

A REMARKABLE CASE OF CIRCUITOUS AUTUMN
MIGRATION OF THE BOOTED EAGLE
HIERAAETUS PENNATUS THROUGH THE WESTERN
AND CENTRAL MEDITERRANEAN

EXTRAORDINARIA MIGRACIÓN INDIRECTA OTOÑAL
DE AGUILILLA CALZADAS *HIERAAETUS PENNATUS*
EN EL MEDITERRÁNEO OCCIDENTAL Y CENTRAL

Guido PREMUDA*¹, Luca BAGHINO**, Tristan GUILLOSSON***, Mickaël JARDIN****,
Miguel TIRADO***** and Vicente ESTELLER*****

The booted eagle *Hieraaetus pennatus* is a trans-Saharan migratory species, sometimes regarded as a partial migrant, since a few individuals are known to overwinter in Southern Europe (Zalles and Bildstein, 2000) and North Africa (Thévenot *et al.*, 2003; Isenmann *et al.*, 2005). Two distinct populations are found in Europe: one in south-western France and Spain with several thousand pairs, while the more extensive eastern breeding range hosts hundreds of pairs (mostly in Russia and Turkey; BirdLife International, 2004). In the Mediterranean basin, booted eagle migration takes place mainly over the Straits of Gibraltar, where the highest numbers are recorded with several thousand individuals counted each autumn, and over the Bosphorus, where maximum autumn counts do not exceed three figures (Cramp and Sim-

mons, 1980; Finlayson, 1992; Zalles and Bildstein, 2000; Thévenot *et al.*, 2003).

In eastern Spain this species is a scarce migrant. Four visible migration counts in autumn at Cabanes (Castellón) yielded a maximum of 24 birds in 2003 (Grup Au D'Ornitologia), although there is a previous record of a total of 41 booted eagles heading NE recorded in Estivella (Valencia) on 7 October 1997 by the Valencia Ornithological Society (SVO). A western migratory route (from France) through Italy in autumn has recently been identified, with regular passage of individuals along the French and Italian Mediterranean coast (Premuda, 2003; Premuda and Baghino, 2004). In France, along the Côte d'Azur, two opposite migration directions have been noted: one flow heads toward Italy (SW - NE) along the

* Via P. Da Palestrina n.20, 40141 Bologna, Italy.

** Centro Ornitologico e di E.A. di Case Vaccà c/o Ente Parco del Beigua - LIPU Liguria,
Via Marconi 165, 16011 Arenzano (GE), Italy.

