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# REPRODUCTIVE SUCCESS OF THE HOODED CROW *CORVUS CORNIX* POPULATION IN RELATION TO VARIABLE HYDROLOGICAL CONDITIONS IN A FLOODED RIVER VALLEY (W POLAND)

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SUMMARY.—*Reproductive success of the hooded crow* Corvus cornix *population in relation to variable hydrological conditions in a flooded river valley (W Poland)*

**Aims:** (i) Description of basic nesting parameters of the breeding biology of the hooded crow under changeable hydrological conditions of a flooded lowland river valley during six seasons and comparison of results obtained between years. (ii) Analysis of the main environmental factors probably affecting the breeding success in the population studied. (iii) Comparison of results obtained from published studies, carried out in most probably secondary and more stable types of habitats.

**Location:** The "Ujście Warty" National Park, Western Poland.

**Methods:** The study was carried out during six breeding seasons in years 2000 - 2005. The size of the breeding population was estimated on the basis of nests found in the study area.

When climbing the tree was possible, nests were inspected directly. Inaccessible nests were checked by means of a mirror attached to an aluminium tube. The data came from 1,204 inspections of 235 nests. The complete data, from egg laying up to fledging or failure, were obtained for 211 nests.

**Results:** The population was characterised by a relatively high density of breeding pairs (2.6 - 3.8 pairs/km$^2$), small mean clutch size (4.34) as well as moderate mean (50.2 %) and changeable (24.5 % - 84.4 %) breeding success throughout the years. Furthermore, the breeding success was positively affected by water conditions as well as mean daily air temperature and negatively by mean daily precipitation. Moreover, the mean number of fledglings per each inspected nest (1.48) was low, whereas the mean number of offspring per successful nest (2.95) was relatively high in comparison with other studied crow populations.

**Conclusions:** In the flooded lowland river valley during the breeding seasons, two periods were distinguished: the first period, the time of egg formation and their laying, when hydrological conditions were unfavourable but relatively stable in comparison to other breeding habitats of the hooded crow and do not differ between seasons; the second period, the time during which nestlings stay in the nests, which is characterised by variable water conditions. This determined the scale of breeding success and the relatively big differences in the overall breeding output between years.

As a result of most probably primary biotope and relatively unfavourable conditions for breeding, the population studied is characterised by high breeding density but small clutch size and low breeding success in comparison with other populations studied.

*Key words*: breeding success, clutch size, *Corvus cornix*, hooded crow, water level, weather, wetlands.

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RESUMEN.—*Cambios en el éxito reproductivo de una población de cornejas cenicientas* Corvus cornix *bajo condiciones hidrológicas variables en un valle de inundación, oeste de Polonia.*

**Objetivos:** (i) Descripción de los parámetros básicos de la biología reproductiva de la corneja cenicienta bajo condiciones hidrológicas cambiantes en un valle fluvial de inundación de tierras bajas durante seis temporadas y comparación de los resultados obtenidos entre los años. (ii) Análisis de los principales factores ambientales que probablemente afecten al éxito reproductor de la población estudiada. (iii) Análisis comparativo de los resultados obtenidos con otros estudios, probablemente llevados a cabo en hábitats secundarios y más estables.

**Localización:** Parque Nacional Ujście Warty, Polonia occidental.

**Metodología:** El estudio se desarrolló durante seis estaciones reproductoras entre los años 2000 - 2005. El tamaño de las poblaciones fue estimado basándose en los nidos encontrados en el área de estudio, los cuales fueron inspeccionados directamente cuando fue posible trepar a los árboles. Los nidos inaccesibles se registraron utilizando un espejo añadido a un tubo de aluminio. Los datos obtenidos provienen de 1,204 inspecciones de 235 nidos. Los registros completos, desde la puesta hasta los volantones o fracaso en la puesta, se obtuvieron de 211 nidos.

**Resultados:** La población se caracterizó por una alta densidad relativa de parejas reproductoras (2,6 - 3,8 parejas /km$^2$), pequeño tamaño de puesta (4,34) así como una media moderada (50,2 %) y variable (24,5 % - 84,4 %) del éxito reproductor a través de los años. Además, el éxito reproductor estuvo afectado positivamente por las condiciones hídricas así como por la temperatura media diaria del aire, y negativamente por la precipitación media diaria. Asimismo, la media de volantones por nido inspeccionado fue baja (1,48), mientras que la media de descendientes por nido exitoso fue relativamente alta (2,95) en comparación con otros estudios de poblaciones de córvidos.

