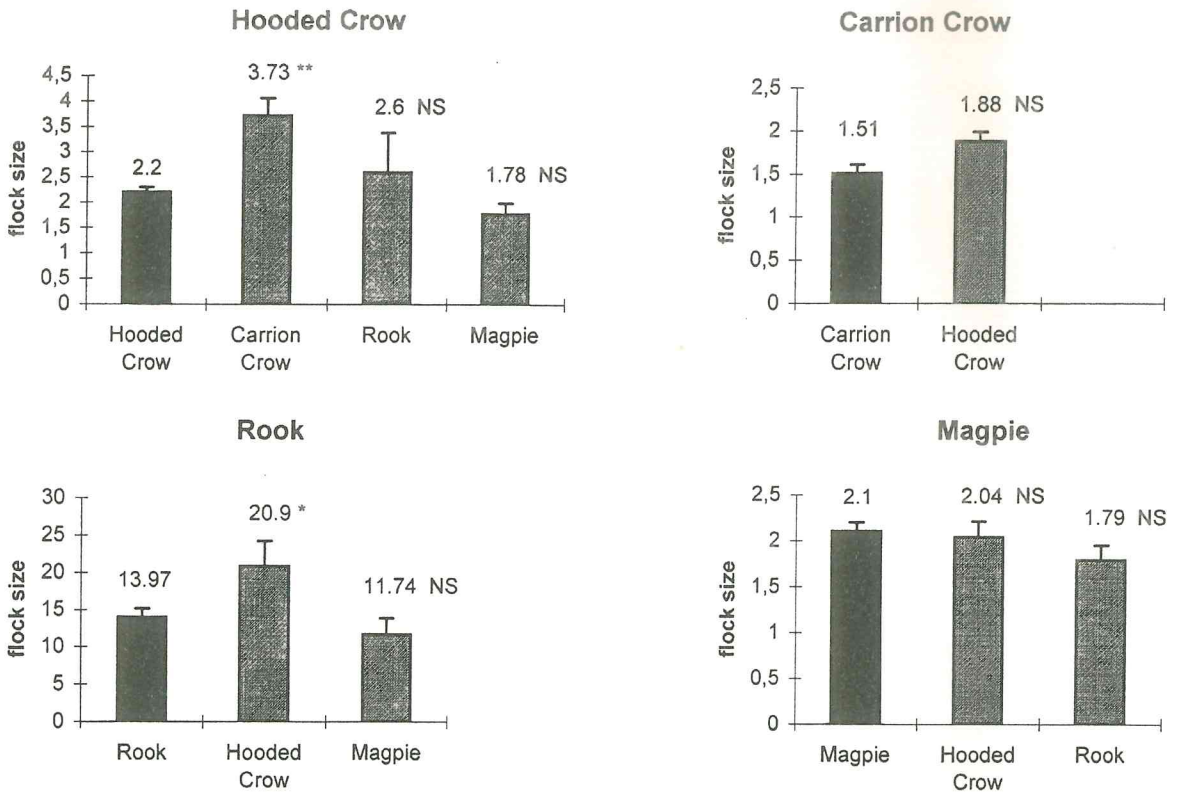

Fig. 2. Mean flock sizes of each species in homotypic (black bars) and heterotypic (two-species) flocks (grey bars). Significances of statistical comparisons (one-way ANOVA) between homotypic and heterotypic flocks above s.e. bars (*=P<0.005, **= P<=0.001, NS= not significant).

Discussion

Corvids are rather flexible in foraging habitat use. Seasonal changes in habitat use according to crop availability have been in fact extensively observed (Feare *et al.* 1974, Møller 1983a, 1983b) and intraspecific comparisons made across various European areas show a large variability as well (Vines 1981, Waite 1984a, Rolando and Palestrini 1994). Nevertheless, given a certain farmland, each species usually selects crops according to its own distinct foraging preference (Loman 1980, Waite 1984a, Baglione *et al.* 1990, Rolando and Palestrini 1993), as indirectly confirmed by the significant interspecific differences observed in our study area. If habitat preferences are species-specific, the interspecific order of habitat preference would remain rather constant, whatever the local crop availability. At Cuneo the Magpie used meadows

(both dunged and undunged) significantly more often than the other species. The same was true at Leinì, another area in the western Padana Plain (Rolando and Palestrini 1993). However, at Keel (England) (Waite 1984a) and at Kraghede (Denmark) (Møller 1983a and 1983b), the Rook and the Hooded Crow, respectively, occurred on grassland more often than the Magpies. This lack of constancy of interspecific order of ecological preferences suggests that no species-specificity in foraging habitat use exist in corvids.

