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Migration strategies of raptors as revealed by direct visual observation

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Most raptors depend on soaring/gliding flight during migration. This strategy reduces energetic costs by exploiting thermals and deflection updrafts over land. Since thermals are very weak over water, these species tend to avoid crossing large water surfaces and follow peninsulas and concentrate their passage through isthmuses, straits, islands and mountain ridges. The aim of this Ph.D. research was to investigate, by direct visual observation, migration strategies of some species of European raptors at several watchsites in Italy, Greece and Turkey. The results showed the existence of species specific behaviors in relation to wind drift, topography and geography.

1 Introduction

Migration can be definite a movement which involves a change in habitat, recurring periodically and in alternate direction. Such definition, even though not sufficiently wide to describe a wider series of movements (dispersion, nomadism, local movements), can be considered as valid in the case of migration of diurnal raptors in reply to the periodic food availability changes. Of 285 species of diurnal raptors 133 (46,7%) show migratory movements [1]. Most raptors breed in the Northern hemisphere and as more the nesting population is far from the equator, as more it tends to migrate. Nearctic and Palearctic birds head southwards in autumn, to spend the winter, while in spring they fly back to occupy their reproductive territories. During the winter, the prey shortage can be caused by the fact that they migrate, go in hibernation or get less visible under the snow. The reason which pushes the birds to leave the wintering grounds in spring to undertake an expensive journey, is more difficult to comprehend. Many of these areas, in fact, seem suitable also during the reproductive period. However, if birds did not migrate, in the northern areas a big amount of food would remain unused. In consequence, it is logical to think that every individual migrating northwards can rear juveniles avoiding competition with species resident in the wintering grounds and exploiting areas that are rich of food in a relatively short period. In this picture, migratory movements must be therefore considered as a product of the natural selection which assures a bigger reproductive efficiency [2]. It is possible to identify two types of migration. The total migration includes movements of all the individuals of a determinate population, with a little or no overlap between breeding and wintering grounds. In the partial migration, instead, such movements are made by some individuals of a population, with a variable degree of overlap between breeding and wintering territories. In particular, a species is considered as total migrant if more than 90% of individuals leave the breeding areas [1]. Furthermore, it is necessary to mention the irruptive movements, that verify in species which capture preys whose populations show unforeseeable changes. In this case birds leave the breeding areas only in years in which preys are lacking. At last, taking into consideration the length of the journey, it is possible to identify a migration on short (< 300 km), medium (300-1500 km) and long distance (> 1500 km). Among European raptors, 11 are total migrants and 27 partial migrants. No one shows irruptive movements [3]. Unlike *Falconiformes* which, during migration, mostly

use powered flight, nearly all *Accipitriformes* exploit the soaring/gliding flight, using thermal currents and deflection updrafts thanks to their broader wings. In doing so they are able to fly for long distances reducing energetic costs. Since thermal currents are very weak over water surfaces, most raptors tend to avoid water crossings concentrating their passage through peninsulas, isthmuses, straits and islands. In addition, since stronger thermals form on terrains oriented perpendicular to solar radiation, they concentrate along mountain ridges especially when they are aligned along the axis of migration [4]. The species most dependent on this flight style are also those which show a greater tendency to migrate in flock. The flocking behavior, in fact, can be used to locate the thermal currents as groups engaged in soaring flight can be detected even from a distance. However, among *Accipitriformes*, there are species with different degrees of dependence on soaring flight. Studies made in the United States, on Lake Superior and the Delaware Bay, have shown that the tendency of a given species to cross the water barriers is a positive function of its aspect: birds with relatively long wings (high aspect ratio; aspect ratio = (Wing Span)^2 / Wing Area) are better suited to fly on water surfaces of birds with relatively short wings (low aspect ratio). The wings relatively long, in fact, decrease the induced drag and thus the energy cost of powered flight [5]. This feature is present in some species of *Accipitriformes* (e.g. harriers and kites), while it is highly developed in all *Falconiformes* that, for this reason, mostly use powered flight and rarely are reported in huge concentrations during migration. Over the past three decades, several studies have been carried out on some aspects of raptor migration using radar, satellite telemetry and direct visual observation. The aim of this Ph.D. research was to investigate, by direct visual observation aided with binoculars and telescopes, migration strategies of some species of European raptors when facing a water surface, passing through isthmus areas and along mountain ridges. Visual observation remains a widespread and irreplaceable method, allowing the collection of a huge amount of data and , at the same time, a lower impact on budgets [1]. This was a significant factor given that researches concerning this Ph.D., with the exception of the fieldwork made at the Aspromonte National Park, had limited financial support and were largely self-funded.