**Conclusiones:** En un valle fluvial de inundación de tierras bajas se distinguieron dos periodos durante las estaciones de cría. El primero, en el que se efectuó la puesta, con unas condiciones hidrológicas desfavorables pero relativamente estables en comparación con otros hábitats reproductores de la corneja cenicienta, y no diferentes entre estaciones. Y otro segundo periodo, durante el cual los pollos se encontraban en los nidos, caracterizado por condiciones variables de agua. Esto determinó la escala de éxito reproductor y las grandes diferencias relativas en el éxito reproductor total entre los años. Como resultado de un muy probable biotopo primario y condiciones para la cría relativamente desfavorables, la población estudiada se caracterizó por una alta densidad de cría pero con pequeños tamaños de puesta y bajo éxito reproductor, en comparación con otras poblaciones estudiadas.

*Palabras clave:* corneja cenicienta, *Corvus cornix*, éxito reproductor, niveles de agua, pantanos, tamaño de puesta, tiempo atmosférico.

## INTRODUCTION

The hooded crow *Corvus cornix* breeds in the Western Palearctic from sub-arctic and boreal zones, through temperate to Mediterranean, steppe and desert zones, and up to 1,000 m above sea level in the Carpathians and Urals (Cramp 1998). This species breeds mostly in river valleys and along lake shores, in different kinds of farmland habitats, in big cites and avoids extensive forest complexes.

So far, the breeding biology of the hooded crow has been studied mainly in areas considered to be secondary habitats for this species, such as farmland (Picozzi, 1975; Sondell, 1976; Loman, 1977, 1980; Parker, 1985), fishponds (Grabiński, 1996) and on the coast (Tenovuo, 1963). Except for results carried out on the Ural river valley during one breeding season (Levin and Gubin, 1978), there is a lack of data from flooded river valleys and similar habitats which are considered as primary biotopes of the hooded crow (Tomiałojć and Stawarczyk, 2003). In comparison to secondary habitats, flooded river valleys and similar areas offer breeding crows different

conditions, which are strongly connected with changeable water level on such areas. Most important is that the water level determines the composition and access to food, which is one of the most important factors responsible for the birds' breeding success. Furthermore, the flooded areas are also much more inaccessible for potential predators or people than secondary habitats like agricultural regions or fishponds. Therefore, the study of the breeding biology of the hooded crow in its most probable primary biotope is justified.

The aims of this paper were: a) description of basic parameters of the breeding biology of the hooded crow nesting under changeable hydrological conditions of a flooded lowland river valley during six seasons and comparison of results obtained between years; b) discovery of the main environmental factors influencing the breeding success in the population studied; c) comparison of results obtained from other, most probably secondary and more stable types of habitats. Part of the presented results, obtained during the first three of the six years of study, has already been published (Zduniak and Kuczyński, 2003). However, further research, conducted in the next three years, showed great differences in the overall reproductive output. Therefore, it was essential to present together all of the results from 6 years of study in order to describe a more complete pattern of the variation.

## METHODS

The study was carried out in the "Ujście Warty" National Park (N 52º 34', E 14º 43') in Western Poland on the Warta river at its confluence with the Odra river. This area is a wildfowl refuge of international importance (Grimmet and Jones, 1989), and is under the protection of the RAMSAR convention. A characteristic feature of the Park is the variable water level (details in Choiński, 2000; fig. 1).

