Raptor migration in Greece: a review

MICHELE PANUCCIO[1]*, NICOLANTONIO AGOSTINI[1], CHRISTOS BARBOUTIS[2,3]

[1]MEDRAPTORS (Mediterranean Raptor Migration Network) - Via Mario Fioretti 18, 00152 Rome (Italy)
[2]Antikythira Bird Observatory, Hellenic Ornithological Society - Themistokleous 80, 10681 Athens (Greece)
[3]Natural History Museum of Crete, University of Crete - P.O. Box 2208, 71409 Heraklion, Crete (Greece)
**Corresponding author: Michele Panuccio (panucciomichele@gmail.com)*

Abstract – Greece is located at the southernmost end of the Balkan Peninsula and the shortest distance between Greece and north Africa is roughly 280 km. As raptors mostly fly over land exploiting thermal currents, the ecological barrier shaped by the Mediterranean Sea south of Greece, has a strong impact on the migration strategy adopted by each species. Using data from recent studies at three watchsites in Greece (island of Antikythira, Mount Olympus, National Park of Dadia-Lefkimi-Soufli) we discuss the migratory behaviour of some selected species. The three commonest species were the Eurasian marsh harrier *Circus aeruginosus*, the western honey buzzard *Pernis apivorus* and the short-toed snake eagle *Circaetus gallicus*. The first migrates on a broad front over the sea. A similar migration strategy is adopted also by the Eleonora's falcon *Falco eleonorae*. The western honey buzzard performs a loop migration strategy concentrating over the island of Antikythira in autumn but bypassing it in spring. The short-toed snake eagle, on the other hand, avoids the crossing of the Mediterranean Sea performing a long detour and crosses the sea at the Bosphorus. Observations suggest that the levant sparrowhawk *Accipiter brevipes* and the lesser spotted eagle *Aquila pomarina* adopt a similar strategy. Finally, species such as the common buzzard *Buteo buteo* and the sparrowhawk *Accipiter nisus* do not cross the Mediterranean Sea but move across Greece to winter in southern Greece.

Key-words: Mediterranean, island of Antikythira, Mount Olympus, National Park of Dadia-Lefkimi-Soufli, water-crossing behaviour.

INTRODUCTION

Every year a huge number of Palaearctic birds, at the end of their breeding season, leave the European territories heading towards their wintering areas often located in Africa (Berthold 1993). In doing so birds face different natural barriers, among them the Mediterranean Sea. Land birds cannot feed or land over water and, during the crossing, the weather could suddenly change (Alerstam 1990). Migratory birds show different strategies to increase their survival chances during migration. These strategies may be both, morphological and behavioural (Åkesson & Hedenström 2007, Newton 2008). In particular, broad-winged raptors move mostly using soaring-gliding flight while the majority of land birds move using flapping flight (Newton 2008). As a result during migration Passerines and other small birds select the flight altitude in order to find the best tailwind assistance more than soaring raptors (Mateos-Rodríguez & Liechti 2012). Moreover raptors migrate mostly during the day since they use thermals over land avoiding to fly over water surfaces where they are forced to use powered flight (Newton 1979). However, among raptors, there are different degrees of dependence on soaring flight; Kerlinger (1989) suggested that the shape of the wings could explain the water crossing tendency of raptors, while recent research showed that also the weight of the bird, and therefore the energy consumption rates, is of paramount importance (Panuccio *et al*. 2012, 2013b).

Relevant numbers of raptors crossing the Mediterranean Sea are observed at the Strait of Gibraltar, at the Channel of Sicily and at the Bosphorus (Agostini *et al*. 2004a, Panuccio *et al*. 2005a, Kirwan *et al*. 2008, MIGRES 2009). At every of those mentioned sites the observed specific composition of migrating raptors is different from each other. This is also related to the different length of the stretches of sea. For instance the minimum distance between Italy and Tunisia is about 130 km, a real barrier for eagles but not for harriers, Black Kites and European Honey Buzzards (Agostini & Panuccio 2005, 2010). More East, Greece is located at the southern end of the Balkan Peninsula that lies south in an indented coast characterized by peninsulas and islands. The narrowest point between Greece and Africa is about 280 km between the large island of Crete and the Cyrenaica Peninsula in Libya. The

barrier represented by the Mediterranean Sea in this area strongly influences the migration of birds moving through the Balkans: only few species could attempt to undertake that long water crossing successfully (Kerlinger 1989, Lucia *et al*. 2011). As a result, their main flyways through the Balkans and in the Eastern Mediterranean area converge at the Strait of Bosphorus (Kirwan *et al*. 2010, Panuccio *et al*. 2012). Because of the peculiar geography of Greece, the different species use different migration strategies when moving between the Balkans and Africa. Until the early years of this century only patchy information was available on raptor migration in Greece (Handrinos & Akriotis 1997), while in the last decade some research carried out by independent organizations has revealed some migration strategies performed by the different species (Agostini *et al*. 2012, Lucia *et al*. 2011, Panuccio *et al*. 2011a, 2012, Schindler *et al*. 2009). The aim of this paper is to review these recent findings and attempt to give an overall view.