*** 4 rue du Tourrou, 11420, France.

**** LPO PACA, Rond-point Beauregard, "Villa La paix", 83 400 Hyères les Palmiers, France.

***** Gran Avenida n.158, Benicàssim, Castellón, E-12560 Spain.

***** Avenida el Maestrazgo, n.7, Cabanes, Castellón, E-12180 Spain.

¹ Corresponding author: guidopremuda@tiscali.it

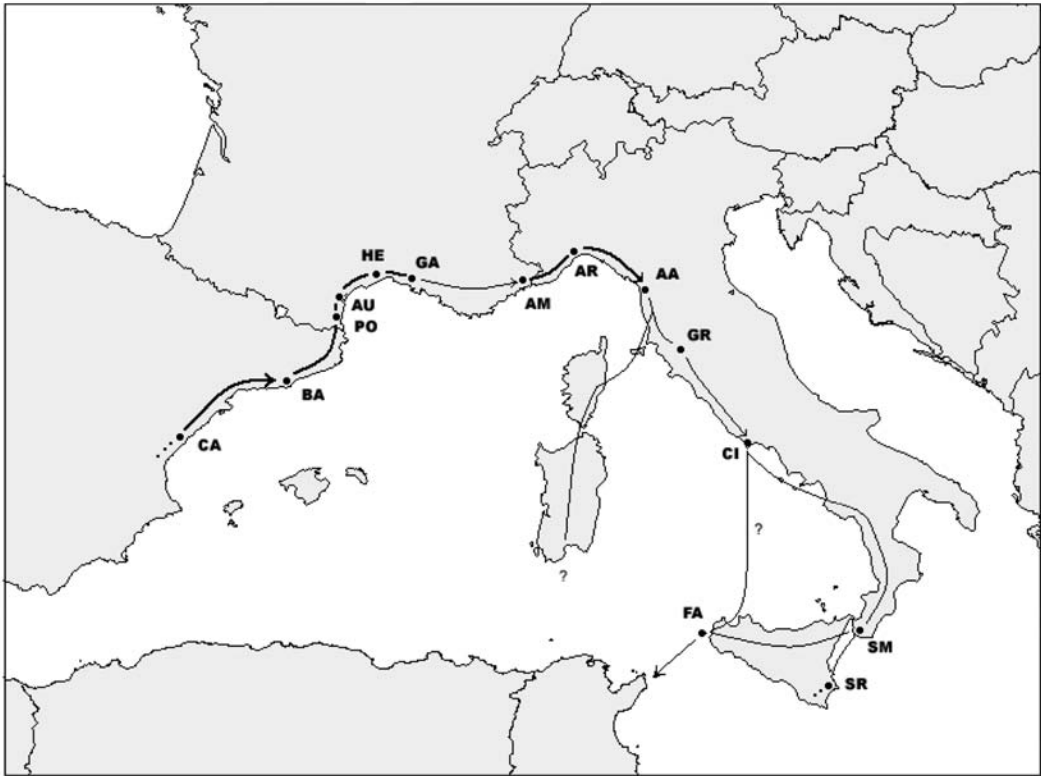


FIG. 1.—Map of the Western Mediterranean Region with the hypothetical routes taken in autumn 2004 - 2005 by booted eagle *Hieraetus pennatus*: the sites mentioned are the ones with the most observations and information about flight paths (CA = Castellón, BA = Barcelona, PO = Pyrénées orientales, AU = Aude, HE = Hérault, GA = Gard, AM = Alpes Maritimes, AR = Arenzano, AA = Apuane Alps, GR = Grosseto, CI = Circeo, SM = Strait of Messina, FA = Favignana, SR = Siracusa).

[Mapa de la región oeste del Mediterráneo con las rutas hipotéticas tomadas por las aguilillas calzadas en el otoño de 2004 - 2005.]

coast, while another is oriented NE - SW. It has been suggested that the migratory route from the west European range takes booted eagles along the Tyrrhenian coast of Italy towards wintering areas in Central Mediterranean (Sicily and N Africa). The existence of this movement is confirmed by recoveries in Italy of birds ringed in Spain (Premuda and Baghino, 2004).

During autumn 1985, an exceptional influx of booted eagles was recorded across Italy, with sightings and shootings of at least 22 individuals reported from northern and central regions (Premuda and Baghino, 2004). As explanation

for this phenomenon, the effect of a low pressure over Eastern Europe with strong easterly winds displacing young birds of an eastern origin was initially put forward (Bijleveld, 1986). However the unusual numbers of booted eagles recorded in the Aude dept. (S France) 7 - 19 October of that year (Pineau, 1986), seem to point toward a Spanish origin of these birds (Guillosson *et al.*, 2006).

In 2004, the study area covers western and central Mediterranean Basin coastal regions. In Spain, the main site was the "Desert de Les Palmes" Natural Park (Cabanes, Castel-

lón). Some observations took place also at Muntanyeta de Sant Antoni in Bechí and at Sierra de Irta (Castellón), Marbella (Málaga), Valencia, Vandellós (Tarragona) and El Garraf (Barcelona, Catalonia). In France, regular monitoring took place only at Fort de la Revère (Alpes Maritimes), from 28 August to 14 November. Sightings were also collected at Narbonne, Leucate, Les Coussoules (Aude), St. Laurent de la Salanque (Pyrénées Orientales), Cayrelles (Hérault), Gard and Bouches-du-Rhône. In Italy, monitoring took place mainly at: Arenzano (Special Protection Area "Beigua-Turchino") (Genova, Liguria), Apuane Alps (Lucca, Tuscany) and Circeo (Roma, Lazio). Additional sightings from several other Italian sites were also collected (Table 1). Significant sightings of migrating booted eagles from September to December 2004 were collected, both in the field and from Internet emailing lists (Pernis; Obsmedit; EBN Italia).

