Letter to Editor

Rapid reduction in migration distance in relation to climate in a long-distance migratory bird

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Migratory birds likely evolved from residents as a consequence of intraspecific competition for limiting resources followed by dispersal of such individuals to novel sites that had previously not been occupied by migrant conspecifics (Alerstam and Högstedt 1982). If recent climate change has increased the benefits of short-distance migration and residence, with such individuals not paying the fitness costs of longer migration, we should expect an increase in the abundance of these shorter-distance migrants or residents. Alternatively, seasonal fluctuations in food may result in intraspecific competition or altered patterns of avoidance of predators and parasites that may affect the relative role of migration and residency for the distribution of barn swallows (\textit{Hirundo rustica}; Cheng et al. 2019). Barn swallows are long-distance migratory birds with a global breeding distribution with resident populations in Egypt and possibly in southern China (eBird back to 1993 and http://datazone.birdlife.org/species/factsheet/barn-swallow-hirundo-rustica) and are increasingly wintering further northward from the equator due to climate change. Studies of stable hydrogen isotopes in feathers (\(\delta^2\)H) grown in natal areas and at the wintering grounds can be used to infer molt origins and have shown that barn swallows are philopatric to their wintering grounds, and during winter to their once-chosen communal winter roosts (Szép et al. 2009). During the last 5 years, hundreds of individual barn swallows have increasingly abandoned long-distance migration and have instead wintered closer to their breeding grounds in Southern Europe (\textit{BirdLife International 2021}). There is also information on change in timing of molt in barn swallows in South Africa, and this has had consequences for the northward shift in molt and migration by barn swallows wintering in that area (Ambrosini et al. 2011). Barn swallows have recently started to winter in Porto, Lisbon, and Algarve, Portugal, during December–February (van Nus and Neto 2017). The change in migratory behavior by large numbers of individual barn swallows in southern Europe constitutes a reduction in migratory distance and the timing of the annual molt. Here, we first used measurements of \(\delta^2\)H from Portuguese-wintering barn swallows during the annual molt to assign molt origins to a mixed sample of juvenile and adult birds (Hobson et al. 2012). We used characteristics of tail feather length and the size of white spots on these feathers to estimate the proportion of adults and juvenile birds in our sample (Møller et al. 1995; Kose and Møller 1999; Supplementary Material). Growth bars were used to estimate feather growth rates (Grubb 2006; Supplementary Material). However, we were forced to use only primary feathers for the isotopic analysis and subsequent depiction of molt origins using the isotope approach (Supplementary Material). We assumed that the proportion of adults versus juvenile birds determined from tail feathers would be approximately the same as the distribution of these 2 age classes in the primary feathers for the isotope sample. The \(\delta^2\)H values allowed us to estimate natal origins in Europe of juvenile barn swallows, and if adults had grown feathers the previous year in the traditional west African or European winter quarters in Europe. If adults had grown feathers in Europe versus Africa, this would indicate an established wintering population in Europe that had abandoned long-distance migration to Africa. Second, we tested whether molt phenology of barn swallows that have recently started to winter in Portugal differed from breeding birds that originated from the Iberian breeding grounds while wintering in Western Africa.

We found a total of 561 feathers of which 332 were primaries, 214 tail feathers, and 15 secondaries. Our analyses of tail feathers revealed that the approximate proportion of adults in the population was 66.5\%. The length of primaries and secondaries was normally distributed, while the length of the outermost tail feathers was bimodally distributed. The category of long tail feathers (typical of adults) was on average 92.46 mm (\(SE = 1.15\) mm), \(N = 50\), while the category of short-tail feathers (typical of juveniles) was 66.5%. The length of primaries and secondaries was normally distributed. The category of long tail feathers (typical of adults) was on average 92.46 mm (\(SE = 1.15\) mm), \(N = 50\), while the category of short-tail feathers (typical of juveniles) was 66.5%.
Measurements of naturally occurring deuterium ($^{2}$H) in the plumage of barn swallows wintering in Portugal overwhelmingly confirmed European natal origins of juvenile birds and showed that the majority of adults had also grown their feathers the previous year in Europe rather than at their traditional sub-Saharan African winter quarters (Figure 1 and Supplementary Table S1). We showed that for all feathers analyzed, $\delta^{2}$H was on average $-57.0_{\text{mean}} \pm 1.35_{\text{mean}}$ (range $-27.4_{\text{mean}}$ to $-92.5_{\text{mean}}$, $N = 69$. Duration of feather molt that was independent of age decreased with increasing temperatures from 24.4°C in 2019 (95% CI: 6.9–8.9°C) to 7.9°C in 2019 (95% CI: 6.9–8.9°C). This increase was statistically significant (GLM with normally distributed data and an identity link function; likelihood ratio statistic LR = 4.47, $df = 1$, $P = 0.035$, estimate [SE] = 0.208 [0.089]).

Assignment of barn swallows to their molting grounds based on primary feathers only indicated support for winter molt (the previous and subsequent year) largely in Europe with some birds possibly molting as far north as France in the preceding year and a smaller group having molted previously in Africa (Figure 1). Within Europe-grown feathers, there was a significant difference in $\delta^{2}$H with date, showing that birds that molted later also wintered more northerly in the previous year.

Numerous species of migratory birds have been shown to advance the timing of migration phenology in recent decades. Traditionally, barn swallows from Spain and Portugal molt during 5 months in September–January in western Africa (Møller 1994) before migrating back to the breeding sites in the Iberian Peninsula in February–April (Møller 1994). The timing and the long duration of the single annual molt suggests that barn swallows cannot migrate to Western Africa in January–February before returning to the breeding grounds in the Iberian Peninsula. Based on our isotope data and detailed analyses of feather growth patterns, we conclude that barn swallows have recently changed their migration from breeding areas in the Iberian Peninsula to now also winter in the Iberian Peninsula. Our examination of the mean winter temperature in Portugal showed increases over the last decade confirming that barn swallows wintering there is consistent with a response to climate change in general and warmer winters in particular.

Ethics
The study did not require ethics approval since only molted feathers were used.

Data Accessibility
All data are available in the manuscript.

Authors’ Contributions
A.P.M. and K.A.H. designed the study and wrote the manuscript. T.v.N. collected the samples. K.A.H. analyzed the samples. A.P.M. analyzed the data.

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Supplementary Material
Supplementary material can be found at https://academic.oup.com/cz.

Competing Interests
The authors declare that they have no conflicts of interest.

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