

MOSAIC DISTRIBUTION AND BREEDING HABITAT OF THE HOODED CROW *CORVUS CORONE CORNIX* AND THE MAGPIE *PICA PICA* IN PADANA PLAIN (NORTHERN ITALY)

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ABSTRACT. The density distribution and habitat use of breeding Crow and Magpie were studied over 12 900 km² of the plain, by winter roadside counts and observations on the nest sites of the preceding breeding season. The densities of the two species varied widely (from zero to 3.2 breeding pairs/km² in the Crow and from zero to 1.9 in the Magpie), despite the adaptability of the species and the uniformity of the habitat. The limits of the density zones did not coincide with any evident environmental change. The Crow and Magpie replaced one another both in their geographical distribution and in the local nest placing. The territories of the two species were statistically discriminated by habitat characteristics, of which the most important were the extension of poplar plantations, fields, Acacia woods and buildings. The two species were more segregated in habitat use in the areas of overlap than in areas of segregation, because the Magpie shifted in the use of the same 4 important habitat characteristics where it coexisted with the Crow. We conclude that competitive exploitation of similar resources, behavioural interference and predation on nests determine in the Crow and Magpie a mosaic distribution of contiguous territories in the areas of coexistence, the coexistence changing gradually into segregation in other zones. The prevalence of each species in different zones is determined by minor environmental characteristics of the uniform plain, such as prevailing cultivation. It is unclear how the sharp changes in density are determined in the apparently uniform plain and why both species are absent from a large zone.

KEY WORDS: breeding / census / competition / *Corvus corone cornix* / distribution / habitat / Italy / territory / *Pica pica* / population density.

Large ecological valency, high mobility and ample habitat availability promote a widespread presence of a species (Udvardy 1969). The Crow *Corvus corone* and Magpie *Pica pica* are adaptable in feeding behaviour and food choice, and breed in a variety of habitats from woods to open country and city parks (Sharrock 1976, Coombs 1978). Hence the distribution of these two species on the Padana plain, a relatively uniform and intensively cultivated landscape, may be expected to be uniform. However we noted marked differences in density of the Hooded Crow *Corvus corone cornix* and Magpie between zones of the plain.

Aim of this paper is to describe the breeding distribution and habitat use of the two species over a large zone of the plain, and to discuss the ecogeographic patterns observed.

The study was carried out by winter observations on the Crow's and Magpie's

nests of the preceeding breeding season; thus we recorded a large amount of data, which could not be obtained during the reproductive season when the nests are concealed by foliage. Some approximations in the density estimates and habitat records were probably caused by the time lapse between the winter observations and the actual nesting, as a qualitative drawback of a method which is quantitatively productive. Similar census techniques were previously used only by Pape Moller (1978) and on a limited scale by Spanò (1981). We described in detail the geographical density-distribution of the Crow and Magpie over a 12.900 km² zone. Little comparable information is available on other territorial birds, whose distribution is usually studied either qualitatively over large zones (e.i. in Atlas projects) or quantitatively in small sample plots.

STUDY AREA

The study area lies in the central part of the Padana plain in Northern Italy (Fig. 1) and is bounded at the North and at the South by the first hills of pre-Alpi and the pre-Appennini respectively. This area is a flat plain, gently sloping eastwards (the bed of the river Po is from 90 to 10 m above sea level); a slope is also noticeable from the North and from the South towards the Po (respectively from 260 and from 150 to 90 m on the West side of the study area). The major rivers run in wide shallow valleys. Only two small groups of hills (in the centre and in the N-E side of the area) raise 70-90 m above the level of the plain. This area is densely inhabited and intensively cultivated prevalently with wheat, maize, rice and poplar plantations. Different cultivations prevail in some parts of the plain, as will be described in the Results. The landscape is made of fields with trees isolated or in rows, small blocks of poplar plantations, small patches of wood, and farms; it is uniform over all the study area, except along some of the rivers, which are bordered by large woods.

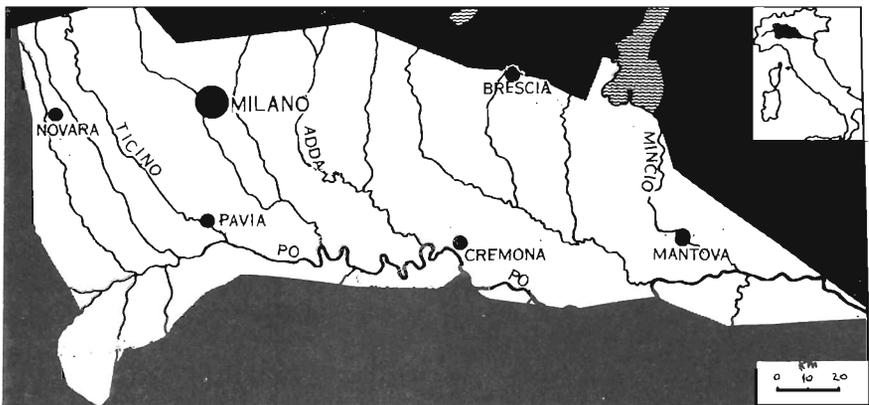


FIGURE 1. Study area (light) with the major rivers, lakes and cities.

