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Brief report

Does arrival date influence autumn departure of the White Stork *Ciconia ciconia*?

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1. Introduction

Evidence for a prolonged breeding season for delayed or advanced autumn migration is equivocal (Gatter 1992, Sokolov *et al.* 1999, Bairlein & Winkel 2001). Determining the date of autumn departures of breeding birds is problematic for observational recorders. Where records exist they usually concern the last observation date of a species, which requires considerably more effort than noting the first bird in spring. Sparks and Mason (2004) noted the greater variability in last departure dates in autumn relative to first arrival dates in spring.

The timing of autumn migration is governed mainly by four factors: (i) the end of the annual reproductive period; (ii) the conditions in the breeding area after the breeding season; (iii) the timing of moult and (iv) the expected conditions on passage and in the wintering grounds. Recent climate changes may have altered the relative importance of these factors, resulting in an advance or a delay of autumn migration. Spring temperatures, which have increased strongly in Europe (Easterling *et al.* 1997, Walther *et al.* 2002), may have an indirect effect on autumn migration by affecting the timing of reproduction. Autumn temperatures, which have increased much less in Europe (Easterling *et al.* 1997), may directly or indirectly affect autumn migration.

Studies of autumn migration (e.g. Hildén 1979, Ellegren 1990, Sokolov *et al.* 1999, Jenni & Kéry 2003, Lehikoinen *et al.* 2004) can not typically match the arrival and departure dates for individual birds, pairs or nest sites. Rather they tend to focus on features of the migrating population (e.g. mean date or last departure), which in autumn may contain juveniles not present in the preceding spring or may mix breeding populations. In contrast, in this paper we undertake an analysis of data on the autumn departure of White Stork *Ciconia ciconia* in Poland over two years where arrival and departure dates at nest sites can be matched.

2. Material and methods

The study was conducted during 2002 and 2003 in the agricultural landscape of western Poland, near Leszno (51°51'N, 16°35'E). In this area of 810 km^2, arable fields are interspersed with meadows, pasture, human settlements and small woods (for details see Kuźniak 1994). The White Stork build nests mainly on roofs of buildings, trees and electric poles. During recent years the number of nests located on poles increased rapidly (Kuźniak 1994).

The dates of arrival of the first bird (usually male) and second bird (usually female) to each nest site were recorded on special forms by farmers living near occupied nests and sent direct to the authors (details in Ptaszyk *et al.* 2003). Data on the last departure dates from nest sites of juvenile and adults were also requested.

The breeding success (measured as the number of fledglings produced) of the white storks was established directly in the field by standard methods used during the International Census of White Storks (Creutz 1988). Data were not complete for all variables. Dates were converted to days after December 31 prior to analysis. Statistical analysis involved correlation and randomisation tests (Manly 1997) using the MINITAB v.13 package (Minitab Inc. 2000). Where data from two years is combined, multiple linear regression analysis including year as a covariate was used as an alternative to correlation.

3. Results

3.1. Arrival date, differences between parents and breeding success

Mean arrival date differed slightly between years; April 9 in 2002 (n = 54) and April 12 in 2003 (n = 54) for the first bird of each pair and Apr 13 (n = 48) and Apr 16 (n = 51) for the second bird in each pair. Across both years there was a highly significant positive relationship between the arrival dates of first and second birds ($F_{1,96}$=314.28, P < 0.001), with the interval between partners narrowing with later arrivals ($F_{1,96}$=8.89, P < 0.01). Because of the very high correlation in arrival dates between partners all subsequent comparisons are reported only for the second partner of each pair. Breeding success was negatively correlated with the arrival date of the second partner ($F_{1,95}$=23.05, P < 0.001).

3.2. Arrival date vs. departure date

Arrival date of the second partner did not relate significantly to the departure date of adults (Fig. 1, $F_{1,48}$ =1.40, ns) nor of juveniles from the nest ($F_{1,21}$=1.86, ns). In comparing variability in dates, the dataset was reduced to the 51 nests for which complete data were available. Variability in arrival dates (SD = 8.29 for the second partner) was significantly greater than that for departure date of adults (SD = 5.03, variance ratio test $F_{50,50}$ = 2.72, P < 0.001). The skewness coefficients for the 51 pair subset were 0.41 for the first adult, –0.14 for the second adult and –0.27 for the last departure. Whilst these suggest different levels of skewness (and which are more pronounced when all data are considered) they did not differ significantly when examined using a randomisation test.

Departure dates of adults were also not significantly related to the number of chicks in each nest ($F_{1,48}$=0.00, ns). Mean departure dates of adults, 23 August 2002 (n = 25) and 22 August 2003 (n = 26), were very similar between years.