In order to gain a greater insight into the phenomenon, some visible migration monitoring was organized during autumn 2005 and 2006. In Spain visible migration counts were carried out from 2 September to 22 October 2005 (almost every day, 3 to 4 hr/day) and from 25 August to 3 November 2006 (3 hours daily) at "Desert de Les Palmes" Natural Park (Cabanes, Castellón). In France, records were collected from the Fort de la Revère migration camp (Alpes Maritimes) (28 August - 13 November 2005, 25 August - 5 November 2006) and irregular visible migration counts made in the Gruissan-Leucate area (Aude) (mid August - early November 2005 - 2006). In Italy, daily simultaneous migration counts at Arenzano (Genova, Liguria) and Apuane Alps (Lucca, Tuscany) sites took place over two sample 12-day periods (15 - 26 September and 8 - 19 October 2005). The same counts took place over the two sites during 2006 (but only from 14 to 18 October at the Apuane Alps). Additional sightings at Arenzano were collected from EBN Italia mailing list as well. Data from similar field surveys in Italy

(2001 - 2004) were also analysed. Percentage of juveniles (1st calendar year birds) was estimated according to proportions recorded in the sample of adults and juveniles which could be separated in the field (Kjellén, 1992). Characters used in separating age groups were those in Forsman (1999).

In early October 2004, an unusual flow of booted eagles heading NE was reported from central E Spain, in Castellón (Tables 1 and 2). Nevertheless, 23 birds were seen heading SW between 6 and 30 October. The same phenomenon (booted eagles migrating N) was recorded in other areas of Spain near the coast (Catalonia, Andalusia and Valencia), but none with the intensity recorded in Castellón (Table 1). In France, the first signs of booted eagles migrating NE were noted in late September (one on 26 at St. Cyprien, near the Spanish border and five on 29-30 at la Révère), but the influx was significantly noticeable from 7 October in Narbonne (Aude) (Tables 1 and 2). During the studied period about 50 eagles were noted heading S to SW, most of them in late October - early November (Guillosso *et al.*, 2006). In North-west Italy (Arenzano), a significant influx of eagles was noted from 13 October, with hundreds of birds flying E (L. Baghino, *unpubl. data*). In the same period, over three days of visible migration counts, 16-18 October in the Apuane Alps, 231 booted eagles were recorded flying SE along the coast, of which 5 birds were aged as adults and 39 as juveniles (G. Premuda, *unpubl. data*).

Other sightings took place later along the Italian Peninsula (Table 1). It's worth mentioning that: 26 individuals from 18 to 26 October at Stribugliano (Grosseto, Tuscany), 78 from 20 October to 1 November at Cape Circeo (Lazio) and 6 during October at Pianosa Island (Tuscany) heading towards Corsica were seen (Ruggieri, 2005). At Cozzo Pantano (Siracusa, Sicily), 42 individuals were seen arriving from NE on 17 December, of which 41 juveniles and 1 adult (A. Corso, *unpubl. data*). During autumn 2004 there were several recoveries of in-

TABLE 1

Most important sites and significant observations (>10 ind.) of migrating booted eagles during autumn and early winter 2004: ¹ Marbella (Málaga), ² Valencia, ³ Vandellós (Tarragona), ⁴ El Garraf (Barcelona), ⁵ Grosseto (Tuscany), ⁶ Trento (Trentino); ⁷ Accadia (Apulia); ⁸ Strait of Messina (Calabria); ⁹ Favignana (Sicily); ¹⁰ Siracusa (Sicily).
 [Observatorios importantes y significativos (> 10 individuos) de aguilillas calzadas durante el otoño e invierno de 2004.]

	Castellón (ES)	Other sites (ES)	Pyrénées orientales (FR)	Aude (FR)	Hérault (FR)	Gard, Bouches-du -Rhône (FR)	Alpes Maritimes (FR)	Arenzano (Liguria) (IT)	Apuane (Tuscany) (IT)	Circeo (Lazio) (IT)	Sicily (IT)	Other sites (IT)
1 Oct.		19 ¹										
2 Oct.	16	16 ²										
3 Oct.	33											
4 Oct.	44											
5 Oct.	70											
6 Oct.	254											
7 Oct.	38	13 ³		21								
8 Oct.	173	40 ⁴		15								
9 Oct.	21		248									
10 Oct.			22	406	148							
11 Oct.				84	23							
12 Oct.				14		35	31					
13 Oct.					19			55				
14 Oct.							65	12				
15 Oct.					13		224	109				
16 Oct.						12	143	39	84			
17 Oct.							29	190	94			
18 Oct.								32	53			
20 Oct.										24		
22 Oct.								15				11 ⁵
23 Oct.									28			
24 Oct.									12			
25 Oct.								80				10 ⁶ 10 ⁷
26 Oct.												10 ⁸
30 Oct.										14		16 ⁹
1 Nov.												
17 Dec.												42 ¹⁰

dividuals found shot or starved in Italy and Malta: 4 in Liguria; 5 in Tuscany; 2 in Emilia Romagna; one in Campania; one in Malta. Considering that some individuals must have been missed, we can estimate that at least 650 - 700 booted eagles were involved in this movement and reached the Italian Peninsula during autumn 2004 (Tables 1 and 2).