METHODS

The distribution of nests and the nesting habitat were investigated by roadside censuses in autumn and winter (from 15 November to 15 February 1979/1980, 1980/1981, 1981/1982), when the nests built in the preceding breeding season were easily detectable on leafless trees. We censused the nests in the study area (Fig. 1) travelling along a grid of roads such that each itinerary was not further than 10 km from its neighbour (a total of 2830 km of roadside censuses).

Census of the nests

We drove along the itineraries, stopping every 0.5-1 km, and scanned the landscape with binoculars. We covered an average 15 km of roadside census per hour. All the nests identified within 300 m at both sides of the road were mapped on 1:100000 scale maps. The detectability of the nests was good because very few conifers were present. We mapped only one nest for each group of nests within 50 m of each other, assuming that all belonged to the same pair. The Magpie's nests were identified by 1) the presence of a dome or some twigs above the nest's rim; 2) higher ratio between height and width of the nest's cup than in the nests of the Crow; 3) placement on thinner branches.

An Index of the Number of Nests (no./km of road) was calculated for every 5 km of road. In order to obtain density-distribution maps, we divided these tracts into 5 classes of nest-density for each species and we bounded the tracts of each class in convex polygons. A distinct area was bounded when at least 5 tracts of the same density-class were adjacent; the boundaries between itineraries with different nest-densities were traced in the middle. No adjustment by eye was made to compact the areas, except in the case of class 0.1-0.5 nests/km of the Magpie in the central zone, where the nests were clearly associated with the small valleys of the rivers, and the boundaries were made to follow the valleys.

A test of this census technique (Fasola *et al.* 1983) was performed by counting the breeding pairs of the Crow and Magpie in spring, and taking roadside censuses during the following winter in the same sample plots. The correlation between the actual number of breeding pairs (P) and the Index of Number of Nests (IN) was good. Conversion factors ($P=1.6$ IN for the Crow and $P=0.8$ IN for the Magpie) allowed us to estimate the breeding densities from the winter census data, with an average error margin of 17% from the actual densities.

Nesting habitat description

During the roadside censuses, we recorded the site of 737 nests, and the habitat of the presumable territory around 370 nests. A random sampling of the nests was impracticable, so we selected all the nests which were clearly observable from the road. Thus we included more roadside and open landscape nests than random.

The presumable breeding territory (the home range to which all the activity of the breeding pair is confined during the nestling period) was postulated as a circle around the nest, with a 200 m radius for the Crow and 150 m for the Magpie. These postulated radii reflect the average data on territory size and nearest neighbour distance of the nests by Tompa (1975), Vines (1981), Pape Moller (1982), and of personal observations on a sample zone of our study area.

At each record we visually estimated the following variables.

For the nest site.

Nest: SPECIES (Crow, Magpie), HEIGHT (in m), PLACEMENT (near trunk, on primary branching, on secondary branching).

Nest's tree: SPECIES, (Poplar *Populus* sp., False Acacia *Robinia pseudoacacia*, Oak *Quercus* sp., Lombardy Poplar *Populus nigra italica*, Elm *Ulmus* sp., Plane *Platanus orientalis*, others). HEIGHT (in m), DISPERSION (isolated, in row, in patch of wood).

For the breeding home range.

Habitat: PERCENTAGE OF AREA covered by 13 habitat types (woods with prevailing Poplar, woods with prevailing False Acacia, mixed woods, poplar plantations, shrubs including vineyards and orchards with trees less than 5 m tall, natural grassland, fields, roads, buildings, water, railways, bare ground with stones or sand, sloping ground).

Distance: of the NEST FROM NEAREST ROAD AND BUILDING (in m).

Discriminant analysis

The discrimination of the Crow and Magpie based on the variables of the territory was studied using a statistical package (SPSS, Nie *et al.* 1975). Discriminant analysis weighs and combines the variables so that the species are as statistically distinct as possible. This is done by a discriminant function $D = d_1Z_1 + d_2Z_2 + \dots + d_nZ_n$ where D is the score on the function, the d 's are the weighting coefficients, and the Z 's are the standardized values of the 1, 2 ... n variables. Each coefficient represents the relative contribution of the variable to differentiation along the function.

A stepwise selection (Wilk's lambda) determined the variables to be included in the function. The significance of the inclusion of each variable was tested by the change in Rao's V . A discriminant score for each home range was computed by multiplying each variable by its coefficient and adding together the products. Each score is in standard form and represents the number of standard deviations by which the given home range varies from the mean of all ranges on the discriminant function. The average score of each species is the species' centroid, i.e. the central tendency of the cases along the discriminant function. The plot of the scores was assumed to show the breadth and overlap in habitat use by the two species. The likely species membership of each nesting home range was identified from the values of the given range on the discriminant variables (classification). The percentages of cases correctly classified were used to evaluate the separation of the two species. The F -statistic, a measure of the distance of the two species along the discriminant function, was interpreted as a test of the separation in habitat use.

