Flight behaviour of Honey Buzzards (*Pernis apivorus*) during spring migration over the sea

Migrační chování včelojeda lesního (*Pernis apivorus*) při jarním tahu přes moře

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ABSTRACT. The aim of this research was to study the flight behaviour of migrating Honey Buzzards (*Pernis apivorus*) over water in relation to atmospheric conditions considering the flock as sampling unit. Observations were made between 29 April and 16 May 2001 over the island of Ustica (southern Italy), located about 60 km N of western Sicily, 270 km NE of the Cap Bon Promontory (Tunisia), 140 km NE of the island of Marettimo and 230 km W of the Italian Peninsula. A total of 124 flocks were counted, of them 101 undertook the crossing of the sea towards NE. The highest proportion of crossing flocks was seen during midday, but those seen leaving the island during the afternoon, about two-three hours before sunset, are evidence of the capacity of these raptors to migrate across water surfaces during the night. Considering both crossing and not crossing flocks, ideal weather conditions for crossing existed with following and weak lateral winds. During following wind, Honey Buzzards, although flew at low altitude, used soaring flight over water successfully.

INTRODUCTION

During migration, many species of raptors mostly use soaring flight exploiting thermal currents and limiting powered flight to reduce energetic costs (Kerlinger 1989). As a rule, because thermals are almost absent over water, these birds are reluctant to undertake water crossings. Factors influencing the decision whether to cross or not a body of water include weather, length of the crossing, distance around the water barrier, physiological state of the bird, flock size, time of day and experience (age dependent), while the risk of mortality probably increases with the absolute distance of the crossing (Kerlinger 1984, 1989, Agostini & Duchi 1994, Agostini et al. 1994a, b, 2002, 2004, Meyer et al. 2000, Thorup et al. 2003). Moreover, also the flight morphology plays a role; in particular, species with relatively long wings (high aspect ratio) are more suited to undertake crossings of large body of water as this feature decreases the induced drag, and thus the energy needed for powered flight (Kerlinger 1985). Among Accipitriformes, Osprey (*Pandion haliaetus*), harriers (*Circus* sp.) and kites (*Milvus* sp.) show higher aspect ratio while the Honey Buzzard (*Pernis apivorus*) has intermediate flight morphology between them and buzzards (*Buteo* spp.) (Kerlinger 1989). Eagles (*Aquilla* sp.) and vultures (i.e. *Gyps* sp.) show lower aspect ratio (Kerlinger 1989).

The Honey Buzzard is a summer resident in Europe wintering in west-central equato-

rial Africa (Cramp & Simmons 1980). Although these birds, unlike ospreys and harriers (Kerlinger 1989, Spaar & Bruderer 1997), mostly use soaring flight over land during migration, thousands of Honey Buzzards cross the Mediterranean Sea between the Cap Bon peninsula (Tunisia) and western Sicily (approx. 150 km) concentrating later at the Straits of Messina (Giordano 1991, Agostini 1992, Agostini et al. 1994a,b, Corso 2001). Moreover, hundreds of Honey Buzzards crossing this Mediterranean area reach directly the Italian Peninsula via the island of Ustica (Fig.1; Agostini 2002, Panuccio et al. 2004), undertaking a further water crossing of more than 300 km. Previous observations made at the Cap Bon Promontory, over the island of Malta and at the Straits of Messina, showed that Honey Buzzards apparently cross the Mediterranean Sea mostly during weak lateral and contrary winds but not during following wind (Beaman & Galea 1974, Agostini 1992, Agostini et al. 1994a). In particular, during strong following wind (>35 km/h), these raptors were seen flying at low altitude over water and were not able to maintain a steady forward movement (Agostini 1992).

The aim of this research was to verify these results by studying the spring migration of Honey Buzzards while making one of the longer sea crossings among Accipitriformes. Our results were also compared with those of previous researches made on the water-crossing behaviour of migrating raptors both in Europe and North America.

