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Author(s): Nicolantonio Agostini, Carmela Cardelli, Marco Gustin
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FACTORS SHAPING PATHWAYS OF EUROPEAN HONEY-BUZZARDS (*PERNIS APIVORUS*) DURING SPRING MIGRATION IN THE CENTRAL MEDITERRANEAN BASIN

NICOLANTONIO AGOSTINI,[1] CARMELA CARDELLI, AND MARCO GUSTIN
LIPU (Lega Italiana Protezione Uccelli), Conservation Dep., Via Trento 49, 43100 Parma, Italy

KEY WORDS: *European Honey-buzzard*; Pernis apivorus; *migration*; *navigation*; *orientation*; *water crossing*; *wind*.

During migration, European Honey-buzzards *Pernis apivorus* mostly use soaring flight, exploiting thermal currents over land. Because thermals are almost absent over water, travelling there requires more energetically-expensive powered flight (Kerlinger 1989) and European Honey-buzzards are reluctant to undertake long sea crossings. However, each spring, thousands of migrants wintering in west-central equatorial Africa cross the central Mediterranean to reach their breeding areas in central-eastern Europe (Cramp and Simmons 1980). During this sea crossing, the migrants concentrate at a narrowest point (approx. 150 km) leaving the African mainland from the Cap Bon Peninsula en route to western Sicily, and also later at the Straits of Messina (Agostini et al. 1994a, 1994b, Agostini and Logozzo 1998, Corso 2001, Agostini et al. 2006). Moreover, at least some of European Honey-buzzards crossing this Mediterranean area use alternative paths, reaching the Italian Peninsula directly via Ustica and Lipari Islands (Fig. 1; Panuccio et al. 2004, Agostini and Panuccio 2005, Agostini et al. 2005a). In doing so, they undertake a further water crossing flying over the Tyrrhenian Sea, bypassing the Straits of Messina. Unlike the Straits of Messina, where migrants are reported mostly during head winds (Agostini 1992), at Ustica, European Honey-buzzards move through during tailwinds, making a faster and energetically less-expensive flight over water (Agostini et al. 2005a). The aim of this study was to investigate factors shaping the pathways of European Honey-buzzards in the central Mediterranean basin during spring migration by simultaneous observations at four watch-sites, Marettimo, Pantelleria, Panarea (Lipari Islands) and the Straits of Messina (Sicilian side).

STUDY AREA AND METHODS

Observations, using binoculars and telescopes, were made between 25 April–20 May 2004, the peak of the spring migration of the European Honey-buzzard in the Mediterranean basin (Cramp and Simmons 1980). Marettimo is a small (12 km^2) mountainous island, approximately 30 km from western Sicily and 20 km west of the islands of Levanzo and Favignana. This island is located in the northern half of the Channel of Sicily, ca. 130 km NE of the Cap Bon Promontory (Tunisia, Fig. 1). Monte Falcone is its highest point, at 686 m. The observation station was located at an altitude of ca. 500 m. Pantelleria is a volcanic island (84 km^2), approximately 110 km SW of western Sicily and 70 km ESE of the Cap Bon Peninsula, in the southern half of the Channel of Sicily (Fig. 1). The observation station was located along the western coast (Punta Fram) at an altitude of ca. 100 m. At this island the highest elevation inland (Montagna Grande) reaches 836 m. Like Pantelleria, Panarea is a volcanic island (3.5 km^2), located approximately 65 km NW from the Straits of Messina (Fig. 1). The observation station was at the island's highest point, ca. 400 m a.s.l. Finally, at the Straits of Messina the observation station was located along the Sicilian slope, over the Peloritani Mountains at an altitude of ca. 500 m.

