Ethology Ecology & Evolution
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/teee20

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Published online: 23 Jul 2013.

To cite this article: Ethology Ecology & Evolution (2013): Circannual variation in movement patterns of the Black Kite (Milvus migrans migrans): a review, Ethology Ecology & Evolution

To link to this article: http://dx.doi.org/10.1080/03949370.2013.812147

Ethology Ecology & Evolution, 2013
http://dx.doi.org/10.1080/03949370.2013.812147

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Circannual variation in movement patterns of the Black Kite (*Milvus migrans migrans*): a review

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Received 2 July 2012, accepted 3 June 2013

The nominal subspecies of the Black Kite is a summer resident in Europe and Asia that winters mostly in western Africa, although numbers of birds wintering in the Mediterranean area are increasing. During migrations, tens of thousands are observed migrating through the Strait of Gibraltar between Spain and Morocco, along the eastern side of the Black Sea, and in the Middle East, while substantial numbers cross the central Mediterranean and the Bosphorus. This paper provides a review of research concerning migration and its relationship with foraging behaviour in a circannual perspective. In particular, research made both by satellite tracking and by visual observations suggests a more evident time-selected migration during autumn rather than spring. Moreover, differences in timing occurring among different flyways could be explained either by different rates of intra-specific competition in areas with different breeding density and/or by different distances between wintering and breeding grounds.

KEY WORDS: *Milvus migrans migrans*, migration, Black Kite, dispersal behaviour, Mediterranean Sea.

The Black Kite has a wide distribution in all the Palaearctic, Afro-Malagasy, Indomalayan and Australasian regions, but is absent in the New World (Neartic and Neotropic). At least six subspecies are known (CRAMP & SIMMONS 1980). Among them, two live in Africa and are mostly residents or short-distance migrants. *Milvus migrans aegyptius* is found in the Nile Valley and on both coasts of the Red Sea with some individuals wintering in Sudan and coastal Kenya. *M. m. parasitus* is widely distributed in sub-Saharan Africa, Comoros, and Madagascar and has strong intra-continental

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movements (Cramp & Simmons 1980; Ferguson-Lees & Christie 2001). The nominal subspecies is almost entirely migratory and is distributed in the Western Palaearctic and in some areas of Central Asia. *M. m. migrans* (hereafter called Black Kite) is a widespread summer visitor in Europe, with a breeding population counting less than 100,000 pairs (BirdLife International 2004). Its wintering grounds are located mostly in Africa, south of the Sahara Desert, but also in the Middle East (Shirihai et al. 2000; Ferguson-Lees & Christie 2001); birds breeding in central-western Europe mostly overwinter in Western Africa (Cramp & Simmons 1980; Meyburg & Meyburg 2009).

Black Kites are opportunistic predators; they can feed on "live animals from the size of a mosquito to a 1-kg adult rabbit, and use all sources of carrion when available" (Tanferna et al. 2013: 7) exploiting concentrations of food that are spatially and temporally unpredictable (Viñuela 2000; Sergio 2003a; Cortés-Avizanda et al. 2011). This species often breeds in loose colonies (Cramp & Simmons 1980), and it has been observed that juvenile and adult survival is higher for individuals born or living in high-density areas, at least in some populations (Forero et al. 2002).

The flight behaviour of this species during migration is halfway between broad-winged raptors like buzzards, eagles and vultures and relatively long-winged raptors like *Circus* species. For this reason, Black Kites tend to use soaring flight over land during migration to minimize energetic costs and concentrate at straits and isthmuses, but they are also able to cross large bodies of water using long powered flights (Zalles & Bildstein 2000). This species is one of the most well studied diurnal raptors of the Western Palaearctic (see Sergio et al. 2009 and references therein), being an excellent model for research concerning breeding, biology and ecology. Recently, some research showed a phenotypic plasticity of the species in response to climate change: climate warming seems to trigger earlier egg laying and a northward shift of the breeding and wintering ranges (Burton 1995; Sunyer & Viñuela 1996; Moss 1998; Sarà 2003; Sergio 2003b; Sergio et al. 2007). Thus, several studies are now available, but knowledge about the migratory routes and the connectivity with African wintering grounds is still incomplete. Our aim is to review and compare information and results of some aspects of the biology of the Black Kite in order to find and discuss hypotheses on the causes that have led to different and regional migration patterns and behaviours, and to propose further research topics. For this reason, this paper focuses on the variation of movements, migration timing, and foraging behaviour of Black Kites across their range and throughout the year.

Understanding the interactions between different periods of the annual cycle in migratory birds is of the outmost importance for their conservation (Martin et al. 2007; Limiñana et al. 2012a; Mellone et al. 2012b). It has been recently shown that populations of long-distance migratory birds are declining at a faster rate than short-distance migrants or resident species (Sanderson et al. 2006). Given its wide ranging movements, optimal conservation strategies for the Black Kite should focus both on breeding and wintering grounds as well as on migration flyways, and, in this scenario, a detailed knowledge of its behaviour is of paramount importance.