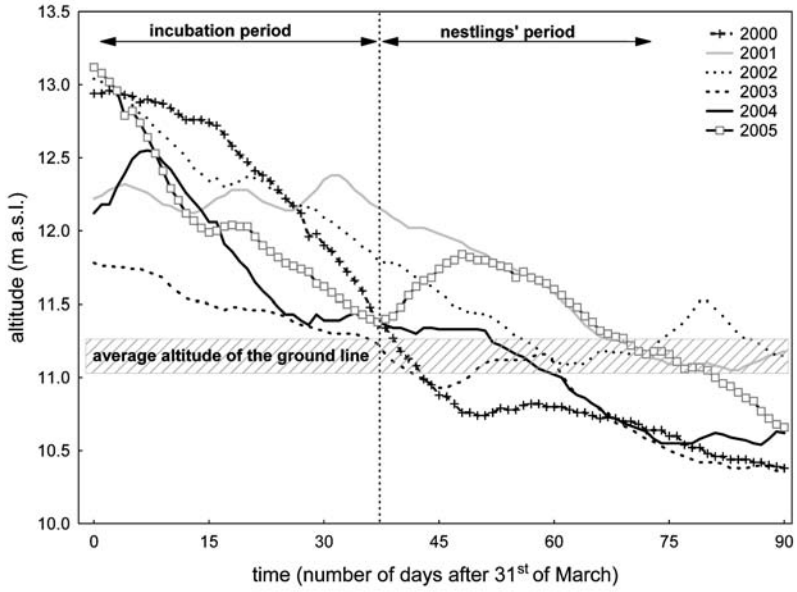


FIG. 1.—Water levels in the study area for six years during the incubation and nestlings' periods.
*[Niveles de agua en el área de estudio durante los periodos de incubación y cría de los pollos en seis años.]*

The study plot was located in the western part of the Park inside the retention reservoir at an altitude of ca. 10.0, 11.5 m a.s.l., which is a permanently flooded area of the Warta river estuary. It is covered by a mosaic of herbaceous vegetation, dominated by reed-canary grass *Phalaris arundinacea* and arborescent vegetation consisting exclusively of old willows *Salix sp*. and willow shrubs. Additionally, shallow lakes, old river-beds, ditches and dikes occur on this area. The access to the study plot by the observer depended on the water conditions that occurred during the first part of the breeding season (April - the first ten days of May). Therefore, the size and the boundary of the study area differed slightly between 15.7 and 16.5 $km^2$ between the years.

*Fieldwork*

The fieldwork was carried out during six breeding seasons (April – the first ten days of June) in the years 2000 - 2005. Most of the nests were found at the beginning of April, before the appearance of leaves on the willow trees. Nests of pairs which later initiated their broods were detected on the basis of birds' presence near potential nesting sites. When climbing the tree was possible, nests were inspected directly. Inaccessible nests were checked by means of a mirror attached to an aluminium tube.

The data came from 1,204 inspections of 235 nests. The mean number of inspections per nest per season was 5.1 (95 % CL: 4.6 - 5.7), and 6.3 (5.9 - 6.6) per nest with breeding success. It was not possible to acquire the whole history for all inspected nests. Thus, sample sizes may differ in different analyses. The complete data, from egg laying up to fledging or failure, were obtained for 211 nests.

The size of the breeding populations was estimated on the basis of nests found in the study area. There were few non-breeding birds in the area, probably resulting from the relatively high breeding density of the studied population as well as crow territoriality outside the breeding season (Slagsvold, 1984, 1985).

A total of 439 eggs from 100 nests were examined during 6 breeding seasons. Egg length and breadth were measured to the nearest 0.1 mm using sliding calipers.

*Data processing and analysis*

The time of a brood initiation was the moment when the first egg was laid in the nest. The length of breeding season was defined as the time from the date that the earliest egg was laid in the population until the date that the last juvenile fledged from the nest. For each nest, the relative date of nest initiation was calculated as the residual from the yearly population median.

Egg volume index was calculated from the length and breadth using the formula (Hoyt, 1979): $V = 0.51 \times L \times B^2/1000$ where V is volume (in $cm^3$), L is length and B is egg breadth (in mm). Only eggs from complete clutches were included in the analysis.

The number of nestlings was estimated, being based on the first inspection of a nest after hatching.

The number of fledglings was defined as the number of nestlings present in the nest during the last visit before they fledged, providing that they were older than 25 days, and that the next inspection did not show any evidence of nest failure.

The proportion of nests where at least one nestling hatched to all inspected nests where eggs were laid was defined as hatching success and the proportion of successful nests (i.e. with at least one juvenile fledged) to all visited nests as breeding success.

