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Movements of immature European Honey Buzzards *Pernis apivorus* in tropical Africa

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Immature European Honey Buzzards *Pernis apivorus* are believed to remain in tropical Africa during the first years of their lives. We studied their movements during this period with the aid of satellite telemetry. After crossing the Sahara Desert on autumn migration, all six tracked young buzzards stopped at relatively northerly latitudes, between 9.9–13.6°N. Of the five individuals that continued transmitting, four made south-directed movements, mainly in November, to areas located further south or east within latitudes 1.7–9.8°N. Three young buzzards were tracked for more than three months in tropical Africa, and these individuals continued to perform extensive movements within the tropics throughout the tracking period. They travelled between 2,430 and 3,990 km (minimum distances) during 13 to 14 months, in which they visited several sites. In contrast, adult birds migrate directly to their wintering sites where they remain stationary within restricted territories. The mobile life of young Honey Buzzards during the period prior to their first northbound migration may be associated with responses to seasonal weather changes in the tropics and prospecting behaviour. These movements may also reflect intraspecific competition which might be catalyzed by forest degradation and fragmentation.

Key words: European Honey Buzzard, satellite tracking, nomadic movements, tropical Africa

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Our knowledge about the ecology of long-distance migrating birds in the tropics is limited, despite the fact that this period is of the utmost importance to understand population changes (for a review see Zwarts *et al.* 2009). Of particular interest is the ranging behaviour of immature birds of long-lived species, such as raptors, which spend up to several years in the non-breeding range before returning to their breeding grounds (e.g. Mellone *et al.* 2011 and references therein). The development of satellite transmitters small enough to be carried by birds has made it possible to track individuals throughout the annual cycle. The focus of satellite tracking studies has hitherto been the process of animal migration. However, there are also several studies concerning the wintering behaviour of tracked migrants, such as age differences in ranging behaviour of wintering Gyrfalcons *Falco rusticolus* (Burnham & Newton 2011) and young Egyptian Vultures *Neophron percnopterus* (Meyburg *et al.* 2004), flexibility and site fidelity in wintering areas of White Storks *Ciconia ciconia* (Berthold *et al.* 2001, Berthold *et al.* 2004), within-Africa movements of immature Short-toed Eagles *Circaetus gallicus* (Mellone *et al.* 2011), and habitat-related winter-movements of Montagu's Harriers *Circus pygargus* (Trierweiler *et al.* 2012).

In this study we investigate the movements of young European Honey Buzzards *Pernis apivorus* after reaching tropical Africa south of the Sahara. Honey Buzzards normally start breeding when they are three years or older (Roberts 2011; R.G. Bijlsma pers. comm.) and remain in the wintering areas until they are two years old (Gamauf & Friedl 2011). Thus, information about the whereabouts and habits of young Honey Buzzards during their first visit to the wintering

areas may be important from a conservation perspective, as survival and carryover effects are, to a large extent, influenced by what the birds encounter at the wintering grounds in Africa.

METHODS

From 1997 to 2005 we attached satellite transmitters (PTT-100s, Microwave Telemetry Inc.) as backpacks to seven adult and eight juvenile Honey Buzzards at nest sites in southwestern Sweden between 57–59°N and 12–13°E (autumn migrations described in Hake *et al.* 2003). Juvenile birds included siblings from two different nests; two young (No. 2 and 3) were tagged at the same nest in 2000, and three young (No. 4, 5 and 6) were tagged at another nest during consecutive seasons (No. 4 born in 2004; No. 5 and 6 born in 2005).

To study post-migratory behaviour, we used positions from the period after the birds had completed autumn migration and reached tropical Africa south of the Sahara. For defining stationary periods, transit travels and post-juvenile movements (see definitions below) we mainly used the more precise ARGOS-class 1–3 positions (http://www.argos-system.org/manual). Class 0 positions were only used if there were two or more locations separated by less than 10 km at roost sites or by less than 25 km during longer stationary periods (e.g. when only receiving a few class 0 positions from an area during a period of one month).