3.3. Between year changes in arrivals, departures and productivity

The arrival date of the second partner from a pair at a nest site did correlate significantly between years (r = 0.33, P = 0.043, n = 39). Chick numbers at nest sites correlated well between years (r = 0.34, P < 0.01, n = 57). However, there was virtually no correlation between departure date of adults at a nest site in 2002 with that in 2003 (r = 0.001, ns, n = 12). Similarly we did not find a correlation between departure date of adults in 2002 and subsequent arrival date the following year (r = 0.08, ns, n = 22, for the second partner).

The benefits in advancing second partner arrival date were (almost) demonstrated when comparing changes in arrival date between years with changes in chick numbers (Fig. 2, P = 0.079, randomisation test), and this relationship is more

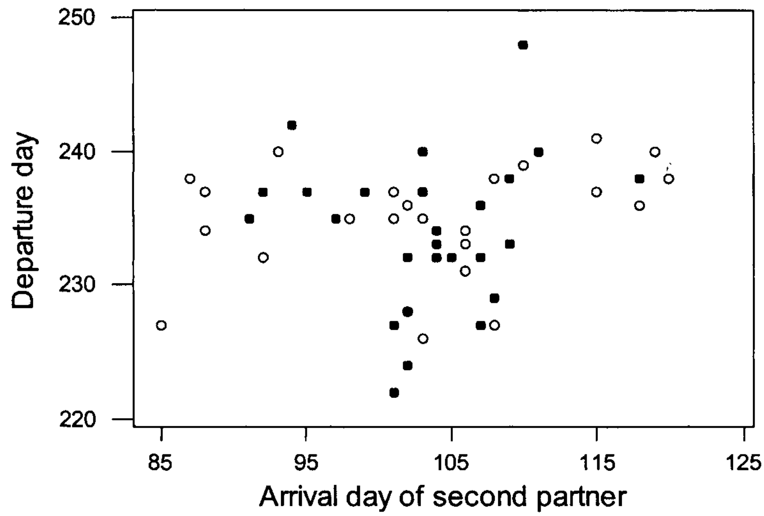

Figure 1. The (lack of) relationship between arrival date of the second partner and final departure date, open circle 2002, closed circle 2003.

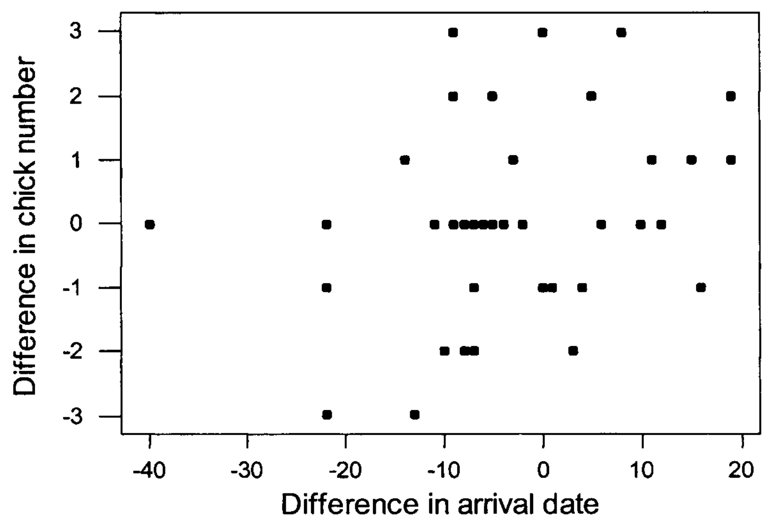

Figure 2. The relationship between year to year changes in arrival date of second partner and in chick number. Note: Positive values on x-axis indicate earlier arrival in 2003 compared to 2002 and positive value on the y-axis indicate better chick productivity in 2003.

pronounced (P = 0.037) if a very late arrival in 2003 is omitted.

4. Discussion

It is well known that there is pressure via natural selection for early arrival and breeding in birds (Kokko 1999), including the White Stork (Tryjanowski *et al.* 2004). Therefore our findings on correlation between arrival date and productivity are not surprising.

Departure dates of adults were more synchronised (lower SD) than arrival dates. However, predictions of departure dates resulting from changes in arrival date (in particular) and changes to climate (in general) are not easy. Different authors postulated both types of potential change, earlier and later (or no change) in autumn migration dates (Sparks & Mason 2001, Gilyazov & Sparks 2002, Jenni & Kéry 2003). The type of change can depend on migration route, breeding history traits and are probably species-specific (Sokolov *et al.* 1999, Jenni & Kéry 2003, Lehikoinen *et al.* 2004).