Previous studies made at the Cap Bon Promontory and at the islands of Marettimo, Ustica and Pantelleria, showed that European Honey-buzzards of the same flock tended to remain together in front of the water barrier because the first individuals making a decision (crossing or not) were followed by the others (Agostini et al. 1994a, 1994b, 2005a, 2005b). Thus, a flock-member did not act and orient independently. For this reason, in our statistical analysis, we considered the flock as sampling unit to avoid pseudoreplication of the data (Hurlbert 1984, see also Agostini et al. 2005a, 2005b). To investigate the circadian pattern of migration, each observation day was divided into three time periods: morning (0800–1159 H), midday (1200–1559 H) and afternoon (1600–2000 H, solar time). Hourly meteorological data from the two study areas (Pantelleria–Marettimo and Straits of Messina–Panarea) were recorded at the meteorological stations of Pantelleria and Reggio Calabria, respectively, and obtained at the Italian web site of the Weather Underground Inc. (www.ilmeteo.it/dati.htm). Observations were interrupted only because of rain and/or poor visibility. Contingency tables were used to test the influence of prevailing winds and of the time of the day on the migratory flow through the Channel of Sicily (Marettimo-Pantelleria) and eastern Sicily (Straits of Messina-Panarea).

RESULTS

Pantelleria–Marettimo. At these two sites, 325 flocks (216 at Pantelleria, 109 at Marettimo) and 54 solitary individuals (19 at Pantelleria, 35 at Marettimo) were re-

[1] Present address: Mediterranean Raptor Migration Network, Via Carlo Alberto 4, 89046 Marina di Gioiosa Jonica, Italy; Email address: nicolantonioa@tiscalinet.it

