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Characteristics of black kite *Milvus migrans* nest-trees in two Italian colonies

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Abstract - Black kites often nest on trees, but little information is available on the characteristics of trees used for nest building. In this study we analysed several tree parameters that may affect tree choice, using data on 53 nests from two Italian colonies. Black kites preferred to build their nests on “chandelier type” branch platforms located at approximately 70% of relative tree height (i.e. regardless of the absolute tree height), and used stable trees, as evaluated using a stability index (tree diameter/tree height). In both study areas, oaks *Quercus* spp. appeared to be more likely to meet all these criteria, though nests were also located on other tree species with similar characteristics.

Riassunto - *Caratteristiche degli alberi nido di nibbio bruno* Milvus migrans *in due colonie italiane*. In questa ricerca descriviamo le caratteristiche degli alberi nido utilizzati dal nibbio bruno in due differenti colonie italiane, valutando alcune fattori quali la specie arborea, la struttura della piattaforma-nido, l’altezza, il diametro e la stabilità degli alberi. Dai dati rilevati su un totale di 53 nidi, il nibbio bruno risulta nidificare preferibilmente, in entrambe le aree di studio, su piattaforme di rami “a candelabro”, posizionate ad un’altezza relativa pari a circa il 70% dell’altezza dell’albero nido (indipendentemente dall’altezza assoluta dell’albero), e su alberi molto stabili. In entrambe le aree di studio, le querce *Quercus* spp. costituiscono le specie arboree che soddisfano maggiormente tali requisiti, anche se i nidi possono essere costruiti su altre specie di alberi con caratteristiche simili.

Introduction

The black kite *Milvus migrans* is a long-distance migrant and a widely distributed species, which appears to have declined in the last decades throughout Europe (Tucker and Heath 1994, Sergio 2002, Sergio *et al.* 2003a). Following the observed declines, it has been classified as Vulnerable in the Italian Red List (Bulgarini *et al.* 1998). Although several studies described the status and biological aspects of different black kite populations (e.g., Petretti 1976, Bustamante and Hiraldo 1992, De Giacomo *et al.* 1993, Blanco 1994, Petretti 1995, Blanco 1997, De Giacomo *et al.* 1999, Mason *et al.* 1999, Sergio and Boto 1999, Sergio *et al.* 2003a, Sergio *et al.* 2003b, Sergio *et al.* 2003c, Battisti *et al.* 2004), relatively little is known about the breeding habitat and the modalities of choice of breeding sites (Sergio *et al.* 2003a). Apparently, black kites breed preferentially in mosaic landscapes consisting of woody patches and cultivated areas, in close proximity to freshwater (Cramp and Simmons 1980, Sergio *et al.* 2003c). Nest building often occurs in trees, although cliffs may be utilized as well. Regarding nest-trees, different species, both coniferous and deciduous, may be used, suggesting opportunistic choices (Cramp and Simmons 1980). However, as far as we know, there is little information on the tree characteristics possibly preferred by this species to choose nesting trees (e.g. Sergio *et al.* 2003a). Such investigations may help in defining an integrated multi-scale approach for the conservation of this species.

Here we analyse some tree parameters that may affect tree choice in black kites, using data collected at two Italian colonies located about 400 km apart. One colony is located in a small anthropized agricultural area in the suburbs of Rome (central Italy; Borlenghi 1996, Battisti *et al.* 2004). The other is an old and well-known colony located in a residual woodland in the Po plain (near Mantova, northern Italy; Arrigoni degli Oddi and Moltoni

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1931). Therefore, a comparison of nest-tree characteristics between these two colonies located in different habitats allowed us to evaluate the generality of our findings.

Methods

Study areas
The "Tenuta dei Massimi" Nature Reserve (TM hereafter) is located in the suburbs of Rome (41°50' N; 12°23' E). It extends over 140 ha, including a mosaic of cultivated areas and woodland patches. In this study, 8 patches were investigated, with a size ranging between 0.1 and 5 ha. In the last years we have constantly monitored a small colony of black kites nesting there (3-4 estimated breeding pairs, Borlenghi 1996, Battisti *et al.* 2001, Battisti *et al.* 2004).
The "Bosco della Fontana" Biogenetic Reserve (BF hereafter) is a 233-ha nature reserve located about 5 km from Mantova (45°12' N; 10°44' E). 198 ha are covered by a "Primary Ancient Wood" (Mason 2002), 33 ha by grasslands, paths and streams, and the remaining 2 ha by an artificially created swamp. The whole reserve is divided in 40 sectors. The site is completely isolated and surrounded by cultivated areas. According to the last survey, undertaken in 1998, the black kite breeding population consists of at least 22 pairs (Mason *et al.* 1999).

