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SHORT NOTES

Influence of wind and geography on orientation behavior of adult Honey Buzzards *Pernis apivorus* during migration over water

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Abstract. During autumn migration across the Central Mediterranean, adult Honey Buzzards cross the sea at its narrowest point, between western Sicily (southern Italy) and the Cap Bon Peninsula (Tunisia). This study investigated the influence of prevailing winds and geography on the orientation behaviour of migrants during this sea crossing by observations over two islands, one on the northern side, the other on the southern side of the Channel of Sicily. The flock was taken as the sampling unit. Honey Buzzards reached the island of Marettimo, approx. 30 km off western Sicily and 130 km NE of the Cap Bon Peninsula, regardless of the direction of the prevailing winds (NW and S). By contrast, Honey Buzzards passed via Pantelleria, about 110 km SW of western Sicily and 70 km ESE of the Cap Bon peninsula, mostly during NW winds. Birds reached Pantelleria from the NE and left the island flying WNW. They applied true navigational abilities in choosing the shorter crossing between Pantelleria and Tunisia and showing a curvilinear migration. Our results agree in part with the "optimal use of wind" hypothesis. In particular, wind, geography and navigational abilities seem to interact to shape the orientation behaviour of migrating Honey Buzzards, perhaps to minimize the risks of non-stop powered flight over the water.

Key words: Honey Buzzard, *Pernis apivorus*, migration, water crossing, orientation, geography, wind, navigation

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The Honey Buzzard is a summer visitor to Europe wintering in west-central equatorial Africa (Cramp & Simmons 1980). This species shows a strong tendency to migrate in flocks, mostly using soaring flight over land. Thermals are almost absent over water and thus the sea crossing implies a long powered flight with considerable expenditure of energy (Kerlinger 1989). For this reason, in the Mediterranean basin, adult Honey Buzzards concentrate their passage at the shorter points, the Strait of Gibraltar, the Sicilian Channel and the Bosphorus (Agostini & Logozzo 1997, Agostini et al. 2000, Schmid 2000). In the Central Mediterranean region, they tend to follow the Italian peninsula and after crossing the Strait of Messina, between southern continental Italy and Sicily, deviate westwards. In doing so they take the same route as in spring between western Sicily and the Cap Bon Peninsula, which, as mentioned above, takes them across the Channel of Sicily, approx. 150 km wide (Fig. 1, Agostini & Logozzo 1997, Agostini et al. 2000, Agostini 2004). A recent study, using satellite telemetry, showed that adult Honey Buzzards tend to compensate lateral winds during migration over land, leaving only a limited drift effect (Thorup et al. 2003). The present study investigated their autumn migration across the Channel of Sicily by direct visual observations on the islands of Marettimo and Pantelleria, located at its northern and southern side, respectively (Fig. 1). The aim was to verify the influence of prevailing winds and geography on the orientation behaviour of these raptors during sea crossings.