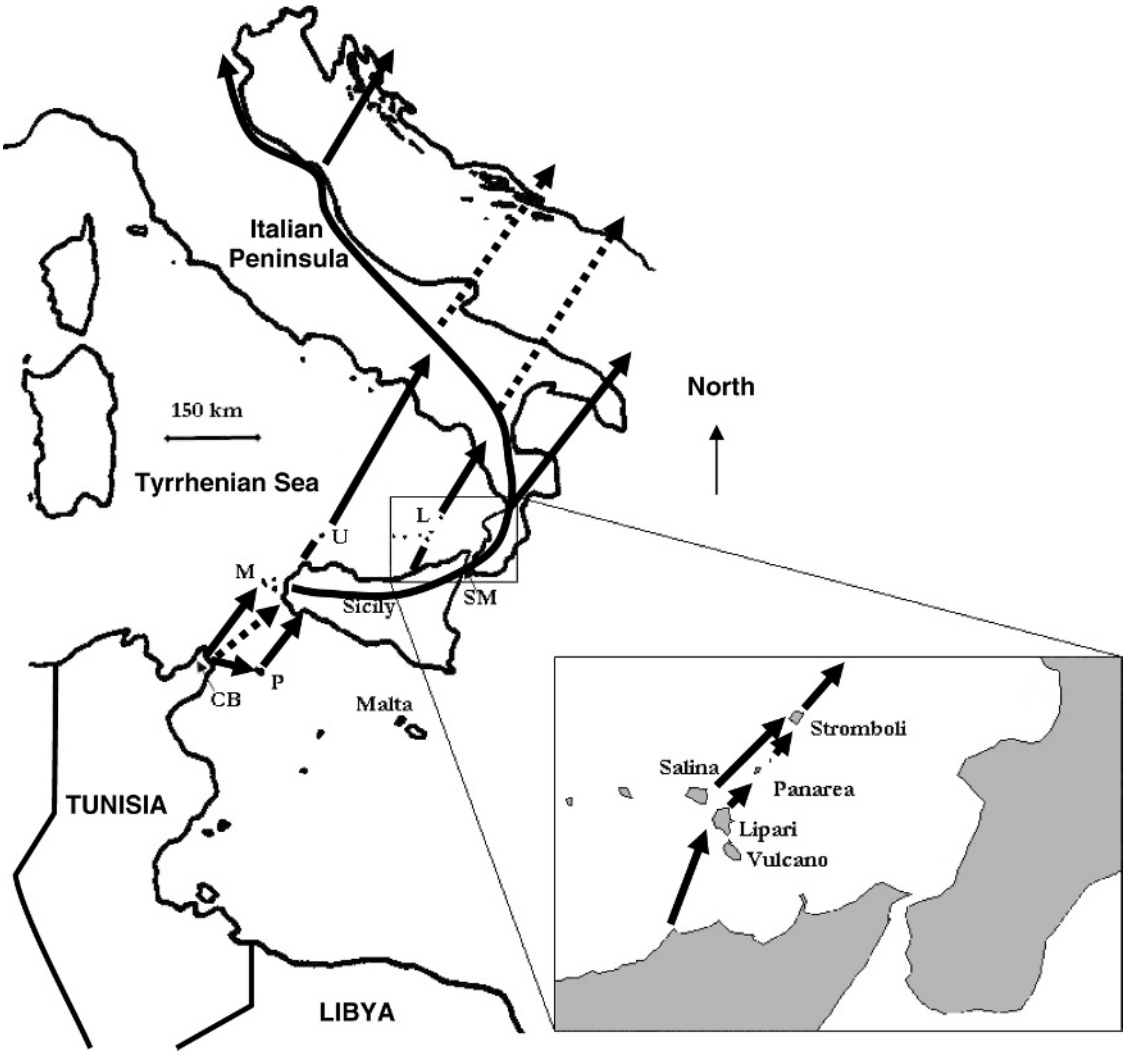

Figure 1. The study area and approximate paths used by European Honey-buzzards during spring migration across the Central Mediterranean (dotted arrow: expected path; CB = Cap Bon Peninsula; P = Pantelleria; M = Marettimo; U = Ustica; L = Lipari Islands; SM = Straits of Messina).

corded in 444 hr of observation (265 hr at Pantelleria, 179 hours at Marettimo). A total of 6446 individuals migrated in flocks, 5397 at Pantelleria, 1049 at Marettimo, with an average flock size of 25.0 ± 4.0 (SE) and 9.9 ± 1.3 (SE) birds, respectively and a maximum flock size of 757 at Pantelleria. Among 142 (65.7%) flocks detected over the sea while reaching Pantelleria, all were reported from the WNW, apparently coming from the Cap Bon Peninsula (Fig. 1). A total of 74 (34.3%) flocks reached the site undetected as they crossed the sea; of these, 53 moved along the western coast heading NE, six headed SW, and 15 were observed inland. European Honey-buzzards left Pantelleria heading NE. At Marettimo, European Honey-buzzards were seen reaching the site from SW and then leaving the island toward E. Prevailing winds, from N-NNE, W-WNW-NW, and WSW-SW-SSW had a significant effect on the migratory flow at the two sites ($\chi^2 = 45.92$, df = 2, $P < 0.01$, Table 1). During N-NNE and W-WNW-NW winds flocks passed mostly via Pantelleria; conversely, during south-westerly winds, flocks passed mostly via Marettimo, although during such atmospheric conditions observations were made mostly at Pantelleria because of poor visibility at Marettimo ($\chi^2 = 13.96$, df = 2, $P < 0.01$, Table 1). Because of its geographic characteristics, Marettimo not uncommonly experiences poor visibility (see also Agostini and Logozzo 1998). The circadian pattern of mi-

Table 1. Number of flocks of European Honey-buzzards recorded, and number of hours observed, 25 April–20 May 2004, at migration stations at Pantelleria and Marettimo islands, central Mediterranean Basin, as a function of prevailing wind direction and time of day.

Factor	Flocks *†		Hours *	
	Pantelleria	Marettimo	Pantelleria	Marettimo
Prevailing winds				
N-NNE	96	14	39	42
W-WNW-NW	111	67	123	107
WSW-SW-SSW	9	24	78	30
Time of day				
Morning	28	10	88	52
Midday	42	62	99	78
Afternoon	146	37	78	49

* = $P < 0.05$ for prevailing winds.
† = $P < 0.05$ for time of day.