RESULTS

Distribution

The Crow and Magpie showed highly variable densities over the plain (Fig. 2). The density zones were arranged in well connected strips or patches suggesting a response to some environmental gradient. Changes from high to medium and low density were gradual in most of the study area, but in some zones the Crow decreased sharply in the space of a few kilometres e.g. in the North-West and SW zones, similarly the Magpie in SW e NE. Both species were absent from a large northern strip of the study area. However the changes in density did not coincide with any clear ecotone nor with any major change in habitat or in the appearance of the

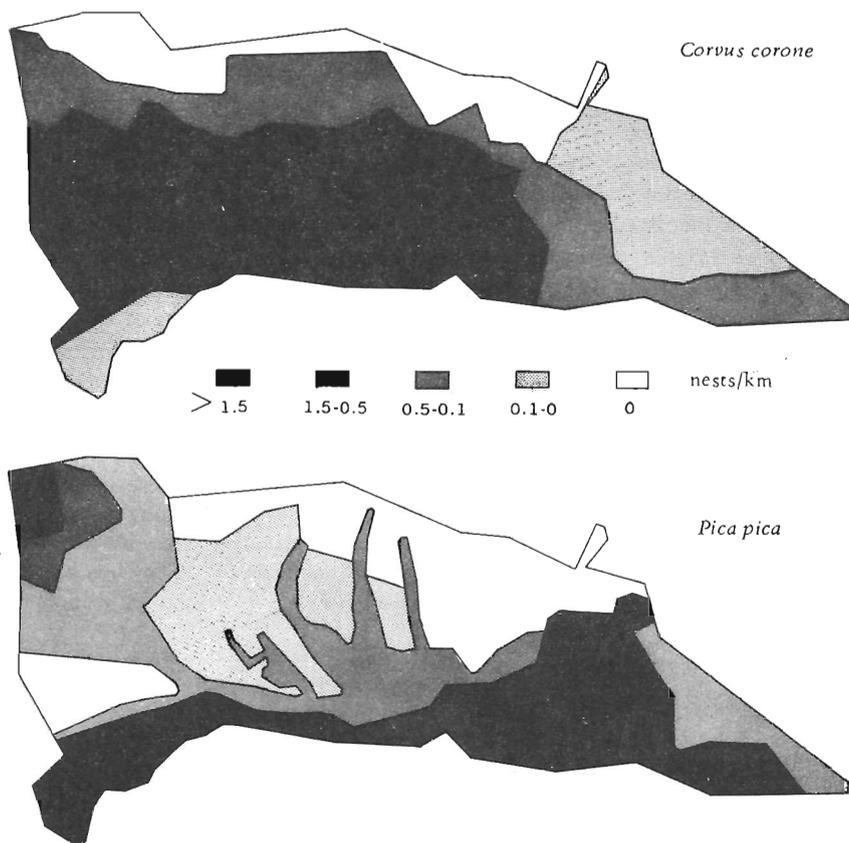


FIGURE 2. Distribution maps of the Crow and Magpie. Classes of nest-density recorded during roadside censuses.

landscape. Table I shows the average density of nests and the extension of each zone of Fig. 2. Using the conversion factors (1.6 for the Crow and 0.8 for the Magpie) we estimated an actual density of 3.2 breeding pairs of Crow/km² and 1.9 of Magpie in the zones of highest abundance; the average actual density over all the study area was 1.0 and 0.4 breeding pairs/km² respectively.

The peak densities of the Crow and Magpie covered different zones. Areas of segregation occurred in the North-West, SW and NE zones of the study area (Magpie only) and in the W and centre (Crow only), covering about one half of the study area (Fig. 2, Tab. I), and suggesting a mosaic pattern of replacement by the two species. This pattern was even more evident at local scale. For instance the few scattered nests of the Magpie in zones of high density of the Crow were often clumped in groups and were placed in patches lacking Crow's nests. In the areas of overlap the

territories of the two species were contiguous (pers. obs. on a sample area); the Magpie reacts territorially to the presence of Crows as if they too were Magpies (Ellemberg, pers. com. based on observations in Germany). The relations between the local densities of the Crow and Magpie are shown in Fig. 3. The parts of the tridimensional plot where observed frequencies are higher than expected, indicate that each species is abundant only where the other is scarce or absent. The lower frequencies in other parts show that both species avoid a common zone: the column with zero Crow and zero Magpie corresponds to the Northern zone where both are absent. In the centre of the plot the frequencies are low (most are zero), and none of the observed cases reach the diagonal line connecting the highest densities of the two species; this shows that the sum of the densities of the two species in areas of overlap is less than the density of each species in areas of segregation.

TABLE I. Average density of nests, extension of each density zone, and extension of the areas of overlap, segregation and absence of the Crow and Magpie over all the study area. We defined "areas of overlap" as those where nest-density was more than 0.1 for both species, and "areas of segregation" as those where the density was more than 0.1 for one species and less than 0.1 for the other.