MOVEMENTS

Spring migration

During the movements from Africa to Europe towards the breeding territories, an important flyway is located between the Nile Valley and the Red Sea in Egypt, and two

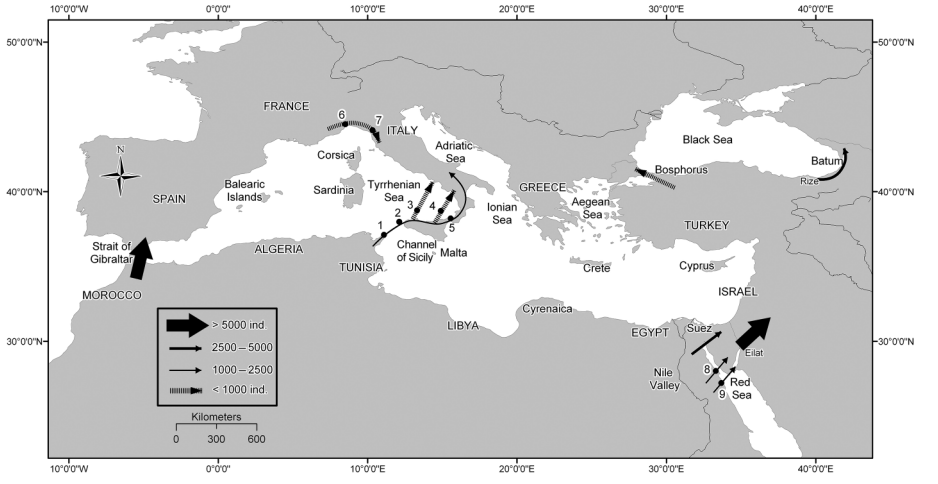

Fig. 1. — Flyways used by Black Kites (*Milvus migrans migrans*) during spring migration: 1, Cap Bon Promontory; 2, Marettimo island; 3, Ustica island; 4, Panarea island; 5, Strait of Messina; 6, Arenzano (Ligurian Apennines); 7, Apuane Alps; 8, Bûr Sâfaga; 9, Zait Bay (FINLAYSON 1992; MEININGER & DE RODER 1992; AGOSTINI & DUCHI 1994; SHIRIHAI 2000; ZALLES & BILDSTEIN 2000; MELLONE et al. 2007; HILGERLOH 2009; PANUCCIO & AGOSTINI 2010; ÜNER et al. 2010; PREMUDA & BAGHINO 2012).

watch-sites are known along this route: Bûr Sâfaga, on the Red Sea Mountains, and Zait Bay, where 925 and 1660 individuals were respectively reported (Fig. 1; ZALLES & BILDSTEIN 2000; HILGERLOH 2009). Numbers recorded at Suez are larger in spring than in autumn; up to 3860 individuals have been observed in spring (MEININGER & DE RODER 1992; ZALLES & BILDSTEIN 2000). In the Middle East, the migration takes place mostly between the second half of March and the first days of April, with few birds observed outside this period. In some years, a second, smaller wave of migration has been observed at Eilat in late April. Until the end of March, aged Black Kites were mostly adults, but in late April and May 2nd calendar-year birds predominated. At Eilat a maximum of 36,690 individuals per year were counted, in the 1980s (SHIRIHAI et al. 2000).

At the Strait of Gibraltar, 42,488 and 61,890 individuals were counted during spring 2008 and 2009, respectively, from six watch points that were used simultaneously (DE LA CRUZ et al. 2011). Here, the migration starts during the last third of February with a peak in the first half of March. Smaller numbers, mostly immature, are recorded later in the season (FINLAYSON 1992; DE LA CRUZ et al. 2011). At the Bosphorus, few birds migrate (223 individuals in 2006), with a peak recorded in late March (ÜNER et al. 2010). On the other hand, kites migrating along the eastern coast of the Black Sea (2664 counted at Fırtına river, Rize Province) in Turkey peaked in the first half of May (ZALLES & BILDSTEIN 2000; KIRWAN et al. 2008). Conversely, in the Central Mediterranean area, no individuals were recorded migrating at the Strait of Messina during the first half of March (AGOSTINI & MALARA 1997). At this and several other sites in southern Italy and Tunisia, hundreds of birds are reported migrating later in the season, between the last 10 days of March and the second third of May with a substantial passage between late April and early May, when significant numbers of immature birds are reported (AGOSTINI & DUCHI 1994; AGOSTINI & LOGOZZO 1998; PANUCCIO et al. 2004; PANUCCIO & AGOSTINI 2010). Unlike during autumn, birds migrate singly

or in small flocks, rarely comprising tens of individuals, during the spring in the central Mediterranean (Panuccio & Agostini 2010). In this area, Black Kites leave the African coast mainly at Cap Bon. Few individuals have been observed migrating outside this area, as shown by research made at the islands of Malta, Lampedusa, and along the Sardinia-Corsica corridor (Beaman & Galea 1974; Premuda et al. 2007; Corso et al. 2009). Upon reaching western Sicily, Black Kites tend to migrate on a broader front with a passage of hundreds of birds through the Tyrrhenian Sea, in particular via the islands of Ustica and Panarea (Panuccio et al. 2004; Mellone et al. 2007). The maximum number counted at the Strait of Messina was 1008 in 2000, while through the Thyrrenian Sea a maximum of 302 birds was counted at the island of Ustica in 2002 and 109 at Panarea, in 2006 (Fig. 1; Corso 2001; Panuccio et al. 2004; Mellone et al. 2007). On the other hand, the species is virtually absent at watch-sites located on the Adriatic coast of Italy (Gustin & Sorace 2004; Premuda et al. 2004, 2008), suggesting that the individuals migrating through the Central Mediterranean belong mainly to the Italian population and do not cross the sea en route to the Balkans, differently from other species (Premuda et al. 2004, 2008). Finally, some tens of Black Kites are observed in March in northwestern Italy, probably coming from the Strait of Gibraltar; the two sites where these movements are observed are Arenzano on the Ligurian Apennines and the Apuan Alps. At the latter site, Black Kites are also observed (Fig. 1) moving toward the southeast (Premuda & Baghino 2012).