Even though all species are largely omnivorous and use similar resources, significant interspecific differences in frequencies of items collected have been pointed out in certain areas (Fasola *et al.* 1986, Soler and Soler 1991). Moreover, volumetric percentages of vegetable and animal matter in the diet of the same species varied a lot from area to area (Holyoak 1968, Jollet 1984, Reebs and Boag 1987, Barbero *et al.* 1993, Soler *et al.* 1993). It is therefore likely that habitat preferences depend upon the food that species can collect in certain foraging habitats and that similar foraging habitats across Europe do not house the same feeding resources.

At Cuneo the Hooded-Carrion Crow pair was the only worthy exception to the pattern of interspecific differences described so far. No significant foraging habitat differences between the two races were in fact pointed out. Both Hooded and Carrion Crows mostly occurred on maize stubbles and dunged meadows, whereas they were seldom observed on harrowed fields. This outcome is in keeping with previous observations carried out in another area of western Piedmont (Rolando and Laiolo 1994), but it disagrees with observations previously carried out by Saino (1992) just in the same area considered in the present paper (most of our study area was placed in that surveyed by Saino). He observed that Carrion and Hooded Crows showed sharply different winter foraging habitat preference, the former selecting pastures and meadows, whereas the latter selecting maize stubbles. Hence, assuming that no missampling was done and that the two studies are properly comparable, the only possible explanation is that an impressive variation in habitat use takes place from year to year within the same area. Saino suggested that the adaptation of Carrion Crow and Hooded Crow to different foraging habitats is one of the proximate factor that promote the maintenance of mainly allopatric distributions and determine the position of the hybrid zone in northern Italy. The results of previous (Rolando and Laiolo 1994) and present observations are not in keeping with such an hypothesis.

All species used foraging techniques opportunistically, according to the crop type visited. Digging, for instance, were used prevalently on harrowed fields, whereas turning objects (dung pieces, in this case) prevailed on dunged meadows. Flexibility in the use of techniques is also confirmed by comparisons between different areas. At Keele (England) the Magpie and the Hooded Crow were mostly observed pecking on the surface (56% and 42% respectively, F%), the Rook was mostly observed probing deep in the soil (36%). The Hooded Crow was also often observed to turn dung (25%) (Waite 1984a). These frequencies were not matching with those recorded at Cuneo. Deep probing, for instance, was virtually avoided at Cuneo. Nevertheless, at Cuneo, like at Keele, the Magpie ranked first and the Crow ranked second in the order of pecking from the surface, and in both areas the Rook used digging to a similar extent. Some of these discrepancies may depend upon the behavioural categorizations made and it is also possible that some behaviours were mismatched in the two studies. However, differences regarding easily identifiable foraging behaviours (i.e. deep probing) were probably true.

Feeding and pecking rates were recorded only in homospecific flocks, so that possible differences between species were not dependent upon interspecifc interactions. Although total feeding rates of all species were rather close, interspecific differences were quite evident within certain foraging habitats. Most of the feeding differences regarded the Rook, which fed significantly quicker than the other species on two foraging habitats. Pecking rates showed that this higher feeding activity was obtained through a higher pecking activity. Rooks, in fact, pecked quicker than other birds on almost all the habitats considered (undunged meadows being the only exception), in keeping with previous observations carried out at Leinì (Rolando and Palestrini 1993). The Magpie was less quick than the other species in collecting foods in maize stubbles and this scarce efficiency was associated with a lower pecking rate.

The Hooded and the Carron Crow did not show any significant differences in feeding rates, whereas pecking activity was significantly different on harrowed fields. Feeding rates from different studies are hardly comparable because of the differential capability of observers to record items taken and swallowed by birds. Crude pecking rates are certainly more useful because pecks can be easily observed and recorded. On average, peck rates observed at Cuneo were half lower than those recorded at Kraghede (Møller 1983a and 1983b), suggesting feeding behaviour (and food availability) changes from area to area.