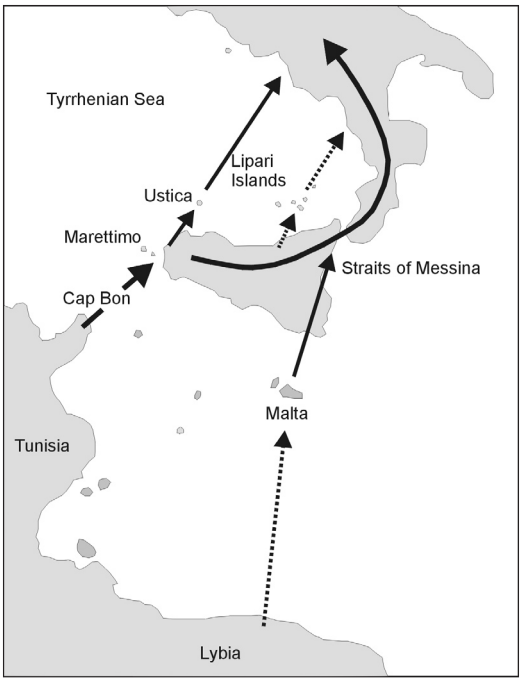

Fig. 1 – The study area (arrows: migratory routes of Honey Buzzards crossing the Central Mediterranean; doted arrow = supposed route).

Obr. 1 – Studované území (šipky: migrační trasy včelojedů lesních v centrálním Středomoří; tečkované šipky = předpokládané trasy).

STUDY AREA AND METHODS

Ustica is a small island (8.5 km^2) about 60 km N of western Sicily, 270 km NE of the Cap Bon Promontory (Tunisia), 140 km NE of the island of Marettimo and 230 km W of the Italian Peninsula (Fig.1). A total of 162 hours of observation (nine hours per day), aided with 10 x 40 binoculars, were made between 29 April and 16 May 2001, the peak period of the spring migration of this species on the Mediterranean basin (Cramp & Simmons 1980). The observation post was at the highest point (approx. 150 m) of the promontory dominating the NE coast of the island (its highest point, inland, reaching about 250 m). From this post it was possible to detect birds undertaking the crossing of the Tyrrhenian Sea and their behaviour over water. Each day was divided in three periods: morning (09:00-11:59 hours), midday (12:00-14:59) and afternoon (15:00-18:00; solar time). Previous studies made at the Cap Bon Promontory and over the island of Marettimo, 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. 1994b, Agostini & Panuccio pers. obs.). Thus a flock-member does not act 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 wind conditions on the migratory flow considering both crossing and not crossing flocks. Hourly meteorological data from Ustica were provided by the Italian Air force.

RESULTS

A total of 124 flocks were seen reaching the north-east coast of the island from SW and S, 101 (81.5%) of them undertook the crossing of the Tyrrhenian Sea towards NE. A total of 992 birds migrated in flocks while 66 individuals migrated alone. In the sample of crossing birds, 13 flocks (12.9%) and six solitary individuals hesitated before crossing towards NE; in particular, birds were seen returning to the island from the sea, flying along the coast, leaving the island flying towards SE or, with opposite wind, remaining stationary heading NE sometimes beating their wings. All 23 flocks and 23 solitary individuals that did not undertake the crossing and flew back inland, hesitated in front of the water barrier. It is interesting to note that the proportion of in-

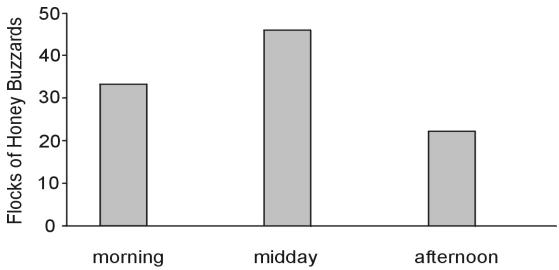

Fig. 2 – Variation of the migratory flow of crossing flocks of Honey Buzzards through the day over Ustica.
Obr. 2 – Změny v počtu hejn včelojeda lesního migrujících v průběhu dne přes ostrov Ustica.

dividuals migrating alone was significantly higher in the sample of not crossing birds (χ^2 = 33.55, DF = 1, P < 0.01). The migratory flow of Honey Buzzards undertaking the crossing of the Tyrrhenian Sea varied significantly throughout the day (χ^2 = 7.85, DF = 2, P < 0.05) with the highest proportion of flocks (Σ = 101) observed during midday (Fig.2). Finally, considering both crossing and not crossing flocks reported during following/contrary winds (Σ = 74) and weak/strong lateral winds (Σ = 48), ideal conditions for crossing existed with following and weak lateral winds (Table 1, 2).

Two flocks were seen leaving the island with absent wind (frequency four hrs). Generally, birds soared inland but not over the promontory. With lateral and contrary winds (the latter never stronger than 20 km/h), they passed high over our post using mostly gliding flight and disappearing over the sea towards NE. With following winds, although Honey Buzzards soared inland, they passed quickly often at altitudes lower than our observation post using both gliding and powered flight; sometimes they reached very low altitude over water. During this weather condition, 27 (71.1%) flocks used soaring flight over the sea successfully, quickly disappearing towards NE using flapping/gliding. However, during soaring over water their altitude was rarely higher than our observation post. Only six flocks were seen soaring over water, unsuccessfully, with lateral and contrary winds.