	CLASSES OF NESTS DENSITY OF THE ZONES					ALL STUDY AREA (12.900 Km ²)
	0	0-0.1	0.1-0.5	0.5-1.5	1.5	
CROW						
Nests/km	0	0.09	0.26	0.76	1.97	0.72
Km ²	1581	1975	3446	3741	2157	
MAGPIE						
Nests/km	0	0.5	0.27	0.74	2.36	0.69
Km ²	2779	1877	3964	2832	1448	
AREA OF OVERLAP OF THE TWO SPECIES (km ²)						6138
AREA OF SEGREGATION (Km ²)						
Crow						3454
Magpie						2259
AREA OF ABSENCE OF BOTH SPECIES (km ²)						1049

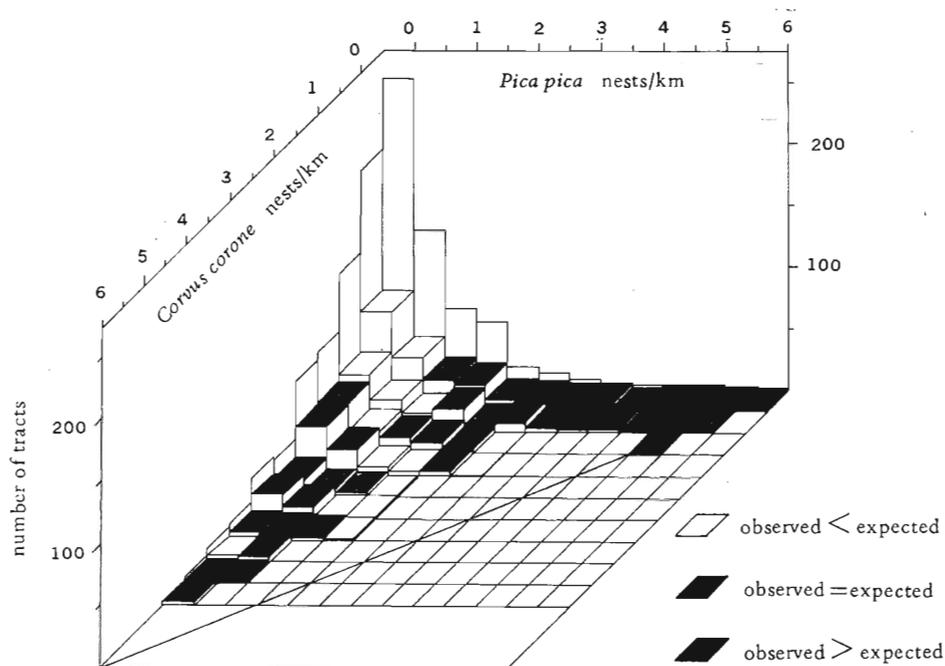


FIGURE 3. Frequencies of road tracts with different densities of nests of the Crow and Magpie. The frequency versus density plots for the two species are depicted on the vertical planes. The tridimensional plot in the middle shows the observed frequencies of tracts with given densities of both species. These frequencies are compared with a random (i.e. no inter-species interaction) expectation obtained by the products of the frequencies of the species.

Nesting habitat

The nest sites of the Crow and Magpie differed only in the species of the most common nest-tree (Tab. II). We found some variations in the nest site characteristics between zones, e.g. for the Magpie in the South, E and W zones the tree was a Poplar in 11% , 39% and 12% respectively of the nests, a False Acacia in 46, 5 and 73% , a Lombardy Poplar in 13, 25 and 5%. Consequently the average height of the nest was 11.8, 16.5 and 13.8 m respectively in these three zones. In both species, the differences were much wider between geographical zones than between areas of overlap and of segregation. These differences thus depended on the availability of different species of trees.

The territories of the Crow over all the study area comprised, on average, less wood, shrub, grass, buildings and sloping ground and more poplar plantations and fields than those of the Magpie; the nests of the Crow were more distant from roads and buildings (Tab. III). The characteristics of the territories differed between zones (Tab. III, with examples of two zones), so that it was difficult to separate the effects of geography from those of the coexistence of the species. However a comparison of the areas of segregation and of overlap showed that the characteristics of the territory were identical in both areas for the Crow, while the Magpie shifted in the use of Acacia woods, poplar plantations, fields and buildings where it coexisted with the Crow (Tab. III).

TABLE II. Average characteristics of the nest-site of the Crow and Magpie in all the study area. "Other" trees were *Alnus*, *Abies*, *Morus sp.* and indeterminate for the Crow; *Alnus*, *Salix*, *Pyrus*, *Carpinus*, *Tilia sp.* and indeterminate for the Magpie. Sample size was 301 nests (Crow) and 436 (Magpie).

