

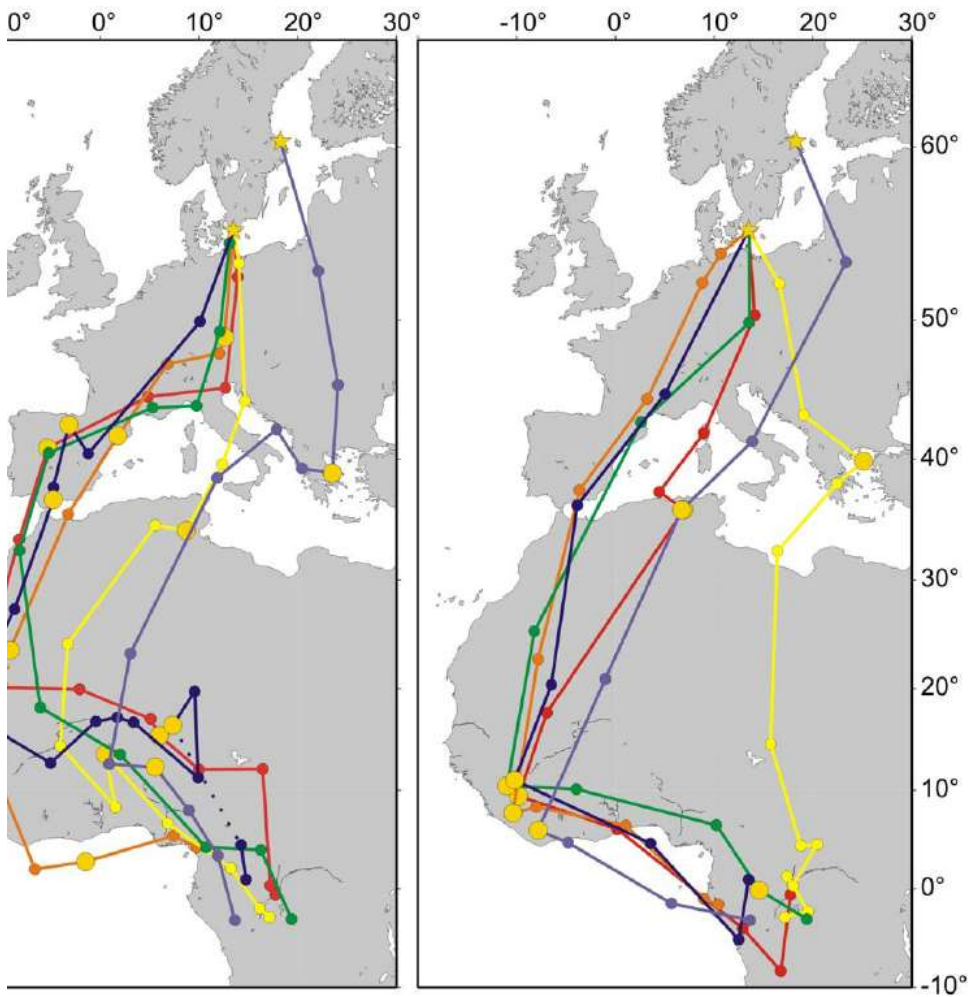
Advertisement

led by [Jan Holmgren](#)
subject to copyright.

Download

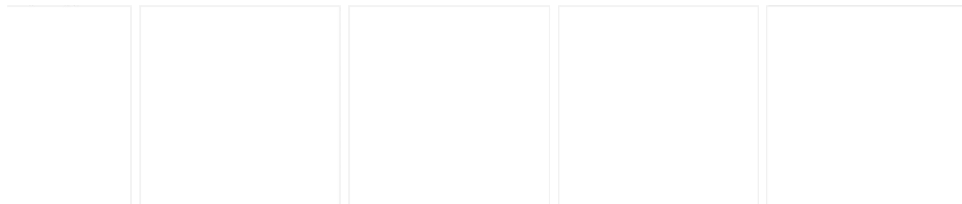


View publication



tracks of swifts. (A) Autumn migration tracks for 6 individuals where filled circles represent 3-day positions and filled yellow circles represent stopover periods when the bird did not move (2 days or more). Dashed lines indicate lack of data around autumn equinox. (B) Spring migration tracks for the same individuals. doi:10.1371/journal.pone.0041195.g001

publication



on Routes and Strategies in a Highly Aerial Migrant, the Common Swift *Apus apus*,
led by Light-Level Geolocators

Full-text available

2

anne Akesson · Raymond Hendrikus Gerardus Klaassen · Jan Holmgren · [...] ·

cking of small avian migrants has only recently become possible by the use of small light-level
ctors, allowing the reconstruction of whole migration routes, as well as timing and speed of
on and identification of wintering areas. Such information is crucial for evaluating theories about
n strategies and pinpointing crit...

