

Umbrella pine seeds selection by Hooded Crow, *Corvus corone cornix*

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Abstract — Probably the Hooded Crow selects longer and heavier pine-seeds to obtain bigger endosperms or to select the full pine-seeds. The old valve absence among the pine-seeds opened by the Hooded Crow also confirms the latter hypothesis. Smaller pine-seeds having a more elongated shape are opened on anvils, maybe because they are more difficult to break open, but the different techniques used to open pine-seeds on the ground and anvils still need further study.

Introduction

Various species of Corvids as Hooded Crow, adapt very easily as far as food is concerned (Goodwin 1976, Coombs 1978). Some of these species feed also on pine-seeds; because of this kind of feeding, they have acquired certain specific behaviour patterns (see Tomback and Linhart 1990). For example, Vander Wall and Balda (1977) have observed that Clark's Nutcrackers select more productive pines and cones with a greater number of seeds, and Vander Wall (1988) observed that this species, to obtain maximum energy gain, carries out a selection according to the season, both on open and closed cones and among the various species of pines.

We observed Hooded Crows feeding on pine-seeds using tree roots as anvils. The birds would take the seeds into their bills, carry them to a root of pine tree, jutting out from the ground, hold them with their feet and open them with a series of blows with their bills along the cleft of the valve. This behaviour is not too far from the cases of true tool use observed in the Hooded Crow (Rolando and Zunino 1992) and in other Corvids (James 1976, Montevecchi 1978, Beck 1980, Boswall 1985).

The first aim of this work is to investigate possible preferences that the Hooded Crow shows feeding on pine seeds of Umbrella pine *Pinus pinea*. Moreover, this study aims at investigating differences of size between the pine seeds opened by the Hooded Crow on the anvils and those opened on the ground.

Methods

The study area was an Umbrella Pine wood with an

extension of 1.6 ha within the park of Villa Pamphili (Rome) (41°53'N, 12°27'E) (Battisti 1986, Manganaro *et al.* 1990). The trees have an average diameter of 70 cm and are arranged in rows: in each row, the average distance between the trees is 9.3 m, the average height of the trees is 20 m, and the average density 87 trees per ha. There is no underwood.

As to the analysis of Hooded Crow feeding, we have identified three categories of pine seeds:

a) "control sample": 1,019 pine-seeds collected on 30th September 1988 and 7th October 1988 along a 700 m transect considering the homogeneity of the study area vegetation, the average size of these pine-seeds should be the same as in the study area. The seeds fall in summer (Gellini 1973) and consequently these are the ones available for the rest of the season.
b) "ground": 560 pine-seeds collected on the same transect on 15th December 1988 opened by Hooded Crows on the ground with the technique carried out on the anvil.

c) "anvil": 501 pine-seeds collected on the same transect on the 15 December 1988 opened by Hooded Crows on the anvil.

The pine-seeds opened by Hooded Crows are easily identifiable because they are split exactly into two valves; furthermore, they are found in clusters either on the "ground" or on the "anvils", which, in the study area, were only roots of Umbrella Pine jutting out from the ground.

We measured the length and width of the valva of pine-seeds with a 0.05 mm precision gauge; the weight with a 0.01 g precision balance. We also formulated an index in order to calculate the shape of the pine-seeds: $\text{form} = 100 \times \text{length}/\text{width}$.

The pine-seeds with a more rounded shape have values close to 100.

From June 1984 to June 1986 fortnightly visits (3-5 hours long) to the environments of Villa Pamphili urban park were carried out in the following years, autumnal visits (6 in 1986, 4 in 1987) to the park were carried out during the latter period, feeding Hooded Crows in the study pine wood were observed for at least 30 consecutive minutes. For statistical analysis of the data we used the z test and linear correlation.

Results

During the study period pine-seeds were a very important autumnal food element for the Hooded Crow of Villa Pamphili urban park; in this season the only feeding Hooded Crows (10-20 individuals) were generally observed in the morning in the study pine wood. In this area the Crows almost exclusively took pine seeds (e.g. 86% of 218 observed cases during the visits in 1986). In the afternoon some individuals (2-3) feeding on pine-seeds are sometimes noticed in other small pine woods.

The seeds of the control sample were significantly lighter and, to a minor extent, shorter if compared

to the seeds opened by the Hooded Crows, both on the ground and on the anvils (Tab. 1 and 2).

The linear correlations between weight ($r = 0.70$, d.f. 251, $p < 0.001$) or length ($r = 0.61$, d.f. 251, $p < 0.001$) of the valve and the weight of the endosperm were highly significant.

Pine-seeds collected on the ground were wider, rounder and heavier than those opened on anvils, as shown in Tables 1 and 2.

Discussion

The period when the Hooded Crow collects the greatest number of pine-seeds, is also that of maximum availability of the Umbrella Pine seeds in the Mediterranean area (Gellini 1973). This trend is similar to the one observed in America for other species of pine trees (*Pinus flexilis* and *P. monophylla*) whose seeds also have greater energetic contents towards the end of summer (Vander Wall 1988).