	NEST'S TREE									NEST					
	Species (in %)		dispersion (in %)			height (in m)	placing (in %)		height (in m)						
	Poplar	False Acacia	Oak	Lombardy Poplar	Elm	Plane	Others	isolated	in rows	in patches	near trunk	primary branching	secondary branching		
CROW	83	3	3	1	5	2	2	22	50	28	18.3	60	32	8	14.9
											(range 5-30)				(range 5-23)
MAGPIE	39	21	4	20	4	6	6	25	49	26	17.3	62	31	7	15.3
											(range 4-27)				(range 3-22)

Discrimination by habitat

Discriminant analysis identified 8 of the 13 variables measured which statistically distinguish the home ranges of the Crow and Magpie (Tab. IV). The coefficients for all the study area were obviously intermediate between those for the areas of overlap and of segregation.

TABLE III . Average characteristics of the breeding territories of the Crow and Magpie

SPECIES AND ZONE	PERCENTAGE HOME RANGE WITH											DISTANCE (in m) OF NEST FROM NEAREST	
	Poplar woods	False Acacia woods	mixed woods	Poplar plantations	shrub	grass	fields	roads	buildings	water, railways, bare ground	sloping ground	road	building
CROW													
all study area	2.7	0.8	0.8	14.1	0.4	0.5	74.5	3.0	2.1	0.6	2.6	93.7	106.9
North zone	2.1	0.5	0.7	0.5	0.3	0.4	82.2	2.4	2.4	0.6	2.1	104.7	115.6
East zone	9.1	2.2	1.0	8.4	2.1	1.1	68.1	2.6	1.5	2.0	3.5	75.3	100.0
area of overlap	3.2	0.5	1.2	13.6	0.8	0.9	74.0	2.7	1.6	1.0	3.8	102.4	117.4
area of segregation	2.2	0.9	0.5	14.7	0.1	0.2	75.0	3.3	2.6	0.2	1.4	84.3	97.4
MAGPIE													
all study area	2.6	10.5	4.5	1.8	2.7	3.2	57.6	5.3	10.5	1.4	12.1	51.4	49.8
North zone	2.9	10.8	1.6	4.3	3.2	4.2	52.0	5.7	12.5	2.3	15.4	59.5	51.6
East zone	7.1	0	7.7	0.3	4.1	3.7	68.1	2.8	3.7	2.4	11.1	50.0	40.0
area of overlap	3.5	5.4	7.5	0.2	3.4	3.5	63.1	5.5	7.3	1.2	13.5	52.0	51.7
area of segregation	2.0	13.8	2.6	2.9	2.2	3.0	53.5	5.2	12.8	1.6	11.3	51.5	47.9

TABLE IV. Discrimination of the Crow and Magpie, based on the habitat of their breeding territories.

Standardized discriminant function coefficients and significance of the inclusion (+++ $P < 0.001$, ++ $P < 0.005$, + $0.1 < P < 0.2$) are shown for each characteristic. The degree of separation along the discriminant function is expressed by the distance between the centroids. The F-statistic is an index of the discriminating success of the function. The classification is based on the predictions of the discriminant function.

	ALL STUDY AREA	AREA OF OVERLAP	AREA OF SEGREGATION
POPLAR WOODS	0.214+++	0.171++	0.251+++
FALSE ACACIA WOODS	-0.254+++		-0.301+++
POPLAR PLANTATIONS	0.644+++	0.747+	0.687+++
SHRUBS	-0.078+		-0.161+
FIELDS	0.474+++	0.783+	0.365+++
ROADS		0.176++	-0.134+
BUILDINGS	-0.247+++	-0.150+	-0.194++
SLOPING GROUND	-0.189+++	-0.174++	-0.219++
CENTROIDS			
Crow	0.641	0.724	0.553
Magpie	-0.648	-0.631	-0.689
DIFFERENCE			
BETWEEN CENTROIDS	1.289	1.355	1.242
F			
(and degrees of freedom)	36.94 (7, 362)	27.83 (6, 197)	12.02 (8, 155)
TERRITORIES			
CORRECTLY CLASSIFIED (%)	80.8	81.9	78.1

The most important characteristics (those with higher coefficients) were poplar plantations, fields, woods and buildings. These are the same four characteristics in the use of which the Magpie shifted between areas of segregation and of overlap. The centroids were positive for the Crow and negative for the Magpie, and the species were well separated, as shown by the high values of F (Tab. IV) and of correct classification (Tab. IV).

The plot of the discriminant scores (Fig. 4) shows that the Crow is more selective, while the Magpie occupies a wider range of habitats. The two species overlap in 19% of the scores (the common area of their histograms). The frequency distributions seem to be truncated at the sides of overlap, suggesting a compression in breadth of habitat use due to inter-species competition.

A comparison of the areas of overlap and of segregation, may be based on the discriminating success of the respective functions (F values in Tab. IV), on the distance between centroids and on the percentages of territories correctly classifiable (Tab. IV). These comparisons confirm that the habitat use is slightly more separated in the area of overlap.