Table 2. Number of flocks of European Honey-buzzards recorded, and number of hours observed at migration stations, 25 April–20 May 2004, at the Straits of Messina and Panarea Island, central Mediterranean Basin, as a function of prevailing wind direction and time of day.

Factor	Flocks *†		Hours	
	Straits of Messina	Panarea	Straits of Messina	Panarea
Prevailing winds				
N-NNE	594	127	135	146
WSW-SW-SSW	124	68	39	35
Time of day				
Morning	244	82	101	82
Midday	327	70	98	103
Afternoon	224	74	68	68

* = $P < 0.05$ for prevailing winds.
† = $P < 0.05$ for time of day.

gration showed an evident peak during the afternoon at Pantelleria and during midday at Marettimo ($\chi^2 = 47.19$, df = 2, $P < 0.01$; Table 1).

Straits of Messina–Panarea. 795 flocks were recorded at the Straits of Messina (in 267 hr of observation), 226 flocks at Panarea (in 253 hr of observation), and 186 and 88 birds migrated alone at the two sites, respectively. Flocks contained 11 509 and 4210 birds, with an average flock size of 14.2 ± 0.6 (SE) and 20.1 ± 2.2 (SE) birds, respectively (maximum flock size was 227 at Panarea). In this region, prevailing winds were from N-NNE and WSW-SW-SSW. Although at both sites European Honey-buzzards were seen mostly during N-NNE winds, the proportion of flocks recorded at Panarea during south-westerly winds (34.9%, $N = 195$) was higher than that recorded at the Straits of Messina during such atmospheric conditions (17.3%, $N = 718$; $\chi^2 = 27.33$, df = 1, $P < 0.01$, Table 2). The circadian variation of the migratory flow differed at the two sites; the peak occurred during midday at the Straits of Messina, during the morning at Panarea ($\chi^2 = 7.65$, df = 2, $P < 0.05$; Table 2). Among flocks recorded at Panarea, at least 31 (13.7%), containing 1290 (30%) birds, bypassed the island, flying directly toward Stromboli, apparently coming from the island of Salina (Fig. 1). They were seen using soaring flight over the sea, probably flying in thermals deviated over water by the wind (see also Agostini et al. 2005a) but, apparently, their altitude was never higher than our observation post.

Finally, it is interesting to note that the proportion of flocks reported during south-westerly winds was higher at the Straits of Messina–Panarea than at Marettimo–Pantelleria ($\chi^2 = 27.29$, df = 1, $P < 0.01$, Table 3), although, during such wind conditions, a greater proportion of the hours of observation was made at the last two locations ($\chi^2 = 15.27$, df = 1, $P < 0.01$, Table 3).

Discussion

European Honey-buzzards crossing the southern and northern side of the Channel of Sicily, via Pantelleria and Marettimo, used the same pathways they did during

Table 3. Number of flocks of European Honey-buzzards recorded, and number of hours observed, 25 April–20 May 2004, at the two study areas during south-westerly and other wind directions.

Factor	Flocks *		Hours *	
	Straits of Messina–Panarea	Marettimo–Pantelleria	Straits of Messina–Panarea	Marettimo-Pantelleria
Prevailing winds				
Other winds	603	292	446	336
WSW-SW-SSW	192	33	74	108

* = $P < 0.05$ for prevailing winds.