2 Study area and methods

Observations were made at several watchsites (Fig. 1) in Italy (Arenzano, Circeo promontory, Marcellinara Isthmus, Aspromonte National Park), Greece (island of Antykitira, Mount Olympus) and Turkey (Bosphorus).

2.1 Through a water surface

The Circeo Promontory (41°12′N, 13°03′E) is located at the southernmost point of the Pianura Pontina, reaching 541 m a.s.l. and approximately 500 km northeast of Tunisia. At this site I studied the water crossing behavior of European Honey Buzzards and Western Marsh Harriers. I used a post (altitude approx. 400 m) in a military zone, on the roof of the ENAV (Ente Nazionale Assistenza al Volo) building; from this post it was possible to observe the flight behavior of birds both inland and over the sea. The Ponziane Islands are nearly always visible from this watch-point; the closer island is Zannone, about 30 km south-southwest of the promontory. A total of 324 hours of observations were carried out between 26 August and 30 September 2002, from 09:00 until dusk.
Antikythira (35◦ 52’ N; 23◦ 18’ E) is a small island (20 km2; max. altitude 378 m), oriented in a NW-SE direction, located 32 km SE of the island of Kythira and 33 km NW of Crete, which in turn is located approximately 300 km NE of the Cyrenaica Peninsula (Libya). At this site I collected data concerning European Honey Buzzard migration during both spring and autumn. During spring, observations were made from 25 April to 15 May 2007 and from 19 April to 14 May 2008, each day between 08:00 and 17:30 h (solar time); during autumn, from 24 August to 20 September 2007 and from 21 August to 20 September 2008, each day between 08:00 and 17:30h (solar time), covering peak periods of the passage of adult birds through the Mediterranean basin [6]. It has been already shown that prevailing winds

significantly affect pathways of adult European Honey Buzzards when migrating over water [7, 8]. In this framework, I analyzed historical data concerning the direction and strength of the wind in the Central-Eastern Mediterranean region to reconstruct general wind patterns [9].

2.2 Along a mountain ridge

In southern continental Italy observations were made from 23 August to 2 October 2011 focusing on the migration of European Honey Buzzards and Western Marsh Harriers in relation to topography, geography and wind conditions. Three observation posts were used during the fieldwork, two located in the Aspromonte National Park and one about 5 km inland of the Tyrrhenian coast. Two observers monitored the migration at each post. A flat zone (Piana di Gioia Tauro) lies north of the study area. Post 1 is located along the ridge of the mountain chain, while the other two posts are on the Aspromonte plateau, but the central one is closest to the western slope of the ridge. As a result I divided the study area in two topographic zones and defined passage along the mountain ridge as those raptors observed from post 1 and those passing east of post 2; and defined passage over the plateau as those raptors seen over head or passing west of post 2 and those reported from post 3 (inland of the narrowest point of the Strait of Messina).
At Mount Olympus (northeastern Greece) and Arenzano (northwestern Italy) I recorded data on Short-toed Snake Eagle migration. In northeastern Greece, the mountain chain (approx. 40° 01' N, 22° 29' E) runs parallel to and approximately 7 km from the coast, forcing migrants to concentrate over a narrow corridor of land between the sea and the mountain [10]. North of Mount Olympus there is a large flat area and the mountain chain continues southward. At Arenzano, the observation site was at the northernmost point of the mid-western Mediterranean Basin (44° 25' N, 8° 40' E), where the ridge of the Ligurian Apennines, after running parallel to the coast, reaches its closest proximity to the sea (6 km). Observations were made from 9 September to 1 October 2009 at Mount Olympus, from 8 to 29 September 2009 at Arenzano, from 6 to 26 March 2010 at Mount Olympus, and from 8 to 29 March 2010 at Arenzano; these periods corresponded to the peak times of autumn and spring migration of the Short-toed Snake-Eagle in the Mediterranean basin [11, 12].

