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Local Weather Conditions Affect Migration Strategies of Adult Western Honey Buzzards *Pernis apivorus* through an Isthmus Area

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Michele Panuccio, Nicolantonio Agostini, Giuseppe Lucia, Ugo Mellone, Stephen Wilson, Jack Ashton-Booth, Gianpasquale Chiatante, and Simone Todisco (2010) Local weather conditions affect migration strategies of adult Western Honey Buzzards *Pernis apivorus* through an isthmus area. *Zoological Studies* **49**(5): 651-656. We tested the effect of crosswinds, barometric pressure, and time of day on the visible migration of adult Western Honey Buzzards *Pernis apivorus* through an isthmus area in southern continental Italy. Simultaneous observations from 3 posts were made in autumn 2005 and 2006, and birds were assigned to one of 3 local migration corridors: western, central, and eastern. During our observations, prevailing winds were perpendicular to the direction of migration. The peak of migration occurred during the afternoon and with westerly winds. Ideal weather conditions for soaring flight occurred during weak winds and high barometric pressure. An analysis of migration frequencies among the 3 corridors suggests that adult Western Honey Buzzards tend to compensate for deviations in lateral winds on a small scale when migrating through this isthmus area. It appears that they do not slow their travel speed during weather conditions that are unfavorable for soaring flight (strong lateral winds 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, thus showing a broad front of migration over water. http://zoolstud.sinica.edu.tw/Journals/49.5/651.pdf

Key words: Western Honey Buzzard, Raptor migration, Wind drift, Central Mediterranean.

During migration, birds face a variety of challenges including geographical complexity, competition during stopovers, and the variability and unpredictability of meteorological conditions (Berthold 2001). In particular, weather conditions can affect flight behaviors and migration pathways on both large and small scales and ultimately a bird's decision when to depart (Alerstam 1979, Richardson 1990, Maransky et al. 1997, Danhardt and Lindstrom 2001, Shamoun-Baranes et al. 2006, Agostini et al. 2005, Liechti 2006). In particular, sea-level pressure was shown to be one of the most important factors triggering the onset of soaring-bird migration (Shamoun-Baranes et al. 2003), and favorable winds can minimize both the time and energy birds allocate to migration (Houston 1998). General wind conditions can shape the migratory routes of raptors; for example, Klaassen et al. (2010) demonstrated how crosswinds cause Western Marsh Harriers *Circus aeruginosus* to partially drift thus promoting a loop migration. The Western Honey Buzzard *Pernis apivorus* is one of the most common raptor species recorded at migration hotspots in the

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Western Palaearctic (Bildstein 2006), and their wings show an intermediate morphology between those of large raptors with a low aspect ratio (e.g., buzzards, vultures, and eagles) and those of raptors with a high aspect ratio (e.g., kites, harriers, and the osprey; Kerlinger 1989). For this reason although Western Honey Buzzards mostly use soaring flight during migration (Bruderer et al. 1994), they will also cross large water bodies using flapping flight (Agostini et al. 2005).

Recent visual studies made in the Central Mediterranean showed that the sea crossing behavior of adult Western Honey Buzzards was affected by several factors, such as geography, prevailing winds, time of day, and navigational abilities among others (Agostini et al. 2005). Crosswinds also play a significant role in these birds' movements and tend to induce a significant drift effect during the 1st stage of their long sea crossings whereby they exploit small islands to facilitate soaring flight (Agostini et al. 2007a). During flight through the Channel of Sicily, between western Sicily (southern Italy) and Tunisia, adult Western Honey Buzzards migrate on a broad front between the islands of Marettimo and Pantelleria (a distance of approximately 120 km), and those passing via Pantelleria compensate for deviations caused by lateral winds during the final stage of the crossing showing a curvilinear path over water (Fig. 1). During autumn, before reaching the Channel of Sicily and flying west along the mountain chains of northern Sicily, these birds follow the Italian peninsula (Agostini and Logozzo 1997, Panuccio et al. 2005). During passage through southern continental Italy, they concentrate across a narrow front (the Marcellinara Isthmus) where the distance between the Tyrrhenian and Ionian coasts is narrowest (approximately 30 km) before approaching the Straits of Messina.