autumn migration (Agostini et al. 2005b). In particular, those passing via Pantelleria used a curvilinear flyway, apparently choosing the shortest route between North Africa and this central Mediterranean island, where they changed their orientation and flew NE toward western Sicily. They probably applied true navigational abilities, as Pantelleria is nearly always out of sight from Tunisia (Agostini pers. obs.). Flocks using this flyway with W-WNW-NW winds flew in tailwinds between the Cap Bon Peninsula and Pantelleria, and then moved in lateral winds from Pantelleria to western Sicily. In contrast, during N-NNE winds, birds perhaps allowed themselves to drift ESE toward Pantelleria, thus avoiding flying directly into the wind, and later flew about 110 km in head winds between that island and western Sicily. As a result, during both W-WNW-NW and N-NNE winds, birds saved energy during the first stage of the crossing; upon reaching Pantelleria, they interrupted their non-stop powered flight over water, exploiting thermals over land before undertaking the final sea crossing from Pantelleria to western Sicily at a higher altitude. As during their autumn migration, this flight pattern of interrupting the powered flight over water could lower the risk of unpredictable weather changes during the water crossing, and may perhaps result from a conservative strategy (Agostini et al. 2005b). Moreover, passing mostly in the afternoon, the birds at Pantelleria were probably more fatigued than those undertaking the sea crossing in the morning and thus more reluctant to fly directly toward western Sicily from the Cap Bon Peninsula. Conversely, during WSW-SW-SSW winds flocks passed mostly over Marettimo, probably exploiting the tailwind to minimize energetic costs. However, during south-westerly winds, a lower proportion of flocks was seen at Marettimo–Pantelleria compared to that observed in eastern Sicily (Panarea–Straits of Messina). Probably, during such winds, many flocks used a more direct path between North Africa and western Sicily, bypassing both Marettimo and Pantelleria. During observations made at the Ustica Island (Fig. 1), European Honey-buzzards were seen flying quickly with tailwinds, sometimes at a very low altitude over the water, which was in agreement with our observations made at Panarea (Agostini et al. 2005a).

Between eastern Sicily and Italian Peninsula (Straits of Messina-Panarea) European Honey-buzzards migrated on a broader front in the morning and during south-westerly winds, when a higher proportion of flocks crossed the southern Tyrrhenian Sea via the Lipari Islands. Conversely, flocks concentrated their passage via the Straits of Messina with N-NNE winds and during midday. These results might be explained by the fact that the thermals presumably are weaker in the morning than during midday, and, consequently, the difference between energetic costs of flight over land and over water is less consistent during the morning. Moreover, as we found for the Pantelleria–Marettimo area, during south-westerly winds a higher proportion of flocks might choose the more direct route to reach the Italian Peninsula, exploiting the tailwinds. During tailwinds, the difference in energetic costs of powered flight over water vs. soaring flight over land is likely lower than the difference during head winds. Finally, the location of breeding areas might also play a role in the decision of whether or not to cross the Tyrrhenian Sea; in particular, birds breeding in southernmost Europe may be less reluctant to make the sea crossing because they are nearing the end of their migration and flying in large numbers over wide water surfaces (Agostini and Panuccio 2005). Observations of thousands of European Honey-buzzards seen undertaking further sea crossings between the Italian Peninsula and the former republic of Yugoslavia and Albania are consistent with this hypothesis (Gustin and Sorace 2004, Premuda et al. 2004). In conclusion, our study suggests that prevailing winds, geography, navigational abilities, and the time of the day interact to shape the migratory paths of European Honey-buzzards.

FACTORES QUE DETERMINAN LAS RUTAS DE *PERNIS APIVORUS* DURANTE LA MIGRACIÓN DE PRIMAVERA EN LA DEPRESIÓN CENTRAL DEL MEDITERRÁNEO

