

A long-term study of differential postnuptial migration timing between age classes in the Honey Buzzard *Pernis apivorus* in the NE Iberian Peninsula

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In some raptor species, adults undertake postnuptial migration before juvenile birds. Few long-term studies of this phenomenon, known as differential migration, have ever been conducted on the Honey Buzzard *Pernis apivorus*. In 2003–2012, the postnuptial migration of this species on its flyway over La Garrotxa Volcanic Zone Natural Park (NE Iberian Peninsula) was studied in order to detect differences in the timing of adult and juvenile migration. Every year, a constant sampling effort consisting of counts of migrant individuals was conducted in the period 25 August–25 September (32 days) between 10:00 and 14:00 h. As found in previous studies, the mean passage date for adults was approximately two weeks earlier than the date for juveniles. This difference was statistically significant in all the studied years and ranged between 11 and 17 days.

Key words: Honey Buzzard, *Pernis apivorus*, differential migration, age classes, La Garrotxa.

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The phenomenon of differential migration timing between age and sex classes in certain raptor species has been well documented in the Holarctic in recent decades (Kerlinger 1989, Kjellén 1992, 1998; Gustin & Pizzari 1998, Mueller *et al.* 2000). In some long-distance migratory raptors, adults migrate before juveniles in postnuptial migration (Kjellén 1992). Although several studies have remarked on this migratory behaviour in the Honey Buzzard (Agostini 2004, Sammut & Bonavia 2004, Michev *et al.* 2011), only a few have ever quantified timing differences between age classes (e.g. Kjellén 1992, Agostini & Logozzo 1995, Schmid 2000, Hake *et al.* 2003). Furthermore, long-term surveys of differential migration timing are scarce (Kjellén 1992). In general, juvenile Honey Buzzards migrate two weeks later than adults (Kjellén 1992, 1998; Agostini & Logozzo

1995, Forsman 1999, Schmid 2000), fly across a broader front and undertake long sea crossings (Schmid 2000, Hake *et al.* 2003, Agostini 2004, Agostini *et al.* 2004). However, on the central Mediterranean flyways, a few juveniles migrate with adults and in doing so probably learn the shorter sea-crossing between Sicily and Africa (Agostini *et al.* 2004).

The aim of this study was to analyse from a long-term perspective differential postnuptial migration timing between adult and juvenile Honey Buzzards crossing La Garrotxa Volcanic Zone Natural Park (GVZNP) (NE Iberian Peninsula). Specifically, we studied differences in the migratory phenology and the numbers involved in each age class. This is the first long-term study to analyse differential postnuptial migration between age classes in this species on the western Mediterranean flyway.

Material and Methods

Observations of Honey Buzzard migration were conducted from the top of the Aiguaneira volcano (42°20'N 2°52'E, 588 m a.s.l.) in the GVZNP (Catalonia, Spain; García & Tralalon 2014), a protected area that is approximately 50 km from Mediterranean coastline. There is good visibility from this site across an approximately 40-km- x 30-km-wide strip (distances northwards and southwards, respectively).

The study was conducted on 25 August–25 September (32 consecutive days) every year between 2003 and 2012. Monitoring followed a standard protocol to ensure a constant sampling effort (García & Tralalon 2014). Counts of all raptors on visible migration were performed by a single observer (FT) between 10:00 and 14:00 h using a telescope (20–60x) and binoculars (8x40). This time interval was selected because, in line with other studies, a higher frequency of migratory passage was detected in the morning during a pilot study in 2002 in the same area (e.g. Bruderer *et al.* 1994). In total, 34 days were discarded due to rain or fog that prevented the observation schedule from being fulfilled (total sampling days = 286).

Honey Buzzards were identified as either adults or juveniles. Juveniles were considered

to be birds born in the same year as the survey (i.e. first calendar year). Adults were any birds exhibiting definitive mature plumage. The age classification in our study was precise: all non-juveniles detected in the area are necessarily adults because immature birds remain on their wintering grounds in sub-Saharan Africa until their first breeding attempt (in their third calendar year) (Kjellén 1992, Forsman 1999, Strandberg *et al.* 2012). Many birds could not be aged due to distance or to the size of the flocks of simultaneously migrating individuals.

In order to analyse differences between the migratory passage dates of adults and juveniles, a general linear model (GLM) was constructed with the passage date – numbered as days from 1 to 32 – of each individual as the response variable and the age of birds, year and their interaction as predictor variables.

Results

A total of 395 adults and 572 juveniles were classified during the study period, giving an annual percentage of age determination in the range 1.9–24.2% (Table 1). The annual mean passage date for adults ranged between 31 August (2009) and 6 September (2003), while for

Table 1. Summary of the main annual counts of Honey Buzzards on postnuptial migration in the GVZNP in 2003–2012. N Total is the number of birds counted every year, while N aged is the number of adults (ad) and juveniles (juv) identified. The mean passage dates of both age classes and the difference between them are also given.