Publication

by birds is typically carried out as cycles of fuelling at stopovers followed by flight towards the
stopover [1]. In some extreme cases the whole migration is covered in one flight step, such as
in bar-tailed godwits *Limosa lapponica baueri* [2,3]. This strategy has probably evolved as a
non-uniform distributions of food limited to specific habitats, combined with the need to cross
cal barriers like seas and deserts. This migratory strategy involves not only the deposition of
erves but also associated physiological changes such as temporarily enlargement and
flight muscles and organs involved in food assimilation [4]. During periods of extensive fuelling,
k may increase as a result of reduced manoeuvrability due to heavy fuel loads [5–7]. An
igration strategy involves short flights with small fuel reserves, which avoids the costs of
vy fuel loads but instead requires many stopovers and availability of suitable habitats along the
ite. Other birds, like seabirds, raptors and terrestrial species feeding on aerial insects, may
a fly-and-forage migration strategy [8], without the need of extensive stopover periods if their
evenly distributed and available along the migration route. Note that a fly-and-forage strategy
bined with stopovers as observed in certain seabirds [9,10], so that not all energy required for
acquired during migratory movement itself. How migrants organize their travels in relation to
al conditions can only be resolved if we are able to track individual birds throughout their
it until recently this has been limited to relatively large birds that can sustain the weight of a
mitter or GPS logger. The tracking of small (avian) migrants has only recently become
he use of retrievable archival geolocator units (e.g. [10,11]), which record time and light-level
y for the reconstruction of time-stamped latitudes and longitudes. In the present study we
recorded the full migration of common swifts *Apus apus* (henceforth called swift) from two
s in Sweden. The swift is a highly aerial species, only leaving its aerial habitat during the
ason and during occasional roost events in trees [12]. Non-breeding birds roost on the wing
ght [13], and during migration and wintering they are believed to spend all their time airborne
migration routes used by swifts and their wintering areas in tropical Africa are to a large extent
ce only a few ringing recoveries have been reported from south of the Sahara thus far [17–19].
cribe the details of the migrations of individual swifts, discuss the migration strategy for this
erial migrant, and compare with other migrants following the typical migration strategy of
ds. The autumn mean initial migration direction was 182 for the tracked birds, with one bird
e easterly initial direction (Figure 1 A). Four of the birds shifted to a direction towards SW
pe to reach Africa via Gibraltar, while two crossed the Mediterranean via the Balkan and/or
ninsulas to arrive in Africa near Cap Bon, Tunisia (Figure 1 A). Within West Africa migration
wards south, while the two individuals entering Africa near Cap Bon proceeded towards SSW.
irds aggregated in Central West Africa (latitudes 5.97 u N–11.05 u N; longitudes 7.85 u W–
with one bird taking a more southerly route towards the final wintering area in Central Africa
an open sea crossing (Figure 1 A). Five of the birds made stopovers in West Africa, lasting
and 56 days, before proceeding to the wintering area in Central Africa. All six birds spent the
same general area in Central Africa between latitudes 0.97 u N–3.20 u S and longitudes 10.42
E (Figure 2), during a period of on average 198 days (range 172–243 days). Three of the birds
on during the winter (Figure 2), while one of these (7969) returned to the area where it had
t part of the winter. Spring migration routes were similar to the autumn routes, while five of the
a rather restricted area in SW West Africa (Liberia), where they stopped over for on average 7
1.1, range 2.5–11.5 days), before continuing towards NNE across Sahara (Fig. 1B). One bird,
he colony in southern Sweden (see Methods), took a more direct route through Central Sahara
the Central Mediterranean to reach the Balkan Peninsula on the way north (Figure 1 B). The
tion direction through Europe was NNE in five of the birds, except the individual arriving in
where it took a NNW-direction towards its breeding site in southern Sweden. The individual
he northern site shifted from NNE towards NNW during the last migration leg that involved a
the Baltic Sea (Figure 1 B). The autumn migration route was on average 53% longer than the
between the breeding site and the wintering area, while it was slightly more direct during spring
h a 43% detour. The difference between autumn and spring detours was however not
atched pair test, $P = 0.36$). The duration of the entire autumn migration was on average 69

