Short Communication

Notes on the reproductive biology of the Common Raven *Corvus corax* in Sicily

Angelo Nardo

Abstract - The Common Raven *Corvus corax* was studied in two areas of Sicily: between the Erei Mountains and the rocky hills of the Caltanissetta valley for a three-year period 2018-2020, and in the Southern area of the Iblei Mountains between 2023-2025. The survey was launched to determine the density and spatial distribution of nesting sites using the Nearest Neighbour Distance (NND) methodology. A density of 1.51 pairs/100 km² was recorded in the area between the Erei Mountains and the Caltanissetta valley and a density of 1.59 pairs/100 km² in the Iblei Mountains. In the first area, a random spacing of nesting sites was calculated, while in the Iblei Mountains area, it was regular. The fledging rate (fledged young/nests with fledglings) was 2.8 in the first study area and 4.0 in the second study area. A comparison with data in the bibliography confirms a downward trend in the population in recent decades. The Sicilian population of the Common Raven has been estimated at 900-1,000 individuals, of which 230 are territorial pairs.

Key words: *Corvus corax*, density, distribution, reproductive biology, Sicily.

Riassunto - Note sulla biologia riproduttiva del Corvo imperiale *Corvus corax* in Sicilia.

Il corvo imperiale *Corvus corax* è stato studiato in due aree della Sicilia: compresa tra i monti Erei e le colline rocciose del vallone di Caltanissetta – triennio 2018-2020 e nell'area meridionale dei monti Iblei – triennio 2023-2025. L'indagine è stata avviata per conoscere la densità e la distribuzione spaziale dei siti di nidificazione utilizzando la metodologia della *Nearest Neighbour Distance* (NND). È stata rilevata una densità di 1,51 cp./100 km² nell'area tra i monti Erei e il vallone di Caltanissetta e una densità di 1,59 cp./100 km² nei monti Iblei. Nella prima area è stata calcolata una spaziatura casuale dei siti di nidificazione, mentre nell'area dei monti Iblei una spaziatura regolare. Il tasso di involo (giovani involati/nidi con involi) è stato di 2,8 nella prima area di studio e di 4,0 per la seconda area di studio. Dal confronto con i dati in letteratura si conferma una tendenza al decremento della popolazione negli ultimi decenni. È stata stimata la popolazione siciliana di Corvo imperiale in 900-1.000 individui di cui 230 coppie territoriali.

Parole chiave: biologia riproduttiva, *Corvus corax*, densità, Sicilia, spaziatura.

Stazione Ornitologica Siciliana *Aegithalos*, Via Aquino Molara 75, 90046 Monreale (Palermo), Italia.
E-mail: maestro.nardo@gmail.com

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Received for publication: 15 October 2025
Accepted for publication: 5 January 2026
Online publication: 23 November 2026

INTRODUCTION

The Common Raven, *Corvus corax*, a polytypic species with a Holarctic distribution, it breeds in Italy in the Alps, the northern Apennines, the central-southern regions, and the islands, with an estimated population of 3,000-6,000 pairs (Brichetti & Fracasso, 2011). It breeds from sea level to 2,700 meters above sea level; more frequently between 200 and 700 m (Gatti, 2022).

In Sicily, the species is sedentary and breeds, it is most common in the Western and central regions but scarce and localized in Eastern Sicily (Corso, 2005). It was found to breed in 175 parcels measuring 10x10 km (58.9%) (Ientile & Massa, 2008). Over a period of approximately 150 years, the Sicilian Common Raven population has been in sharp decline (Massa *et al.,* 2021).

As part of regular annual monitoring of *Accipitriformes* and *Falconiformes* in two different sectors of Central-Southern and South-Eastern Sicily, data on its presence and distribution have been collected since 2018.

In the Erei Mountains and the rocky hills of the Caltanissetta Valley, specific surveys have been conducted by Giudice & Mascara (in Massa, 1985), by Mascara (2006, 2017), and in central Sicily by Salvo (2015), while no specific research has been found in the literature on the Iblei Mountain area.

STUDY AREA

The survey was conducted in two areas located in two different sectors of the island: area A in the Erei Mountains and the rocky hills of the Caltanissetta Valley; area B located in the Iblei Mountains. The two study areas, although geologically and morphologically different, share similar ecological characteristics based essentially on phytoclimatic, vegetational, and zoogeographical aspects. According to an ornithologically based ecological zoning of Sicily, both fall within the ornithological zone known as *meso-Mediterranean agricultural systems* (Londi *et al*., 2012).