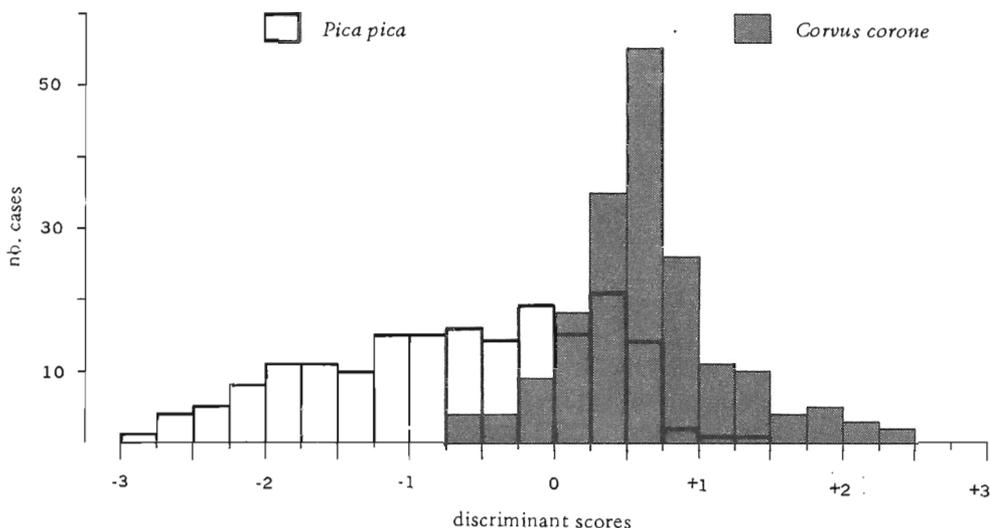


FIGURE 4. Frequency of the standardized discriminant scores of the Crow and Magpie, based on the breeding home range characteristics over all the study area.

Habitat and distribution

During the census surveys we hypothesized some relations between the distribution of the species and the general appearance of the landscape. In North-West and SW zones of the study area, high densities of Magpie coincided with the presence of patches of False Acacia woods, of grass, of well drained soils and limited strips of sloping ground. The same coincidence was found in the centre of the study area with abundant Crows, where the few and scattered Magpie's nests seemed to be again associated with patches of land showing the same characteristics, and to be preferentially placed near buildings. The Crow seemed to be associated with blocks of poplar plantations, or with open landscape with trees isolated or in rows.

However these associations did not hold over all the study area. High densities of Magpie in western zone occurred in open landscape which was by appearance very

similar to the East and centre zones where there were abundant Crows; the habitat in the North zone where both species were absent was not distinguishable from that of areas with high densities. Both species nested in parks and alleys of those towns in their respective high density zones, and the densities in the towns were similar to the densities in the surrounding zone. Thus the distribution of the two species was not fully explained by any visually noticeable habitat gradient. Attempts to correlate the densities with geological structure of the land and with soil lithology were unsuccessful. Some relations were found with prevailing cultivations. We calculated the percentage of land covered by 10 types of cultures (data from Istituto Centrale di Statistica, 1972) in each density-zone depicted in Fig. 2. In 5 types of culture, no relation was found (pastures, vegetable-gardens, grass-leys, woods, "others"); on the other hand the densities of the Crow and Magpie showed contrasting correlations with the other 5 cultures plotted in Fig. 5 (contrasting because those positive in one species were negative in the other species). The positive correlation for the Crow (and negative for the Magpie) with poplar plantations confirms the importance of this culture shown by its high coefficient in the discriminant function (Table IV).

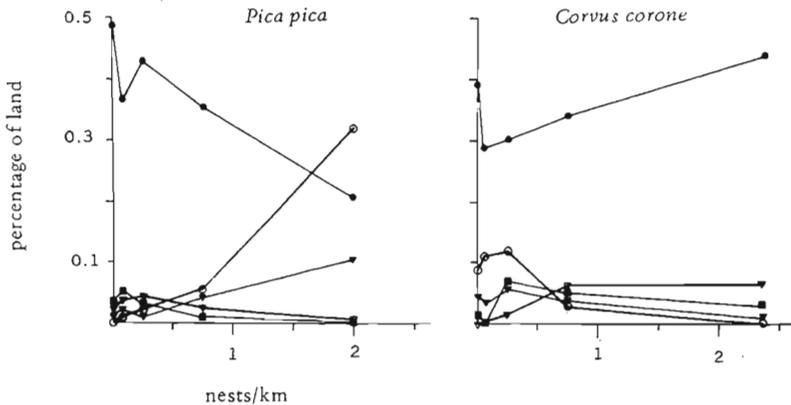


FIGURE 5. Density of nests and percentage of land covered by different types of cultures. ● cereals, ○ rice fields, ▲ poplar plantations, ■ vineyards and orchards, △ sugar beet.

DISCUSSION AND CONCLUSIONS

The distribution of animals is mainly determined by the environmental conditions to which each species is adapted and by inter-species competition. Coexisting species are always separated along some component of their ecological niches, e.g. time, food or space. Competition between species exploiting similar niches may act as competitive exploitation of common resources, and as behavioural interference, this latter preventing exploitation (Mac Arthur 1972, Partridge 1978, Cox & Moore 1980).