METHODS AND MATERIALS

This review is based on studies made at three watch-sites in Greece: the National Park of Dadia-Lefkimi-Soufli Forest (DNP) and Mount Olympus in north Greece and the island of Antikythira in the south (Lucia *et al*. 2011, Panuccio *et al*. 2011a, Schindler *et al*. 2009; Fig. 1), as well as a satellite tracking study of the Eleonora's falcon in the Aegean Sea (Kassara *et al*. 2012).

Description of watchsites

DNP is a protected area in Thrace, close to the border with Turkey and situated inland along the Evros valley, ca. 80 km northwest of the Dardanelles Strait. For more details on the main habitats of the site see Schindler *et al*. (2008). In this area migrating raptors tend to follow the Evros river valley moving toward north. Raptor migration at the site was monitored during the spring of 2003, 2004 and 2005 (Schindler *et al*. 2009).

Mount Olympus (2917 m) is the highest mountain in Greece and is located between the regions of Thessaly and Macedonia, close to the Aegean coast; it is enclosed within a National Park. In this area, migrating raptors are constrained to fly along a narrow corridor between the eastern slope of the mountain chain and the sea (Panuccio *et al*. 2012). Since a valuable fraction of the Greek population of short-toed snake eagles migrates there, it has been proposed to consider the eastern slope of this mountain as an Important Bird Area (Panuccio *et al*. 2011a). Observations were made in autumn 2009 and in spring 2010.

Antikythira is a small island (20 km^2; max. altitude 378 m), oriented in a NW-SE direction, located 32 km SE of the island of Kythira, 59 km S of the Peloponnesus and 33 km NW of Crete, which in turn is located approximately 280 km NE of the Cyrenaica Peninsula. Systematic counts were made during both spring (2007 and 2008) and autumn (2007, 2008 and 2009). In spring, migrating raptors typically approached from the southeast, presumably via Crete, and disappeared towards Kythira to the northwest, while the opposite occurred in autumn (Lucia *et al*. 2011).

The species taken into consideration in this review are the Eurasian marsh harrier *Circus aeruginous*, the western honey buzzard *Pernis apivorus*, the short-toed snake eagle *Circaetus gallicus*, the common buzzard *Buteo buteo*, the booted eagle *Aquila pennata*, the levant sparrowhawk *Accipiter brevipes*, the sparrowhawk *Accipiter nisus*, the black kite *Milvus migrans*, the lesser spotted eagle *Aquila pomarina*, the Egyptian vulture *Neophron percnopterus* and the Eleonora's falcon *Falco eleonorae*.

RESULTS AND DISCUSSION

Eurasian marsh harrier *Circus aeruginosus*

No more than 80 pairs breed in Greece, mostly in the north (BirdLife 2004, Handrinos & Akriotis 1997). On the other hand the whole country is visited during both migrations as well as during the winter in the main wetlands (De Nobel *et al*. 1990).

During spring movements few tens of individuals were observed migrating at the different watch-sites. At DNP the peak of migration was recorded in early April, similarly to other Mediterranean sites (Agostini & Panuccio 2010, Schindler *et al*. in press), while at the other two sites observations in the peak period of this species are lacking (Lucia *et al*. 2011, Panuccio *et al*. 2011a). However, at the island of Antikythira some tens of individuals were recorded migrating between mid-April and mid-May.

In autumn 268 individuals were reported migrating at Mount Olympus, while up to 187 were observed at the island of Antikythira during simultaneous observations (Lucia *et al*. 2011, Panuccio *et al*. 2013b). A compared analysis between the two sites suggested that the migratory flow at the island was not correlated with the migratory flow at Mount Olympus.

