

Colonization of Eurasian Jay *Garrulus glandarius* and Holm Oaks *Quercus ilex*: the establishment of ecological interactions in urban areas

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The Eurasian Jay *Garrulus glandarius* is one of the most common Corvidae in Europe (BirdLife International 2012) and its populations in Italy is increasing (Brichetti & Frassino 2011, Campedelli *et al.* 2012). Jays play an important role on plant dynamics as they are the main seed dispersers of oaks *Quercus* spp. (Bossema 1979, Gómez 2004a, 2004b, Pons & Pausas 2007a, Myczko *et al.* 2014), the most abundant genus of tree forest species in Europe (San-Miguel-Ayanz, 2016). This abundance has also been confirmed in Italy (Patterson *et al.* 1991). Jays collect oak fruits, store them on the ground for later consumption. However a part of these seeds are not recovered, thus enabling the germination and growing of oaks (Gómez 2003, Pons & Pausas 2007b). Moreover, this cache behaviour reduces the probability of seed predation by rodents or ungulates (Kollmann & Schill 1996, Pons & Pausas 2006). Due to their great flying capacity, jays can move the seeds far away from the mother plant, usually spreading them over a wide area. In an heterogeneous Mediterranean landscape, the dispersal distance of Holm Oak acorns by jays was empirically estimated to vary from 5 up to 1000 m (average: 260 m) away from the source (Gómez 2003). This jay-oak interaction is a very valuable ecosystem service, providing several benefits at different levels (Hougnier *et al.* 2006). The jay's occurrence is usually correlated with forested habitats; however, in recent times some individuals in Sicily have been sighted at marginal urban areas, such as parks and orchards (Autori Vari 2008, La Mantia *et al.* 2014). Here we describe the establishment of the ecological interaction between jays and oaks in an urban area after colonization by the jays.

The observations were carried out in a mixed orchard in the plains surrounding the city of Palermo known as "Conca d'Oro". The specific area (Fondo Micciulla), with about 100 ha (Fig. 1) is characterized by traditional orchards, where some are abandoned and others managed in order to create different layers of trees, resulting in a forest-like structure (La Mantia 2007), composed of differ-

ent species of trees, such as lemon, mandarin, orange *Citrus* spp., loquat *Eriobotrya japonica*, walnut *Juglans regia* and Mediterranean hackberry *Celtis australis*.

The bird communities of the area have been studied since the 1980s, and the jay was never observed (La Mantia 1982, La Mantia & Lo Valvo 1982, Lo Valvo *et al.* 1985, Massa & La Mantia 2009). Interviews with old farmers and hunters, who are familiar with species, all confirmed its absence from this locality. An adult Jay was observed for the first time in Fondo Micciulla in July 2009, and from then onwards there has been an increasing presence. Presently the species is observed almost daily. Some adult jays have also been recently observed in the more central areas of the city, such as at the University Campus (from July 2013, B. Massa, T. La Mantia *pers. obs.*), in other areas of the Conca d'Oro, like Borgo Molara (from June 2010, B. Massa *pers. comm.*) or in very small wooded gardens inside the city near Corso Calatafimi (from December 2015, A. & T. La Mantia *pers. obs.*) (Fig. 1).

Throughout Fondo Micciulla there is only one mature Holm Oak planted in 1975 which has been regularly bearing fruit since more than ten years ago. However, despite the constant presence of potential seed dispersers, like Woodpigeon *Columba palumbus*, Eurasian Magpie *Pica pica* and Hooded Crow *Corvus cornix*, it was only in 2014 that the first oak seedling was observed, both in cultivated as well as in abandoned orchards (Fig. 2).

Also in Borgo Molara, where there are fruiting holm oak trees, it was only after the arrival of jays that the first seedlings were observed far from the trees (B. Massa *pers. comm.*). The Woodpigeon, one important consumer of oak acorns (Gutiérrez-Galán *et al.* 2017), is considered in some studies as an acorn seed predator (Tanton 1965, Pulido & Diaz 2005). The Hooded Crow was often seen feeding on the acorns of the only oak tree of Fondo Micciulla (G. La Scala *pers. comm.*); nevertheless, it seems that this species, together with Woodpigeons and Magpies, does not effectively play the role of Holm Oak seeds dispersers.