Nest survey
Nests were thoroughly searched across woodland fragments (TM) or sectors (BF) in the winter 2002-2003, when lack of leaves allowed easy spotting of nests. When nests were not known to have been utilized in the past years, they were identified according to the following criteria: (1) the apparent minimum size of the nest and of the nest-twigs (larger than those in a crow nest); (2) presence of egg fragments on the ground; and (3) presence of artificial material (plastic and tissues) in the nest or in the immediate surroundings (hanging from branches under the nest or on the ground) (refuses were present in most nests). In TM no other breeding diurnal raptor is present except the kestrel *Falco tinnunculus* (Cignini and Zapparoli 1997). In BF the sparrowhawk *Accipiter nisus* is also present with a single breeding pair (Longo 2002). Overall, sample size consists of 40 nests in BF and 13 nests in TM.

Tree characteristics and tree community
The height of the nest and of the nest-tree were estimated from the base of the tree by means of trigonometric calculations, using a 20-m tape and a clinometer. Nest height was also expressed as relative nest height [(nest height/tree height) x 100], in order to evaluate the relative height of the nest independent of tree height. Diameter at breast height (DBH) was measured for each tree. The ratio between tree height and DBH (h/DBH) was used as a tree stability index (Mason 2002). In addition, for each nest we recorded the characteristics of branch platforms sustaining the nest, in order to look for possible common platform shapes used by the kites. Ramification orders were also noted.
In both study sites, the community of nest trees was compared with the community composition of the woodlands. In BF, we used a vegetation inventory to derive tree species frequencies (Mason 2002). For analyses of heights and DBH we used data collected in 3 sample areas (see Mason 2002 for the description of sample areas). In TM, vegetation structure was recorded by means of a modified James-Shugart methodology (James and Shugart 1970). Briefly, a total of 26 squares (20 x 20 m) were randomly selected within all woodland fragments. For each square, all trees with a DBH > 7.5 cm were classified. In both study areas oak species were gathered into a single class (including *Quercus robur* and *Q. cerris* in BF, and *Q. cerris*, *Q. frainetto*, *Q. crenata* and *Q. pubescens* in TM).

Results

Nest-trees and woodland tree communities
TM and BF showed a different composition of tree species (Fig. 1): oaks were the most frequent tree in TM, while white hornbeams *Carpinus betulus* were most frequent in BF. Considering both study sites 90.6% of all nests were located on oaks, however, frequency of nests vs. frequency of available tree species was different in the two areas. In TM proportion of nest-oaks and nest-non-oaks trees did not differ from proportion of oaks and non-oak tree frequency ($\chi^2 = 0.00$, d.f. = 1, Yates correction, $P = 0.998$). By contrast, in BF a strong preference for oaks emerged, despite the low frequency of this tree species ($\chi^2 = 207.98$, d.f. = 1, Yates' correction, $P < 0.001$).

Nest-tree characteristics
Mean tree height, height of nest-trees, as well as DBH differed between study areas, being lower in TM compared to BF (Tab. 1, *t*-test, $P < 0.05$ for all parameters). However, relative nest heights did not differ between study sites (*t*-test on log-transformed data, $p > 0.05$). Nest height was positively correlated with DBH ($r = 0.32$, $P < 0.05$, $N = 53$) as well as with tree height ($r = 0.78$, $P < 0.0001$, $N = 53$) (data from both sites pooled).