The impact of several environmental factors possibly influencing nest success, such as water level as an altitude in m a.s.l., mean daily air temperature in °C and mean daily precipitation in mm, were tested. The period characterised by the highest probability of nest failure was the first week of nestling life (Zduniak, 2006a).

Thus, the independent variables were expressed as the mean values for this period considering the phenological condition of each season. In practice the mean values for the seven day period were computed for each brood.

Differences in breeding success between years were most probably connected with different environmental conditions occurring during individual seasons. Thus, it was directly investigated how these conditions but not a "year factor" influenced breeding success in the population studied and data from six years were pooled.

To analyse the effect of environmental factors on breeding success Canonical Variates Analysis was applied (Ter Braak and Šmilauer, 2002) with nest success and failure as binary dependent variables and the three environmental factors as independent variables. Moreover, standardized time was included in the model as a co-variate. The significance of tested factors as well as the significance of the model created was estimated during forward selection using Monte Carlo Permutation test set for 9999 permutations (maximum number possible in the program) and CANOCO for Windows 4.5 was applied (Ter Braak and Šmilauer, 2002).

Throughout the text, means values are presented with 95 % confidence limits (95 % CL).

Water levels in the study area (daily water levels recorded on Kostrzyn river gauge; N 52º 35', E 14º 37') were obtained from the Regional Office for Water Management in Poznań. The nearest meteorological station to the study site was the IMGW in Słubice (N 52º 21', E 14º 33'), which provided access to daily weather data.

## Results and dicussion

### *Breeding pairs density and distance among nests*

The mean density of breeding pairs was 3.1 (2.5 - 3.6) pairs/km$^2$, varied from 2.6 in year 2000 to 3.8 in year 2005 but did not differ significantly between years ($\chi^2 = 3.64$, $df = 5$, $P = 0.60$). The breeding densities of the studied population were higher than those recorded in agricultural landscape in Scotland (1.0 - 1.2 p/km$^2$; Picozzi, 1975), Slovenia (1.1 - 1.9 p/km$^2$; Vogrin, 1998), Sweden (1.9 - 2.5 p/km$^2$; Loman, 1980) and in Norway (1.8 - 2.1 p/km$^2$; Parker, 1985), as well as on fish ponds in Poland (1.2 - 2.1 p/km$^2$; Grabiński, 1996). On the other hand, higher densities were recorded in large cities such as Wrocław, Poland (7.5 - 12.3 p/km$^2$; Udolf, 2005) and Berlin, Germany (to 4.6 p/km$^2$; Lehmann, 2002) as well as in the agricultural landscape near the Mediterranean Sea in Israel (17 - 19 p/km$^2$; Erez and Yom-Tov, 1995).

### *Timing of breeding season*

The median date of laying the first egg was different between years (Kruskal-Wallis ANOVA, $H_5 = 14.33$, $n = 228$, $P = 0.014$), and differences particularly concerned the years 2002 and 2003 (value $P$ for multiple comparisons of mean ranges after Bonferroni correction, $P = 0.005$, fig. 2). During the six breeding seasons no replacement clutches were recorded.

### *Clutch size and eggs dimensions*

In the 223 visited nests, 968 eggs were laid that gave on average 4.34 (4.19 - 4.49) eggs per nest. The most common clutch consisted of 5 eggs (number of mode = 87), and the range varied from 1 to 9 eggs. No differences were recorded in the mean clutch size between years (Kruskal-Wallis ANOVA, $H_5 = 7.32$, $n = 223$, $P = 0.20$). Furthermore, clutch size did not change during the breeding season (Spearman correlation, $r = -0.13$, $n = 219$, $P = 0.056$).