The Hooded Crow might prefer heavier and longer pine-seeds to obtain larger contents or/and select full pine-seeds. An observation confirming the selection

Table 1. Mean and S.D. for length, breadth, weight and shape for three considered categories i.e. "control sample", "ground" and "anvil". (Sample sizes are shown in parentheses).

	Length	Breadth	Weight	Shape
"Control sample" (n = 1019)	18.72 ± 1.52	9.12 ± 0.93	0.29 ± 0.08	205.8 ± 20.7
"Ground" (n = 560)	18.97 ± 1.40	9.20 ± 0.85	0.35 ± 0.06	207.4 ± 18.2
"Anvil" (N = 501)	18.91 ± 1.29	8.93 ± 0.88	0.33 ± 0.07	212.4 ± 22.2

Table 2. Statistical significance (z test) of comparison, for the mean length, breadth, weight and shape of the valves between: 'control sample' and 'ground', 'control sample' and 'anvil', 'ground' and 'anvil'. (Sample sizes in Tab. 1).

Comparisons	z test	Significance
Length:		
Control sample - ground	2.17	$p < 0.05$
Control sample - anvil	2.55	$p < 0.05$
Ground - Anvil	0.11	N.S.
Breadth:		
Control sample - ground	1.74	N.S.
Control sample - anvil	3.87	$p < 0.01$
Ground - Anvil	5.08	$p < 0.01$
Weight:		
Control sample - ground	16.03	$p < 0.01$
Control sample - anvil	9.74	$p < 0.01$
Ground - anvil	4.83	$p < 0.01$
Shape:		
Control sample - ground	1.59	N.S.
Control sample - anvil	5.56	$p < 0.01$
Ground - Anvil	3.98	$p < 0.01$

of full pine-seeds by the Crows was that no old valves (that is valves uncoloured and with old timber typical of empty pine-seeds) were found among opened pine-seeds. Ligon and Martin (1974) observed that Piñon Jay *Gymnorhinus cyanocephalus* learns to recognize good pine-seeds, i.e. those containing edible endosperm, on the basis of visual, auditory and tactile stimuli.

However, the behaviour of bill clicking (a rapid opening and closing of mandibles on the seed) used by the Piñon Jay to identify full pine-seeds (Ligon and Martin 1974) and by Clark's Nutcracker to decide which technique to adopt in order to open the pine seeds (Vander Wall 1988), was not observed in the Hooded Crow. On the other hand pine-seeds are not a usual food for this species (Goodwin 1976, Coombs 1978) but are of great importance in the feeding habits of Clark's Nutcracker (Vander Wall 1988) and the Piñon Jay (Balda and Bateman 1971, Ligon 1971), to such a point that the latter species may be genetically programmed to learn the means of identification of full pine-seeds (Ligon and Martin 1974).

As to the observed differences in shape and size between the pine-seeds collected on the ground and those on anvils, it is possible that on anvils the Crows break the pine seeds that are most difficult to open, more quickly, whereas on the ground it may be more convenient to open heavier and larger pine-seeds which are more likely to contain a larger endosperm; a seed is advantageous when it requires a short time to handle (Hespenheide 1966, Wilson 1971, 1972, Grant 1981).

Consequently it is also possible that smaller pine-seeds are not selected because they are difficult to open. Scott Johnson et al. (1987) observed that there are individual differences in Clark's Nutcracker as concerns the choice of the best technique to adopt in order to open the pine-seeds; these two techniques require a different amount of time and are used according to the kind of pine-seeds selected; in particular, to open wider pine-seeds with a thicker outer layer, this species uses the technique described above for the Hooded Crow.

However, more detailed observations are required concerning techniques used by the Hooded Crow to open pine-seeds on the ground and anvil, and, in particular, the time required, the number of bill blows and the success in finding endosperm.

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Riassunto — Sono stati analizzati alcuni aspetti dell'alimentazione su pinoli da parte della Cornacchia grigia, *Corvus*

corone cornix, nel parco urbano di Villa Pamphili (Roma). Nel periodo autunnale i pinoli costituiscono per la specie un importante fonte alimentare. La Cornacchia grigia apre i pinoli sia sul terreno che su "incudini" naturali che nell'area studiata sono le radici emergenti dal terreno del Pino domestico *Pinus pinea*.

La Cornacchia grigia seleziona sia su incudine che sul terreno pinoli più lunghi e pesanti rispetto ad un campione di controllo, mentre pinoli meno rotondeggianti e meno larghi vengono aperti preferibilmente su incudine rispetto al terreno, forse a causa della loro maggiore difficoltà di apertura. Ulteriori studi sono necessari per approfondire le tecniche usate dalla Cornacchia grigia per aprire i pinoli sul terreno e su incudine.

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