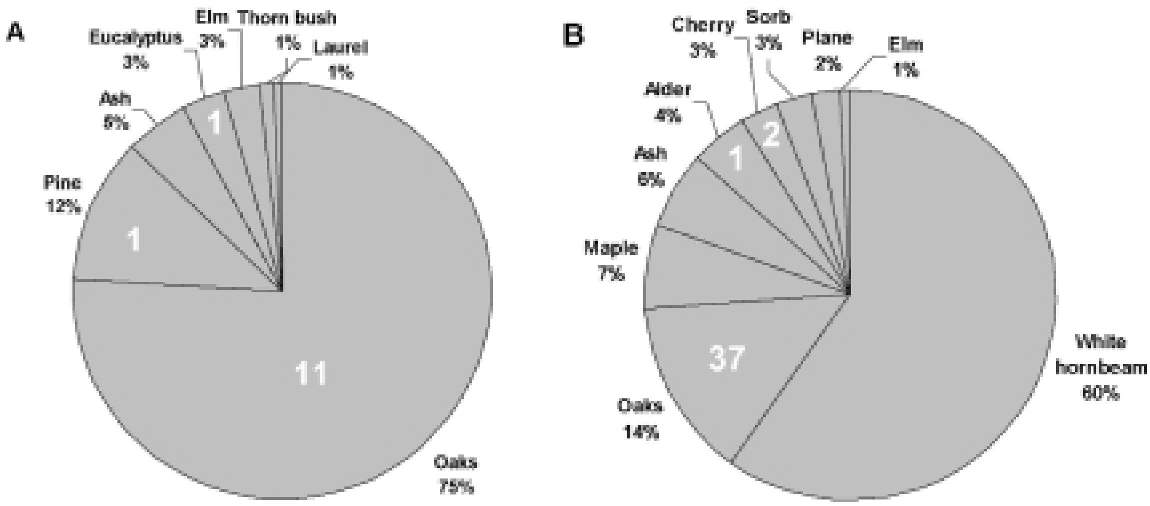

Figure 1. a) Frequency of tree species in TM (*N* = 725). Numbers inside slices are counts of black kite nests (overall *N* = 13). Tree species are: oaks *Quercus* spp., pine *Pinus pinea*, ash *Fraxinus ornus*, eucalyptus *Eucalyptus* sp., elm *Ulmus minor,* thorn bush *Crataegus* sp., laurel *Laurus nobilis.* b) Frequency of tree species in BF (*N* = 68632, Mason 2002). Numbers inside slices are counts of black kite nests (overall *N* = 40). Tree species are: white hornbeam *Carpinus betulus,* oaks *Quercus* spp., maple *Acer campestre,* ash *Fraxinus ornus,* alder *Alnus glutinosa,* cherry *Prunus avium,* sorb *Sorbus torminalis*, plane *Platanus* spp., elm *Ulmus minor.*

Table 1. Nest tree characteristics (mean and SD) in TM and BF. Asterisks denotes significant differences between study areas.

Three characteristics	TM (*N* = 13)	BF (*N* = 40)
Nest height*	11.6 (2.9)	19.2 (3.5)
Tree height*	15.9 (3.6)	27.0 (4.5)
Relative nest height (%)	73.8 (11.6)	72.2 (12.0)
DBH*	47.5 (18.5)	59.5 (15.5)
Stability index	38.4 (17.4)	47.6 (11.1)

In BF, in order to investigate why oaks are preferred, we compared oak characteristics with those of the most frequent tree species, the hornbeam (Fig. 1b), where no black kite nests were found during our survey. Hornbeams were not only the most frequent tree in BF as a species (60%) but, according to data from the BF sample core areas (Mason 2002), they were also more frequent than oaks among taller trees (height class > 18 m) ($\chi^2 = 78.49$, $P < 0.0001$).

To test equality of heights and maintain statistical homogeneity, we utilized the data from the 37 tallest hornbeams and oaks measured in the core area samples. No difference was found among the mean heights of these two groups and the 37 nest oaks (one-way ANOVA, $F_{2,108} = 2.79$, $P > 0.05$); however, the mean stability index (h/DBH, log-transformed) differed markedly between nest oaks and hornbeams, oaks showing a significantly lower value (= higher stability) as compared to hornbeams (Fig. 3). In addition, oaks with nests were more stable than both oaks and hornbeams from the tree samples (one-way ANOVA, $F_{2,108} = 22.34$, $P < 0.0001$).