The mean clutch size obtained in the present study was higher than that recorded in Scotland

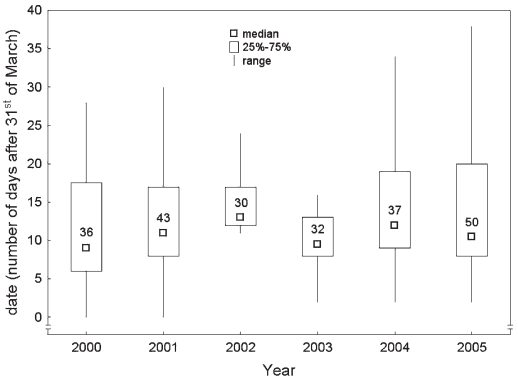


FIG. 2.—Median date of laying the first egg in the consecutive years of study. Numbers represent the sample size.
*[Fecha media de puesta del primer huevo en los años consecutivos de estudio. Los números representan el tamaño de muestra.]*

(4.1, Picozzi, 1975) but lower than noted in Finland (4.7, Tenovuo, 1963), Russia (4.7, Levin and Gubin, 1978), Norway (4.8, Parker, 1985), and SW Poland (4.8, Grabiński, 1996) and in Israel (4.95, Erez and Yom-Tov, 1995). The same clutch size was recorded in studies carried out in Sweden (Sondell, 1976; Loman, 1980) and in islands in Finland (Tenovuo, 1963).

The observed range of clutch size is wider than generally established for the hooded crow (2 to 7 eggs; Cramp, 1998). Two nests were recorded where one egg was laid and incubated. Most probably these nests belonged to young and inexperienced females. This was suggested by the choice of poor nesting locality and defective nest construction. Furthermore, the measurements of the eggs and nestlings support the presumption that two large clutches containing 8 and 9 eggs were laid by one female each and that another clutch with 9 eggs was probably laid by two females (Zduniak, 2003).

None of the egg measurements (table 1) differed significantly between years (one-way Anova, in all cases $P > 0.08$) and did not depend on clutch size (in all cases $P > 0.47$).

Dimensions of eggs reported here are smaller than those noted by Rofstad and Sandvik (1985) as well as Grabiński (1996), where the mean measurements were 41.9 mm x 29.4 mm, 18.4 $cm^3$ and 41.8 mm x 29.4 mm, 18.1 $cm^3$ for length, breadth and volume, respectively.

*Hatching and breeding success*

The mean hatching success was 75.1 % (69.0 % – 81.0 %; $n = 221$) and differed between the years ($\chi^2 = 40.94$, $df = 5$, $P < 0.001$, fig. 3a).

In the 221 of visited nests, 559 nestlings were hatched that gave on average 2.53 (2.29 - 2.77) nestlings per nest and 3.37 (3.17 - 3.57; $n = 166$; mode = 4, $n = 63$; range: 1 - 8) nestlings per nest with hatching success.

The mean number of nestlings per nest differed between years (Kruskal-Wallis ANO-

TABLE 1

Means and ranges of egg measurements.
*[Medias y rangos de medición de huevos.]*

| Measurement | Mean (95 % CL) | Range (clutch) | Range (eggs) |
|---|---|---|---|
| N | 100 | 100 | 439 |
| Length (mm) | 41.31 (40.92 - 41.70) | 35.98 - 45.50 | 34.7 - 46.7 |
| Breadth (mm) | 29.10 (28.92 - 29.27) | 26.78 - 31.57 | 26.1 - 32.3 |
| Volume ($cm^3$) | 17.89 (17.56 - 18.21) | 13.17 - 22.62 | 12.15 - 24.32 |