We classified movements as (see Table 1):

(1) Autumn migration movements – a southward directed movement from the nesting area to the first stopover area south of the Sahara, where the birds stopped for at least 7 days (one week) in a restricted area (moving <10 km from the location on the first day).

(2) Transit movements – a directed flight away from the first stopover area south of the Sahara to an area where the bird stopped >30 days (one month) before making nomadic movements. All observed transit movements consisted of daily flights of >50 km/day.

(3) Post-juvenile movements – movements during the period in tropical Africa prior to the first northbound migration, typically back and forth to one or several staging sites where the bird was stationary for longer periods. These movements were recorded during several days and over distances of hundreds of km. Transmission from juveniles No. 1, 2 and 3 ended during their first winter (October–January), while the other three young were tracked during 14–19 months after arriving in tropical West Africa (Table 1).

Table 1. Timing of movements (shaded rows), flight distances and staging areas for young Honey Buzzards in tropical Africa. Transit period: the period for the first directed movement to the major staging area. Number of positions used for calculating transit and post-juvenile movements is divided into class 3, 2, 1, and 0 positions. Note that individuals 2 and 3 stopped transmitting during their first winter in Africa (= post-juvenile movements unknown). Tracks of individuals 2–6 are shown in Figure 1.

Individual	1	2	3	4	5	6
Arrival date	7 Oct 1998	14 Oct 2000	15 Oct 2000	9 Oct 2004	4 Oct 2005	12 Oct 2005
Arrival site (coordinates)	NW Nigeria (12.1N, 6.2E)	SW Mali (11.0N, 7.8W)	NW Nigeria (13.6N, 5.8E)	S Burkina Faso (9.9N, 3.3W)	N Ivory Coast (10.3N, 6.4W)	N Ivory Coast (10.3N, 6.6W)
Transit period	-	2–13 Nov	23 Oct–14 Nov	-	7 Nov–4 Dec	4–28 Nov
Distance (km)	-	951	928	-	3699	1889
Number of positions	-	2,1,2,0	1,3,2,0	-	8,7,2,1	2,7,1,1
Staging area (coordinates)	-	SW Ivory Coast (5.2N,6.2W)	C Togo (7.7N, 0.9E)	Ivory Coast-W Ghana (6.4–9.8N, 2.3–6.3W)	D.R. Congo-C.A. Republic (1.7–8.0N, 15.4–22.1E)	Benin-Togo-Ghana (6.7–9.3N, 1.3W–2.7E)
Start date post-juv movement	-	-	-	14 Nov 2004	23 Feb 2006	26 Mar 2006
Distance (km)	-	-	-	2430	3990	2457
Number of positions	-	-	-	2,6,7,4	12,7,2,3	7,7,1,0
Last message (coordinates)	23 Oct 1998 (12.1N, 6.4E)	31 Dec 2000 (5.2N, 6.2W)	8 Jan 2001 (7.7N, 0.9E)	19 Dec 2005 (9.0N, 4.8W)	23 Mar 2007 (5.5N, 20.9E)	10 May 2007 (6.8N, 2.6E)