Advertisement

30–99 days), divided into 30 days of travelling and 39 days of stopover (i.e. stops . 2 days, see the large variation was due to that three individuals spent lengthy stopovers of 56–82 days in (Table 1, Figure 1 A). Corresponding numbers for spring migration was 29 days duration (range), divided between 21 days of travelling and 8 days at stopovers (Table 1). The number of days did not differ significantly between autumn and spring (Matched pair, $t = 1.82$, $P = 0.064$), nor of days at stopovers did ($t = 2.30$, $P = 0.035$). Also the total duration of migration differed between seasons with an average duration of 69 and 29 days ($t = 3.46$, $P = 0.009$), respectively. This difference is largely due to very long stopovers in three individuals during the autumn migration. Stopover periods were more evenly distributed along the migration route during autumn migration than in the spring, when the stopovers were concentrated to sites in West Africa (Liberia) and after crossing (Figure 1). Those individuals stopping for the shortest periods south of the Sahara during northward spring migration (0, 2.5 and 2.5 days, respectively) were those that also stopped over in West Africa and the Balkan, while the birds stopping for longer periods south of the Sahara (7, 9.5, and 10 days) did not stop after having crossed the Sahara ($P = 0.012$, Mann-Whitney U-test). Overall migration speed is the rate of travel when including time for actual movement and time for refuelling at stopovers [9]. An appropriate estimate of migration speed should therefore also include fuelling time at the stopover and wintering sites, but such information is impossible to achieve on the basis of tracking data. During a long inter-continental migration as in the swift the relative importance of the first fuelling stopover at the breeding or wintering sites, if it exists, is relatively unimportant. Furthermore, fuelling loads were small in the swift; five swifts captured immediately before onset of autumn migration weighed less than when captured soon after arrival at the breeding colony (see Methods). The migration speed was significantly higher in spring (on average 336 km/day, Table 1) than in autumn (300 km/day, Table 1) (Matched pair test, $t = 3.09$, $df = 5$, $P = 0.027$). By excluding the stopovers we can calculate the rate of travel for the periods of movement (travel rate), which again was higher in spring (469 km/day, Table 1) than in autumn (344 km/day, Table 1), but the difference was not significant ($t = 1.71$, $df = 5$, $P = 0.11$). The travel rate (based on three-day averages) appears to show a non-linear relationship with latitude in both seasons (Figure 3). A statistical model including latitude, latitude squared and individual as random factor showed that both latitude squared and season had significant effects on travel rate (Fixed effects; latitude*latitude: $F_{1,58} = 20.3$, $P = 0.0001$; season: $F_{1,58} = 9.5$, $P = 0.003$). As geolocators do not provide information about the altitude of the bird, thus we calculated wind speed and direction for different flight altitudes along the individual migration tracks for spring migration (Table 2). The birds migrating via Liberia in spring experienced favourable wind assistance at most altitudes at the northern leg between the wintering area and Liberia (Table 2), with particularly strong tail winds at high altitudes (1000 – 5000 m a.s.l.). The one bird that took a more direct route across the Sahara towards North Africa, and then via Liberia, experienced head winds (negative wind assistance) at all altitudes during the migration, while the birds migrating via Liberia could find favourable winds across the Sahara at most altitudes (Table 2). The bird that migrated directly towards the North from the wintering area in central Africa had the slowest migration speed (234 km/day) and speed of travel (274 km/day) among all the birds, and the shortest detour (Table S1). For the final migration leg across Europe there were mostly

a critical sun angle (i.e. the sun angle corresponding to a light-level value of 2 on the arbitrary logarithmic light scale) that minimised the difference in latitude between pre- and post equinox, and thereby reduced the uncertainty in latitude close to equinox for periods when the birds were stationary (as measured in longitude). This 'Hill-Ekstrom' procedure is based on the observation that around the equinox the error in latitude increases with increasing mismatch between light threshold value and sun angle [45]. The appropriate sun angle can be determined by calculating latitudes for a range of sun angles and selecting the one that minimizes the variation before and after the equinox [45]. A comprehensive explanation and evaluation of this and alternative calibration methods see ref. [46]. The sun angle used varied from 2.6 to 2.7 degrees. Data on latitude were excluded for approximately 14 days before vernal and autumnal equinox. Overall, we obtained two positions per day, and both morning and afternoon locations were used in our analyses. We distinguished between movements and stationary periods (migratory stopovers, breeding, wintering) by inspecting subsequent positions. Due to the limited positioning data, stopovers shorter than two days could not be distinguished from slow movements. For further analysis and plotting we calculated 3-day mean positions (i.e. means for 6 position estimates). Total migration distance is the sum of the length of segments based on 3-day mean positions in which stationary periods are excluded. The direct distance is the Great Circle Route between the wintering site and the final wintering site. The period over which to calculate mean positions affect the estimated migration distance and derived properties such as detour and migration speed. We consider 3-day means as a reasonable compromise between using shorter periods that will inflate migration distance due to noise in the data, and using longer periods that will underestimate the true migration distance due to the omission of real movements away from the straight line between successive positions. To test the effect of period on the estimated migration distances we calculated mean positions for 1-day and 5-day periods in addition to the 3-day means used for the analyses for autumn and spring migration, respectively. As expected, 1-day and 2-day means resulted in increased estimated migration distance compared with 3-day means by 37% and 8.6%, respectively, while 5-day means resulted in increased migration distance by 5.4% compared with 3-day means (percentages are means for all the six corresponding numbers for estimated migration distances for spring were increased by 36% and 2-day means), and a decrease by 7.8% (5-day means), when compared with 3-day means.