The aim of this study was to verify through visual observations the effects of small-scale weather patterns such as crosswinds, barometric pressure, and time of day on the visible migration of adult Western Honey Buzzards through the Marcellinara Isthmus.

MATERIALS AND METHODS

Study area

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. Birds concentrate along the passage in the Pesipe Valley and often fly close to the ground (< 100 m) allowing for an accurate study of the migration by direct visual observations (Agostini and Logozzo 1995a 1997). Observations were made between 24 Aug. and 12 Sept. in both 2005 and 2006, the main migration period of adult Western Honey Buzzards through the central Mediterranean (Agostini and Logozzo 1995b). Three observation posts were used (Fig. 1), and observations were made with the aid of telescopes and binoculars. These 3 vantage points were located on the slopes of Mt. Covello and Mt. Contessa (both at approximately 700 m in elevation) and in the town of Girifalco (at approximately 450 m). Observations were made simultaneously at every post and were only interrupted during rain. To investigate the daily pattern of migration, each day of observation was divided into 5 (solar) time periods: 07:20-09:19, 09:20-11:19, 11:20-13:19, 13:20-15:19, and 15:20-17:20. The passage of raptors was examined along 3 topographical corridors: western (west of the post on Mt. Contessa), central (between Mt. Covello and Mt. Contessa), and eastern corridor (east of Mt. Covello). Because observation distances between posts overlapped, at the end of each day, data recorded at each post were compared with data from the other posts, to eliminate possible double counting of the same birds according to the time and location of the birds' passage (see also Dovrat 1991 in Shirihai et al. 2000).

In the statistical analysis, when comparing the average numbers of birds passing through the study area per hour, we used the *z* test (Fowler and Cohen 1996) after logarithmic transformation of the original data. In order to keep our analysis as conservative as possible, we did not consider hours in which no Western Honey Buzzards were reported, since it could have been related to factors occurring outside our study area. We classified barometric pressure as either high (all values above the median; ≥ 1016 hPa) or low (all values below the median; < 1016 hPa). Moreover, we classified the altitude of raptors as high, when they passed higher than the observation posts, and low, when they passed lower than the observation posts or at eye level. Finally, prevailing winds were considered strong when their speed was ≥ 20 km/h. Hourly weather data at the Marcellinara Isthmus were obtained from the Lamezia Terme meteorological station which are at the web site www.ilmeteo.it/dati.htm.

RESULTS

In total, 1346 (19%), 4727 (65%), and 1177 (16%) Western Honey Buzzards were seen along the western, central, and eastern corridors, respectively. The time of day had a significant effect on the visible migration; the passage showed an evident peak in the afternoon at 13:20-15:19 (Fig. 2; $\chi^2 = 632.94$, *d.f.* = 4, $p < 0.01$). Along the eastern corridor, the proportion of migrants was significantly higher during this period of the day (Fig. 3; $\chi^2 = 151.2$, *d.f.* = 8, $p < 0.01$). During our study, prevailing winds were mainly perpendicular to the direction of migration (lateral winds for 304 h and other wind conditions for 87 h) with westerly winds (WNW-W-WSW) being more common than easterly winds (ENE-E-ESE) (232 vs. 72 h,