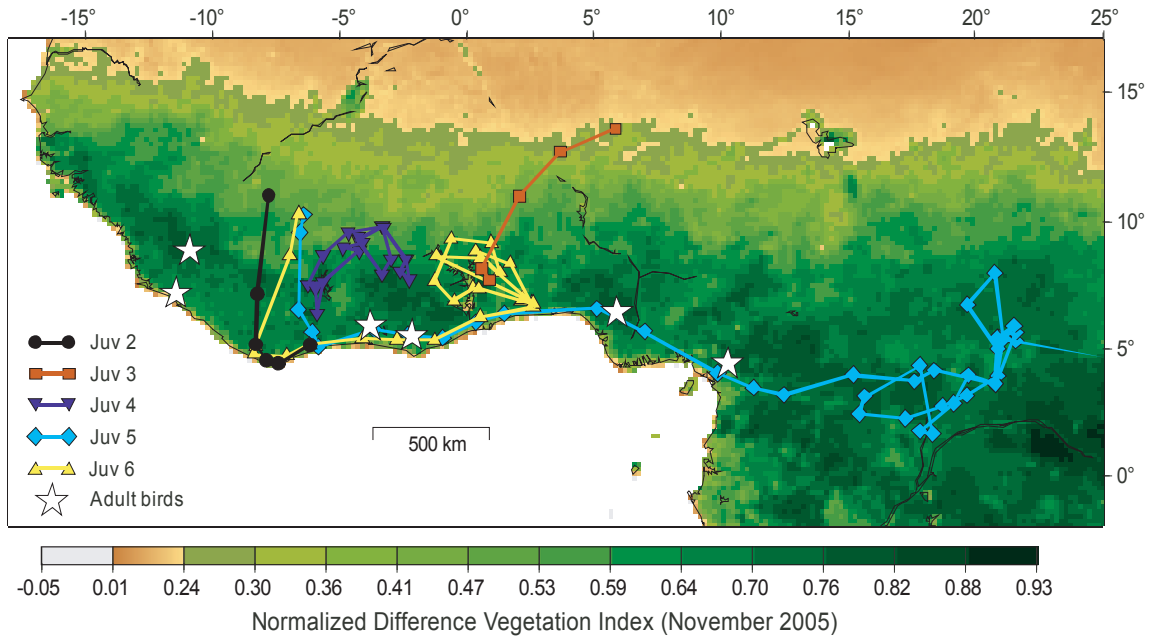

Figure 1. Post-juvenile movements made by young Honey Buzzards in tropical Africa with NDVI for November 2005 (representing the vegetation index at the time when adults are stationary in the area while juveniles perform their transit movements). Individuals are presented in Table 1. The stars indicate wintering sites for tracked adult Honey Buzzards from Sweden (Hake *et al.* 2003).

RESULTS

Six out of seven adult Honey Buzzards reached their wintering grounds. These birds travelled directly to wintering sites at latitudes 4.4–8.8°N. The four individuals that were tracked during 1 to 4 months after arrival remained stationary within areas less than 53 km^2 according to high quality positions (wintering sites shown in Figure 1; see also Hake *et al.* 2003).

Out of eight juvenile birds, six arrived south of the Sahara. The two juveniles that did not reach tropical Africa stopped transmitting during autumn migration in Denmark and the Mauritanian desert, respectively. All six successful juveniles stopped in the Guinea savanna zone, between latitudes 9.9–13.6°N, where they arrived between 4 and 15 October. These sites ranged from Mali in the west to Nigeria in the east (Table 1). Juvenile No. 1 stopped transmitting from the latter site by 23 October.

Of the remaining five birds, four individuals (No. 2, 3, 5 and 6) initiated transit movements between 23 October and 7 November and arrived at their main wintering sites between 13 November and 4 December. These movements were first directed to the south, after which the birds turned eastwards as soon as they reached the coast (Figure 1). The fifth individual (No. 4) started to move on 14 November 2004 from its first post-migratory site, but this movement was not considered to be a true transit movement, as the bird did not continue to a staging area further south. Instead, this and subsequent movements strongly resembled the post-juvenile movements observed for the other juveniles (see below), in which the bird regularly returned to latitudes close to the post-migratory area (reaching northern Ivory Coast). This individual was tracked until 19 December 2005, when transmission ceased 13 months after the first post-juvenile movement within the tropics.

The siblings from 2005 (individuals No. 5 and 6) were also tracked for extensive periods after their November transit movement to their main wintering area. These individuals initiated nomadic movements two and a half and four months after arrival to the main staging areas, respectively. These birds continued to make such post-juvenile movements until the last contacts with these birds in March and May 2007; 13 months after their first post-juvenile movements had started.