on derived properties were very similar. Positions derived from light-level geolocators are errors of magnitudes estimated at 143.6 ± 62 km (mean ± 95% confidence interval) and 186.6 ± 6 SD) for latitude position [40,47], respectively, depending on factors such as geographical location, year, habitat and weather. Errors of longitude estimates are generally lower than those of latitude estimates at 50.6 ± 34 km (mean ± 95% confidence interval) and 85.6 ± 47 km (mean ± SD) [40,47]. Errors in longitude estimates may affect derived properties such as migration and travel rates. Most errors in longitude estimates are caused by shading events; i.e. due to the shading by feathers, vegetation, and the sun seems to rise later or sets earlier than expected. Shading events affect estimates of the day length (and night) and time of local solar noon (and midnight), and consequently result in errors in longitude estimates. When determining longitude, there will be no error from shading if the same amount of shading is present at rise and set. If the amount of shading differs, the derived local noon/midnight will be biased and there will be an associated error in derived longitude. For latitude, where day/night length is input, if the shading experienced differs from that which formed the relationship between light level and sun altitude through calibration, there will be an error in latitude. In addition, any bias in the time of the day between rise/set and set/rise will alter the derived day/night length and local solar time in a manner that is unlikely to result in the mean position for the bird. The dominant error due to shading is with calculated latitude but is cancelled if consecutively derived noon and midnight latitudes are used [44], as we have done. In the present analysis (following [48]), distance estimates are based on multiple observations, i.e. 6 subsequent positional estimates for each location, which reduces the errors in distance estimates. Furthermore, the plotted migration routes (Figure 1) show relatively straight movement patterns which suggest that estimated travel distances and rates have not been inflated due to precision errors that errors arising from an incorrect calibration of threshold light level with sun altitude are systematic and so have far less effect on speed estimates than on actual location. For the wind direction data were smoothed twice (cf. [49]), giving weighted estimates for noon and midnight which were used to define 12 h-segments. Wind data (speed and direction of the wind) were from the NCEP/NCAR Reanalysis project, as provided by NOAA/OAR/ESRL PSD, Boulder, CO, USA. For every 12 h-segment, wind data were extracted for the start, mid- and end-point, in which the end-point was given twice as much weight during averaging. We subsequently calculated, for each segment, the tailwind component of the average wind vector, which is the amount of wind blowing in the same direction as the general migration direction (i.e. the projection of the wind vector on the general axis of migration). For the spring migration, two general migration directions were defined, the direction from the wintering area to the stopover area in Liberia, and the direction from Liberia to the breeding site. For the autumn migration, which did not make a detour via Liberia, a single general migration direction was used from the wintering area to breeding site). The amount of tailwind experienced by the swifts was calculated for each individual and per travel leg (wintering area – Liberia, crossing of the Sahel and Sahara, crossing of the Sahara to Europe). Negative tailwind values represent headwinds. These calculations were done at different pressure levels (925, 850, 750 and 500 hPa), which correspond to different altitudes (3000 and 5000 m, ...

Spring migration respectively, suggest there is some ecological advantage of migrating via West Africa instead of along a direct N-S axis. Detours can occur for several reasons, such as when the direct route involves the crossing of an ecological barrier (desert, sea or ice) where fuelling is not possible. A detour around the barrier, or one involving a shorter barrier crossing, may be favourable if the detour allows migration with smaller fuel reserves than needed for a direct flight across the barrier or it may also be favourable if it allows faster fuelling at stopovers than for the direct flight, or if the cost of migration is reduced due to for example tail winds [25]. Focusing on the spring migration, swifts experience tailwinds during both the initial migration leg to the stopover in Liberia, as well as during the Sahara crossing from West Africa. Generic wind patterns in the Sahara during spring are favourable [26], and thus swifts would predictably encounter tailwinds in the Western Sahara, whereas in the eastern Sahara are dominated by headwinds. Furthermore, the timing of the stopover in Liberia coincides with the mass emergence of insects in connection with the onset of rains [24], which provides an opportunity for rapid fuel accumulation. Swifts have an exceptional capacity to forage and consume large numbers of aerial insects in a short time, and thus, potentially a capacity for fast increases in fuel stores [27]. Hence, there are two ecological factors favouring the West African detour to allow for a fast migration. The swift taking a direct route from the wintering area towards N in spring experienced a slow progress across the Sahara, resulting in a relatively slow progress, illustrating the possible cost associated with this more direct route. The quadratic relationship between travel rate (including days of migration) and latitude indicates that relatively more time was devoted to directed flights, and less to en-route stopovers at latitudes 25–30° N. This pattern may also arise if wind assistance varies in relation to latitude. In fact, analysing travel rate in relation to latitude and wind assistance showed that both variables contributed to the variation in travel rate, except for wind data at the lowest altitude (e.g. at 500 m) (model fixed effects; latitude $F_{1,106} = 15.2$, $P = 0.0002$, wind assistance $F_{1,105} = 32.3$, $P = 0.0002$, model $F_{1,105} = 11.7$, $P = 0.0009$). The migration paradigm for passerines involves multiple cycles of stopovers for fuelling and flight [28]. Theoretical calculations suggest that small birds should divide time on migration between flight and stopover at about 1:7, which means that most of the time is spent at stopovers [28]. A study using geolocators found that six passerines (two purple nuthatches, five wood thrushes *Hylocichla mustelina*) spent on average 64% of the time at stopovers during autumn migration, while the corresponding numbers for spring migration was 24% [11]. The swifts of this study spent on average 47% and 27% of the time at stopovers during autumn and spring migration, respectively.