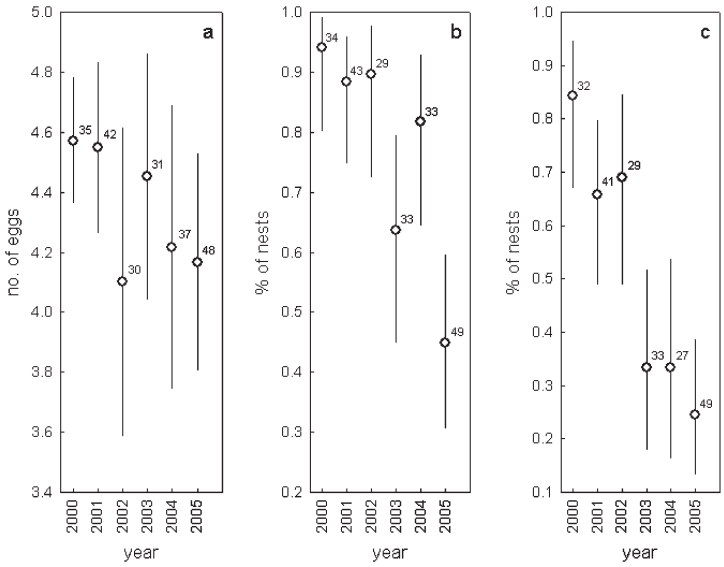


FIG. 3.—Clutch size (a), hatching success (b) and breeding success (c) in the consecutive years of study; means are given with 95 % CL and numbers represent the sample size.
*[Tamaño de puesta (a), éxito de eclosión (b) y éxito reproductor (c) en los años consecutivos de estudio; las medias se dan con el 95 % IC y los números representan el tamaño de puesta.]*

VA, $H_5 = 23.18$, $P < 0.001$, fig. 5a). The differences concerned years 2000 and 2005 as well as years 2001 and 2005 (value $p$ for multiple comparisons of mean ranges after Bonferroni correction, 2000 *vs* 2005 – $P = 0.016$, 2001 *vs* 2005 – $P = 0.003$). No such differences were recorded for nests with hatching success ($H_5 = 8.70$, $n = 166$, $P = 0.12$, fig. 5b).

The mean breeding success was 50.2 % (43.3 % - 57.2 %; $n = 211$) and differed between years ($\chi^2 = 42.84$, $df = 5$, $P < 0.001$). In years 2000 - 2002 the probability of success was higher than in years 2003 - 2005 (fig. 3b).

The effect of water level, mean daily air temperature and mean daily precipitation on breeding success was analysed. The Canonical Variates Analysis model with all environmental factors analysed was significant (Monte Carlo Permutation test; first canonical axis: $F = 22.14$, $P = 0.0002$; all canonical axes: $F = 7.38$, $P = 0.0002$). All factors included in the model after forward selection were significant (Monte Carlo Permutation test, water level: $F = 9.30$, p = 0.003; temperature: $F = 6.43$, $P = 0.012$; precipitation: $F = 5.76$, $P = 0.016$). The breeding success was positively affected by water conditions and mean daily air temperature (fig. 4). Simultaneously, mean daily precipitation was negatively related to breeding success (fig. 4).

The mean breeding success in the population studied was lower than that recorded in Norway (88 %, Parker, 1985), Sweden (86 %, Sondell, 1976; 61 %, Loman, 1980), Scotland (64 %, Picozzi, 1975) and in Russia (62 %, Levin and Gubin, 1978). On the other hand, the observed success was higher than that in Israel (49 %, Erez and Yom-Tov, 1995) and SW Poland (23 %, Grabiński, 1996).

The factors like air temperature and precipitation that influenced the nestling's survival in the first days of their life and thereby breeding success in the population studied most probably have direct influence and heighten their

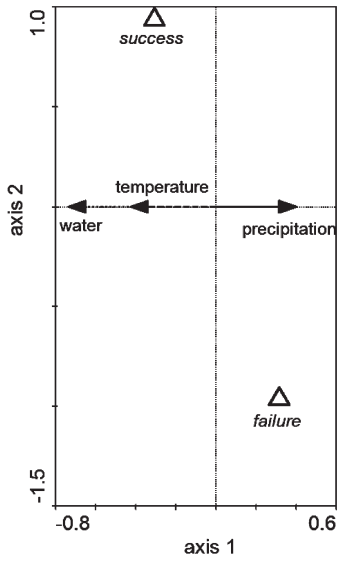


FIG. 4.—Canonical Variates Analysis ordination diagram for the effect of environmental variables (water level, mean daily air temperature, mean daily precipitation amount) on reproduction as a breeding success/nest failure (n = 228)
*[Análisis de variables canónicas en un diagrama de ordenación de los efectos de las variables ambientales (nivel de agua, temperatura media diaria del aire, cantidad media diaria de precipitación) en la reproducción medida como éxito de cría o fracaso de nidada (n = 228).]*