Resum de les principals estadístiques anuals del pas postnuptial d'alligots vespers al Parc Natural de la Zona Volcànica de la Garrotxa entre el 2003 i el 2012. N Total és el nombre d'aus censades cada any, mentre que el N datat és el nombre d'adults (ad) o juvenils (juv) identificats. També es mostren la data mitjana de pas d'ambdós grups d'edat i la diferència entre ells.

Year Any	N Total N Total	N aged N data		% aged % datat		Mean passage date Data mitjana de pas		Difference Diferència
		ad	juv	ad	juv	ad	juv	
2003	727	20	28	2.8	3.9	06-sep	19-sep	13.3
2004	225	10	25	4.4	11.1	01-sep	12-sep	11.3
2005	405	16	43	4.0	10.6	01-sep	13-sep	12.8
2006	533	16	57	3.0	10.7	01-sep	12-sep	11.4
2007	1297	24	75	1.9	5.8	03-sep	16-sep	13.0
2008	288	40	53	13.9	18.4	05-sep	16-sep	10.9
2009	943	31	44	3.3	4.7	31-ago	15-sep	14.4
2010	1020	66	100	6.5	9.8	03-sep	20-sep	17.3
2011	462	73	112	15.8	24.2	02-sep	17-sep	14.8
2012	641	99	35	15.4	5.5	02-sep	17-sep	15.0
TOTAL	6541	395	572	6.0	8.7	02-sep	16-sep	13.9

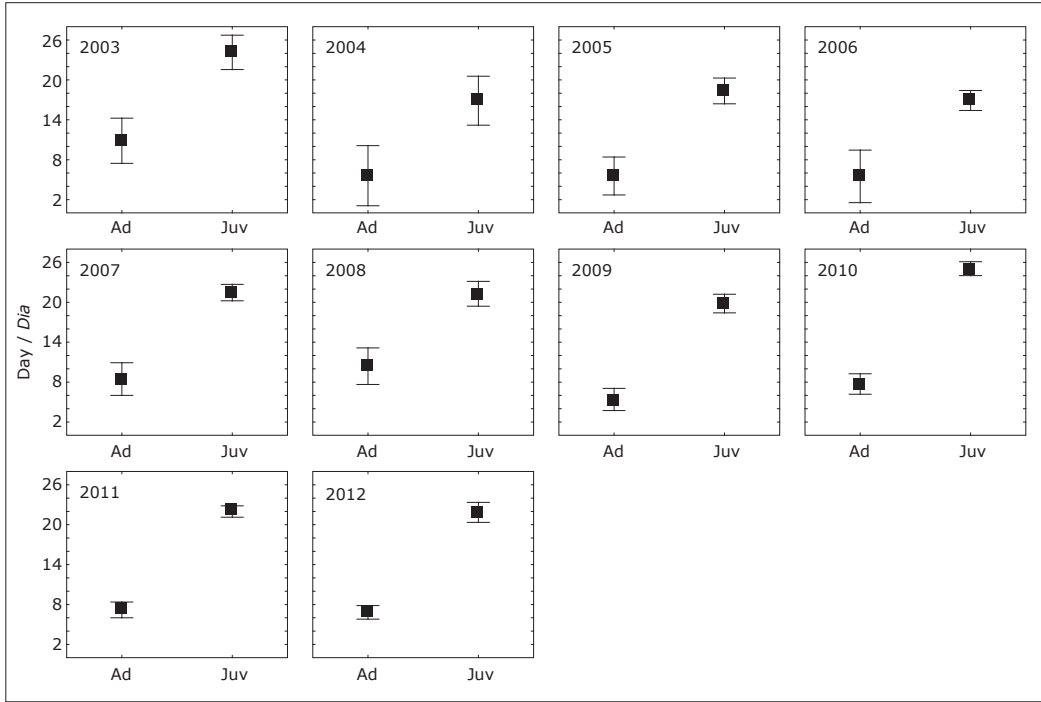


Figure 1. Temporal distribution of age classes in the postnuptial migration of Honey Buzzards in the GVZNP for each study year. The days in the period 25 August–25 September are numbered from 1 to 32. Squares represent means and error bars show the 95% confidence interval.

Distribució temporal de la migració postnupcial de les classes d'edat d'Aligot vesper al PNZVG per a cada any d'estudi. Els dies del 25 d'agost al 25 de setembre estan numerats de l'1 al 32. Els quadrats representen la mitjana i les barres d'error l'interval de confiança de la mitjana al 95%.

juveniles ranged between 12 September (2004 and 2006) and 20 September (2010; Table 1).