Arrival date at the breeding sites and dispersal behaviour

At the breeding sites, temporal patterns of settlement vary greatly. In northern Italy, all breeding individuals settle in less than 20 days, while at Doñana National Park (Southern Spain), the population builds up rapidly at first, but new settlements span a period of about 2 months (Sergio et al. 2007). In central Italy, Black Kites reach their breeding sites mostly after the second third of March (Battisti et al. 2003; Panuccio & Agostini 2010). Older individuals arrive earlier than younger ones and the quality of territory is strongly correlated with the date of settlement, with the first individuals occupying the best-quality sites. Moreover, annual breeding performance is better in high-quality than in low-quality sites (Sergio & Newton 2003; Sergio et al. 2007). Older individuals defend their territory better than younger ones, highlighting that social dominance is age-related for Black Kites (Sergio et al. 2009). Early arrival of older individuals might be the result of the timing and efficiency of migration and could be promoted by: (1) early accumulation of sufficient body reserves to depart from the wintering quarters, (2) rapid migration speed and optimal choices along the route, (3) social dominance at stopover sites, and (4) high feeding efficiency to counter the costs of potentially unfavourable conditions during the migration journey (Berthold 1993, 1996). All the above-mentioned characteristics are likely to be met by more experienced, older individuals of larger size and/or in better physical condition (e.g. Gwinner 1990; Lindstrom et al. 1990; Marra 2000). As a result, only high-quality phenotypes will be able to meet the high risks and energetic demands of early arrival (Sergio et al. 2007).

Research made at Doñana National Park (Southern Spain) showed a high fidelity to the breeding site of Black Kites (more than 80%) and the average natal dispersal is less than 5 km (Forero et al. 1999, 2002). Among sex classes, males generally disperse shorter distances than females, while the dispersal distance decreases sharply at older ages. Short-distance movements in natal dispersal are probably related to the

benefits of philopatry (ecological and genetic) and dispersal costs associated with finding a new territory in a saturated population, such as the one studied at Doñana. Some circumstantial evidence indicates that individuals in other populations may disperse over longer distances (FORERO et al. 1999, 2002).

Autumn migration

Compared to spring, autumn migratory behaviour of Black Kites is characterised by a stronger flocking behaviour, at least in some areas of the Mediterranean (AGOSTINI et al. 2000, 2004). In this species, mortality rates are high between the first and second year of life, suggesting a very strong selection episode during the first migration and wintering (SERGIO et al. 2011b). This powerful selective force may have favoured juvenile Black Kites to migrate together with adults during their first migration, and this hypothesis could explain both the large overlap observed in the autumn migration timing of adults and juveniles and the strong tendency of Black Kites to migrate in flocks during the southbound migration (AGOSTINI et al. 2000, 2004; PANUCCIO & CANALE 2003).

During southward movements, Black Kites cross the Mediterranean mainly at the Strait of Gibraltar while substantial numbers migrate through the central and eastern Mediterranean corridors (via the Channel of Sicily and Bosphorus); the small breeding population of Greece (few tens of pairs) crosses the eastern Mediterranean between the Peloponnesus, Crete and Libya (Fig. 2; FINLAYSON 1992; AGOSTINI et al. 2000, 2004; MIGRES 2009; LUCIA et al. 2011; PANUCCIO et al. in press). The huge populations on the Iberian peninsula, France, Germany and Switzerland reach Africa through the Strait of Gibraltar (FINALYSON 1992; MEYBURG & MEYBURG 2009). At the Pyrenees, an average

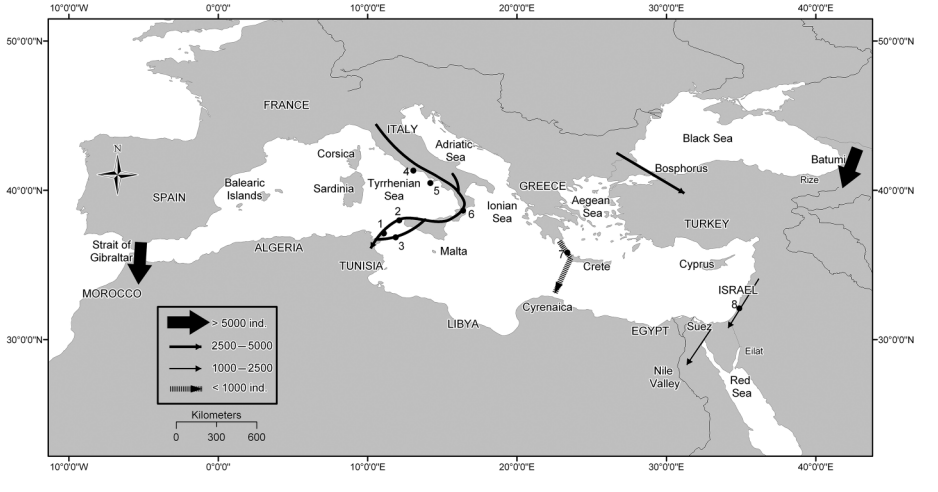

Fig. 2. — Flyways used by Black Kites (*Milvus migrans migrans*) during autumn migration: 1, Cap Bon Promontory; 2, Marettimo island; 3, Pantelleria island; 4, Circeo Promontory; 5, Capri island; 6, Calabrian Apennines; 7, Antikythira island; 8, Kfar Qassem (BIJLSMA 1983; AGOSTINI et al. 2000, 2004; SHIRIHAI et al. 2000; ZALLES & BILDSTEIN 2000; PANUCCIO et al. 2005; KIRWAN et al. 2008; MIGRES 2009; LUCIA et al. 2011; VERHELST et al. 2011).