Competition between two species may lead to contiguous home ranges and habitat restriction when sympatry is maintained, or to segregated geographical distribution (Pianka 1976, Dienske 1979).

The Crow and Magpie are possible competitors due to their wide overlap in use of resources, but may be separated by minor preferences. The food of the two species is similar (Holyoak 1968). However the Magpie feeds closer to thick vegetation and rough grass and spends more time on marginal lands and hedgerows (Holyoak 1974, Coombs 1978); the Magpie places its nest closer to the buildings while the Crow avoids human presence (Baeyens 1981, Vines 1981, Schifferli & Fuchs 1981, Pape Moller 1981, 1982). The Crow preys on the eggs of the Magpie in various countries (Baeyens 1981, Vines 1981, Pape Moller 1982); this predation must be frequent in our study area too, as we observed two such instances of predation on Magpie's nests during a few hours of observation. The Crow dominates the Magpie in the exploitation of a variety of resources by intense behavioural competition (Vines 1981). It was suggested that the Magpie breeds near buildings in order to avoid nest predation by the Crow, and that the presence of Crows may exclude breeding Magpies from a zone (Baeyens 1981). Therefore the predation and the dominance of the Crow over the Magpie should leave no "free" habitat choice to the Magpie in zones of coexistence.

In our study area the Crow and Magpie showed a mosaic distribution of contiguous territories with slight habitat displacement in the areas of overlap, changing gradually into segregation in other areas. This complementary distribution of the two species may be determined by their interactions both in competitive exploitation of common resources and in behavioural and predatory interference. The habitat available in the cultivated plain is simple in structure, so that the possible habitat displacement between the two species is insufficient to allow coexistence. The Crow dominates the Magpie and causes it to restrict habitat use. However the Magpie must be a superior competitor in the exploitation of those large zones of the plain where it is the sole species. The prevalence of each species in different zones may be determined by a balance of competitive abilities, which are enhanced by minor environmental characteristics of the uniform plain, possibly the prevailing cultivations or some other factor associated with the cultivation types.

Terborgh (1971) schematically argues that :

- 1) an environmental gradient determines a gradual change in population density;
- 2) competitive exclusion decreases sharply the densities of the competing species by repulsion interaction;
- 3) the presence of an ecotone truncates the densities. Each of the above three models could be applied to some parts of the distribution of the Crow and Magpie (Fig. 2). Competitive exclusion could account for the sharp decrease of the Crow and Magpie in the NW and SW zones. In the central and N zones the Crow decreases gradually as if along a gradient. In the NE zone the density of the Magpie is truncated, although no ecotone is noticeable.

It is however unclear how the sharp differences in breeding densities are determined in the apparently uniform plain. Some "invisible" environmental factors may be

the determinants, for instance the abundance of some particular type of food could be influenced by land productivity; this factor determines the densities of Sparrow-hawks *Accipiter nisus* in England (Newton *et al.* 1977). It is also unclear why both species are absent from a large zone of the plain. The absence coincides largely with the countries around Brescia and Bergamo (North-East and N zones of the study area) where hunting is much more intense than elsewhere and where decoys and concealed shooting huts are widely used. Therefore hunting could partially account for the absence of both species from these zones. Human persecution influences the distribution of the Corvidae (Sharrock 1976, Coombs 1978), although the influence is only local or apparent (Pape Moller 1978, Fjeldsa 1981).

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RIASSUNTO

DISTRIBUZIONE E AMBIENTI DI NIDIFICAZIONE DI CORNACCHIA *CORVUS* CORONE *CORNIX* E GAZZA *PICA PICA* NELLA PIANURA PADANA

- Le densità di nidificazione di Cornacchia e Gazza sono state studiate in dettaglio su un'area di 12.900 km² (Fig. 1) mediante conteggio invernale standardizzato dei nidi della primavera precedente, lungo una rete di itinerari di osservazione. Sono state inoltre registrate variabili descrittive della situazione dei nidi e dell'ambiente nei territori di nidificazione.
- Le marcate variazioni di densità delle due specie nella pianura (Fig. 2, Tab. I) non coincidono con alcun evidente cambiamento ambientale. Ogni specie è abbondante solo dove l'altra è assente (Fig. 3).
- La Gazza ha ambienti più vari intorno ai nidi, e le due specie si sovrappongono in parte nell'uso dell'ambiente (Fig. 4).
- Esistono differenze significative tra le due specie, negli alberi usati per il nido (Tab. II) e nel tipo di ambienti inclusi nei territori di nidificazione (Tab. III); nelle zone in cui coesiste con la Cornacchia, la Gazza è più limitata nell'uso di alcuni ambienti (Tab. III, IV).
- Cornacchia e Gazza si rimpiazzano a mosaico, sia localmente mantenendo territori contigui, sia geograficamente con distribuzioni di densità complementari.
- La distribuzione complementare delle due specie è determinata dalla loro competizione, la Cornacchia è dominante nelle interazioni comportamentali e come predatore dei nidi della Gazza stessa, mentre la Gazza sembra prevalere in altre zone della pianura.
- La prevalenza di una specie sull'altra nelle varie zone è probabilmente decisa da minori caratteristiche dell'ambiente uniforme della pianura, ad esempio dalle coltivazioni prevalenti nella zona (Fig. 5).