Short communications - Brevi note

Otherwise oak seedlings should have been noted since the first fructification. For the Hooded Crow it is probably true what Mellanby (1968) wrote "The fact that a particular species eats many acorns may not mean that it is a major factor in preventing regeneration". Moreover, generally other corvids usually don't have the same caching behaviour of jays (Coombs 1978).

Dispersed but unburied seeds are more prone to be predated or damaged (Pulido & Diaz 2005). The higher efficiency of the jays compared to other acorns consumers is summarized by Coombs (1978): "In the autumn, jays, as well as Woodpigeons and in some places Rooks and Ra-

vens, rapidly use up the supply of acorns, so the jays must store them, and most effectively in damp ground. These may germinate by the spring".

So, by exclusion, we can associate the appearance of the seedlings with the colonization by jays.

Presently there are several seedlings scattered over the study area. Those growing in cultivated orchards are usually destroyed during normal farming operations, while those growing in abandoned areas manage to survive. An interesting aspect is the distance at which the seedlings are found in relation to the source, arriving up to 170 meters, thus excluding any potential dispersal by rodents. How-

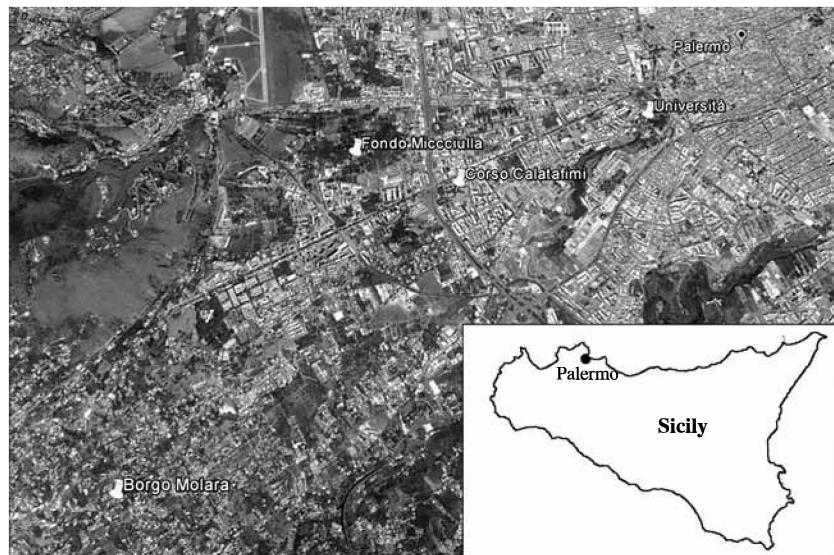


Figure 1. Location of the area and Google Earth image showing the sites where jays were recorded in recent years at Palermo and surroundings, Sicily, Italy.



Figure 2. Two Holm Oak seedlings close to a lemon tree in a cultivated orchard in Fondo Micciulla, Palermo, Italy.

ever, despite the jay's great dispersal capacity, we exclude that result from the acorns of oak trees located several kilometers away.

Despite the importance of this ecological interaction, the role of jays on seed dispersal in Italy is still poorly understood. At the Ficuzza Nature Reserve, a protected area 7.400 ha wide, located about 25 km South of Palermo (37°52'25 N, 13°23'42 E), we are evaluating the role of animals on seed dispersal and some preliminary results indicate the presence of many seedlings from oaks *Quercus ilex* and *Quercus cf. pubescens* scattered over the open areas outside the forest, in some cases more than 300m away from any oak tree. At Ficuzza the interactions network is much more complex than in urban areas like at Fondo Micciulla, however the spatial pattern, distance and location of the seedlings show the typical pattern of dispersal by jays, thus demonstrating that in both natural and urban areas jays are key actors for the dispersal and establishment of oaks in Sicily.

Our observation provide a clear evidence that the colonization of jays in Fondo Micciulla coincides with the appearance of Holm Oak seedlings, showing that beyond the jays and oaks colonization there is also the establishment of a previously inexistent ecological interaction.

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