Table 1 – Crossing and not crossing flocks recorded with following and contrary winds
Tab. 1 – Počet hejn, která přeletěla a nepřeletěla moře za podmínek proti větru a po větru.

	Following wind	Contrary wind	
Average strength (km/h)	20.0 ± 1.7 SE	10.0 ± 0.6 SE	χ^2 = 12.94
Crossing flocks	38	24	DF = 1
Not crossing flocks	0	12	P < 0.01

Table 2 – Crossing and not crossing flocks recorded with weak (≤20 km/h) and strong (>20 km/h) lateral winds.
Tab. 2 – Počet hejn, která přeletěla a nepřeletěla moře za slabého (≤20 km/h) a silného bočního větru.

	Weak wind (< 20 km/h)	Strong wind (> 20 km/h)	
Average strength (km/h)	12.6 ± 0.7 SE	33.3 ± 2.7 SE	χ^2 = 7.29
Crossing flocks	31	6	DF = 1
Not crossing flocks	4	7	P < 0.01

DISCUSSION

Our observations partially agree with those previously made on the spring migration of this species at the Cap Bon Promontory (Tunisia; Fig.1); raptors there, once reached the coast near the promontory, rarely undertook the crossing of the Channel of Sicily hesitating on the coastline zone and flying back inland (Agostini et al. 1994a, b). In particular, as mentioned above, Honey Buzzards, unlike Black Kites and harriers (species with higher aspect ratio, Agostini & Duchi 1994), were seen crossing mostly with weak lateral wind probably to minimize "drifting", such as Sharp-shinned Hawks (*Accipiter striatus*) migrating across Lake Superior and Delaware Bay (Kerlinger 1984, 1989), but very few with following winds (Agostini et al. 1994a).

The strong tendency to continue migrating showed by Honey Buzzards at the island of Ustica, could be explained assuming that birds are seen over this site mostly with ideal wind conditions for crossing. However, since following wind should allow a faster and energetically less expensive flight over water (KERLINGER 1989), why have few birds been seen undertaking the crossing with such wind at the Cap Bon Promontory? Only a minority of Honey Buzzards crossing the Channel of Sicily leave Tunisia from this promontory, located in the north of the Cap Bon Peninsula (Fig.1); large flocks of raptors leave this peninsula much farther south (AGOSTINI 1994a, b). Perhaps, mostly birds fatigue, often not able to cross the sea, concentrate over that promontory; this could explain both the hesitation showed there by most of raptors and the low percentage of crossing birds also with favourable (following) wind.

A nonsignificant relation between water crossing tendency and winds with following/contrary component was reported in a study on the Sharp-shinned Hawk (*Accipiter striatus*) migration in North America (KERLINGER 1984). To explain his results, KERLINGER (1989) suggested that, although following wind should allow a faster and energetically less expensive flight over water, birds initiating crossing with such wind "might experience difficulty returning to the place where they initiated the crossing". In contrast, a recent study made simultaneously by radar and visual observation during the autumn migration at the southern coast of Spain, about 100 km NE of the Straits of Gibraltar, showed that some raptors as falcons, harriers and ospreys undertook the sea-crossing preferably with a good tailwind support, but also under strong (>15 km/h) sidewinds (MEYER et al. 2000). However it is interesting to note that in the case of the Marsh Harrier (*Circus aeruginosus*), few birds were seen crossing the Thyrrhenian Sea with wind stronger than 15 km/h independently of its direction just during spring migration over Ustica (PANUCCIO et al. 2002). Moreover, at the southern coast of Spain, ospreys, falcons and harriers, differently from theory (PENNYCUICK 1975 ex. MEYER et al. 2000), did not decrease airspeed with following wind, minimizing time of migration above the sea and flying at high altitudes (MEYER et al. 2000). The authors suggested that this strategy leads to lower the risk of unpredictable weather changes during migration over water. Our observations concerning the low altitude of Honey Buzzards seen with following wind, agree with those recorded along the eastern coast of the Straits of Messina, between southern continental Italy and Sicily, where, unlike our study, birds were seen mostly during contrary winds (Fig. 1; AGOSTINI 1992). In particular, at that site, few birds were observed with following wind, and, as mentioned above, when its strength exceeded 35 km/h, raptors reached the continental coast of the Straits very low to the ground and were not able to maintain a steady forward movement (AGOSTINI 1992). During our study, any bird was not seen with following wind stronger than 30 km/hour. Apparently Honey Buzzards flying above the sea, differently from falcons, harriers, and ospreys (MEYER et al. 2000), are not able to avoid the slowing of their airspeed during following wind and, consequently, a decreasing of their altitude over water. Over land, Honey Buzzards are able to fly greatly varying in airspeed (ranging from 5.3 to over 24 m/s; BRUDERER et al. 1994, see also BRUDERER & BOLDT 2001). However, over land, raptors can easily increase their altitude using soaring flight. On the contrary, since thermals are almost absent over the sea, raptors cannot use soaring during its crossing. In our study birds which used soaring over the sea with following wind successfully, probably flew in thermals deviated over water by such wind. Therefore, our observa-