Post-juvenile movements were recorded mainly in February–May and October–December (Figure 2). As the solar-panel powered satellite transmitters seem to work inefficiently inside forest with closed canopy, longer periods without contact with the birds suggest stationary behaviour (Figure 2). Concerning the three

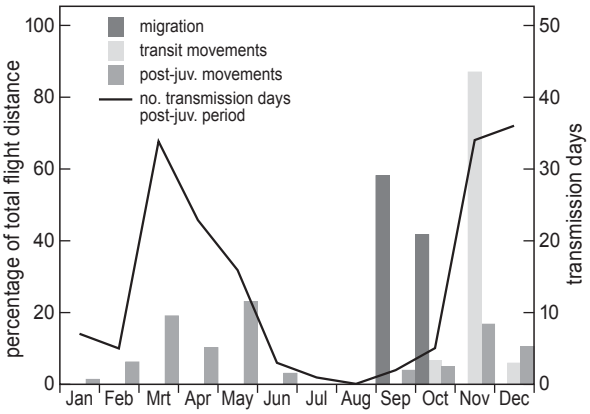

Figure 2. The monthly distribution of distance flown by immature Honey Buzzards throughout the transmission period. The different types of movement are defined in the methods section. During the periods of migration, transit movements and post-juvenile movements, the numbers of recorded birds were 6, 4, and 3; the numbers of positions were 61, 39, and 59, respectively. Bars show the monthly proportion of recorded flight distance for each category of movement (y-axis on left-hand side). The total number of days with positions received from the transmitters during the post-juvenile period are given by the dashed line (y-axis on right-hand side).

juveniles transmitting for a longer period of time in Africa (No. 4, 5 and 6), very few positions were obtained during their first summer in Africa. For individual No. 4 only one position was obtained between the end of April and the end of October, for individual No. 5 positions were obtained during only one transmission cycle (8 h) between mid-May and September, and for individual No. 6 no positions were obtained from the beginning of June until the end of March.

DISCUSSION

After completing autumn migration and arriving in tropical West Africa, young Honey Buzzards differed in their behaviour from adults in two main ways: (1) the young birds used post-migratory stopover sites in the Guinea savanna zone during the first 1–3 months after their Sahara crossing, after which they continued southwards by transit movements, and (2) the young birds made extensive nomadic movements during their stay in Africa. In contrast, adult Honey Buzzards seem to travel directly to well-defined wintering sites where they remain stationary (Hake *et al.* 2003; also shown by Meyburg & Meyburg 2011). In a Dutch tracking study (www.uva-bits.nl) most adults showed similar behaviour during the winter. However, some adults used several well-defined home ranges far apart (from West Africa to Equatorial Guinea) during the same winter (Jan van Diermen, Willem van Manen & Willem Bouten unpubl.), i.e. similar to the juveniles tracked in this study. This is interesting, but further studies are required to investigate whether this is a common behaviour among some adults or if such movements may be triggered by deteriorating conditions in their regular wintering area due to e.g. weather conditions or disturbance.

The use of post-migratory stopover sites has earlier been found to occur among both adult and juvenile Marsh Harriers *Circus aeruginosus* and Montagu's Harriers, in which birds seem to explore temporal feeding opportunities at the northern edge of the Sahel (Strandberg *et al.* 2008, Trierweiler *et al.* 2012). In the Honey Buzzard, sub-Saharan stopovers were used only by juvenile birds. The juveniles have no previous experience of migratory journeys, and it seems reasonable that they, after crossing the Sahara, stop as soon as they find a suitable feeding habitat, as their energy reserves may be exhausted. The timing of movements to more southern sites suggested that transit movements may have been associated with the start of the dry season, causing reduced foraging opportunities in the northern staging areas.

Transit movements were directed south-southwest, in accordance with the general migration direction, but the birds moved eastwards as soon as they reached the coastline. Similarly, all four juveniles (out of seven birds) that reached the southern coastline of West Africa in an Austrian tracking study changed their orientation from south(-west) to east as soon as the coast was reached (Gamauf & Friedl 2011). Thus, it seems a general behaviour of immature inexperienced Honey Buzzards to continue their travels in an eastward direction when confronted with the coast, which will enhance their chances to find suitable wintering habitat as tropical forest is more abundant in Central Africa. Interestingly, such eastward movement is against the prevailing easterly winds (Kemp *et al.* 2010), suggesting that this change in orientation is an innate response rather than an effect of wind drift.