The timing of migration was different at the two sites as well as sex and age composition of the observed individuals. In particular the proportion of juveniles was higher at Mount Olympus than at Antikythira while, comparing the proportion of individuals belonging to different sex classes, adult males outnumbered adult females at the

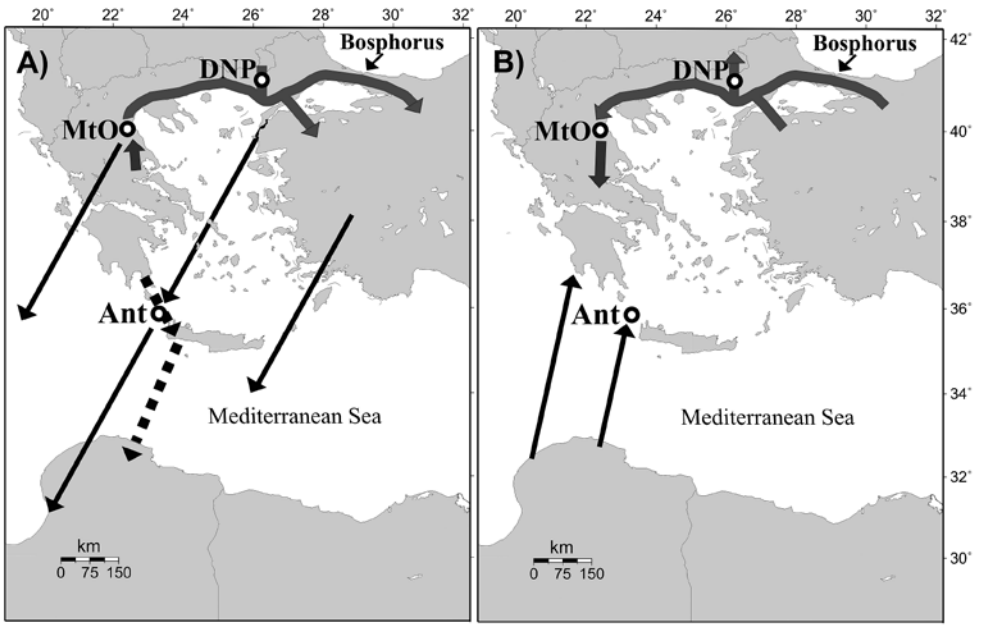

Figure 1. Locations of the watchsites of the study: Antikythira (Ant), Mount Olympus (MtO) and the National Park of Dadia-Lefkimi-Soufli Forest (DNP). A) The grey solid arrows represent the detour migration, the black arrows the broad front migration and dotted arrows the funnelled migration of the Honey Buzzards during autumn period. B) The grey solid arrows represent the detour migration and the black arrows the broad front migration during spring.

island of Antikythira rather than at Mount Olympus (Panuccio *et al*. 2013b). These results suggested that Eurasian marsh harriers tend to travel along parallel NE-SW flyways using parallel migration paths over water and over land, just as they do in the Central Mediterranean region (Agostini *et al*. 2003, Agostini & Panuccio 2010). The higher percentage of adult males observed at the island of Antikythira appears to confirm that in autumn they tend to migrate earlier and over longer distances than adult females; in fact some authors have hypothesized (Agostini & Logozzo 2000, Panuccio *et al*. 2005b) a latitudinal segregation of sexes over the populations of this species that are entirely migratory. This is in agreement with observations in Greece showing that adult males are extremely rare in winter (Handrinos & Akriotis 1997). The tendency of males to migrate over further distances than females seems to be confirmed by ringing recoveries analysis (Panuccio *et al*. 2013c). Finally, the higher percentage of juveniles observed migrating at Mount Olympus rather than at Antikythira could reflect their tendency to follow leading lines of the mainland during their first migration (Kjellén 1992; Panuccio *et al*. 2005a).

Western honey buzzard *Pernis apivorus*

Between 1000 and 2000 breeding pairs of this species are estimated in Greece (BirdLife International 2004). The most important watch-site for this species is the island of Antikythira, where up to 1300 individuals were observed (Lucia *et al*. 2011). At this site the peak of migration occurs during the last ten days of August, when almost all adult individuals were observed. In September the passage over the island is less intense and involves mostly juveniles (Agostini *et al*. 2012). At Mount Olympus observations in the peak period of adults are lacking, however in September the passage of 177 individuals, mostly juveniles, was reported (Panuccio *et al*. 2011a). The comparison of the autumn movements of the species at Mount Olympus and at the island of Antikythira suggests a correlation between the two sites. Probably, at least some of the individuals migrating through continental Greece, once reached the south Peloponnese follow the fingers of the peninsula and cross the sea via the islands of Kythira, Antikythira and Crete en route to Libya (Panuccio *et al*. 2013b).

A similar migratory behaviour of juvenile birds was suggested between Central Italy, Malta and Libya (Agostini *et al*. 2004b).

Differently from the autumn, only few individuals were observed migrating in spring at all the Greek watchsites. This fact could reflect a stronger tendency of western honey buzzards to migrate over a wider front in spring rather than in autumn across the Mediterranean sea (Agostini *et al*. 2012).