Study area A (geographical coordinates Longitude E 13°59' - Latitude N 37°25') covers an area of 2,052 km² and is located largely within the territory of the former province of Caltanissetta. Human presence is sparse, and human activity is primarily based on agriculture and pastoralism. The landscape is hilly, reaching altitudes of

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up to 800 m, with notable rocky outcrops of limestone, chalk, and sandstone, and wide valleys crossed by several torrential intermittent streams. Precipitation is sparse and occurs primarily in the autumn and winter months. The land is largely cultivated with cereal crops and, to a much lesser extent, trees (olive groves, almond groves, and vineyards). There are also numerous uncultivated areas and steppe grasslands with *Ampelodesmos mauritanicus*, *Cymbopogon hirtus*, and *Lygeum spartum*. There are also some reforestation areas of *Eucalyptus* spp. and *Pinus* spp.

Study area B (geographical coordinates: Longitude E 14°47' - Latitude N 36°52') covers an area of 820 km² and is located in the southern sector of the Iblei Mountains. Morphologically, it features a vast plateau and hills up to 600 meters high, composed of sedimentary limestone rocks and affected by widespread karstification. Erosive fluvial action over millennia has created wide, deep grooves known as *cave*, giving the landscape a truly unique appearance.

The landscape mosaic on the plateau is characterized by a highly anthropized environment, interspersed with small plots cultivated primarily with cereals. Carob trees *Ceratonia siliqua* and olive trees *Olea europaea* are also present. Steppe grassland and garrigue prevail in the slopes; in the *cave*, typical Mediterranean scrub plants thrive, including the tree spurge (*Euphorbia arborescens*), the wild olive *Olea europaea* var. *sylvestris*, the holm oak *Quercus ilex*, and the downy oak *Quercus cfr. pubescens*. Some reforestation with *Pinus* spp. is present. Cattle herding is widely practiced.

MATERIALS AND METHODS

Data collection took place between 2018 and 2025, from January to June, for a total of 143 outings at different times of the day. Direct observation of pairs and their nests/territories was carried out using a Bushnell 20-60x80 spotting scope and Nikon 10x42 binoculars. Area A was surveyed from 2018 to 2020, and Area B from 2023 to 2025. Whenever possible, photographic documentation was collected with telephoto lenses up to 800mm.

The collected data was archived and analyzed in spreadsheets. Each nesting site was georeferenced and mapped using *Google Earth Pro*, a digital and interactive mapping software.

Density was measured using the *Nearest Neighbor Distance* (NND) method (Newton, 1976; Newton *et al*., 1977), as proposed by Penteriani & Pinchera (1995) to standardize the research method. Density was calculated by circling sites outside the surveyed area with a diameter equal to the mean NND, used to delineate the entire surface area actually occupied by nesting pairs. This method is often used for birds of prey but is well suited for a territorial and aggressive species like the Common Raven.

The dispersion of nesting sites was analyzed using the G test statistic, or GMASD (Brown, 1975), calculated as the ratio of the geometric mean to the arithmetic mean of the squared *nearest neighbor distance* (NND). The index ranges from 0 to 1: values close to 1 (> 0.65) indicate a uniform distribution of nests.

It was deemed inappropriate to publish the distribution map of the sites since they largely coincide with the nesting areas of sensitive species of *Accipitriformes* and *Falconiformes*.

RESULTS AND DISCUSSION

Pairs began occupying the territory and restoring or building nests between January and February.

In study area A, during the three-year survey period, 31 breeding pairs, both confirmed and probable, were recorded, active throughout the entire research period. Nesting sites were located at a mean altitude of 449 m a.s.l. (SD = 149.6; N = 30; range = 200–778). The mean distance between nearest sites (NND) was 5.39 km (SD = 3.08; N = 22; range = 1.09-11.03 km). The G test value was 0.53 (N = 22), indicating random spacing of pairs. The density found in the reference area was 1 pair/66.2 km², or 1.51 pairs/100 km².

In study area B, 13 confirmed and probable pairs were recorded, active during the three years of the research. The nesting sites were located at an average altitude of 327.6 m a.s.l. (SD = 130.2; N = 13; range = 116-525). The average distance between the closest sites (NND) was 5.66 km (SD = 2.65; N = 10; range = 1.8 km-10 km). The G test value was 0.66 (N = 10), indicating regular spacing. The density found in the reference area was 1 pair/63.1 km², or 1.59 pairs/100 km².

All nests were located on cliff (100%) (Fig. 1), and when it was not possible to verify the nest location, the altitude of the cliff was taken into consideration with an approximation of a few tens of meters.

Regarding the exposure of the cliffs used for nesting by the Common Raven, with data from both study areas (N=35), in order of importance, exposure to the SE (37%), NW (26%), S (17%), SW (11%), E (6%), and N (3%) was preferred.