Even though the extreme variability of measures and the low sample size reduce the usefulness of a statistical analysis, a descriptive comparison suggested that BF and TM non-oak nest-trees had a stability index similar to oak nest-trees (BF nest oaks: 47.9 ± 1.8 SD; BF nest non-oaks: 42.8 ± 9.7 SD, *N* = 3; TM nest-oaks: 40.3 ± 17.9 SD, *N* = 11; TM nest non-oaks: 28.6 ± 0.9 SD, *N* = 2).

Characteristics of nesting branch platforms

Most nests could be assigned to 2 basic branch platform structures (see Fig. 2): (1) “chandelier” type, a sort of crown of 3-5 branches arising from the same point of the trunk or from a branch of 1st order (rarely 2nd order) in a vertical or subvertical orientation; and (2) “open hand” type, corresponding to the point of ramification into 2-5 branches of a branch of 1st or 2nd order, positioned in a horizontal or subhorizontal orientation. In all cases nests were located at the branch intersections. In TM, 58% of nests were on “chandelier” platforms and 42% on “open hand” platforms. In BF, 59% of nests were built on “chandeliers”, 28% on “open hands” and 13% were located on platforms with intermediate characteristics.

As oaks were preferred in BF, we evaluated if these trees might have a higher number of “chandeliers” as compared to the most frequent (60%) tree species, the hornbeam (see Fig. 1b). Results from a random sample

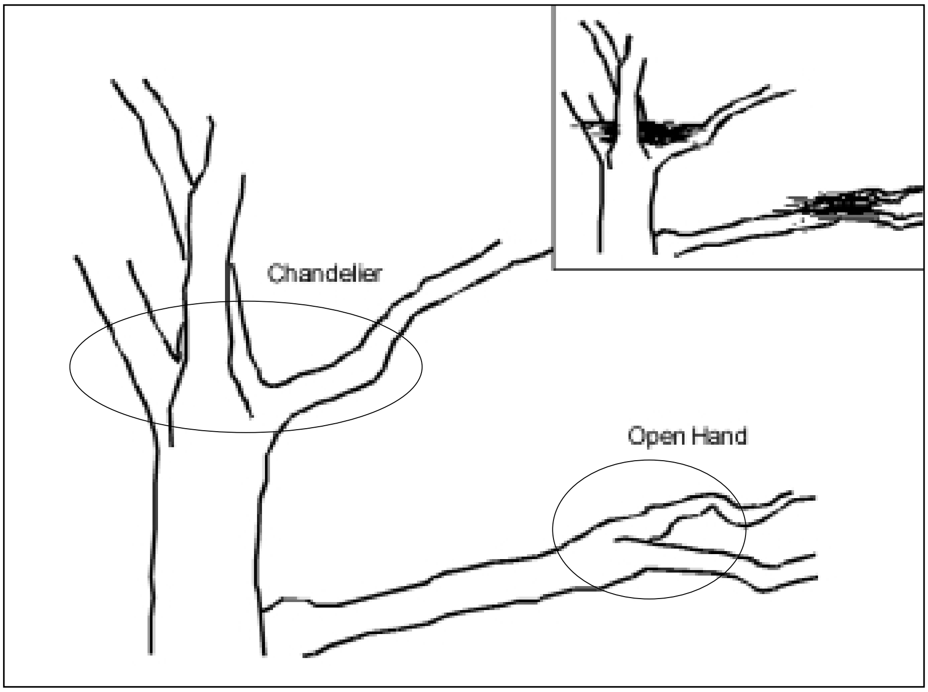

Figure 2. Typical branch platforms used by black kites to build nests. Inset: position of nests on the two types of platforms.

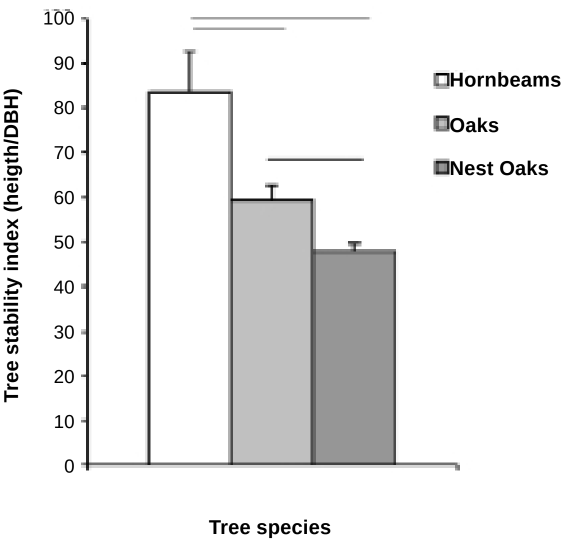

Figure 3. Stability index (mean + SE) of the 37 tallest hornbeams and oaks in the 3 sample areas and of the 37 nest-oaks found in the BF study area. Solid line: $P < 0.01$; broken line: $P < 0.05$ (one-way ANOVA, Fisher post-hoc test).