The GLM with age and year as explanatory factors was highly significant since the model fitted the data very well ($F_{19,947} = 78.38$, $p < 0.0001$, Adjusted $R^2 = 0.603$). The most important variable was age, which explained 54% of variance in passage dates ($F_{1,947} = 856.6$, $p < 0.0001$). On average, adults migrated 13.9 days earlier than juveniles (Table 1). There were also statistically significant differences in the passage date of Honey Buzzards between years ($F_{9,947} = 8.57$, $p < 0.0001$). We found up to eight days of difference between the earliest and the latest years (2012 and 2003, respectively) in the sample of aged individuals. Finally, the interaction of age and year was also statistically significant ($F_{9,947} = 2.99$, $p = 0.016$). Thus, the differences in the timing of adult and juvenile migration were not constant over the years (Table 1) and ranged from 11 to 17 days. Nevertheless, the difference

was statistically significant in all years (post-hoc tests for age in all years: $p < 0.0001$; Figure 1).

Discussion

Different hypotheses attempt to explain why age-related differential migration occurs. Newton (1979) reports that adult long-distance migrants depart earlier because they obtain the body condition needed for migration faster than juveniles. Another possibility is that adults need to arrive earlier in their winter quarters to be able to establish prey-rich territories and thus increase their chances of success in the next breeding season (Kjellén 1992). Yet, regardless of the ultimate causes that motivate this phenomenon, data from different studies are unequivocal: juveniles migrate later than their adult conspecifics (Kerlinger 1989, Kjellén 1992, 1998; Gustin & Pizzari 1998, Mueller *et al.* 2000).

Although the large size of Honey Buzzard flocks limited our ability to determine by direct observation the age of most individuals, the differences observed between age classes in migration timing were statistically significant in all years. Thus, our results clearly support the existence of differential postnuptial migration between adults and juveniles (Kjellén 1992, Agostini & Logozzo 1995, Schmid 2000, Hake *et al.* 2003). The mean dates obtained for both age groups in the present study were consistent with the peak migration dates detected at Falsterbo, Sweden, (27 August for adults and 11 September for juveniles) by Kjellén (1992) and in southern Italy (31 August for adults and 18 September for juveniles) by Agostini & Logozzo (1995). As reported by these authors, differences in migration timing between adults and juveniles were approximately two weeks.

In conclusion, our results agree with those obtained previously by other authors. However, we consider that it is essential to continue long-term studies on this question in light of the great environmental challenges now facing long-distance migratory birds (e.g. Knudsen *et al.* 2011).

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Resum

Estudi a llarg termini de les diferències temporals entre classes d'edat en la migració postnupcial de l'Aligot vesper *Pernis apivorus* al NE de la península Ibèrica

En algunes rapinyaires els adults migren abans que els juvenils durant la migració postnupcial. Aquest fenomen, que és un tipus de migració diferencial, és ben conegut però no existeixen gaires estudis a llarg termini per a l'Aligot vesper. Durant el període 2003-2012, es va estudiar la migració postnupcial d'aquesta espècie al seu pas pel Parc Natural de la Zona Volcànica de la Garrotxa, nord-est de la península Ibèrica,

amb la finalitat d'establir les diferències temporals entre el pas d'adults i de juvenils. L'estudi es va dur a terme mitjançant l'observació directa dels individus entre el 25 d'agost i el 25 de setembre (32 dies), cada any amb un esforç de mostreig constant entre les 10:00 i les 14:00 h. Vam trobar que la data mitjana de pas dels adults va precedir aproximadament en dues setmanes a la data de pas dels juvenils, de manera similar a estudis previs, essent aquesta diferència estadísticament significativa en tots els anys estudiats, tot i que va oscil·lar entre 11 i 17 dies.

Resumen

Estudio a largo plazo de las diferencias temporales entre clases de edad en la migración postnupcial del Abejero europeo *Pernis apivorus* en el NE de la península Ibérica

En algunas rapaces los adultos migran antes que los juveniles durante la migración postnupcial. Este fenómeno, que es un tipo de migración diferencial, es bien conocido pero no existen demasiados estudios a largo plazo para el Abejero europeo. Durante el período 2003-2012, se estudió la migración postnupcial de esta especie a su paso por el Parque Natural de la Zona Volcánica de la Garrotxa, noreste de la península Ibérica, con la finalidad de establecer las diferencias temporales entre el paso de adultos y de juveniles. El estudio se llevó a cabo por observación directa de los individuos entre el 25 de agosto y el 25 de septiembre (32 días), cada año con un esfuerzo de muestreo constante entre las 10:00 y las 14:00 h. Encontramos que la fecha media de paso migratorio de los adultos precedió aproximadamente en dos semanas a la fecha de paso de los juveniles, de manera similar a estudios previos, siendo la diferencia estadísticamente significativa en todos los años estudiados, si bien osciló entre 11 y 17 días.

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