Short-toed snake eagle *Circaetus gallicus*

The short-toed snake eagle has a wide distribution over the Greek mainland with 300-500 estimated pairs (Birdlife International 2004, Handrinos & Akriotis 1997). The results of the recent research did not confirm the previous hypothesis that short-toed snake eagles reach Africa via Peloponnese and the island of Crete flying about 300 km over the sea (Vagliano 1985); in contrast, a migration of this species across southern Greece in September is almost absent (Lucia *et al*. 2011). As mentioned above, thermal currents are very weak over water, thus migrating eagles cannot use soaring-gliding flight during the crossing as they do over land (Kerlinger 1989). The crossing of the Mediterranean between Crete and Libya would imply a long powered flight with a considerable expenditure of energy: in the case of the short-toed snake eagle the powered flight would require 8.7 times the energy needed for the soaring-gliding flight (Panuccio *et al*. 2012). Thus, birds breeding in Greece perform a long migratory detour reaching the Bosphorus in order to avoid the crossing of the Mediterranean Sea. Observations at Mount Olympus clearly showed this migratory pattern: hundreds of individuals were seen heading toward NNE in autumn and toward SSW in spring (Panuccio *et al*. 2012). During autumn mixed flocks of adults and juveniles were observed, while the few individuals recorded moving S were all juveniles and one immature. Since raptors during their first migration use an innate migration route from NE to SW (Kerlinger 1989), the migration strategy of the short-toed snake eagle implies information transmission between adults (experienced individuals) and juveniles (inexperienced individuals, Maransky & Bildstein 2001).

The high synchronicity in departure times allows the formation of mixed age flocks. In contrast, juvenile short-toed snake eagles migrating later cannot learn the safe detour and attempt to cross the Mediterranean heading south. Some tens of juveniles were observed passing over the island of Antikythira in October some weeks later than the peak migration of the species (Lucia *et al*. 2011). At DNP few tens of individuals (a mean of 45) were reported in spring moving toward N (Schindler *et al*. 2009). When referring to short-toed snake eagles, De Nobel *et al*. (1990) reported a spring passage of 316 individuals moving toward west along the coast of Thrace with a peak in late March. These non systematic observations along the coastal area of Thrace probably are related to the same migratory flow observed at the Olympus mountain. Concerning the migration timing, also at Mount Olympus and at DNP the peak of migration is reported at the end of March, while in autumn the peak at the first site was observed the 19th of September (Panuccio *et al*. 2012, Schindler *et al*. 2009).

An analysis of the influence of weather conditions on the migration of this species at Mount Olympus shows that birds are able to compensate the drift effect of lateral winds. Moreover, it is likely that the higher temperatures of September may allow raptors to reach higher altitudes, adversely affecting the raptor counts (Panuccio *et al*. 2013a).

Common buzzard *Buteo buteo*

The common buzzard is the commonest raptor in Greece (Birdlife International 2004, Handrinos & Akriotis 1997). The passage of tens or even hundreds of birds has been observed at all the watch-sites. At DNP up to 300 individuals peaking in mid-March were counted, while in late April 282 individuals were observed at the island of Antikythira (Lucia *et al*. 2011, Schindler *et al*. 2009). Unfortunately at the latter site observations in March and early April are lacking. Finally at Mount Olympus only few common buzzards were recorded in spring and 82 in September moving toward south (Panuccio *et al*. 2011a). Along the coast of Thrace 470 individuals were counted in spring 1987 moving toward west and northwest peaking during the second half of March (De Nobel *et al*. 1990) In autumn, at the island of Antikythira a maximum of 105 individuals was reported passing mostly in October (Lucia *et al*. 2011). Since this species rarely undertakes long water crossings (Agostini *et al*. 2005, Panuccio *et al*. 2011b), it is likely that individuals migrating through the island of Antikythira spend the winter in Crete, where substantial numbers of common buzzards are regularly observed in winter (Tzortzakaki *et al*. 2012).

On the other hand, observations at DNP and along the coast of Thrace indicate that there is a flyway of this species passing across the Turkish Straits (De Nobel *et al*. 1990, Schindler *et al*. 2009).