of 12,478 Black Kites are counted moving toward the Iberian Peninsula and the Strait of Gibraltar. At this site kites are significantly advancing their autumn migration dates (Filippi-Codaccioni et al. 2010). One watch point count at the Strait of Gibraltar during autumn 2008 reported 88,986 individuals migrating almost all in August while very few migrated in September (Migres 2009).

In the Central Mediterranean area, the migration peak of Black Kites occurs in a few days between the end of August and the beginning of September with a large overlap in the migration period of adults and juveniles (Agostini et al. 2000, 2004). During their travel to reach the Channel of Sicily, they tend to follow the Italian Peninsula, avoiding crossing the Tyrrhenian Sea (Panuccio et al. 2005). At watch sites located along the mountain chains inland of southern continental Italy (Serre and Aspromonte mountains), hundreds of Black Kites were observed with a daily peak in the late afternoon–evening when many birds, apparently coming from the coastal area, were seen roosting (Panuccio et al. 2005, 2007). Upon reaching Sicily, Black Kites concentrate on the western side of the island, crossing the Mediterranean Sea via the Channel of Sicily and flying over the islands of Pantelleria and Marettimo; in doing so, they form huge flocks (Fig. 2; max. 3600 counted over Marettimo between 24 August and 14 September 1998; max. 1100 seen together; Agostini et al. 2000, 2004). These counts, compared to those made in spring along the same flyway (Corso 2001; Panuccio & Agostini 2010), suggest that higher numbers of Black Kites use the central Mediterranean flyway during southbound movements. In September and October a few kites, mostly juveniles, are recorded (Agostini et al. 2000; Panuccio et al. 2011). Since, in Central Italy, some juveniles are not yet fledged in August (Petretti 1992; Panuccio & Canale 2003), it has been suggested that migrating flocks of juvenile Black Kites reported in September at the islands of Marettimo and Pantelleria are probably juveniles belonging to these later breeding pairs (Agostini et al. 2000; Panuccio & Canale 2003). Unlike southern Italy, in northwestern Italy, only a few hundred Black Kites are observed migrating through the Marittime Alps en route to the Strait of Gibraltar (Toffoli & Bellone 1996; Giraudo & Toffoli 2003).

Along the eastern corridor, movements of Black Kites are reported at the Bosphorus (max. 2707 individuals were counted in 1971). At this site the passage starts in mid-August and lasts until October (Kirwan et al. 2008). More eastward, individuals belonging to the Russian population are, at least partially, funnelled along the eastern coast of the Black Sea: at Batumi (Georgia), recent observations estimated the passage of about 100,000 Black Kites mostly during the second and third ten-day period of September (median date: 19 September; Verhelst et al. 2011). In Israel, the main passage is recorded during the first half of September with a yearly average of 676 at Kfar Qassem (1982–1987) and 1574 in the Northern Valleys (1988–1998; Shirihai et al. 2000). At the Channel of Suez and at Bab-el-Mandeb only 579 and 106 individuals were observed, respectively (Bijlsma 1983; Welch & Welch 1988); moreover, 610 individuals were recorded during a 1-day count on a mountainous site of Yemen, located about 100 km NE to the Strait of Bab-el-Mandeb (Zalles & Bildstein 2000). Information concerning migration of Black Kites entering Africa from Asia is incomplete and further research should verify if Black Kites use a broad or a narrow migrating front through the Red Sea. In East Africa, birds moving from the Bab-el-Mandeb Strait are likely to continue inland following the Rift Valley, perhaps until Burundi (Fig. 3); finally, at Lake Langano (Ethiopia), the passage of about 1000 Black Kites moving southwest has been reported (Zalles & Bildstein 2000).

Up to now, little information concerning global positioning system (GPS)-tracked Black Kites has been available; however, in a recent methodological paper, Tanferna