— Rimane non spiegato quale sia il fattore che determina le forti variazioni di densità, e quale sia la causa dell'assenza di entrambe le specie nella fascia Nord dell'area di studio. L'intensa caccia da appostamenti in tale fascia (pianura bergamasca e bresciana) potrebbe essere un fattore limitante "invisibile".

FIG. 1. Area di studio (in chiaro).

FIG. 2. Distribuzione di densità delle due specie, in 5 classi di no. nidi/km di itinerario.

FIG. 3. Frequenza di zone a diversa densità di nidi di Cornacchia e Gazza. Le frequenze delle specie sono raffigurate nei due piani verticali. Il disegno tridimensionale al centro mostra la frequenza delle zone con una data densità delle due specie insieme. Bianco, frequenza osservata minore che a caso. Grigio, osservata = a caso. Nero, osservata maggiore che a caso.

FIG. 4. Frequenze di punteggi dell'analisi discriminante basata sulle caratteristiche ambientali dei territori.

FIG. 5. Relazione tra densità dei nidi e alcune colture prevalenti nella zona.

TAB. I. Densità media dei nidi ed estensione di ogni zona, ed estensione totale delle zone di sovrapposizione, segregazione e assenza delle due specie.

TAB. II. Caratteristiche del sito di nidificazione.

TAB. III. Caratteristiche ambientali dei territori intorno ai nidi.

TAB. IV. Coefficienti della funzione discriminante basata sulle caratteristiche dei territori.

RESUME'

DISTRIBUTION ET HABITAT DE NIDIFICATION DE LA CORNEILLE MANTELEE *CORVUS CORONE CORNIX* ET DE LA PIE BAVARDE *PICA* *PICA* DANS LA PLAINE DU PO (ITALIE DU NORD)

— La distribution des nids de la Corneille et de la Pie a été étudiée en détail dans une zone de 12900 km² (Fig. 1) par recensement pendant l'hiver des nids du printemps précédent. Des variables de l'emplacement des nids et de l'habitat des territoires ont été enregistrées.

— Les marquées différences de densité des deux espèces dans la plaine (Fig. 2, Tab. I) ne coïncident avec aucun changement clairement visible du milieu. Chaque espèce est abondante seulement où l'autre est absente (Fig. 3).

— L'habitat autour les nids de la Pie est plus varié, et les deux espèces se superposent partiellement dans l'utilisation de l'habitat (Fig. 4).

— On a trouvé des différences significatives entre les arbres où les nids des deux espèces sont placés (Tab. II), et entre les habitats de leurs territoires de nidification (Tab. III). Dans les zones de coexistence avec la Corneille, la Pie est plus limitée dans l'utilisation de quelques types d'habitat (Tab. III, IV).

— La Corneille et la Pie se remplacent soit localement en maintenant des territoires contigus, soit à niveau régional avec des distributions de densité complémentaires.

— La distribution complémentaire des deux espèces est due à leur compétition. La Corneille domine la Pie et pille ses nids, mais la Pie l'emporte dans de grandes zones de la plaine. Une espèce l'emporte sur l'autre probablement grâce à des moindres facteurs de l'uniforme milieu de la plaine; les cultivations plus répandues semblent avoir une certaine influence (Fig. 5).

— On ignore quel est le facteur qui détermine les marquées différences de densité, et pourquoi les deux espèces sont absentes de la partie Nord de la plaine. La chasse, particulièrement intense dans la zone Nord, pourrait être un facteur "invisible".

FIG. 1. Zone d'étude (en claire).

FIG. 2. Densité de nidification des deux espèces, en 5 classes de no. nids/km de route.

FIG. 3. Fréquence de zones à différentes densités de nids. La fréquence pour chaque espèce est représenté dans chaque plan. Le dessin tridimensionnel au centre représente les fréquences de zones avec des densités données des deux espèces ensemble. Blanc, fréquences observées < qu'au hasard. Gris, observées = au hasard. Noir, observées > qu'au hasard.

FIG. 4. Fréquences de scores de l'analyse discriminante des habitats dans les territoires.

FIG. 5. Relations entre densité des nids et quelques cultivations dans les différentes zones de la plaine.

TAB. I. Densité moyenne de nids et extension de chaque zone, et extension totale des zones de superposition, ségrégation et absence des deux espèces.

TAB. II. Caractéristiques des emplacements des nids.

TAB. III. Caractéristiques de l'habitat dans les territoires de nidification.

TAB. IV. Coefficients de la fonction discriminante des caractéristiques des territoires.

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