noted that these numbers do not include the initial time for fuelling at the breeding/wintering site. Jays of travel less than 24 hours are likely spent flying in the migration direction, which derestimates the time spent at stopovers. The pattern is similar between the seasons, reflecting migration for both the passerines and the swift. Autumn migration was, however, faster for the purple martin (170 and 153 km/day, respectively) than for the wood thrush (68 km/day), as the aerially feeding species achieve a substantially faster migration. However, the spring speed was on average 242 km/day in the wood thrush, which is very high for a passerine (cf. lower than in the swift and purple martin (336 and 429 km/day, respectively). The highest recorded for any of our swifts was 650 km/day, suggesting migration with wind assistance. Species, such as the wood thrush, probably accumulate large fat reserves at the winter site that allow for spring migration (cf. [30]). Average summer body mass for swifts is about 40 g in southern Europe, depending on food availability as indicated by temperature. Body masses of our swifts at the end of migration (42.5 g) and shortly before departure on autumn migration (43.2 g) did not suggest the presence of any extensive fuel reserves at these times. To the best of our knowledge there is no information about fuelling in the winter quarters before spring departure (cf. [31]). However, the fact that swifts do spend time at stopovers during migration suggests they exploit these areas for fuelling, and since the stopovers appear to be located before the crossing of the Sahara and the Atlantic Ocean (Fig. 1). This pattern was especially pronounced in spring, when five of the swifts stopped in West Africa, involving a substantial detour. Why would they visit this restricted area in West Africa? The period from April and early May coincides with the onset of the rainy season and the associated abundance of aerial insects [24]. Gatter [24] writes that during this period "the skies can be full of Common Nighthawk throughout the country on some days", and out of more than 2 million swifts that he recorded during his study only 7% were observed between August and December, while 92% were recorded from March to April. Gatter [24] also observed a "continuous movement" of swifts flying towards NW from an altitude of 1000 m above broken cloud in western Liberia, while at Mount Nimba departure was towards NNE during March-April. Even if swifts occur in significant numbers during April and May in Ghana and Nigeria [32,33], they do not appear to reach the numbers found in Liberia [24], which supports the notion that swifts to a large extent migrate across the Gulf of Guinea in spring as suggested by Gatter [24]. With such a concentration of swifts during spring migration to a relatively small area in West Africa, it follows that swift populations may be vulnerable to habitat loss there (cf. [34]). A study of the flight speed of swifts can inform about the migration strategy. The flight speed of swifts on migration in southern Sweden measured by tracking radar was 10.6 m/s [34], which corresponds to a distance of about 250 km in the migratory direction if flying for 24 hours. The average travel rate was about half the flight speed, suggesting that the swifts migrated for about 12 hours of the day and presumably foraged for the remaining time. Highly aerial species that hunt food in the open air are likely to adopt a fly-and-forage migration strategy or to combine fly-and-forage with stopovers (mixed strategy). The fly-and-forage strategy will be favoured if where b is the relative benefit from en-route foraging, c is the cost as reduced travel speed due to stopovers, and p is the power ratio ($P_{\text{trav}} / P_{\text{dep}}$, where P_{trav} is power required during travelling (flight) and P_{dep} is the rate of energy accumulation at stopover [8]). Hence, a fly-and-forage strategy is favoured if b is large, c is small or p is large, or a combination of these factors satisfying the inequality. A high b is likely satisfied by the swift, since it can forage in flight during migration with a small reduction in speed, while the power ratio is likely to be low. Swifts have an efficient aerodynamic design that will result in a very low power required to fly [35–37], so a high power ratio will depend on the energy gain at stopovers. In some circumstances swifts can gain weight very quickly [27], but this rate depends on food availability (temperature) and the effort needed to search for food and may therefore vary a great deal. However, the swift possesses features that would make a (mixed) fly-and-forage strategy beneficial to overall migration speed that is much higher than a stop-and-fly strategy. Notice that stopovers are not used in a fly-and-forage strategy, i.e. the fact that a bird makes a stopover does not mean that it uses a stop-and-fly strategy for the rest of its migration. Especially before the crossing of wide ecological barriers, using a fly-and-forage strategy might make stopovers, which seems to be the case in the swift migration across the Sahara on both autumn and spring migration. Because the swift can combine foraging and migration and since it can sample food abundance continually during migration, it will probably not be affected by the search/settling time and energy costs of avian migrants that depend on terrestrial stopovers. Being adapted to a life in airspace, the swift has a low-cost aerodynamic design and a very high effective lift to drag ratio [36,37,39] that minimize the cost of transport. These factors in combination constitute the features that allow the swift to migrate so exceedingly fast, when compared to other aerial species (cf. [30]). Interestingly, the purple martin, which is also a species of efficient aerodynamic design, also exhibits a relatively high migration speed [11]. Based on our migration tracks of the purple martin, the average annual time allocation could be estimated for breeding, migration and wintering as 19%, 21%, and 60%, respectively. Autumn migration took longer time than spring migration, which may be due to a different strategy between the seasons (see above). More than half the year is spent on the ground, presumably without coming to the ground except during rare occasions [15]. Also our tracking data indicate that the swifts are airborne throughout the northern winter as we never ...