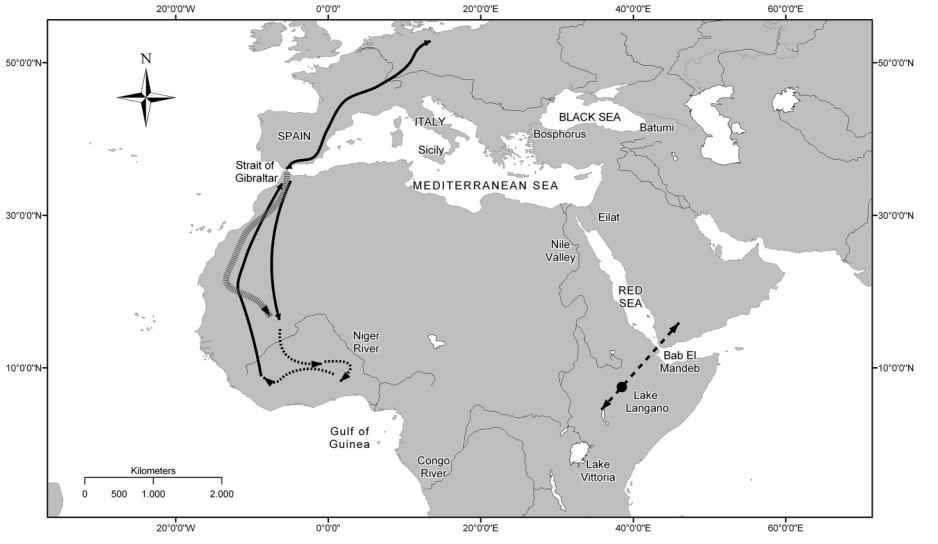

Fig. 3. — Solid lines: simplified plotted flyways used during migrations of Black Kites (*Milvus migrans migrans*) (MEYBURG & MEYBURG 2009). Dotted lines: wintering movements in western Africa of a tracked Black Kite (MEYBURG & MEYBURG 2009). Dashed line: simplified plotted flyway followed by Black Kites during autumn migration and reported by TANFERNA et al. (2012). Sketched line: flyway used by migrating Black Kites through the Bab-El-Mandeb Strait and moving along the Rift Valley (WELCH & WELCH 1988; ZALLES & BILDSTEIN 2000).

et al. (2012) showed four tracks of Black Kites during autumn migration. Those individuals started the migration between 11 July and 8 August and reached south Saharan Africa between the end of July and the end of August. The time of migration seems to vary between 8 and 17 days while the migratory paths were more or less NE–SW-oriented (Fig. 3). These four birds were tracked from Doñana National Park, and they crossed the Sea at the Strait of Gibraltar while they reached an area of SE Mauritania close to the border with Mali (Fig. 3), similarly to the individual tracked by MEYBURG & MEYBURG (2009; TANFERNA et al. 2012).

WINTER: DISTRIBUTION AND MOVEMENTS

Wintering Black Kites are widely distributed in sub-Saharan Africa south to Cape Province with the exception of dense forests (FERGUSON-LEES & CHRISTIE 2001). Their density, however, appears not to be homogeneous since, in some areas, this species is a very scarce wintering bird (THIOLLAY 2001; SEAVY & APODACA 2002). Previous studies indicate Ethiopia as the main wintering area, while more recent ones show that it is the dominant species in winter in the Sahel raptor communities, suggesting that the European population of Black Kites winters in a narrow fringe in the western Sahelian regions (CRAMP & SIMMONS 1980; ANADON et al. 2010). Recent studies showed a decrease of 70% of kites in the Sahel, in particular outside of protected areas, probably due to the increasing density of human population and the large use of pesticides (THIOLLAY 2006; ANADON et al. 2010). Another important wintering area of

Black Kites is the Middle East, in particular in Israel where in many areas it is the most common wintering raptor, with increasing numbers from the 1980s to the 1990s. Up to 9966 individuals were counted during winter counts in 1997–1998 (Hula Valley and Western Negev; SHIRIHAI et al. 2000). The distribution of wintering Black Kites in the Middle East appears to be age-dependent: in the Hula Valley (northern Israel) 40% of aged birds were adults and sub-adults and 60% were first- and second-winter birds; on the other hand, in Western Negev (southern Israel) the first- and second-winter birds made up 90% of the population (ALON & SHIRIHAI 1991). Recently, relevant concentrations of wintering Black Kites in southeast Turkey have been reported (BIRICIK & KARAKAŞ 2011). Further research should verify if these observations are local phenomena or are widespread in the Middle East and if, similarly to the Mediterranean area, they are a result of the shift of wintering grounds due to climate change. On the other hand, they may also be historical wintering sites.

During winter, a male Black Kite tracked (winters 2007–2008 and 2008–2009) by satellite covered a striking distance of at least 7000 km per year within its wintering ground, moving consecutively into three different areas (MEYBURG & MEYBURG 2009; Fig. 3). At first, the Black Kite, moving from the Strait of Gibraltar, reached an area between Mali and Mauritania [latitude (Lat) 15.5°N, longitude (Long) 6.5°W]; in December it moved southwest between Ghana and Togo (Lat 10°N Long 0°W); finally, in February, the Black Kite moved westwards between Guinea and the Ivory Coast (Lat 9°N Long 8°W). The first area was characterized by bare ground and open scrubland, the other two by woodland and wooded grassland. The tracked individual seldom used the same roost for more than one night, covering a distance of 31–42 km between consecutive roosts (MEYBURG & MEYBURG 2009). It is likely that the distribution of Black Kites wintering in the Sahel area largely responds to unpredictable abundant feeding sources, and in particular to locust outbreaks (SÁNCHEZ-ZAPATA et al. 2007).

WATER-CROSSING BEHAVIOUR

For Black Kites, similarly to other soaring birds, seas are ecological barriers that greatly influence their movements. However, this species is able to cross wide stretches of water, as shown by hundreds of individuals observed migrating in spring over the Tyrrhenian Sea, facing a long powered flight of about 250 km from the northern coast of Sicily to the coasts of Central Italy (PANUCCIO & AGOSTINI 2010). At the Strait of Messina, 19 Black Kites were radar-tracked. Their median altitude of flight was 280 m above sea level, and they did not select the absolute best tailwind assistance, as was also previously observed for other raptor species in the area (AGOSTINI et al. 2007; PANUCCIO 2011; MATEOS-RODRÍGUEZ & LIECHTI 2012).