2.3 Through an isthmus area

The Bosphorus is a 30 km long, 1.5 – 3 km wide, N-S strait, located between two peninsulas that form an area similar to an isthmus between the Sea of Marmara and the Black Sea oriented in a WNW-ESE direction. The aim of this study was to investigate the influence of lateral winds, dominant during autumn migration in this area, as well as of the time of day and other weather variables (air humidity, temperature, air pressure) on the visible migration of raptors in the northern side of the Bosphorus to verify the existence of eventual species specific behaviors in relation to wind drift as supposed by Van Den Bossche and Lens [13]. A total of 400 hrs of observations were made between 22 August and 1 October 2010, each day between 7:30 and 17:30 hr (solar time), using a post (Toygar Tepe; 41°12'N, 29°14'E; 309 m. a.s.l.) located in the Asian side, about 20 km north of the Sea of Marmara and 10 km south of the Black Sea.
The aim of this study was to verify the effects of small-scale weather patterns such as crosswinds, barometric pressure, and time of day on the visible migration of adult European Honey Buzzards through the Marcellinara Isthmus. The study area is located in the narrowest point of the Italian peninsula. In this area, the Apennines are interrupted to the south by the Sila Plateau and to the west and east by the Tyrrhenian and Ionian Seas. South of this interruption lies a more-diverse area (the Marcellinara Isthmus) including the Pesipe River valley separating Mount (Mt.) Covello centrally from Mt. Contessa (at a distance of < 3 km) to the west. Observations were made between 24 August and 12 September in both 2005 and 2006, the main migration period of adult Western Honey Buzzards through the central Mediterranean [14]. Three observation posts were used simultaneously.

Fig. 1 Study area. The black dots indicate the fieldwork sites: 1) Arenzano; 2) Circeo Promontory; 3) Marcellinara Isthmus; 4) Aspromonte National Park; 5) island of Antikythira; 6) Mount Olympus; 7) Bosphorus.

3 Results and discussion

3.1 Through a water surface

At the Circeo promontory, European Honey Buzzards were more inclined to leave the coast when migrating in flocks. Western Marsh Harriers, such as European Honey Buzzards migrating alone, undertook the water crossing rather than stopping migration during the absence of wind and vice versa during head winds. Conversely, European Honey Buzzards migrating in flocks were not affected in their decision (crossing or stopping migration) by wind direction. Both species undertook the water crossing rather than stopping migration during mornings and vice versa during afternoons. In both species, adults and juveniles showed the same behavior in front of a water barrier. This result was expected in the case of the Western Marsh Harrier but not from the European Honey Buzzard since, in this species, the water-crossing tendency is age dependent with adults avoiding sea crossings. This study confirms that flocking significantly affects the water-crossing behavior of European Honey Buzzards during migration. Moreover, in this species, inexperience of juveniles, and presumably younger adults, about the high energetic costs of long powered flight and about the existence of shorter routes over water, might explain the strong water-crossing tendency shown by migrants independently from their age.
During the study made at the island of Antikythira (southern Greece) a total of 135 birds were counted during spring while, during post-reproductive movements, the passage of 2479 individuals was reported. These results clearly show differential spring and autumn migration of adult European Honey Buzzards through this region. The general wind patterns in the Central-Eastern Mediterranean region showed north-northwesterly winds between southern Greece and Libya during both spring and autumn, but very weak (<10 km/h) during the first period. I discuss two hypotheses to explain why the spring visible migration was so scarce: 1) a narrow migratory loop, with the European Honey Buzzards using a direct path between Libya and Peloponnesus during spring, bypassing Antikythira, and 2) a loop migration on a greater scale, involving a detour via the Bosphorus/Dardanelles' Strait and/or the Central Mediterranean,

that would allow the Honey Buzzards to minimize the water crossing but increasing the overall migration distance. In the light of previous studies on this species the first hypothesis seems to be much more reliable than the second one.