ns

Timing, rate, routes and wintering areas of White-crested Elaenia (*Elaenia albiceps*) as a key seed disperser for Patagonian Forest regeneration



[Full-text available](#)

Patricia Bravo ·  Víctor R. Cueto ·  Cristian Andrés Gorosito

Animals often play key ecological roles within the communities they visit throughout their annual life cycle. As a consequence of the links between biomes mediated by migrants, changes in one biome can affect remote areas in unpredictable ways. Migratory routes and timing of most Neotropical austral migrants, which breed at south temperate latitudes, are poorly understood.

Connectivity at High Latitudes: Sabine's Gulls (*Xema sabini*) from a Colony in the High Arctic Migrate to Different Oceans

[Full-text available](#)

David A. Donov ·  Mark Maftai ·  Mark L. Mallory

Arctic latitudes are some of the most recently colonized by birds, and an understanding of the connectivity of circumpolar species offers insights into the mechanisms of range expansion and contraction. Migratory divides exist for many birds, however for many taxa it is unclear where such divides exist, and to what extent they exist.

Carbon isotope minimum zone expansion offshore West Africa: Evidence for global cooling events

[Full-text available](#)

Victoria Peck ·  R. W. Jones ·  Michael A. Kaminski

Carbon isotope minimum events ca. 16 Ma, 15.5 Ma, and 14.3 Ma ago have been identified in sediments from the Atlantic. Multiproxy benthic foraminiferal and sedimentary records suggest an expanded oxygen minimum zone consistent with enhanced upwelling at these times. Low oxygen species *Bulimina elongata*, *Bulimina zanzanensis*, *Bulimina marginata* and *Valvulineria*...

Long-distance sea crossing by a migratory bird

[Full-text available](#)

Olives ·  Maria P. Dias ·  Verónica Méndez · [...] ·  Tómas Grétar Gunnarsson

undertaking within-continent migrations have the possibility to stop en route, but most long-distance migrants must also undertake large non-stop sea crossings, the length of which can vary greatly. As migrating from Iceland to West Africa, the shortest route would involve one of the longest sea crossings while alte...

Amphibians and reptiles of Nouabale-Ndoki National Park, Republic of Congo (Brazzaville)

[Full-text available](#)





Johnson ·  David C. Blackburn

An annotated list of 20 amphibian and 14 reptile species collected along the southern edge of Nouabale-Ndoki National Park in the Republic of Congo, which comprises lowland forests that are part of the Congo River drainage basin. This study has resulted in the first definitive records of the frogs *Aubria tectophrynus regularis*,...

Migration strategies occurred among great reed warblers *Acrocephalus arundinaceus* wintering in sub-Saharan non-breeding sites; with translocations over larger distances by moving to breeding and wintering further eastwards (Koleček et al., 2018). Wintering movement strategy of common swifts *Apus apus* wintering in Africa appears to correlate with breeding location, with both Swedish and Dutch birds sharing a major wintering area in the Congo basin, and only Dutch birds vacating this area midwinter to make a round trip to south-east Africa (Johnson et al., 2012; Klaassen et al., 2014). In red-necked phalaropes, the occurrence of different wintering movement strategies within the same species suggests flexibility of movement behavior within the species. ...