In spring, at the Strait of Gibraltar, Black Kites tend to cross the Strait at its narrowest point, but wind drift largely occurs with the migration front sometimes expanding from Cape Trafalgar on the west to Guardiaro on the east (FINLAYSON 1992). On the European side of the Strait, kites are often observed approaching the coast flying "low, flapping continuously to avoid waves, and attempt[ing] to land along the coast, apparently exhausted" (FINLAYSON 1992: 47). As mentioned above, in the Central Mediterranean area, Black Kites are more likely to migrate over the open sea in spring rather than in autumn (PANUCCIO et al. 2004, 2005; MELLONE et al. 2007). Nevertheless, both at the Cap Bon promontory and at the island of Ustica they hesitate when facing the open sea; at both sites, several kites often stop migration, sometimes for several days (AGOSTINI & DUCHI 1994; PANUCCIO & AGOSTINI 2010). On the other

hand, during autumn, Black Kites migrate along narrow corridors to reduce the over-water flight distance. Migration outside the main bottlenecks is virtually absent: at the islands of Cabrera, Malta, and Cyprus only few migrating individuals (mostly inexperienced juveniles) are reported (Rebassa 1995; Sammut & Bonavia 2004; Roth & Corso 2007). Also, a migration over the Tyrrhenian Sea is nearly absent in autumn, as shown by a lack of kite observations at the islands of Capri, Ustica and Panarea, and at the Circeo Promontory (Jonzén & Petterson 1999; Agostini & Panuccio 2003; Panuccio et al. 2005). Observations made in both Spain and Southern Italy confirm the reluctance of Black Kites to undertake sea crossings. At the island of Marettimo, they hesitated when facing the open sea by soaring over the island for many hours (Agostini et al. 2000; Panuccio 2005b). At the Strait of Gibraltar, they followed the shortest sea crossing where the distance between Spain and Morocco is narrower (Tanferna et al. 2012). At this site, considerable wind drift over the sea occurs during both easterly and westerly winds (Finlayson 1992). When weather conditions are not ideal for the flight over water, especially on days with strong crosswinds, kites stop on the Spanish side of the Strait for several days (Finlayson 1992). At the island of Marettimo and the Strait of Gibraltar, Black Kites are observed spending long periods "hanging" on the wind without advancing. Moreover, Finlayson (1992) reported flocks of Black Kites attempting to cross the Strait and returning inland.

SEASONAL FEEDING BEHAVIOUR AND GREGARISM

Spring

In the Central Mediterranean region in spring, migrating Black Kites are regularly seen feeding, as reported for the island of Ustica and the Strait of Messina (Giordano et al. 1995; Panuccio & Agostini 2010). In Israel, large flocks were recorded gathering to hunt termites and locusts (Bahat 1985; Shirihai et al. 2000). These observations indicate that Black Kites show opportunistic feeding behaviour when they meet significant food resources during their migratory journey.

Summer

During the breeding season, the Black Kite shows territorial behaviour, defending an area of about 100–200 m radius around the nest while it forages in undefended communal hunting grounds up to several kilometres away from the nest (Sergio & Newton 2003). In northern Spain during summer, Black Kites might aggregate when resources are clumped and patchily distributed (Cortés-Avizanda et al. 2011). At the breeding sites in northern Italy, Black Kites select hunting areas around water bodies, extensively managed and unmanaged grassland, and urban areas while avoiding woodlands, while at the Doñana National Park they also avoid farmlands and over-select open semi-natural habitats (Sergio 2003a; Sergio et al. 2003a, 2003b) with a diet dominated by wetland prey species (Hiraldo et al. 1990; Forero et al. 1999). The inundation levels of wetlands are unpredictable in arid and semi-arid climates such as in the Mediterranean region, and the Black Kite reproduction rate is strongly influenced by this environmental factor. Therefore, this species has to adjust its breeding timing (i.e. asynchronous clutches) to permit optimal resource tracking (Sergio et al. 2011a). Their preference for water bodies is linked to fish, locally their main prey, while

open areas are used for hunting small animals (i.e. snakes, passerines, small mammals; Sergio 2003a; Sergio et al. 2003a; Gensbøl 2008). At the Doñana National Park, rabbits are another locally dominant prey in the Black Kite diet (Viñuela & Veiga 1992; Viñuela et al. 1994). Finally, urban areas are used to find carrion or waste from butchery also found at the dumping grounds; high concentrations of terrestrial food may also act in the same way as wetlands (Viñuela et al. 1994; Blanco 1994, 1997). Higher temperatures at breeding areas allow better hunting activity, while rain negatively affects it (Sergio 2003a). During summer, the feeding activities of breeding individuals is sex-dependent, with females hunting around the immediate vicinity of the nest and males searching for food mostly in areas far from the nest, since the home ranges of breeding females is about the half the size of males (Forero et al. 1999; Tanferna et al. 2013). On the other hand, ranges are larger for floaters than for breeders, and both categories co-exist, selecting and avoiding the same habitats during the breeding season (Tanferna et al. 2013).