Flock sizes of Crows and Magpies were usually rather small indicating that most individuals were resident pairs. Rooks, vice-versa, formed flocks of several birds (up to 200) throughout the winter, migrating northwards at the end of March. Species in heterospecific flocks may interact aggressively. Previous studies showed the existence of a precise dominance hierarchy, the Carrion Crow being dominant over the Hooded Crow, the Rook and the Magpie, in the order (Bossema *et al.* 1976, 1986, Vines 1981, Waite 1984b, Eden 1987, Rolando and Giachello 1992, Saino and Scatizzi 1991, Saino 1992). In general, heterospecific flocking is rather uncommon and also Hooded and Carrion Crows tend to avoid each other (Saino 1992, Rolando and Laiolo 1994). Interspecific competition and dominance might reflect upon the structure and composition of heterospecific flock. In theory, interspecific interactions and dominance might explain why flocks of Hooded Crows and Rooks were significantly larger when in presence of the Carrion Crow and the Hooded Crow, respectively. It might be that, to cope with a dominant species, the subordinate one (i.e. the Hooded Crow with reference to the Carrion Crow and the Rook with reference to the Hooded Crow) try to aggregate in larger numbers. Interspecific interactions may significantly affect foraging behaviour of corvid species (Eden 1987, Rolando *et al.* 1997). Competition and dominance among species, however, were probably over-emphasized on other occasions. The mosaic distribution of the Hooded Crow and the Magpie observed in the eighties in the Padana Plain had suggested that predation or competition (or both) by Hooded Crows could limit Magpie distribution (Fasola and Brichetti 1983). However, recent surveys did not confirm such an hypothesis (Fasola *et al.* 1996). Analogously, the tendency of the Magpie to nest nearer to human settlements than the Crow where the two species coexist has been interpreted as a strategy to avoid or reduce nest predation (Baeyens 1981, Vines 1981, Fasola *et al.* 1988). However, an attempt to identify the environmental features controlling the distribution and the breeding density of the Hooded Crow and Magpie in areas of sintopy showed that habitat suitability is the major explicative factor, suggesting that competitive and predatory effects are largely overwhelmed (Saino and Meriggi 1990). On the other hand, assuming large flocks of Rooks feel dominated by 2-3 Hooded Crows and react by recruiting other Rooks does not make much sense.

The analysis of crude data shows that a few Hooded Crows and Carrion Crows were usually associated with the largest flocks of Rooks and Hooded Crows, respectively. Heterospecific flocking is usually avoided in small-medium size groups in corvids (Saino 1992, Rolando and Laiolo 1994). However, an interspecific aggregative effect could be exerted by the largest flocks. Large bird assemblages are easily detectable and can raise curiosity of the other corvids, which may be incited to join. Alternatively, a simple sampling effect could be hypothesized, assuming that the higher the number of individuals in a flock, the higher the probability that individuals of different species are seen in the flock. Accordingly, rather than to state that flock sizes of the Rook and the Hooded Crow were larger in presence of the Hooded Crow and the Carrion Crow, respectively, it would be more correct to state that the largest flocks of Rooks and Hooded Crows often contained Hooded Crows and Carrion Crows, respectively, because of aggregative and/or sampling effects. If this hypothesis is true, there is no indication that flock size is influenced by competitive interactions.

The decrease, although not significant, observed in flock sizes of the Rook and the Hooded Crow in the presence of the Magpie and of the Magpie in presence of the Rook, on the contrary, might depend upon the above quoted tendency of the Magpie to stay near human settlements, which, conversely, were usually avoided by the other species.

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Riassunto - Il comportamento alimentare e l'uso dell'habitat sono stati studiati nei corvidi (Gazza, Cornacchia nera, Cornacchia grigia, Corvo) svernanti in un'area vicino a Cuneo. Tutte le specie si alimentavano prevalentemente sui prati e sui campi di stoppie di mais. La differenza nell'uso degli habitat trofici non è risultata significativa solo tra Cornacchia nera e Cornacchia grigia. Le tecniche di alimentazione venivano usate opportunisticamente a seconda dell'habitat utilizzato. In ogni caso, la beccata superficiale è risultata essere la tecnica usata più spesso da tutte le specie, mentre lo scavo veniva adottato frequentemente solo dal Corvo. I tassi di alimentazione variavano a seconda dell'habitat. I Corvi si nutrivano più velocemente delle altre specie sui campi fertilizzati con letame e sui campi arati e livellati, mentre le Gazze erano le più lente sui campi di stoppie. La maggiore efficienza alimentare del Corvo veniva ottenuta grazie ad una maggiore frequenza di beccata e ad un frequente ricorso alle varie tecniche di alimentazione. Cornacchia grigia e Cornacchia nera non hanno mostrato differenze nei tassi di alimentazione. Sia l'uso dell'habitat sia il comportamento alimentare cambiava da area ad area, indicando così che l'ecologia trofica dei corvidi dipende prevalentemente dalle condizioni ecologiche locali. Gli stormi di Cornacchie nere e Corvi erano più numerosi in presenza rispettivamente di Cornacchie nere e Cornacchie grige. Questi dati vengono comunque interpretati senza invocare l'effetto della competizione interspecifica sulla dimensione dello stormo.

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