In 2005, records were collected from the organised migrating raptor counts (Table 2). In Spain, the peak occurred on 3 October with 38 birds heading NE. In France, at the Gruissan-Leucate area (Aude), the maximum was recorded on 8 October with at least 60 birds heading NE, while at Fort de la Revère (Alpes Maritimes) the maximum count was on 12 October with 18 individuals heading E-NE. In Italy, at Arenzano, a peak of 23 birds heading NE on 23 September was recorded (Baghino, 2005; Baghino *et al.*, 2006, EBN Italia, *unpubl. data*, Parco del Beigua-LIPU, *unpubl. data*). At the Apuane Alps, eagles were seen migrating SE along the coast, with a peak of 20 birds on 10 October.

In 2006, observations were collected from the organised migrating raptor counts (Table 2). In Spain, the peak occurred on 17 October with 6 birds heading NE. In France, eagles were noted heading NE at Gruissan (Aude), with maximum 3 birds on 24 October and at Fort de la Revère (Alpes Maritimes) with maximum 2 birds on 28 October. In Italy, at Arenzano, a peak of 12 birds heading NE on 20 September was observed (Baghino, 2006, Baghino *et al.*, 2007). At the Apuane Alps, eagles were seen migrating SE, along the coast, with maximum 13 individuals on 23 September (Premuda, 2006).

This extraordinary phenomenon in terms of number of birds, briefness and intensity of passage and flight direction, which occurred during autumn 2004, might have arisen from the concurrence of factors of different origins:

Weather Effect. Exceptional meteorological conditions can affect movements of birds, which may perform temporary reverse mi-

TABLE 2

Observations of migrating booted eagles recorded during the raptor counts organised in autumn 2004 - 2006. [*Observaciones de aguillillas calzadas durante la migración otoñal de los tres años estudiados.*]

Sites	2004	2005	2006
Castellón (ES)	629	83	18
Aude (FR)	540	116	8
Alpes Maritimes (FR)	504	104	26
Arenzano (IT)	568	232	71
Apuane Alps (IT)	231	66	47

gration in case of a broad warm front (Akesson *et al.*, 1996; Berthold, 2001; Gatter *et al.*, 1979). The unusually warm temperatures recorded across Europe in early October 2004, could have initiated a northbound movement and wandering behaviour, instead of the usual southbound migration.

Drifting Effect. Migrating raptors can drift under the influence of encountered winds until they meet a coastline (Allen and Peterson, 1936) and the booted eagle is a species subject to wind drift during migration (Finlayson, 1992). In the first ten days of October 2004, a wide depression from the Atlantic with strong winds (source: MetOffice.gov.uk), could have displaced eagles along the coasts. The estimated preponderance of juveniles (1st calendar year) birds (89 %, based on observations at the Apuane Alps) within the flux of eagles is consistent with the tendency of this age class to be more affected by strong winds (Thorup *et al.*, 2003).

Coasting Behaviour. Most raptors are reluctant to cross water barriers, which are important in shaping their migration pathways; in addition, raptors with low aspect ratio (proportionately broad wings), such as the booted eagle, are less suited to powered flight over water, due to high energetic costs (Kerlinger,

1989). Assuming that the booted eagle migrates along coasts (Premuda and Baghino, 2004), as has been observed for the Short-toed Eagle's circuitous migration through Italy (Agostini *et al.*, 2002a, 2002b, 2004), birds could have followed the Mediterranean coastline of Spain, thus reaching southern France, northern Italy then going on southwards through the Italian Peninsula. The fact that in Mediterranean France most sightings of reverse migrating individuals took place less than 5 km from the sea (Guillosson *et al.*, 2006) clearly indicates that birds were following the coast.