Differently from other species of raptors, such as the Honey Buzzard (*Pernis apivorus*) and the Short-toed Snake Eagle (*Circaetus gallicus*, Panuccio & Agostini 2006; Mellone et al. 2011), younger Black Kites return to Europe for summertime, reaching at least southern Europe (Cramp & Simmons 1980). The population of this species is, therefore, composed of both territory holders and non-territorial, non-breeding individuals, commonly known as floaters (Newton 2008; Sergio et al. 2011b). In different populations of Black Kites, a trophic segregation between breeding and non-breeding individuals has been reported. For instance, during summer, the rubbish dumps near Madrid are used almost exclusively by floaters (Blanco 1994, 1997), while in Doñana non-breeding birds feed mainly on small prey (invertebrates) and carrion, whereas breeding pairs, constrained by the fidelity to a central place of foraging (the nest), exploit mainly medium-size reptiles, birds and mammals (Espina 1984 quoted in Sergio et al. 2007). Compared to territory holders, floaters of both sexes are smaller, younger and arrive late in the season from the wintering grounds (Sergio et al. 2009). It has been shown that young floaters are physiologically capable of reproduction (Blas & Hiraldo 2010) and, therefore, the cause for deferred breeding may have an ecological rather than a physiological basis, in which the limited access to breeding territories plays an important role. As a matter of fact, the Doñana National Park population shows a high density of breeding pairs, and young birds have poorer competitive abilities for resource and territory defence (Blas & Hiraldo 2010).

Autumn

At the end of their breeding season, kites belonging to the same colony tend to aggregate in roosts, and they often leave breeding sites together; moreover, their flocks increase in number during migration when they meet other migrants along the way or at stopover sites like rubbish dumps or burning cultivated fields (Blanco 1994, 1997; Panuccio & Canale 2003; Panuccio 2005a; Panuccio et al. 2005). For this reason, large concentrations of Black Kites were reported in August in different areas of Italy: more than 1000 at the rubbish dump of Turin (northwestern Italy), hundreds in the rubbish dumps of central Italy and around burning cultivated fields in western Sicily (Panuccio 2005a; Panuccio et al. 2005). In addition, when kites are moving southwards along the Italian peninsula, they are expected to fly mostly into flat areas close to the Tyrrhenian coast where they find suitable areas for feeding (Panuccio et al.

2005). Conversely, at the Strait of Gibraltar, the Black Kites that are forced to stop their migration due to bad weather apparently do not take advantage of these periods to feed (BERNIS 1980 quoted in FINLAYSON 1992).

Winter

THIOLLAY (1989) reported habitat segregation between European and African subspecies (*M. m. parasitus*), with the former apparently feeding mostly in wetlands and the latter in open areas and around villages. In West Africa, Black Kites feed on arthropods and carcasses of domestic ungulates, as revealed by pellet analysis (CORTÉS-AVIZANDA et al. 2011). In Rhodesia, migrants were seen mainly in flocks, whereas local birds are observed mostly singly or in pairs (MOREAU 1972). The increasing flock size could be related to the different foraging behaviour of wintering kites. SÁNCHEZ-ZAPATA et al. (2007) showed that Black Kites change their foraging behaviour, abandoning urban areas and garbage dumps and increasing group size in response to desert locusts outbreaks, whereas they usually remain widely and nearly randomly distributed since food in the Sahel is widespread (CORTÉS-AVIZANDA et al. 2011). In general, wintering raptors in the Sahel are more abundant around crops and close to town (ANADON et al. 2010). As a result, roosts and concentrations of Black Kites may be extremely vulnerable due to pesticide spraying; in fact, since local outbreaks of grasshoppers in fields and large nomadic swarms of locusts are major food sources for wintering kites, aerial and ground sprayings of insecticides often wipe out this resource and indirectly kill many kites (MINEAU 2002; THIOLLAY 2006; SÁNCHEZ-ZAPATA 2007). Moreover, the Sahel region has degraded during recent decades as a consequence of severe droughts and human activities, and this situation could adversely affect the wintering populations of Black Kites (CORTÉS-AVIZANDA et al. 2011).

CONCLUSIONS

Factors potentially influencing differences in timing of migration

The current state of research shows that migration timing of the Black Kite largely varies across the Mediterranean basin (Strait of Gibraltar vs other flyways). This may be due to their highly plastic behaviour, which is affected by different factors. Among them, different densities at the breeding sites could play a role. Black Kites migrating through the Strait of Gibraltar belong to populations from Western Europe, where there have been estimated to be roughly 30–40,000 pairs (BIRDLIFE INTERNATIONAL 2004; BENSUSAN et al. 2007). If higher competition for resources occurs in Western Europe rather than in Italy or Eastern Europe, where the population density is lower (FERGUSON-LEES & CHRISTIE 2001), birds belonging to the populations breeding in Spain, Portugal and France could be forced to reach their nesting sites as soon as possible in spring. This could explain the evident peak passage of this species at the Strait of Gibraltar at the beginning of March, and why the migration occurs later in the central Mediterranean and around the Black Sea (KIRWAN et al. 2008; PANUCCIO & AGOSTINI 2010). Several studies, focused on population dynamics, provide further support to this conclusion; in particular, some authors showed that younger Black Kites delay territoriality as a voluntary restraint in order to enhance longevity and the quality of the territory eventually acquired (SERGIO et al. 2009). This hypothesis has been developed

in a context of high density of breeding pairs. SERGIO et al. (2009) showed that age alone could not be the sole predictor of territorial status, because a wide overlap in the age structure of floaters and holders occurs. The other important predictor is the spring arrival date, with early arriving birds having a higher likelihood to acquire a territory (SERGIO et al. 2007, 2009). Moreover, high individual philopatry in a population would result in a surplus of individuals in relation to vacant places, and would retard the first breeding attempt until birds are between 3 and 5 years old (FORERO et al. 2002). In this picture, the delayed spring migration in the central Mediterranean and in Turkey could be a result of low density, and therefore lower competition, in the breeding areas of those populations (AGOSTINI & DUCHI 1994; KIRWAN et al. 2008; PANUCCIO & AGOSTINI 2010). Black Kites breeding in areas with a low density of pairs could be less motivated to arrive as early as possible from the wintering ground. Moreover, it is reasonable to expect that in areas with a low density of territorial individuals, a lower competition for nest sites could allow a higher percentage of younger individuals to hold and defend a territory and to attempt reproduction, since it has been demonstrated that young individuals are physiologically ready for reproduction (BLAS & HIRALDO 2010).