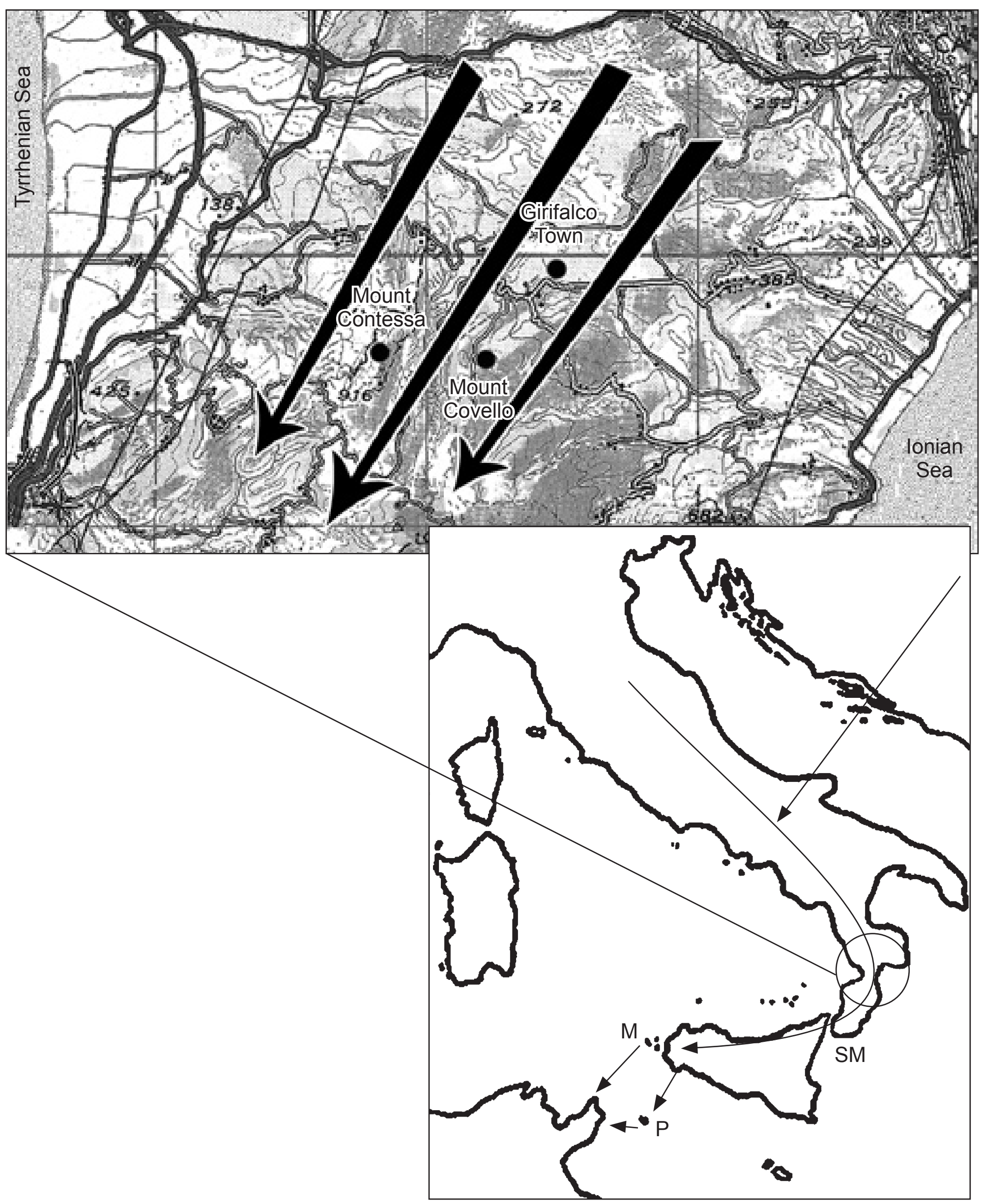

Fig. 1. Study area and approximate flyways (arrows) used by adult Western Honey Buzzards in autumn through the Central Mediterranean. SM, Straits of Messina; M, Marettimo; P, Pantelleria.