3.2 Along a mountain ridge

At the Aspromonte National Park, adult European Honey Buzzards were detected mostly over the plateau, but higher numbers were seen along the ridge during midday and early afternoon probably because of better thermal conditions at that time. In the whole area they were detected during strong winds and during west winds over the plateau. NE winds negatively affected their visible migration. It is suggested that adult European Honey Buzzards were detected mostly over the plateau because they were heading towards the Straits of Messina when they were north of the site and in doing so were more visible when compensating for drift effects of strong westerly winds and flying at lower altitudes. During favorable weather conditions (tail winds) buzzards perhaps reached higher altitude and would pass undetected. Unlike adults, juvenile European Honey Buzzards showed a broader front in their migration. As with adult European Honey Buzzards, Western Marsh Harriers were detected mostly over the plateau perhaps because this species is less dependent on soaring flight.
In this study I provide information on how weather and topography may affect the behavior and detectability of the Short-toed Snake Eagle during migration in NE Greece (Mont Olympus) and NW Italy (Arenzano). More Short-toed Snake Eagles were observed in spring than in autumn. The difference was more evident at Arenzano. Temperatures influenced the number of migrants observed in both periods and sites. Number of individuals observed decreased drastically when temperatures were higher than 24 °C during post reproductive movements. At both sites daily patterns showed a lower proportion of raptors observed during midday and early afternoon in autumn than in spring. It is supposed that, during autumn, several individuals may have passed undetected flying at higher altitude during midday and early afternoon at both sites, most likely because of the stronger thermal conditions in that period according to a typical “midday lull” pattern. Finally, the lack of difference among the numbers of eagles observed during lateral winds and during other wind directions at Mount Olympus suggests that these birds may be able to compensate the drift effect towards the Aegean Sea. Conversely, wind strength and lateral northerly wind negatively affected the number of migrants observed at Arenzano during spring movements.

3.3 Through an isthmus area

At the Bosphorus, the Lesser Spotted Eagles was the only species affected by the time of day, showing a real peak in late morning. Lateral winds affected the passage of European Honey Buzzards, Steppe/Common Buzzards, Levant/Eurasian Sparrowhawks and Short-toed Snake Eagles. In particular these raptors were seen mostly during southerly winds while very few were detected during northerly winds. Conversely, the passage of Lesser Spotted Eagles and Booted Eagles were not affected by lateral winds. In addition, data concerning the Short-toed Snake Eagle suggest age dependent migration behavior in relation to wind drift in this species. It is suggested that Lesser Spotted Eagles, Booted Eagles and adult Short-toed Eagles compensated the drift effect of lateral winds to avoid to be blown off over the Sea of Marmara and over the Black Sea. For these migrants both these bodies of water seem to be a real ecological barrier. It is supposed that during northerly winds European Honey Buzzards, Steppe/Common Buzzards, Levant/Eurasian Sparrowhawks and Short-toed Snake Eagles migrating later in the season, during the peak passage of juveniles, concentrated their migration along the southern side of the isthmus and perhaps over the Sea of Marmara.
During observations at the Marcellinara Isthmus prevailing winds were perpendicular to the direction of migration. The peak passage of European Honey Buzzard occurred during the afternoon and with westerly winds. Ideal weather conditions for soaring flight occurred during weak winds and high

barometric pressure. The analysis of migration frequencies among the three observation posts suggests that adult European Honey Buzzards tend to compensate deviations of lateral winds on a small scale when migrating through this isthmus area. It appears they do not slow their travelling speed during unfavorable weather conditions for soaring flight (strong lateral wind and low barometric pressure) by increasing the use of powered flight. On the other hand, migrants will change their migration strategy in relation to wind drift when migrating through the Channel of Sicily en route to Africa, showing a broad front of migration over water [7].

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