It is not possible to exclude, however, a relationship between timing of migration and the distance between breeding and wintering grounds. In the case of the tracked kite breeding in Germany and wintering in Western Africa, the migratory distance was about 4600 km (MEYBURG & MEYBURG 2009); however, it is likely that Black Kites wintering in Israel are closer to their breeding grounds. Further investigations should provide information on the wintering grounds of Black Kites belonging to the population from Eastern Europe and Russia.

Another factor that could influence the timing of migration is climate differences among breeding areas. This is evident in species breeding in a wide latitudinal range because "the rates at which most bird species move towards higher latitudes in spring seems to be associated with the dates that their particular foods become available at successive latitudes" (NEWTON 2008: 402). It is obvious that the climate in early spring is warmer in Spain than in Russia. Since the autumn departure dates also depend on spring arrival dates (NEWTON 2008), it is possible that the migratory phenology of Black Kites nesting in Russia and passing through southwest Georgia (VERHELST et al. 2011) in September is influenced by the fact that spring arrives later in Russia than in Spain. Similarly, migrating Ospreys (*Pandion haliaetus*) breeding in Florida arrive earlier in spring and leave their breeding areas earlier in autumn than Ospreys do from further northern nesting sites, while they spend as much time in winter territories (MARTELL et al. 2004). Unfortunately, information concerning the advance of migration timing and arrival/departure dates at the breeding sites is patchy (FILIPPI-CODACCIONI et al. 2010). However, it is likely that the advance of migration dates is proportional to the migration phenology of the considered population.

Loop-migration strategy?

Another evident difference concerning spring and autumn movements occurs in the central Mediterranean area. In this area, Black Kites show a narrower front, associated with a higher concentration in time, during autumn rather than spring migration. A higher concentration in time should be associated with a time-minimization strategy and, thus, with a stronger tendency to cross the sea in order to reach the breeding

grounds as soon as possible. Among, birds, generally, migration is more time-selected during spring (NILSSON et al. 2013) and, therefore, the pattern observed in Black kites is quite unusual also from this point of view. In particular, birds are expected to migrate more quickly during spring in a scenario of intra-specific competition during the breeding season (KOKKO 1999). In agreement with research made by the visual observations that we reviewed, MEYBURG & MEYBURG (2009) showed that a Black Kite breeding in Germany covered the migratory distance during autumn migration more rapidly (2007: 234 km/day, 2008: 256 km/day) than during spring movements (215 km/day in spring 2008 and 191 km/day in spring 2009), unlike other raptor species (MELLONE et al. 2012a; LIMIÑANA et al. 2012b; NILSSON et al. 2013). AGOSTINI (2002, 2003) speculated on this pattern, suggesting that it may be related to higher competition for resources in the African wintering areas where migratory European birds meet resident individuals. As a result, Black Kites should minimize time during autumn migration, and some birds crossing the Mediterranean at the Strait of Gibraltar in spring could use loop migration passing through the Central Mediterranean in autumn (for instance, some of the birds breeding in northern Italy; see also PREMUDA & BAGHINO 2012). In this scenario, it is interesting to report that in a similar species, the Red Kite (*Milvus milvus*), the wintering individuals studied in Doñana National Park, in southern Spain, showed a segregation from the resident conspecific, concerning feeding areas, food habits and also roosting sites (HEREDIA et al. 1991). The faster autumn migration time recorded in the Black Kite could also be related to its food habits, strictly linked to seasonal resources that break down abruptly (BUSTAMANTE & HIRALDO 1990). Therefore, trans-Saharan migrants could benefit from early departure from the nesting grounds, because they can reach Sahel at its greenest when feeding opportunities are at their maximum. Since the northern summer is the wet season in Sahel area, migrant species that overwinter in this region face progressively worsening conditions from the time they arrive in Africa to the time when they leave (NEWTON 2008).

The American Kestrel (*Falco sparverius*) takes an advantage in arriving early in the wintering grounds because early-arriving individuals occupy the best territories (SMALLWOOD 1998). Not only territorial species benefit from an earlier arrival in wintering areas. Also, in gregarious species (i.e. waders), it has been observed that as more birds arrive and interactions increase, birds progressively occupy less favoured places (NEWTON 2008).

Future studies should clarify differences in the migration timing along the different flyways and investigate the complex migration patterns of Black Kites migrating through the Central Mediterranean area in spring and autumn, as well as their wintering behaviour in Africa, possibly by means of satellite telemetry.

ACKNOWLEDGEMENTS

We would like to thank Lucia Fanini and three anonymous referees for their useful help and suggestions on an earlier draft of the manuscript. We also thank Kelsey Horvath for reviewing the English of the manuscript. Ugo Mellone is supported by an FPU grant of the Spanish Ministry of Education (AP2008-0947). MEDRAPTORS (www.raptormigration.org), a network of ornithologists and birdwatchers, works to improve research and the protection of migrating birds of prey through specific projects and observation camps.

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