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Temporary shift of body size in hooded crows *Corvus corone cornix* of NW Italy

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A b s t r a c t . Unusual climatic events are known to influence micro-evolutionary changes in birds through selection and directional evolution of body size. In NW Italy a notable climatic episode occurred from 1984–85 to 1986–87 when the winters were unusually severe. In the periods 1986–88 and 1997–2000 we measured the body size and mass of 808 adult hooded crows. Body size measurements of specimens collected from the same area but in two other periods (1950 and 1974) were also considered for comparison. In the 1986–88 sample (just after the unusual climatic period), there was a significant shift of body size, with a greater tarsus length than in the other three periods; body mass was also higher than in 1997–2000. The peak in tarsus length and body mass is discussed with regard to the severe weather in the winter which could have acted as a strong directional selective factor, favouring bigger birds, or may have prompted irruptive movements of Northern larger crows.

Key words: body size fluctuation, severe climate, hooded crow, *Corvus corone cornix*

Introduction

Natural selection can cause a rapid adjustment of morphology in response to climatic (environmental) events (V i t t et al. 1997). In birds, micro-evolutionary processes operating through the differential survival and reproduction of individuals can cause substantial directional evolution of body size (P r i c e & G r a n t 1984). The best documented study showing directional size variations is the well known long-term study on Darwin finches *Geospiza fortis* by G r a n t & G r a n t (1989). They showed that bill size was subjected to strong selection pressure in relation to climatic conditions on the Galapagos Islands. Evolutionary changes in body size have been reported in several other bird studies. Body size decreases have been described in geese (R e e d & P l a n t e 1997, L a r s s o n et al. 1998, C o o c h et al. 1991), gulls (R u i z et al. 1998) and sand martins *Riparia riparia* (B r y a n t & J o n e s 1995). These studies showed a general relationship between worsened climatic conditions and the evolution of size, even though size changes can also be density-dependent (R u i z et al. 1998).

Size shifts in a population can often be related to sudden climatic events (cold, storms, etc.) that act as strong selective factors. In temperate areas, a short but severe period of freezing can cause differential mortality in favour of bigger individuals (D a v i d s o n & C l a r k 1985, C é z i l l y et al. 1996, B r o w n & B r o w n 1998, B r o w n & B r o w n 1999). In these cases the proximate cause of death is likely hypothermia; for allometric reasons it is supposed that bigger individuals have a higher probability of survival, since

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large body size confers a thermal advantage (heat retention) and the benefit of greater fat storage (James 1970, Kendeight 1969, Calder 1974).

The object of our study, the hooded crow *Corvus corone cornix*, is a polytypic cosmopolitan species which is essentially sedentary (Cramp 1994) and particularly abundant in agricultural areas of NW Italy. In this area a rare climatic event occurred in 1984–85 and 1985–86 when the winters were unusually severe. This episode involved conditions far beyond the normal environmental extremes and provided an opportunity for natural selection.

The aim of our study was to examine body size variations from 1950 to 2000, with the idea that climatic events during the half century could have influenced the morphological traits of our species model.

Study Area

The study was carried out in the province of Alessandria, NW Italy (44°46' N; 8°40' E). The climate in the study area is temperate continental (Mennella 1967). Climatological data from December 1784 to December 2002 were taken from a long-term meteorological station in Torino, about 70 km west of the centre of the study area. This site recorded daily high and low temperatures, and the amount of precipitation in the last 219 years. We searched the climatological data set for the occurrence of unusually intense snowfalls and prolonged low temperatures in winter. The return-time of the extreme snowfall events was evaluated on an updated dataset, based on the values reported in Leporati & Mercalli (1993). Temperature extremes were examined considering an updated dataset based on Cortemiglia (1999).

Materials and Methods

In total, 826 adult hooded crows were examined. Individuals were caught in four periods: 1950 (n = 9), 1973 (n = 9), 1986–88 (n = 637) and 1997–2000 (n = 171). Most crows were caught with Larsen traps as part of an agricultural pest management program. Larsen traps were placed mainly in two nearby localities (Novi and Castellazzo) of the Alessandria plain intensively cultivated with maize. Captures occurred in the morning, from 6 a.m. to 10 a.m., in the months of April and May.