tions suggest that following wind could be a problem for Honey Buzzards flying above the sea only if it became stronger (> 30 km/h) during the crossing, such as a strong lateral or contrary wind. In fact during strong following wind these raptors would decrease dramatically their altitude not being able to maintain a steady forward movement (AGOSTINI 1992, AGOSTINI et al. 1994a), while during strong lateral and contrary winds the crossing would obviously require more energy (KERLINGER 1989). In each of these cases the water crossing can result in death. However, why have few Honey Buzzards been seen along the continental coast of the Straits of Messina, less than 5 km wide at its nearest point, with following wind independently from its strength (AGOSTINI 1992)? Perhaps, during following wind, Honey Buzzards approaching the Straits could reach the Italian Peninsula using a more direct route, for instance via the Lipari Islands (Fig. 1).

Although Honey Buzzards, such as other soaring birds, tend to migrate during the day, the flocks seen leaving the island during the afternoon (about two three hours before sunset) are evidence of their capacity to migrate across water surfaces also during the night; in fact, because they fly at an average speed of 11 m/s during flapping-gliding, assumed absent wind (MEYER et al. 2000), birds leaving Ustica should take six to seven hours to reach the Italian Peninsula. Thus this species, such as the Marsh Harrier (PANUCCIO et al. 2002), has evolved navigation and orientation systems that function during both day and night.

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SOUHRN

Dosavadní výzkumy v centrálním Středomoří naznačovaly, že včelojed lesní přelétá moře především za bočního větru a protivětru, nikoliv za podmínek, kdy vane vítr ve směru migrace. V této práci předkládáme výsledky získané během jarní migrace. Včelojed lesní během této cesty vykonává jeden z nejdelších přeletů přes moře mezi dravci. Testovali jsme vliv větrných podmínek na migrační chování zaznamenaných hejn. Pozorování jsme prováděli mezi 29. březnem a 16. květnem 2001 na ostrově Ustica (Obr. 1), ležícím zhruba 60 km severně od západní Sicílie, 270 km severovýchodně od tuniského mysu Bon, 140 km severovýchodně od ostrova Marettimo a 230 km západně od Apeninského poloostrova. Celkem jsme zaznamenali 124 hejn, z toho 101 (81.5%) směřovalo přes moře k severovýchodu. Naše výsledky částečně souhlasí s publikovanými údaji. Včelojedi přelétávali moře především během slabého bočního větru (< 20 km/h; 31 hejn přelétlo, pouze 4 nepřelétly), ale i za podmínek po větru (všech 38 zaznamenaných hejn přelétlo). Naproti tomu protivítr se jeví jako méně výhodný (24 hejn přelétlo, 12 nepřelétlo). Včelojedi se při překonávání moře vyhýbali silnému bočnímu větru (> 20 km/h; 6 hejn přelétlo, zatímco 7 nepřelétlo). Ptáci tedy využívají především větrů příznivějších pro rychlejší a energeticky méně náročné překonání moře. Včelojedům nicméně nevyhovuje silnější vítr (> 30 m/h) vanoucí ve směru přeletu. Za těchto podmínek dravci postupně ztrácí výšku a rychlost pohybu se zpomaluje. V extrémních případech ptáci nejsou schopni pohybu vpřed a přelet přes moře končí smrtí. Ačkoliv naprostá většina migrujících hejn (46 hejn, 45,5 %; N = 101) byla zaznamenána během poledních hodin, některá hejna opouštěla ostrov i zhruba dvě až tři hodiny před západem (22 hejn; 21.8 %). Tato pozorování považujeme za důkaz, že včelojedi jsou schopni překonávat moře i v noci. Tento druh má tedy vyvinuty navigační a orientační smysly pro migraci během dne i noci.

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