Booted eagle *Hieraetus pennatus*

Few booted eagles have been reported migrating at the three watch-sites; the highest number (32 birds) was observed in September 2009 at the island of Antikythira; among them aged birds (N = 19) were all juveniles (Lucia *et al*. 2011, Panuccio *et al*. 2011a, Schindler *et al*. 2009). 50-100 breeding pairs have been recently estimated in the country (Birdlife 2004), mainly in N Greece. In particular, some authors (Handrinos & Akriotis 1997) suggested that "*Booted eagles were apparently not much more numerous in the past*". Unlike short-toed snake eagles, booted eagles belonging to the Greek population apparently do not use a circuitous route bypassing the crossing of the Mediterranean Sea. For this reason it is possible that the scarce number of breeding pairs in central and southern Greece is due

to the limited number of resources available during winter in southern Greece and Crete, where this species probably winters (Handrinos & Akriotis 1997). The fact that all aged individuals observed migrating at the island of Antikythira were juveniles, could suggest an age-dependent migration behaviour with adults wintering mostly in continental Greece. In several species of partial migrants, birds belonging to the dominant class (i.e. adults in this case) take up areas closest to breeding ranges, while the subordinate class is forced to migrate farther (Cristol *et al*. 1999, Gauthreaux 1982).

Levant sparrowhawk *Accipiter brevipes*

This species is a summer resident in Greece with 1000-2000 breeding pairs located mostly in Thrace and Macedonia, while it is uncommon in central and S Greece (BirdLife International 2004, Handrinos & Akriotis 1997). The main migratory flow of this species passes across the Bosphorus and individuals belonging to the Greek populations are expected to use this migratory pathway during both spring and autumn (Kirwan *et al*. 2008, Porter & Willis 1968). In this framework, De Nobel *et al*. (1990) reported the observation of 256 individuals moving west in the lowland of Thrace during early May 1987. Observations at the watch-sites seem to confirm this hypothesis despite the limited observed numbers (Lucia *et al*. 2011, Panuccio *et al*. 2011a, Schindler *et al*. in press). In particular at Mount Olympus, tens of levant sparrowhawks were observed migrating towards north in autumn and south in spring, suggesting that also this species could perform a long detour around the coast of the Aegean Sea (Panuccio *et al*. 2011a). In addition, it is interesting to note that during autumn 2009 at Mount Olympus, all 14 Levant sparrowhawks seen heading S were juveniles (Panuccio unp. data): this behaviour could explain a passage of juveniles migrating on a broad front during autumn and passing also across the island of Antikythira (Lucia *et al*. 2011).

Sparrowhawk *Accipiter nisus*

The sparrowhawk is widely distributed over the Greek mainland but is a rare breeder in Peloponnese and absent in Crete, while during winter it is commonly observed in both areas (Handrinos & Akriotis 1997). This distribution could explain the passage of 144 individuals at the island of Antikythira in late September 2009 (Lucia *et al*. 2011); these birds probably migrated on a short distance wintering in Crete like the common buzzard. A similar migration was reported at the Italian islands of Pianosa and Elba in September, where tens of sparrowhawks were observed migrating en route to Corsica and Sardinia (Paesani & Vanni 2008).

Black kite *Milvus migrans*

Only 5-20 breeding pairs breed in Greece (BirdLife International 2004). Handrinos & Akriotis (1997) reported that this species was more common in the past. For this reason it is not surprising that it is a scarce migrant at all the watch-sites. Only at the island of Antikythira up to 76 individuals were counted during autumn migration, suggesting that an important fraction of the Greek population passes through this island (Lucia *et al*. 2011).

Lesser spotted eagle *Aquila pomarina*

The total breeding population in Greece has been estimated between 67 and 90 pairs (BirdLife International 2004). It breeds in northern Greece, mostly in Thrace and Macedonia (Handrinos & Akriotis 1997, Schindler *et al*. 2008). This broad winged raptor migrates through the Bosphorus during both spring and autumn. Few birds, mostly juveniles, have been reported in southern Greece and Crete during autumn migration (Handrinos & Akriotis 1997, Lucia *et al*. 2011). Among 13 individuals observed in Autumn 2009 at Mount Olympus, six were juveniles, one was immature and two were adults; it is interesting to note that the two adults migrated toward north while juveniles disappeared S-SW (Panuccio unpubl. data).

Egyptian vulture *Neophron percnopterus*

While the species was abundant during the 19th century, only 150 breeding pairs located mostly in the north were estimated in early 2000' (BirdLife International 2004). Nowadays there are only 17 occupied territories of the species in the whole country (Sidiropoulos *et al*. 2010). Data from migration watchsites reflect this negative trend: during non-systematic observations in Thrace in spring 1987, 83 individuals were recorded mostly during the second half of March (De Nobel *et al*. 1990). In contrast, in recent years a maximum of four migrating birds were observed at DNP, while no one has been observed at Mount Olympus during both spring and autumn (Panuccio *et al*. 2012, Schindler *et al*. in press). At the island of Antikythira Egyptian vultures were observed mainly during autumn with a maximum of 10 individuals, mostly juveniles, in 2008 (Lucia *et al*. 2011) and just one individual during spring 2012 (Barboutis unpubl. data).