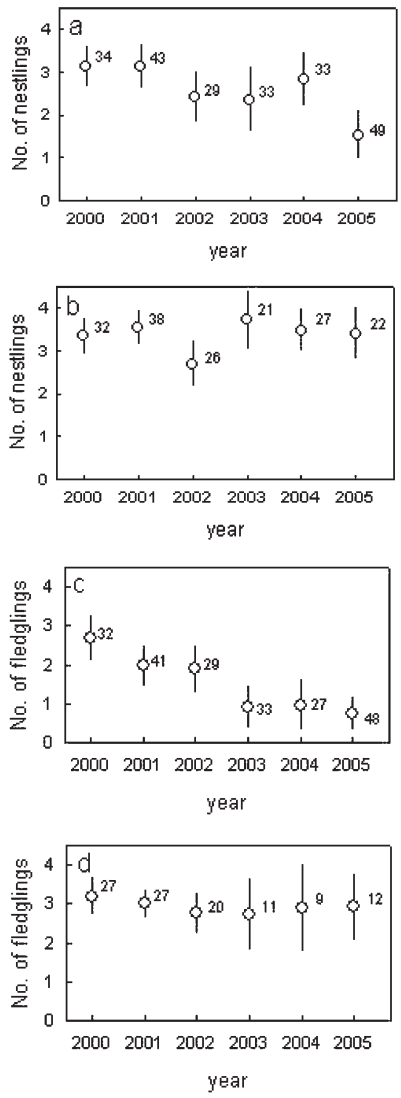


FIG. 5.—Number of nestlings per each inspected nest (a) and per nest with hatching success (b) and number of fledglings per each inspected nest (c) and per each nest with success (d) in the consecutive years of study; means are given with 95 % CL and numbers represent the sample size.
*[Número de pollos por cada nido inspeccionado (a) y por cada nido con éxito de eclosión (b) y número de volantones por cada nido inspeccionado (c) y por cada nido exitoso (d) en los años consecutivos de estudio; las medias se muestran con el 95 % IC y los números representan el tamaño de puesta.]*

own effects. During rainy days the low temperature is much more dangerous for small nestlings, which had started to develop thermoregulation than during days without rain. The influence of the water level occurring at the study site on the breeding success is most probably indirect by determining the composition and access to food. In the study area, the greatest contributions to the nestling's food were fish remains (Zduniak *et al.,* 2008). Also other groups of animals strongly connected with water, such as amphibians, molluscs, crayfish and less specific groups like insects, constitute the main component of crow food. Furthermore, studies based on nestling food samples (Zduniak *et al.,* 2008) as well as on

TABLE 2

Mean number of fledglings in different populations; in parentheses sample sizes are given.
*[Media del número de volantones en diferentes poblaciones; los tamaños muestrales se indican entre paréntesis.]*

| Place of study and source | All nests | Nests with success |
|---|---|---|
| Poland (this study) | 1.5 (211) | 2.9 (106) |
| Israel (Erez and Yom-Tov 1995) | 1.7 (41) | 2.2 (25) |
| Poland (Grabiński 1996) | 0.7 (254) | 2.8 (65) |
| Sweden (Loman 1980) | 2.0 (97) | 2.8 (60) |
| Scotland (Picozzi 1975) | 1.7 (78) | 2.9 (47) |
| Sweden (Sondell 1976) | 2.6 (200) | 3.0 (174) |
| Norway (Parker 1935) | 3.2 (26) | 3.6 (23) |

shells from eaten eggs (Zduniak, 2006b) showed that the hooded crow in the study area is an opportunistic nest predator, which concentrates on the most abundant and most commonly available waterbird species. The abundance of waterbirds positively correlates with the water level occurring in the studied area (Chylarecki and Kuczyński, 1999). In Loman's studies (1977, 1980) starvation was one of the main causes of the mortality of hooded crow's nestlings during the first week of their life.

Overall, in 211 nests 313 fledglings were recorded, that gave on average 1.48 (1.25 - 1.71) per nest and 2.95 (2.73 - 3.17; n = 106; mode = 3, n = 33; range: 1 - 5) fledglings per nest with success. The number of fledglings per each inspected nest differed between years (Kruskal-Wallis ANOVA, $H_5 = 41.16$, n = 211, $P < 0.001$, fig 5c). Year 2000 differed significantly from each of the years 2003 - 2005 (P values for multiple comparisons of mean ranges after Bonferroni correction, 2000 vs 2003 – $P = 0.005$, 2000 vs 2004 – $P = 0.012$, 2000 vs 2005 – $P < 0.001$) and between years 2001 and 2005 ($P = 0.035$). The number of fledglings per nest with success was not different between years ($H_5 = 2.13$, n = 106, $P = 0.83$, fig. 5d).