RESUMEN.—Observamos a individuos de la especie *Pernis apivorus* en puntos migratorios cerca del Mar Mediterráneo central. Se realizaron observaciones simultáneas entre el 25 de abril y el 20 de mayo de 2004 en las islas Marettimo, Pantelleria (localizadas a los costados norte y sur del canal de Sicilia, respectivamente), Panarea y en los estrechos de Messina (ambos al el este de Sicilia). La bandada se utilizó como unidad de muestreo. Un total de 216 bandadas pasaron vía Pantelleria, la mayor parte durante vientos N-NNE y W-WNW-NW con un pico evidente a finales de la tarde y durante el atardecer. Las aves escogieron cruzar por la ruta más corta entre el norte de África y Pantelleria utilizando una migración curvilínea sobre el agua. Durante los períodos de viento con dirección sur-oeste, *P. apivorus* se registró principalmente en Marettimo a lo largo de la ruta más directa hacia el oeste de Sicilia; estas aves probablemente aprovecharon los vientos de cola. Con vientos con dirección sur-oeste y durante las horas de la mañana, *P. apivorus* mostró un frente de migración más amplio entre el este de Sicilia y la Península Itálica (Estrechos de Messina–Panarea). Nuestro estudio sugiere que los vientos predominantes, la geografía, las habilidades de navegación y la hora del día determinan las rutas migratorias en esta especie.

[Traducción del equipo editorial]

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LITERATURE CITED

AGOSTINI, N. 1992. Spring migration of Honey Buzzards (*Pernis apivorus*) at the Straits of Messina in relation to atmospheric conditions. *J. Raptor Res.* 26:93–96.

——— AND D. LOGOZZO. 1998. Primi dati sulla migrazione primaverile degli Accipitriformi sull'isola di Marettimo (Egadi). *Riv. Ital. Ornitol.* 68:153–157.

———, G. MALARA, F. NERI, AND D. MOLLICONE. 1994a. La migrazione primaverile del Falco pecchiaiolo *Pernis apivorus* a Cap Bon (Tunisia) e sullo Stretto di Messina. *Proc. Ital. Ornithol. Conf.* 6:451–452.

———, ———, ———, ———, AND S. MELOTTO. 1994b. Flight strategies of Honey Buzzards during spring migration across the Central Mediterranean. *Avocetta* 18:73–76.

——— AND M. PANUCCIO. 2005. Analysis of the spatial migration patterns of adult Honey Buzzards (*Pernis apivorus*) during spring and autumn in the Central Mediterranean. *Ring* 27:29–34.

———, ———, AND B. MASSA. 2005a. Flight behaviour of Honey Buzzards (*Pernis apivorus*) during spring migration over the sea. *Buteo* 14:3–9.

———, G. PREMUDA, U. MELLONE, M. PANUCCIO, D. LOGOZZO, E. BASSI, AND L. COCCHI. 2005b. Influence of wind and geography on orientation behavior of adult Honey Buzzards *Pernis apivorus* during migration over water. *Acta Ornithol.* 40:71–74.

———, ———, L. COCCHI, R. MOLAJOLI, C. CARDELLI, M. GUSTIN, AND L. BAGHINO. 2006. Spring migration of European Honey-buzzards (*Pernis apivorus*) along the Sardinia-Corsica corridor (Central Mediterranean). *J. Raptor Res.* 40:244–246.

CORSO, A. 2001. Raptor migration across the Strait of Messina, southern Italy. *Br. Birds* 94:196–202.

CRAMP, S. AND K.E.L. SIMMONS. 1980. The birds of the western Palearctic. Vol. II. Oxford Univ. Press, Oxford, U.K.

GUSTIN, M. AND A. SORACE. 2004. Is the Conero promontory, central Italy, an important bridge for migrant raptors entering eastern Europe in spring? *Br. Birds* 97:403–406.

HURLBERT, S.J. 1984. Pseudoreplication and the design of ecological field experiments. *Ecol. Monogr.* 54:187–211.

KERLINGER, P. 1989. Flight strategies of migrating hawks. Univ. of Chicago Press, Chicago, IL U.S.A.

PANUCCIO, M., N. AGOSTINI, AND B. MASSA. 2004. Spring raptor migration at Ustica, southern Italy. *Br. Birds* 97:400–403.

PREMUDA, G., U. MELLONE, AND L. COCCHI. 2004. Osservazioni sulle modalità della migrazione primaverile dei rapaci a Capo d'Otranto. *Avocetta* 28:33–36.

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