Hooded crows differ in size in relation to sex and age (Acquarone et al. 2000, 2002). Thus we analysed adult males and females separately, while 1625 young individuals were not considered for the analysis. Sex was determined by gonadal examination and age by examining the upper mandible and plumage colours (Svensson 1992). We measured wing length (with the flattened wing outstretched perpendicular to the body) and tail length to the nearest 0.5 mm, while tarsus and bill lengths were measured with a calliper to the nearest 0.1 mm. Body mass was measured in the morning the capture day with a 1 g accuracy. One author (F.S.) performed all measurements in 1986–88, while M.C. took the measurements of birds caught in 1950, 1974 and 1997–2000. As the individuals of 1950 and 1974 were skin preserved, their fresh mass values could not be assessed and used for the statistical analysis. The two authors did not differ in duplicate measurements made in a sample of 28 individuals in 1997; measurements taken blind with respect to what the other person had measured; repeatability analyses, using intraclass correlation (Zar 1999): wing length: $r = 0.977$, $P < 0.001$; tail length: $r = 0.944$, $P < 0.001$; tarsus length: $r = 0.88$, $P < 0.01$; bill length $r = 0.91$, $P < 0.001$).

Results

Figure 1 summarizes the morphological differences among years for tarsus length and body mass. There were significant among-year differences in mean tarsus length (ANOVA for females: $F_{8,578} = 192.5$, $P < 0.001$; males: $F_{8,237} = 162.6$, $P < 0.001$) and the variation has a clear pattern: the highest values were in the 1986–88 period, while birds measured before and after were significantly smaller. The mean values in 1986–88 were about 18.2% higher than those of the other periods (mean 66.9 *vs*. 56.3 mm in females, and 69.7 vs. 59.3 mm in males).

The body mass of the 1986–88 individuals was significantly higher than those measured in 1997–2000 (ANOVA for females: $F_{8,578} = 28.8$, $P < 0.001$; males: $F_{8,237} = 11.4$, $P < 0.001$). The percentage difference between 1986–88 and 1997–2000 was about 12.3%, with lighter birds in the latter period (mean 461.9 vs. 386.2 g in females, and 462.6 vs. 440.2 g in males).

The wing, bill and tail measurements did not show a clear pattern of variation in the study period. Although there were significant among-year differences for all three parameters (Table 1), the mean annual values of the parameters did not vary in a consistent manner. Indeed, most of the variability in tail and wing length was due to low values in 1999, while a considerably longer bill length was found in 2000. Moreover, the magnitude of year-to-year differences was small, representing only about 0.7% of the average wing length, 0.3% for the tail and 1.3% for the bill.

An analysis of the climatic dataset showed that snowfalls in 1985 (January 16: 49 cm), 1986 (January 31: 55 cm), and 1987 (January 16: 67 cm) were among the 19 most extreme

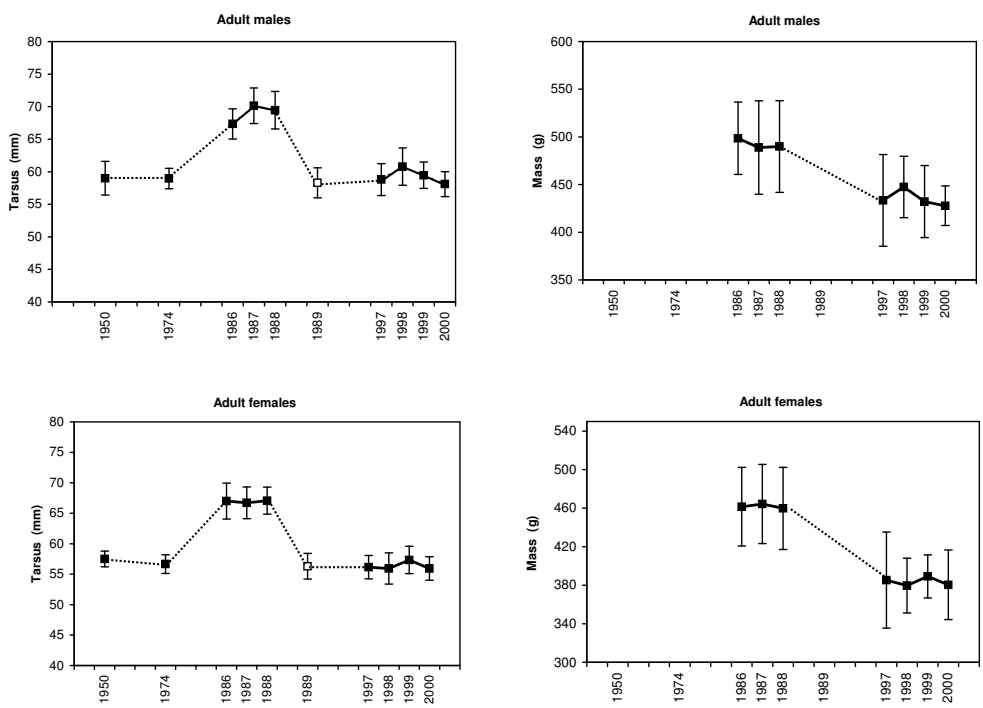

Fig. 1. Variation of body mass and tarsus length of adult hooded crows captured in NW Italy from 1950 to 2000 (mean ± SD; black squares: data collected by authors; open squares: data from S a i n o & S c a t i z z i 1991 are shown for comparison).