of 30 hornbeams and 30 oaks taller than 18 m showed that the number of chandeliers was very low and did not differ between the two groups (hornbeams: 0.3 ± 0.1 SD, oaks: 0.23 ± 0.1 SD; *t*-test, $P > 0.05$).

Discussion

The analysis of nest-tree characteristics in the two breeding colonies showed significant differences between heights, DBH of the nest-trees as well as heights of nests, indicating a great variability in positioning the nest. These results are in line with other data showing very different heights of nests ranging from 5 to 30 m, suggesting an opportunistic exploitation of resource availability (Cramp and Simmons 1980). However, the strong positive correlation between nest height and tree height showed that black kites positioned their nests higher in taller trees. Indeed, a very constant relative height was evident in both TM and BF, though nest heights were significantly different in the two study areas. This result may suggest that nests are positioned as high as possible, probably to avoid predation.

In both study areas, most nests were built on oaks. In TM such a preference might parallel the high oak frequency (75%, Fig. 1a); however, in BF, oaks comprise only 14 % of the wood (Fig. 1b), suggesting that kites operate a choice of tree species. To test this hypothesis, we compared oak characteristics with the most frequent tree species in BF, the white hornbeam. From our observations, it was evident that most nests were built on a branch platform that we classified as “chandelier”. According to our measurements, in a random sample of 30 hornbeams and oaks higher than the lowest nest tree found (18 m), there was no difference in the number of chandeliers. This result, along with the observation that the few nests found on non-oak trees, eucalyptus *Eucaliptus* sp., pine *Pinus pinea*, cherry *Prunus avium* and alder *Alnus glutinosa* were built on "chandelier" platforms, suggests that oaks are not preferred because of a higher availability of "chandelier" platforms.

According to data from the BF sample core areas (Mason 2002), hornbeams taller than 18 m are more frequent than oaks, suggesting that black kites do not avoid this tree species because of lack of availability of large trees. This is also confirmed by the lack of difference between the mean height of the 37 tallest hornbeams and oaks in the sample areas with the mean value of the 37 nest oaks.

By contrast, oaks and hornbeams differed markedly with respect to tree stability. Indeed, random hornbeams showed a higher value as compared to the random oaks, indicating lower tree stability, and stability of the 37 nest oaks was even higher (lower index), suggesting a tendency to choose more stable oaks within the available oak population. The apparent marked preference for stable trees as nest trees may suggest a need for trees that do not oscillate in strong winds, reducing the risk of collapse of the nest and of nest-tree itself. The stability index appeared to be, on average, around 48 in order for a tree to be used by the kites as a nest-tree. The observation that non-oak nest-trees in both study areas showed a similar, or even lower (in TM), stability index to oak nest-trees supports such hypothesis. Furthermore, our data are in agreement with Sergio *et al*. (2003a) results, which show, for 30 pre-Alpine black kite nests, a strong preference for mature trees. Although in that study tree stability was not specifically evaluated, from the reported data it is possible to extrapolate an estimate of the stability index that resulted to be very similar to ours (approximately 44.8).

In conclusion, the present study showed that black kites prefer to build their nests on "chandelier" type branch platforms, located at approximately 70% of relative tree height, and selected the most stable trees. In both study areas oaks appeared to be more likely to meet these criteria, though nests were also located on other tree species with similar characteristics. We are not aware of any other study addressing the issue of nest-tree stability in tree-nesting birds of prey. However, if the importance of tree stability will be confirmed in other studies, it will have important implications for conservation strategies. For example, on the basis of the present results, in TM we are planning to implement an experimental methodology to select and maintain trees suitable for black kite nesting during coppice management.

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