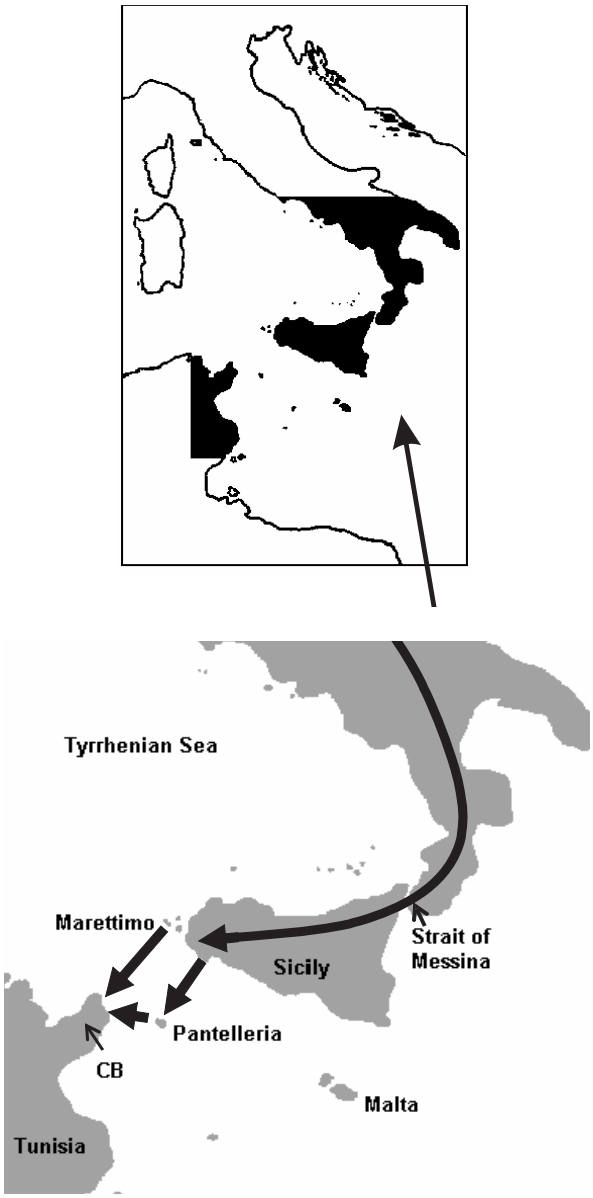

Fig. 1. The study area (CB = Cap Bon Peninsula). Arrows show the migration routes of adult Honey Buzzards.

Visual observations, aided with binoculars and telescopes, were made from 24 August–9 September 2003, the peak of the autumn migration of adult Honey Buzzards (Agostini & Logozzo 1995, 1997, Agostini et al. 2000). Marettimo is a mountainous island (12 km^2), about 30 km off western Sicily and 20 km west of the islands of Levanzo and Favignana. This island is located at the narrowest point of the Central Mediterranean, about 130 km NE of the Cap Bon promontory (Tunisia, Fig. 1). Monte Falcone is its highest relief, reaching 686 m a.s.l. The observation post was located at an altitude of ca. 500 m. Pantelleria is a volcanic island (84 km^2), about 110 km SW of western Sicily and 70 km ESE of the Cap Bon Peninsula (Fig. 1). The observation post was located at the altitude of ca. 600 m. along the slopes of Montagna Grande, its highest relief (836 m a.s.l.). Hourly meteorological data from the northern and southern sides of the Sicilian Channel were provided by the Italian Air Force.

Previous studies made at the Cap Bon promontory and over the islands of Marettimo and Ustica, showed that Honey Buzzards of the same flock, such as Black Kites *Milvus migrans* (Agostini & Duchi 1994), tend to remain together in front of the water barrier because the first individuals making a decision (crossing or not) are followed by the others (Agostini et al. 1994a, 1994b, 2005, N. Agostini and M. Panuccio pers. obs.). Thus a flock-member does not act and orientate independently. For this reason, in the statistical analysis, we consider the flock as sampling unit to avoid a pseudoreplication of the data (see Hurlbert 1984). Finally, contingency tables were used to test the influence of prevailing winds on the migratory flow.

On Marettimo 65 flocks and 14 solitary individuals were recorded. A total of 1305 birds migrated in flocks (max. 147 together). Birds reached the island from East and exploited thermal currents before leaving the site heading SW (Fig. 1). The variation in the migratory flow showed two bouts of movements on 1 and 6 September when about 50% of the migrants were observed. Prevailing winds, from NW (mean ± SE direction: 310.4° ± 3.7°, mean strength ± SE: 16.9 ± 0.7 km/h) and S (mean ± SE direction: 171.6° ± 4.5°, mean strength ± SE: 22.8 ± 1.1 km/h), had a lateral effect on the path of the migrants. They did not affect the consistence of the migratory flow at this site: the proportions of hours and flocks recorded for each wind condition during the whole period (hours: NW = 81, 58.7%; S = 57, 41.3%; flocks: NW = 37, 63.8%; S = 21, 36.2%) were similar (χ^2 = 0.26, df = 1, $p > 0.05$). On Pantelleria 148 flocks and 27 solitary birds were recorded. A total of 2654 individuals migrated in flocks (max. 160 together). The migratory flow here showed two bouts of movements between 31 August – 2 September and 4–5 September (994 and 894 birds counted, respectively). Birds concentrated along the slopes of Montagna Grande to exploit

thermal currents, coming from NE and leaving the site towards WNW (Fig. 1). Like Marettimo, on Pantelleria prevailing winds were from NW (mean direction ± SE: 298.2° ± 1.9°, mean strength ± SE: 17.9 ± 0.6 km/h) and S (mean direction ± SE: 176.1 ± 2.1, mean strength ± SE: 19.2 ± 1.9 km/h). The proportion of flocks recorded at Pantelleria was higher with north-westerly wind independently of its higher frequency (hours: NW = 88, 61.1%, S = 56, 38.9%; flocks: NW = 116, 78.9%; S = 31, 21.1%; $\chi^2 = 9.53$, df = 1, $p < 0.01$).