The mean number of fledglings per each inspected nest was low, whereas the mean number of offspring per nest with success was relatively high in comparison with other studied crow populations (table 2).

*Causes of nests failures*

During six years of the study, 105 nests (49.8 % of all controlled nests) failed to produce fledglings. All causes of nest failures are presented in table 3. The most important factor responsible for nest failures was defective nest construction which in most cases was connected with choice of poor nesting locality (21 clutches; 20.0 % of failures). The next important cause was nest predation (19 clutches; 18.1 % of failures). In 59 nests (56.2 % of failures) the reasons of brood losses were unknown. However, in most unknown cases the failure took place between nest visits, when very young nestlings were in the nests. Therefore, the lack of tracks left by predators point to unfavourable weather conditions, which led to the death of nestlings. Such assumption is confirmed by the CANOCO analysis performed, where the probability of total nest failure increased with the decrease of air temperature and increase of precipitation.

One interesting cause of brood losses in the studied population is the expansion of cor-

TABLE 3

Causes of nest failures.
*[Causas de fracaso de la nidada.]*

| Cause | Eggs | | Nestlings | | Clutches | |
|---|---|---|---|---|---|---|
| | *n* = 968 | (%) | *n* = 559 | (%) | *n* = 211 | (%) |
| American mink *Mustela vison* | 19 | (2.0) | 13 | (2.3) | 9 | (4.3) |
| Hooded crow *Corvus cornix* | 15 | (1.5) | – | (–) | 4 | (1.9) |
| Carrion crow *Corvus corone* | – | (–) | 3 | (0.5) | 1 | (0.5) |
| Grey heron *Ardea cinerea* | 6 | (0.6) | 2 | (0.4) | 2 | (0.9) |
| Predator unknown | 5 | (0.5) | 7 | (1.3) | 3 | (1.4) |
| **Predators total** | 45 | (4.6) | 25 | (4.5) | 19 | (9.0) |
| Bad nesting locality or defective nest construction | 50 | (5.2) | 19 | (3.4) | 21 | (10.0) |
| Severe weather conditions | – | (–) | 12 | (2.1) | 3 | (1.4) |
| Cormorant *Phalacrocorax carbo* | 7 | (0.7) | – | (–) | 2 | (0.9) |
| Eurasian beaver *Castor fiber* | 1 | (0.1) | – | (–) | 1 | (0.5) |
| Unknown | 113 | (11.7) | 78 | (14.0) | 59 | (28.0) |
| **Total** | 216 | (22.3) | 134 | (24.0) | 105 | (49.8) |

morants *Phalacrocorax carbo* in the study plot that led to the occupation of the nesting sites and nests of crows. Also, the eurasian beaver *Castor fiber* was responsible for one nest failure, which cut down the tree with an active nest.

The main cause of nest failures in other studied populations of the hooded crow was predation by marten *Martes sp*, crows from the breeding fraction (Grabiński, 1996), domestic cat *Felis domesticus,* goshawk *Accipiter gentiles* and common buzzard *Buteo buteo* (Loman, 1980). Beside nest abandonment, predation was one of the main causes of nest failures also in Picozzi (1975) research.

In the studied hooded crow population two periods were distinguished during the breeding seasons: the first period - the time of egg formation and their laying, when environmental conditions (mainly very high level of water, fig. 1) were unfavourable in comparison to other hooded crow's breeding habitats and resulted in smaller mean clutch size and egg dimensions. However, the conditions were relatively stable and did not differ between seasons resulting in no significant relationship between clutch size and date of laying the first egg in the nest and no differences in clutch size and egg dimensions between years; the second period - the time during which nestlings stay in nests, which is characterized by variable hydrological conditions (fig. 1) and which determined the scale of breeding success and relatively big differences in the overall breeding output between years (fig. 3c).

As a result of most probably primary biotope and relatively unfavourable conditions for breeding, the population studied is characterized by high breeding density but small clutch size and low breeding success in comparison with otherpopulations studied.

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