All three immature birds that were tracked for longer periods showed extensive irregular movements which occurred during late winter to spring and during late autumn to early winter. Most of these post-juvenile movements occurred at the time when adult birds migrate. However, considerable amounts of post-juvenile movements were also observed during winter, when the adults, at least the majority, are strictly stationary. During the breeding period of Honey

Buzzards (June–August) relatively few observations of post-juvenile movements were obtained, but these positions suggest that the birds were stationary in Africa during the northern summer. This implies that post-juvenile movements are regulated by an internal annual clock, related to periods of migratory restlessness. Alternatively, these movements may be a response to changing environmental conditions, and thus related to local dry and wet seasons. Periods of intensive rainfall may provide unfavourable feeding conditions for Honey Buzzards, while dry seasons might promote nomadic behaviour to explore better feeding opportunities. In this respect, it is interesting to note that the irregular post-juvenile movements took place between seemingly similar habitats (tropical forest), in contrast to the transit flights when the birds moved from open, woody savanna into tropical forest habitat. Another explanation is that the post-juvenile movements are related to the fact that the adult's northbound migration to the breeding areas means that there will suddenly be an increase in feeding areas available during a period of four months (when the adults have left Africa and migrated to temperate breeding grounds), which probably are of higher quality provided that adults are dominant over juveniles. Hence, immature birds may move to occupy the adult's deserted winter territories in spring and move away when the adults return during autumn.

The age-related behavioural differences in tropical Africa, with immatures moving around while most adults remain stationary in small territories, might also be related to intraspecific competition, where juveniles are forced to search for suitable habitats and unoccupied territories as they arrive later to the wintering area. The degradation and fragmentation of tropical forests might catalyze this behaviour as relatively little suitable habitat where individuals can stay for longer periods might be left (see also Bijlsma 2002). Although we have no idea if carrying capacity is currently reached for Honey Buzzards in Africa, the ongoing rapid loss of natural forests in Africa, the preferred wintering habitat of our satellite transmitter birds, is unlikely to be beneficial for Honey Buzzards in general.

Interestingly, the young Honey Buzzard tracked for two years (No. 6) did not show any tendency to move northwards during its second summer in Africa, indicating that at least some Honey Buzzards are not returning to the breeding area until their third spring season as 4-cy birds. That some Honey Buzzards already return to Europe in their second spring (as a 3-cy bird) is shown by an individual tracked from Austria (Gamauf & Friedl 2011).

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SAMENVATTING

Om de bewegingen van Wespendieven *Pernis apivorus* gedurende hun eerste levensjaren te volgen, werden zes jonge vogels op het nest voorzien van een satellietzender. Na het oversteken van de Sahara in oktober verbleven de vogels enige tijd in West-Afrika, ruim boven de evenaar op 9,9–13,6° noorderbreedte. In november trokken vier van de vijf vogels met een nog functionerende zender verder in zuidelijke en zuidoostelijke richting tot op1,7–9,8° noorderbreedte. Drie Wespendieven waren in tropisch Afrika gedurende lange tijd te volgen. In een periode van 13 tot 14 maanden legden ze 2.430–3.990 km af, waarbij meerdere gebieden werden bezocht. Volwassen vogels laten een ander trekpatroon zien door zonder tussenstops naar het overwinteringsgebied te vliegen. Daar blijft hun actieradius vervolgens beperkt tot een klein gebied. De trekbewegingen van jonge Wespendieven in tropisch Afrika hebben mogelijk te maken met weersomstandigheden of exploratief gedrag. Het is ook mogelijk dat jonge Wespendieven voedselconcurrentie met oude vogels uit de weg gaan, al dan niet onder invloed van aantasting van hun leefgebied. (JP)

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