In 77% (N=44) of cases, the occupied nesting areas were shared with some species of birds of prey, such as the Egyptian Vulture *Neophron percnopterus* (1), the Common Buzzard *Buteo buteo* (1), Bonelli's Eagle *Aquila fasciata* (2), the Common Kestrel *Falco tinnunculus* (5), the Lesser Kestrel *Falco naumanni* (6), the Lanner Falcon *Falco biarmicus* (7), and the Peregrine Falcon *Falco peregrinus* (18). Falcons regularly used old Common Raven nests.

Regarding reproductive biology, a fledging rate (fledglings/nests with fledging) of 2.87 (N=8) was recorded in study area A, while in area B a fledging rate of 4.0 (N=3) was recorded; in area B, a single case of 5 fledged juveniles was recorded.

The fledgings recorded for both study areas occurred between May 20 and June 10. Considering that the incubation period for this species is 20-21 days and the weaning period is 35-40 days (Cramp & Perrins, 1994), between 2018 and 2025, the laying must have occurred between March 26 and April 22.



Fig. 1 - Typical nest of a Common Raven *Corvus corax*, with 3 chicks, built in a limestone niche in a canyon in the Iblei Mountains / Tipico nido di corvo imperiale *Corvus corax*, con 3 pulli, costruito in una nicchia di roccia calcarea in una cava dei Monti Iblei.

CONCLUSIONS

The densities of the two studied areas are in line with those found by Mascara (2017) for Central-Southern Sicily (1.63 pairs/100 km²) but are slightly lower than the densities found in the past: province of Caltanissetta, period 2004-2005, 1.85 pairs/100 km² (Mascara, 2006); Central-Southern Sicily, period 1976-2011, 2 pairs/100 km² (Salvo, 2015); Southern Sicily, period 1982-1983, 3.1 pairs/100 km² (Giudice & Mascara in Massa, 1985). In light of the above, a decreasing trend in the Common Raven population can be observed in recent decades in Sicily, and its conservation status in a time period of c. 150 years old, it is classified as a very declining (vdec) species by Massa *et al.* (2021). Conversely, in the central and northern regions of the peninsula, a new expansion of the range has been recorded for several decades (Brichetti & Fracasso, 2011). It has been hypothesized that the potential distribution at the end of the 21st century, reconstructed based on a simulation that takes into account ongoing climate change, indicates a northward shift of the current range with a progressive abandonment of the southernmost areas, including Sicily (Huntley *et al*., 2017).

The choice of cliff face exposure does not appear to be a determining factor in site selection, although in the present study, a preference for SE and NW orientations (63%) was demonstrated; Mascara (2006) reported that 59% of the cliff faces were oriented to the E, SE, and S; Salvo (2015), who followed 41 nestings, believes exposure to be irrelevant. The fledging rates obtained in this study, 2.87 and 4.0, are within those known for Europe (Cramp & Perrins, 1994).

In conclusion, Sicily as an island covers an area of 25,426 km²; the species was found to breed in 59% of the surveyed units (Ientile & Massa, 2008), and based on the densities recorded in this study, a Sicilian population of approximately 230 pairs can be estimated with good approximation. However, to fully understand the Sicilian population, non-breeding individuals must also be considered, which can exceed 50% of the local population (Brichetti & Fracasso, 2011), bringing the estimate to 900-1000 individuals.

Territorial pairs can move up to a few dozen kilometers, while juveniles and non-breeders can move up to a hundred kilometers, likely for trophic reasons. During their wanderings, individuals have been observed crossing the Strait of Messina, likely daily movements for food (Corso, 2005). Non-breeders tend to gather, especially in autumn and winter, in groups that can consist of hundreds of individuals depending on food availability (Oggier, 1986; Snow & Perrins, 1998). Large groups were already known in Sicily in the past (Iapichino & Massa, 1989; Lo Valvo *et al.,* 1993). In the last three years, gatherings have been observed in every part of the island, particularly in the Sicani and Madonie mountains, with an average of 124.7 individuals (SD = 112.78; Range = 13-382; N = 10); mainly in autumn and winter, near feeding areas and roosts.

Acknowledgments

Rosario Mascara, Ursula Veken, and Iacopo Romano for their collaboration and companionship on various field trips; Catriona Gillespie for English revision. Thanks also to: Andrea Ciaccio, Andrea Cusmano, Salvo Grenci, Renzo Ientile, Giovanni Leonardi, Angelo Scuderi and Ursula Veken for providing me with first-hand data and interesting information on Common Raven populations.

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