respectively). Western Honey Buzzards migrated across the 3 sites mainly during prevailing westerly winds: the derived average number of birds counted per hour of observation was 15.1 ± 1.1 (SE) with westerly winds vs. 3.6 ± 1.9 (S.E.) with easterly winds ($z = 7.75$, $p < 0.01$). Barometric pressure and the strength of the westerly winds did not significantly affect migration counts; the derived average number of birds counted per hour of observation was 12.6 ± 3.2 (S.E.) with low barometric pressure vs. 11 ± 3.8 (S.E.) with high barometric pressure, and 17.4 ± 1.1 (S.E.) with weak westerly winds vs. 13.5 ± 1.1 (S.E.) with strong westerly winds. Weather conditions for soaring flight apparently were better during weak winds and high barometric pressure since the proportion of birds passing lower than the observation posts or at eye level was higher during strong (> 20 km/h) rather than weak winds (Fig. 4; contingency table: $\chi^2 = 77.89$, *d.f.* = 2, $p < 0.01$) and during low rather than high barometric pressure (contingency table: $\chi^2 = 206.97$, *d.f.* = 2, $p < 0.01$. Fig. 4). Although the strength of the westerly winds did not affect migration counts, the proportion of migrants was significantly higher along the eastern corridor during strong westerly winds (contingency table: $\chi^2 = 92.2$, *d.f.* = 2, $p < 0.01$; Fig. 5) and low barometric pressure (Fig. 5; contingency table: $\chi^2 = 208.8$, *d.f.* = 2, $p < 0.01$).

DISCUSSION

Wind direction and time of day significantly affected migration counts in our study area. As expected, the peak of migration occurred during the afternoon when thermals were at their strongest, and therefore migrants were able to optimize soaring flight and increase their

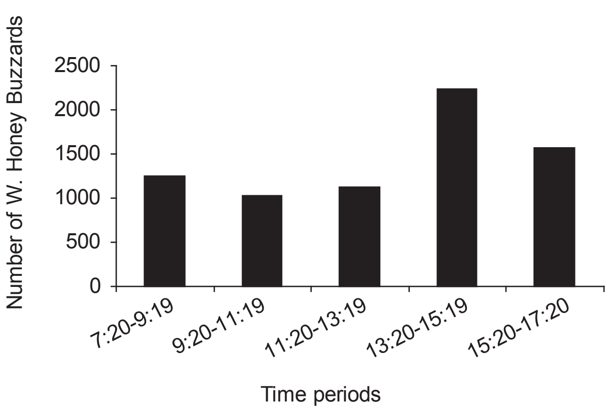

Fig. 2. Variations in the daily patterns of migration (solar time) of Western Honey Buzzards through the Marcellinara Isthmus.

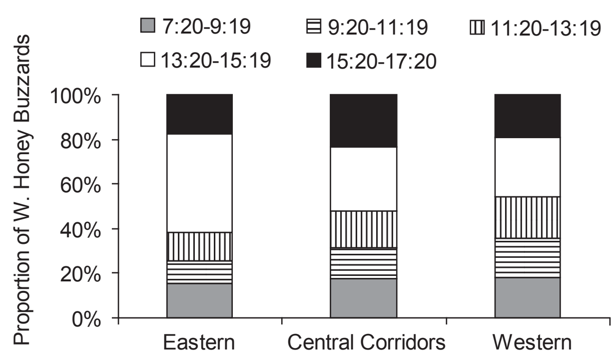

Fig. 3. Variations in the daily patterns of migration (solar time) along the western, central, and eastern corridors.

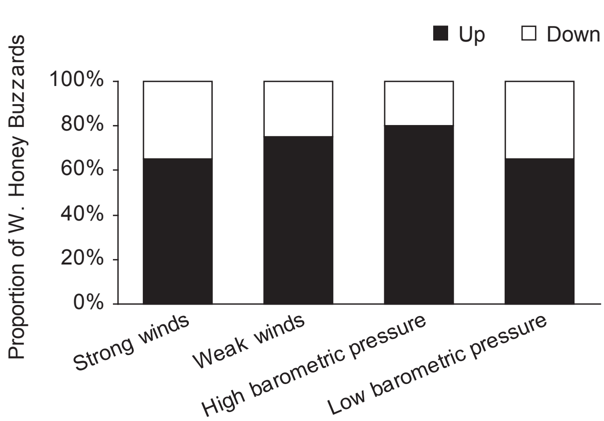

Fig. 4. Proportions of Western Honey Buzzards passing high and low with strong and weak winds and with high and low barometric pressure.