White Storks are long-distance migrants using prolonged soaring flight to cover large distances with low expenditure of metabolic energy. To locate lift they seem to rely on their social behaviour

(Pennycuick 1972). During the migration season and in the wintering quarters the species typically occurs in large flocks. Storks migrate in disorganised flocks (Van den Bossche *et al.* 2002). Recently White Storks even from the Eastern European population have begun to terminate their migration in southern Europe, notably in Bulgaria (Nankinov 1994), rather than continuing to their traditional wintering areas in sub-Saharan Africa (Berthold *et al.* 2001). Hence, at least some individuals have a shorter migration distance to wintering grounds and could potentially stay longer in their breeding areas.

According to Moreau (1972), White Storks migrate slowly in autumn, which allows them to feed at various locations along the route. Like Van den Bossche *et al.* (2002) we discovered in our study that the autumn departure of White Stork was significantly more synchronised than arrival in spring. These findings support the view that spring migration is driven by the goal of securing a nest site early in the year (for a detailed discussion see Tryjanowski *et al.* 2004). In contrast to the competitive nature of spring migration, the greater synchrony in departure suggested increased flock behaviour (Berthold 1996, Van den Bossche *et al.* 2002). This can explain the differences in variation between arrival time to the nest in spring and departure from the nest in autumn. Synchronised departure in autumn will reduce migration costs and birds are encouraged by others to finish their stay in the breeding grounds and start migration to wintering grounds. This decision can be stimulated during massive flock foraging on ploughed fields and meadows in the second half of August (Creutz 1988).

The results presented here suggest independence of arrival and departure dates at nest sites. We recognise that this study is based on two years of data and recommend that confirmation is sought from a longer scale evaluation or by supplementation with data on White Stork, and indeed other species, from additional locations.

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Vaikuttaako kattohaikaroiden saapumisajankohta keväällä haikaroiden poislähdön ajankohtaan?

Pidentyneen pesintäkauden vaikutus syysmuuton myöhästymiseen tai aikaistumiseen on toistaiseksi epäselvä. Lintujen poislähdön ajankohdan määrittämisessä on lisäksi omat hankaluutensa. Syysmuuton ajoittumiseen vaikuttavat lähinnä seuraavat neljä tekijää: 1) pesimäkauden päättymisajankohta, 2) pesimäalueen olosuhteet pesimäkauden jälkeen, 3) sulkasadon ajoittuminen ja 4) odotettavissa olevat olosuhteet muuttomatkan varrella sekä talvehtimisalueella.

Vain muutamissa tutkimuksissa on pystytty vertailemaan tiettyjen lintuyksilöiden saapumis- ja lähtöajankohtia. Artikkelin kirjoittajat tutkivat kattohaikaroiden pesäpaikalle saapumisen ja lähtemisen välisen ajan suhdetta Puolassa vuosina 2002–2003. Haikaroiden saapumisen ja lähdön ajankohdat selvitettiin tunnettujen pesäpaikkojen läheisyydessä asuville maanviljelijöille lähetetyn kyselyn avulla. Myös haikaraparien lentopoikasten määrästä pyrittiin saamaan arviot. Kaikkiaan materiaalia kertyi noin 50 pesäpaikalta vuosittain. Saapumisajankohdassa havaittiin vuosien välillä vain vähäisiä eroja, ensimmäinen yksilö saapui pesäpaikalle keskimäärin 9.–12.4. ja toinen yksilö vastaavasti 13.–16.4.

Ensimmäisen ja toisen yksilön saapumisajankohdan välillä havaittiin merkittävä positiivinen korrelaatio. Mitä myöhemmin toinen yksilö tuli pesäpaikalle, sitä huonompi oli parin pesimämenestys. Saapumisajankohdalla ei havaittu olevan vaikutusta aikuisten tai nuorten lintujen poislähdön ajoittumiseen. Haikaroiden saapumisajankohta vaihteli enemmän kuin poislähdön ajankohta. Poikasten määrällä ei havaittu olevan vaikutusta poislähdön ajankohtaan. Haikarat poistuivat pesäpaikoiltaan keskimäärin 23.8. (vuonna 2002) ja 22.8. (vuonna 2003).

Vuosien välillä havaittiin positiivinen korrelaatio sekä haikaroiden saapumisajankohtien välillä että poikastuotossa. Syysmuuton ajoittumisessa ei vuosien 2002 ja 2003 välillä havaittu riippuvuutta. Tulosten mukaan keväinen saapumisajankohta pesäpaikalle ei näytä vaikuttavan poislähdön ajankohtaan. Kattohaikaroiden syysmuuton ajankohta näyttää olevan helpommin ennustettavissa ja synkronoidumpaa kuin haikaroiden saapuminen pesimäpaikoille. Keväällä haikaroiden on saavuttava mahdollisimman aikaisin pesimäalueilleen, jotta ne onnistuisivat valtaamaan itselleen pesäpaikan. Syksyisin haikarat ilmeisesti hyötyvät samanaikaisesti tapahtuvasta yhteislähdöstä.

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