values recorded along the 219 years from 1784 to 2003. Moreover, there were only three other cases of two consecutive winters with heavy snowfall (more than 40 cm in 1784 and 1785, 1863 and 1864, 1875 and 1876), and no other cases of three consecutive winters with such a high snowfall. Comparison with Fig. 1 suggests that the observed increase in tarsus length and body mass followed the extremely abundant snowfall in the winters from 1984–85 to 1986–87. We did not detect a similar exceptional series of extreme values when examining the temperature values. Indeed, even if the mean temperature of January 1985 was quite low (-0.9 °C), there where other 55 cases out of 219 with such a low temperature.

Table 1. Summary of hooded crow biometry, and ANOVA statistical comparison of values observed in the 1950, 1974, 1986, 1987, 1988, 1997, 1998, 1999 and 2000.

Variables	Mean ± SD (n)	F	P
Adult females			
Wing length	304.1 ± 9.87 (574)	7.65	<0.001
Bill length	51.7 ± 2.08 (573)	5.68	<0.001
Tail length	175.7 ± 6.43 (568)	3.33	<0.001
Adult males			
Wing length	316.7 ± 12.9 (237)	9.7	<0.001
Bill length	55.5 ± 2.54 (238)	5.3	<0.001
Tail length	182.6 ± 8.37 (231)	2.4	<0.02

Discussion

Our study reports a significant shift of body mass and tarsus length in hooded crows measured in 1986–88 with respect to those from 1950, 1974 and 1997–2000. In the more intensely monitored periods (1986–87 vs. 1997–2000), body mass shifted by 18% and tarsus length by 12% in a 14-year interval. Other morphological parameters (tail, wing, bill lengths) showed fluctuations around 1%, without a clear pattern. A decline in body mass over decades has been reported in non-passerine species, for example in geese (Reed & Plante 1997, Cooch et al. 1991, Larsson et al. 1998) and gulls (Ruiz et al. 2001). The decline we observed is comparable to that reported for geese (16% mass, 6% tarsus in 17 years: Cooch et al. 1991; 9% mass, 4% tarsus in 19 years: Reed & Plante 1997).

In micro-evolutionary studies of geese and gulls, the body mass decrease has been attributed mainly to biotic changes: in particular, very sharp population increases frequently cause a noticeable decline in food availability (Sedinger et al. 1998, Cooch et al. 1991) so that the growth of chicks and young birds is impaired. However, we believe that the decrease in mass and tarsus length we observed in recent years was not related to a strong increase in population density in the agricultural plains of our study area. In NW Italy an increase in crow density probably occurred in the 1960's, following changes in the landscape due to intensive agriculture. The species was very abundant both in 1986–88 and 1997–2000 (Mingozzi et al. 1988, Cucco et al. 1996, Acquarone et al. 2002). In fact, local game and fauna administrations started to cull hooded crows in the early 1980's because of their high densities.

Since crows can move erratically when there is a food shortage (Cramp 1994), one possible explanation of the temporary shift of body size is that northern European individuals (on average bigger than Italian ones) migrated into southern areas during the intensely cold

and snowy winters. Such medium-long movements have not yet been described in carrion crows, while short movements are known only for Scandinavian populations (C r a m p 1994). However, the winters where so unusual that may have lead to unusual bird movements that normally are not seen.

As an alternative hypothesis, the greater body size in 1986–88 could be related to a directional selection event (G r a n t & G r a n t 1989) caused by the unusual climatic episodes of the winters 1984–85 to 1986–87. Support for this hypothesis comes from the fact that the two samples of hooded crows collected in the same area in 1950 and 1973–74 had the same tarsus length as those caught in 1997–2000 (all of the crows being significantly smaller than in 1986–88). It is well documented that the winter of 1984–85 was extremely severe in continental Europe, causing very high mortality in many bird species (C é z i l l y et al. 2001, D a v i d s o n et al. 1986). It is conceivable that such a selective force acted on very few generations. Mortality was presumably caused by exhaustion of the fat reserve and starvation during the prolonged severe weather. In ground feeders like crows, food (root crops, cereals and ground arthropods) would have been unavailable if the soil remained frozen for a very long time. In this case, there could have been differential mortality, with bigger birds more likely to survive because they are better at minimizing the energy necessary to maintain body temperature. After the strong selective event, the birds would have returned to their long-term body size values through stabilizing selection (B l a n c k e n h o r n 2000).

The link between the severe climate in the winter and the shift in size of hooded crows is only circumstantial. However, it may stimulate European ornithologists to analyse morphological data sets of recent decades with this idea in mind.

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