Satellite telemetry: the case study of the Eleonora's falcon *Falco eleonorae*

About 80% of the total population of the species is located in the Aegean Sea (Dimalexis *et al*. 2008). Recently, a study made by satellite tracking revealed migration strategies of the Eleonora's falcons breeding in Greece (Kassara *et al*. 2012).

Tracked birds left the colony between the 20th and the 24th of October, but it was not possible to follow the four falcons equipped with transmitters until the end of their spring migration. These individuals did not use any Mediterranean area as stop-over site, as happened over the other ecological barriers that they faced during migration, like the desert (López-López *et al*. 2010, Kassara *et al*. 2012). This behaviour is probably preferred to maximise the migration speed in order to overcome the barriers as quick as possible (Alerstam 2009). Eleonora's falcons migrate during day and night-time without making any detour over the sea (López-López *et al*. 2010).

CONCLUSIONS

The results of these research, though incomplete, reveal that the geography of central-eastern Mediterranean interacted with the morphology of raptors shaping different flyways that reflect different migratory strategies. It is possible to identify at least four different behaviours:

1) detour: the short-toed snake eagle, and most probably the levant sparrowhawk and the lesser spotted eagle avoid to fly over the sea, choosing a risk minimisation strategy similarly to individuals breeding in Italy (Agostini *et al*. 2002a, 2002b, Baghino & Premuda 2007, Mellone *et al*. 2011). Eagles are heavy birds which cannot use powered flight for long since it would require a large amount of energy (Panuccio *et al*. 2012). On the other hand, smaller species like levant sparrowhawks have relatively short and broad wings.
2) Funnelled migration: the western honey buzzard migrates over the Mediterranean Sea but is attracted by geographical features like the island of Antikythira, which represents a natural springboard in autumn but not in spring (Agostini *et al*. 2012). Honey buzzards are expected to undertake longer water-crossings in spring than in autumn, probably to reach as soon as possible their breeding grounds as it has been observed in the Central Mediterranean and confirmed by the mean of satellite tracking (Agostini & Panuccio 2005, Meyburg *et al*. 2010).
3) Broad front migration: the Eurasian marsh harrier and, especially, the Eleonora's falcon migrate on a wide front through the Mediterranean Sea. Compared to other raptors, these species show morphological features that allow them to use powered flight for long distances minimising the energetic costs of flapping flight (Kerlinger 1989, Pennycuick 2008, Agostini & Panuccio 2010). Despite individual variation, previous research did not show the existence of narrow migration corridors through ecological barriers (López-López *et al*. 2010).
4) Short-distance migration: common buzzard and sparrowhawk do not cross the Mediterranean Sea but they move across Greece to winter in Peloponnese and Crete. Some species of migrating raptors do not migrate over long distances, this strategy could reduce the mortality during migration and allow a quick reaction to the upcoming spring (Newton 1979).

Acknowledgements – We would like to thank all the people who participated to the research activities on raptor migration in Greece in the last years, among them Stefan Schindler, Angelos Evangelidis from the Hellenic Ornithological Society and the ME-DRAPTORS staff (www.raptormigration.org), in particular: Ugo Mellone, Giuseppe Lucia and Gianpasquale Chiatante. This is contribution n. 10 from Antikythira Bird Observatory - Hellenic Ornithological Society.

REFERENCES

Agostini N., Amato P., Provenza A. & Panuccio M., 2005. Do common buzzards *Buteo buteo* migrate across the Channel of Sicily? Avocetta 29: 28.

Agostini N., Baghino L., Coleiro C., Corbi F. & Premuda G., 2002a. Circuitous autumn migration in the Short-toed Eagle (*Circaetus gallicus*). J. Raptor Res. 36: 111-114.

Agostini N., Baghino L., Panuccio M. & Premuda G., 2002b. A conservative strategy in migrating Short-toed Eagles (*Circaetus gallicus*). Ardeola 49(2): 287-291.

Agostini N., Coleiro C. & Panuccio M., 2003. Autumn migration of Marsh Harriers across the central Mediterranean in 2002. Ring 25: 47-52.

Agostini N., Coleiro C. & Panuccio M., 2004b. Analysis of the autumn migration of juvenile honey buzzards *Pernis apivorus* across the central Mediterranean. J. Raptor Res. 38: 283-286.

Agostini N. & Logozzo D., 2000. Migration and wintering distribution of the Marsh Harrier (*Circus aeruginosus*) in southern Italy. Buteo 11:19-24.