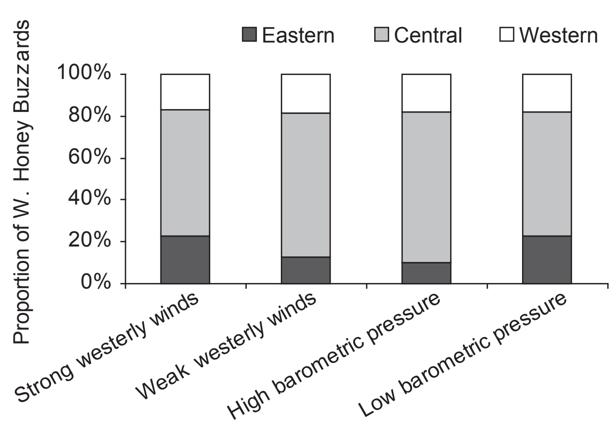

Fig. 5. Proportions of Western Honey Buzzards passing along the eastern, central, and western corridors during periods of strong and weak westerly winds and during high and low barometric pressure.

travel speed as observed in other areas (Spaar 1997). Regarding wind direction, Western Honey Buzzards passed mostly during periods of prevailing westerly rather than easterly winds, since such atmospheric conditions are associated with the thermal-producing, fair-weather period that follows the passage of a cold front in the central Mediterranean region. For the same reason, the barometric pressure probably affected the altitude of raptor flight. In addition, an approaching cold front can cause unfavorable weather conditions (rain and southerly winds) north of the watch points, just along the migratory flyway; Western Honey Buzzards that pass through southern continental Italy during autumn are most likely from breeding areas in central Italy and the Balkans via the Adriatic Sea (Agostini et al. 2007b). As in our study, in eastern Pennsylvania, USA, the peak of raptor migration is associated with weather conditions that help create thermal updrafts on days following the passage of a cold front (Allen et al. 1996, Maransky et al. 1997). There could be 2 alternative explanations for the fact that migration counts did not differ between times of low and high barometric pressure, or weak and strong westerly winds: within the different periods of the day (1) during ideal weather conditions for soaring flight (high barometric pressure and weak lateral winds), a higher percentage of raptors passed through undetected; or (2) migrants did not slow their travel speed during unfavorable weather for soaring flight when passing through the Marcellinara Isthmus, because they increased the use of powered flight to limit the drift effect of lateral winds. The 1st explanation is not supported by the results concerning the peak passage observed in the afternoon, during better weather conditions for soaring flight; because of the flat and hilly zone north of the site, approaching migrants cannot use thermal and/or slope-soaring as raptors do along a mountain ridge (Maransky et al. 1997), and they are often flying close to the ground when they reach the study area (see also Agostini and Logozzo 1995a b, 1997). Conversely, the latter hypothesis would be in agreement with earlier observations concerning the flight style of migrants reported with different strengths of lateral winds made in the study area in the 1990s (Agostini and Logozzo 1995a) such as with our results concerning the higher proportions of birds seen passing at lower altitudes during both strong lateral winds and low barometric pressure. In fact, during such atmospheric conditions, Western Honey Buzzards passing through the study area limit the use of soaring flight (Agostini and Logozzo 1995a), and only a fraction of birds exhibit a light drift effect when passing along the eastern corridor. These results partially agree with those made in Israel where Western Honey Buzzards migrating through the Middle East use soaring-gliding flight for 94% of their migration day and are therefore susceptible to drift (Shirihai and Christie 1992, Shirihai et al. 2000).

Analyzing satellite telemetry data collected all along the migration route, Thorup et al. (2003) showed that adult Western Honey Buzzards compensate for wind drift and are less affected than juveniles by crosswinds when migrating over land. We suggest that adult Western Honey Buzzards also tend to compensate for deviations in lateral winds on a smaller scale when migrating over land through this isthmus area. On the other hand, as mentioned above, migrants will change their migration strategy in relation to wind drift when migrating through the Channel of Sicily en route to Africa by showing a broad front of migration over water (Agostini et al. 2005).

Unfortunately, in the last 3 yr, a proliferation of wind farms has occurred in our study area. Considering the flight strategies adopted by Western Honey Buzzards in particular during strong lateral wind and low barometric pressure, post-operam monitoring for possible mortality effects is recommended.

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