Migration Divide Among Red-Necked Phalaropes in the Western Palearctic Reveals Wintering Migration and Wintering Movement Strategies

[Full-text available](#)

Johnson ·  Rob S.A., van ·  Yann Kolbeinsson ·  Raül Ramos ·  Olivier Gilg ·  Ingrid

Understanding movement strategies of migratory birds may be expected to be flexibly adjusted to the distribution and quality of habitat, but few studies compare movement strategies among populations using distinct migration routes and wintering areas. In our study, individual movement...

This migration step included an abrupt shift in migratory direction from south- south-west

most due east (EN, RR) or to the south-east (PO). A similar change in migratory direction after the Sahara-crossing has also been shown for the Common Swift *Apus apus* and Common Redstart *Phoenicurus phoenicurus* (Åkesson et al. 2012 (Åkesson et al. , Jansen et al. 2013). ...

Spring migration was therefore almost two times faster than autumn migration, when the time spent between the breeding area and the first sub-Saharan staging site was approximately 35 days (09 July-13 August). More rapid northern migration has already been documented for Aquatic Warblers based on migration phenology (Atienza et al. 2001), and fits the general pattern for Palearctic migrants to sub-Saharan Africa (Tøttrup et al. 2011, Åkesson et al. 2012, Schmaljohann et al. 2012, Ouweland et al. 2015). ...

Spring migration routes and non-breeding staging sites of adult males of the globally distributed Aquatic Warbler *Acrocephalus paludicola*

[Full-text available](#)

8 · BIRD CONSERVATION

Łukasz SALEWSKI · 🇵🇱 MARTIN FLADE · 🇷🇺 SIMEON LISOVSKI · ANATOLII POLUDA · 🇩🇪 BEN HAHN

They are long-distance migrants partition their annual cycle among a number of locations over their spatial range. The conservation of these species is particularly complex because it requires knowledge of a number of different and distant habitats based on knowledge of migratory phenology...

The complexity of migratory routes may be affected by historic colonization events and local range expansion sometimes leading to longer and more complex routes around the world [8, 28, 44, 65, 69, 78]. Speciation processes may further result from differential seasonal timing of migratory programs and breeding segregation, where completely new migratory routes may be formed and kept separate in populations with limited gene flow [5]. ...

Seasons and 13,000 km on the wing – route choice in willow warblers *Phylloscopus sibilatrix* migrating from Far East Russia to East Africa

[Full-text available](#)

8

Andreas SOKOLOVSKI · 🇮🇹 Giuseppe Bianco · 🇩🇪 Mikkel Willemoes · 🇷🇺 Diana Solovyeva · 🇸🇪 Åkesson

Background: High-latitude bird migration has evolved after the last glaciation, in less than 10,000 years. Migrating songbirds rely on an endogenous migratory program, encoding timing, direction, and routes, but it is still unknown which compass mechanism they use on migration. We...

Seasonal difference in total migration distance has been shown in some species along their flyways [67, 70]. The absence of any major seasonal difference in total migration distance might also be related to the geography of the EAAF. ...

Seasonal variation in energy minimization migration strategy varies with body size and season in long-distance migratory shorebirds

[Full-text available](#)

7

Yan ZHAO · 🇺🇸 Maureen Christie · 🇺🇸 Jonathan Coleman · 🇺🇸 Chris Hassell · 🇩🇪 Marcel

Long-distance migrants have been hypothesised to use different migration strategies between seasons: a time-minimization strategy during their pre-breeding migration towards the breeding grounds and an energy-minimization strategy during their post-breeding migration towards the...

very large longitudinal spread is surprising and in contrast to the high connectivity and westward movement seen in for example common nightingale *Luscinia sibilatrix* [9]. However, similar variable termination of migration also caused large population variation in wintering longitudes in some swift populations [48] but not in others [49]. Northern and eastern willow warblers migrate via the eastern Mediterranean [31] but it is unknown whether a similar spread westwards into western birds also occurs in winter. ...

Winter gain from continuing migration for more than 3000 kilometres: Willow warblers in Denmark winter across the entire northern Savannah as revealed by geolocators

Full-text available

7

Ulrikke Lerche-Jørgensen · Mikkel Willemoes · Anders P. Tøttrup · Katherine Rachel Furness · Kasper Thorup

For most Afro-Palaearctic migrants, particularly small songbirds, spatiotemporal migration schedules and migratory connectivity remain poorly understood. We mapped migration during the winter of one of the smallest Afro-Palaearctic migrants, the willow warbler...

Both common and pallid swifts perform long-distance migrations toward wintering quarters in sub-Saharan Africa and spend most of their time on the wing (Lack 1951, Cramp 1998, Åkesson et al. 2012, 2016, Liechti et al. 2013). However, the geographical distribution of the two species markedly differs: the common swift has a wide breeding range including Europe up to 70°N, most of Asia and northern Africa, while the breeding range of the pallid swift is limited to the Mediterranean basin (Cramp 1998). ...