Agostini N., Lucia G., Mellone U., Panuccio M., Von Hardenberg J., Evangelidis A. & Kominos T., 2012. Loop migration of adult European Honey Buzzards (*Pernis apivorus*, Linnaeus, 1758) through the Central-Eastern Mediterranean. Ital. J. Zool. 79: 280-286.

Agostini N. & Panuccio M. 2005. Analysis of the spatial migration patterns of adult honey buzzards (*Pernis apivorus*) during Spring and Autumn in the Central Mediterranean. Ring 27(2): 215-220.

Agostini N. & Panuccio M., 2010. Western Marsh harrier (*Circus aeruginosus*) migration through the Mediterranean sea: a review. J. Raptor Res. 44(2): 136-142.

Agostini N., Premuda G., Mellone U., Panuccio M., Logozzo D., Bassi E. & Cocchi L., 2004a. Crossing the sea en route to Africa: autumn migration of some Accipitriformes over two central Mediterranean islands. Ring, 26: 71-78.

Alerstam T., 1990. Bird Migration. Cambridge University Press, UK.

Alerstam T. 2009. Flight by night or day? Optimal daily timing of bird migration. J. Theor. Biol. 258:530-536. doi:10.1016/j.jtbi.2009.01.020

Åkesson S. & Hedenström A., 2007. How migrant get there: migratory performance and orientation. Bioscience, 57: 123-133.

Baghino L. & Premuda G., 2007. New data on the circuitous spring migration of the Short-toed Eagle *Circaetus gallicus* in Italy. Avocetta 31:70-74.

Berthold P., 1993. Bird migration. A general survey. Oxford University Press, UK.

BirdLife International, 2004. Birds in Europe: population estimates, trends and conservation status. Cambridge UK, BirdLife International (BirdLife Conservation series No. 12).

Cristol D.A., Mitchell B.B. & Carbone C., 1999. Differential migration revisited: latitudinal segregation by age and sex class. In: Nolan V. (ed.), Current Ornithology, 15: 33-88.

Dimalexis A., Xirouchakis S., Portolou D., Latsoudis P., Karris G., Georgiakakis P., Fric J., Barboutis C., Bourdakis S., Ivovič M., Kominos T. & Kakalis E., 2008. Breeding distribution and population status of the Eleonora's falcon (*Falco eleonorae*) in Greece. J. Ornithol. 149: 23-30.

Gauthreaux S. A., 1982. Age-dependent orientation in migratory birds. In: Papi F. & Walraff H. G. (eds.), Avian navigation. Springer Verlag, New York, pp. 67-74.

Handrinos G. & Akriotis T., 1997. The birds of Greece. Christopher Helm, U.K.

Kassara C., Fric J., Gschweng M. & Sfenthourakis S., 2012. Complementing the puzzle of Eleonora's Falcon (*Falco eleonorae*) migration: new evidence from an eastern colony in the Aegean Sea. J. Ornithol. 153: 839-848.

Kerlinger P., 1989. Flight strategies of migrating hawks. University of Chicago Press, USA.

Kirwan G. M., Boyla K. A., Castell P., Demirci B., Özen M., Welch H. & Marlow T., 2008. The birds of Turkey. Christopher Helm, UK.

Kjellén N., 1992. Differential timing of autumn migration between sex and age groups in raptors at Falsterbo, Sweden. Ornis Scand. 23: 420-434.

López-López P., Limiñana R., Mellone U. & Urios V. 2010. From the Mediterranean Sea to Madagascar: are there ecological barriers for the long-distance migrant Eleonora's falcon? Landscape Ecol. 803-813.

Lucia G., Agostini N., Panuccio M., Mellone U., Chiatante G., Tarini D. & Evangelidis A., 2011. Raptor migration at Antikythira, in southern Greece. Brit. Birds 104: 266-270.

Maransky B.P. & Bildstein K.L., 2001. Follow Your Elders: Age-Related differences in the Migration Behavior of Broad-Winged Hawks at Hawk Mountain Sanctuary, Pennsylvania. Wilson Bull. 113: 350-353.

Mateos-Rodríguez M. & Liechti F., 2012. How do diurnal long-distance migrants select flight altitude in relation to wind? Behav. Ecol. 23(2): 403-409.

Mellone U., Limiñana, R., Mallìa E. & Urios V., 2011. Extremely detoured migration in an inexperienced bird: interplay of transport costs and social interactions. J. Avian Biol. 42: 468-472.