Following Behaviour. A proportion of juveniles (1st calendar year) birds might have followed relatively few experienced adult birds that had already travelled eastward using the same route (Premuda and Baghino, 2004). This could result in orientation and navigation information transmission, as described for short-toed eagle circuitous migration in Italy (Agostini *et al.*, 2002a, 2002b, 2004).

High Breeding Success. Spain hosts an estimated 2000 - 4000 booted eagle pairs (BirdLife International, 2004) with a minimum of 2905 pairs known (Martí and Del Moral, 2003). In France, 239 pairs were reported in 1984 (Gensbol, 1992), 380 - 650 pairs were reported in 1987 and 400 - 600 pairs were estimated at the end of the 1990s (Birdlife International, 2004). Fombonnat (2004) gives an estimated 380 - 650 in 2003, highlighting a range contraction in NE and central France, while the main population found in Pyrenean foothills is thought to be stable. An exceptionally high breeding success within the west European populations could have contributed to the huge migration affecting mostly juveniles.

Change in overwintering Behaviour. Since the 1980s an increase of wintering booted eagles recorded in some areas of central and western Mediterranean has been noted. This is probably linked to changes in migrating and / or overwintering behaviour within the populations involved whose origin is not precisely

known. Although it is possible that higher observer pressure and better optics have partly contributed to the increase, it is clear that the species is becoming more common in winter in coastal Mediterranean Spain and southern France (Sunyer and Vinuela, 1996; Isenmann, 1993).

Sicily is the region of Italy which appears to be most frequently visited by the species during the winter, this first being noticed in the late 1980s (Iapichino and Massa, 1989; Iapichino, 1993, Ciaccio and Priolo, 1997): Lo Valvo *et al.* (1993) stated that the winter records were becoming more and more frequent in the early 1990s. Later, Corso and Iapichino (1998), Grussu and Corso (1997) attempted to define this presence: on average 5 individuals are wintering annually in the eastern part of the island (Premuda and Baghino, 2004).

In France, winter records are known for the whole of the southern part of the country, most from the Camargue, where 10 to 20 birds are believed to overwinter each year (Dubois *et al.*, 2001) and nearly 450 sightings were reported from 1995 to 2000, 52 % of these in 1997 and 1998 alone (Kayser *et al.*, 2003). This winter presence is thought to be related to a change in migrating behaviour, albeit of minor significance for the species (Oliosio, 1991).

Visible raptor migration counts carried out at Arenzano yearly (15 - 26 September 2000 - 2004) yielded from 0 to 3 eagles per season (Baghino, 2002, Parco del Beigua-LIPU, *unpubl. data*), which contrasts with the 70 and 59 individuals recorded in 2005 and 2006 respectively. The earlier passage could be related to the exceptional October 2004 influx (Baghino and Premuda, 2005).

As circuitous migration through Spain, France and Italy was also recorded during autumn 2005 and 2006, although involving a lower number of individuals, both the regularity of this route and the exceptional nature of the movement in 2004 are confirmed. The observed phenomenon could suggest a real learning capability of the booted eagle, which seems to

follow a pre-known route probably learned during the previous migration.

Although the remarkable “irruption” of autumn 2004 and the observations made during autumn 2005 and 2006 has confirmed the existence of a booted eagle migratory route entering Italy from France (Premuda and Baghino, 2004), more research is needed in the near future to improve the knowledge of this circuitous migration of the booted eagle and the new wintering tendencies in Southern Europe.

RESUMEN.—*Durante el otoño de 2004 tuvo lugar una migración extraordinaria de más 600 aguilillas calzadas *Hieraetus pennatus* que se desplazaron desde el sur de España a Italia, a través de la Francia mediterránea. Este extraordinario fenómeno, que se prolongó durante varias semanas, podría explicarse con varias hipótesis y factores coadyuvantes, como migración inversa y vagabundeo, deriva, migración costera, seguimiento de aves más expertas, éxito en la invernada y éxito reproductor. Este fenómeno se registró también durante el siguiente otoño de 2005 y 2006, aunque implicó a un menor número de individuos, lo que confirma tanto la naturaleza excepcional del flujo de 2004, como la consolidación de la ruta migratoria. Además, el comportamiento observado podría sugerir una auténtica capacidad de aprendizaje del aguililla calzada, al seguir una ruta conocida, probablemente aprendida durante una migración anterior.*

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