Apparently, geography had a strong influence on the orientation behavior of birds reaching the northern side of the Channel of Sicily. Migrants were attracted by the island of Marettimo, nearly always visible, independently of prevailing winds. Considering the direction of such winds, this result could be explained assuming that adult Honey Buzzards compensated (during NW winds) or allowed (during S winds) drift effect to reach this site where they soared before the long powered flight towards Tunisia. By contrast, birds crossing the southern side of the Sicilian Channel passed through Pantelleria mostly during north-westerly winds. Migrants, probably, did not compensate the drift effect of these winds during the first stage of the crossing. As a result of this strategy, birds saved energy during the long powered flight between south-western Sicily and Pantelleria. Later, after the exploiting of the thermal currents over the island, they changed direction, heading WNW and flying about 70 km in headwinds, probably to compensate the previous drift, to reach the Cap Bon peninsula. They avoided a longer sea crossing towards SW making a curvilinear migration applying true navigational abilities, Tunisia nearly always being out of sight. However, flocks seen over Pantelleria during southerly winds, suggest that at least some of the migrants crossing the sea during such weather conditions chose this route, perhaps compensating during the initial stage of migration over water and later saving energy flying in following winds.

Our results partially agree with the Alerstam's "optimal use of wind" hypothesis (Alerstam 1979) which suggested that, when birds migrate through inhospitable regions (i.e. water surfaces in the case of soaring raptors), they do not fly directly to their goal. Instead they follow routes that allow them to avoid head- and lateral winds, using tailwinds to move quickly. Migrants would allow themselves to be drifted by the wind during the initial stage of migration and later would overcompensate to reach their goal. The Alerstam's hypothesis would explain why a smaller number of birds passed through Pantelleria during southerly winds: they had to compensate during the longer stage of the crossing, only later flying in following winds. On the other hand, as mentioned above, Honey Buzzards using this route with north-westerly winds probably compensated the previous drift effect during the final stage of the crossing by changing their orientation behaviour, but did not avoid headwinds between this island and the Cap Bon Peninsula. In this picture, the optimal use of prevailing winds does not seem to be the only factor affecting adult Honey Buzzards crossing the Central Mediterranean. Previous studies made at the Cap Bon promontory during spring migration, showed that these raptors tend to leave the mainland mostly during weak lateral winds probably to minimize "drifting" (Agostini et al. 1994a). However, during the powered flight over water, the probability of changing weather conditions (i.e. because of the passage of low pressure cells) obviously increases with the length of the crossing. By passing through Pantelleria, adult Honey Buzzards migrating across the southern side of the Channel of Sicily lower the risk of unpredictable weather changes interrupting the non-stop powered flight over water. Moreover, as on Marettimo, they can exploit soaring flight thus undertaking the final sea crossing at high altitude. In conclusion, our results suggest that prevailing winds, geography and navigational abilities could interact to shape the orientation behaviour of adult Honey Buzzards during migration, minimizing the risks of the non-stop powered flight over water surfaces.

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STRESZCZENIE

[Wpływ kierunku wiatrów i ukształtowania terenu na zachowania wędrówkowe dorosłych pszczołojadów]

Podczas jesiennej migracji nad Morzem Śródziemnym, dorosłe pszczołojady przecinają ten akwen w najwęższym jego miejscu, między zachodnią Sycylią a półwyspem Cap Bon (Fig. 1). Prezentowana praca analizuje wpływ kierunków wiatrów wiejących na tym obszarze oraz uwarunkowań geograficznych na zachowanie wędrujących ptaków obserwowanych nad dwiema wysepkami położonymi na północ i południe od Kanału Sycylijskiego na podstawie kierunków wybieranych przez wędrujące stada pszczołojadów. Pszczołojady osiągają wyspę Marettimo (30 km na zachód od Sycylii i 130 km od Cape Bon) lecąc ze wschodu, opuszczając wyspę kierują się na południowy zachód. Kierunki wiejących tu wiatrów nie wpływają na migrację. Natomiast ptaki wędrujące nad Pantellerią (110 km na południowy zachód od Sycylii i 70 km na południowy wschód od Cape Bon) istotnie częściej opuszczały wyspę podczas wiatrów północno-zachodnich. Pszczołojady osiągają to miejsce lecąc od północnego wschodu i kontynuują wędrówkę na północny zachód. Wykorzystują one wówczas zdolności nawigacyjne wybierając krótszą drogę między Pantellerią i Tunezją i lecąc po łuku. Otrzymane wyniki częściowo pozostają w zgodzie z teorią "optymalnego wykorzystania wiatru". Bez wątpienia wiatr, uwarunkowania geograficzne i umiejętności nawigacyjne wspólnie wpływają na zachowania migracyjne tych ptaków ograniczając niebezpieczeństwo długiego lotu aktywnego nad lustrem wody.