Meyburg B.U., Ziesemer F., Martens H. D. & Meyburg C., 2010. Zur Biologie des Wespenbussards (*Pernis apivorus*): Ergebnisse der Satelliten-Telemetrie / On the biology of the Honey Buzzard (*Pernis apivorus*) - Results of Satellite Tracking. 7. Internationales Symposium "Populationsökologie von Greifvogel- und Eulenarten" / 7th International Symposium "Population Ecology of Raptors and Owls", Halberstadt, Germany, 21-24.10.2010: Poster.

MIGRES, 2009. Seguimento de la migración de la saves en el Estrecho de Gibraltar: resultados del Programma Migres 2008. Migres 1: 83-101.

Newton I., 1979. Population ecology of raptors. T. & A.D. Poyser, UK.

Newton I., 2008. Migration ecology of birds. Academic press, UK.

Nobel De W.T., Roder De F., Marteijn C.L.E., MeinigerL.P., Stuart J.J. Schepers F. & Westrienen Van R., 1990. Birds in NE-Greece, spring 1987. In: Meininger P.L. (ed.), Birds of the wetlands in North-east Greece, spring 1987, WIWO Report 20, Zeist, pp. 109-263.

Paesani G. & Vanni L., 2008. Campo di monitoraggio dei rapaci "Elba 2008". Infomigrans, Parco Naturale Alpi Marittime 22: 6.

Panuccio M., Agostini N., Baghini L. & Bogliani G., 2013a. Visible migration of Short-toed Snake Eagles: interplay of weather and topographical features. J. Raptor Res. 47(1): 60-68.

Panuccio M., Agostini N. & Mellone U., 2005a. Autumn migration strategies of honey buzzards, black kites, marsh and Montagu's harriers over land and over water in the central Mediterranean. Avocetta 29: 27-32.

Panuccio M., Agostini N. & Bogliani G., 2011a. Mount-Olympus: a new raptor migration bottle-neck in northern Greece. Proc. XVI Ital. Orn. Congr.: 31.

Panuccio M., Agostini N. & Premuda G., 2012. Ecological barriers promote risk minimization and social learning in migrating Short-toed Snake Eagles. Ethol. Ecol. Evol. 24: 74-80.

Panuccio M., Chiatante G. & Tarini D., 2013b. Two different migration strategies in response to an ecological barrier: Western Marsh Harriers and juvenile European Honey Buzzards crossing the central-eastern Mediterranean in autumn. J. Biol. Res.-Thessalon. 19: 10-18.

Panuccio M., D'Amicis B., Canale E. & Roccella A., 2005b. Sex and age ratios of marsh harriers *Circus aeruginosus* wintering in central-southern Italy. Avocetta 29: 13-17.

Panuccio M., Gustin M. & Bogliani G., 2011b. A comparison of two methods for monitoring migrating broad-winged Raptors approaching a long water crossing. Avocetta 35: 13-17.

Panuccio M., Mellone U. & Muner L., 2013c. Differential wintering area selection in Eurasian Marsh Harrier (*Circus aeruginosus*): a ringing recoveries analysis. Bird Study 60(1): 52-59.

Pennycuick C.J., 2008. Modelling the Flying Bird. Academic Press, UK.

Porter R. & Willis I., 1968. The autumn migration of soaring birds at the Bosphorus. Ibis 110: 520-536.

Schindler S., Poirazidis K. & Wrbka T., 2008. Towards a core set of landscape metrics for biodiversity assessments: a case study from Dadia National Park, Greece. Ecol. Indic. 8(5): 502-514.

Schindler S., Ruiz C., Scandolara C. & Poirazidis K., 2009. Systematic monitoring of Spring raptor migration at Dadia National Park, Greece, from 2003 to 2005. RRF'S International Conference on Raptors, Pitlochry, Scotland.

Schindler S., Poirazidis K., Ruiz C., Scandolara C., Carcamo B., Eastham C. & Catsadorakis G., in press. At the crossroads from Asia to Europe: Spring migration of raptors and Black storks in Dadia National Park (Greece). J. Nat. Hist.

Sidiropoulos L., Kominos T., Tsiakiris R. & Kret E., 2011. Technical report to BVCF/FZF: Assessment and monitoring of the Egyptian Vulture Population in Greece, 2011. Hellenic Ornithological Society / BirdLife Greece, WWF Greece (unpubl. report).

Tzortzakaki O., Simaiakis S. & Xirouchakis S., 2012. Abundance of Common buzzards (*Buteo buteo*) in olive monocultures in the island of Crete. J. Biol. Res.-Thessalon. 17: 44-50.

Vagliano C., 1985. The continental and island migration route of the Southeast Mediterranean: problems and propositions. ICBP Tech. Publ. 5: 263-269.

Associate editor: ***Toni Mingozzi***