However, the geographical distribution of the two species markedly differs: the common swift has a wide breeding range including Europe up to 70°N, most of Asia and northern Africa, while the breeding range of the pallid swift is limited to the Mediterranean basin (Cramp 1998). Migration distances also markedly differ between species: common swifts migrate from the south-eastern extreme of Africa in mid-winter (Åkesson et al. 2012, Åkesson et al. 2016, Hedenström et al. 2016), while pallid swifts are traditionally believed to winter in the Sahel region (Cramp 1998), as confirmed also by preliminary migratory data from geolocation (SEO/Birdlife 2017). Overall, we used data from eleven common and three pallid swift colonies (Fig. 1) located either in historical 'swift towers', which provide easy access to the nests (colonies 1, 2, 12 in Fig. 1) or in other buildings. ...

Effect of light-level geolocators on apparent survival of two highly aerial swift species

Full-text available

7 · [J Avian Biol](#)

Stefano Morganti · Diego Rubolini · Susanne Åkesson · Ana Bermejo · Ambrosini

Light-level geolocators are currently widely used to track the migration of small-sized birds, but their potential detrimental effects on survival of highly aerial species have been poorly investigated. We recorded capture-recapture histories of 283 common swifts *Apus apus* and 107 pallid swifts...

Based on the data collected so far, our repeatedly tracked swifts were consistent in the number of stopovers. Swifts are said to combine a 'fly-and-forage' strategy with stopovers, similar to the osprey (Strandberg and Alerstam 2007, Åkesson et al. 2012, Vardanis et al. 2013). This mixed strategy makes them potentially less dependent on specific stopover sites in general (like pelagic seabirds, Dias et al. 2013) and thus probably less vulnerable to unpredictable weather conditions and limited food supply (but see Åkesson et al. 2016). ...

Do you know your procedure as last year?" - Repeatedly tracked swifts show individual consistency in their pattern in successive years

7 · [J Avian Biol](#)

J. Wellbrock · C. Bauch · J. Rozman · K. Witte

al migration pattern during non-breeding season is still a black box in many migratory birds. r, knowledge on both individual level and population level in migration and overwintering is ...

ch questions require research to clarify the Turtle-dove migration system and to top appropriate conservation strategies. New technologies, such as light-level detectors (e.g.Bächler et al., 2010;Catry et al., 2011; Akesson et al., 2012; Bairlein et al., ;Kristensen et al., 2013) and satellite tracking [Geo Location Sensor (GLS),Eraud et al., ;López-López, 2016;Lormee et al., 2016]], are now used for tracking Afro ...

European Turtle-Dove *Streptopelia turtur* Northwest Africa: A Review of Current Knowledge and Priorities for Future Research

7 · ARDEOLA

Hanane

Over the past decades, a general decline in Palearctic-African migrant birds has been recorded over most areas of the Palearctic. The European Turtle-dove *Streptopelia turtur* has undergone a rapid and serious decline across its European range, to the extent that it was categorised as Vulnerabl...

The migration rate of White-crested *Elaenia* was high, in the range of rates reported for fastest migrants studied[52], for example Purple Martins (*Progne subis*; >150 km/day[54]), European Hoopoes (*Upupa epops epops*; >81 km/day[55]), Northern Black Storks (*Cypseloides niger borealis*; 341 km/day[56]), Red-backed Shrikes (*Lanius corullio*; 100 km/day[27]), Northern Wheatears (*Oenanthe oenanthe*; 88–160 km/day[57,58]). The strategies used by White-crested *Elaenia* to cross deserts and grassland regions during fall migration was similar to that reported for species that cross the Gulf of Mexico, temperate or desert regions of Africa[27,30,59, 60] . Our results showed that some individuals use a direct route, flying between 500–600 km/day to cross the desert and grasslands, while others take a detour, flying 100–200 km/day through areas with potentially better refueling opportunities. ...

Migration timing, rate, routes and wintering areas of White-crested *Elaenia* (*Elaenia albiceps*), a key seed disperser for Patagonian Forest regeneration

[Full-text available](#)

7 · PLOS ONE

by Patricia Bravo ·  Victor Rodolfo Cueto · Cristian Andrés Gorosito

Migratory animals often play key ecological roles within the communities they visit throughout their journeys. As a consequence of the links between biomes mediated by migrants, changes in their behavior could affect remote areas in unpredictable ways. Migratory routes and timing of most...

ch questions require research to clarify the Turtle-dove migration system and to top appropriate conservation strategies. New technologies, such as light-level detectors (e.g.Bächler et al., 2010;Catry et al., 2011; Akesson et al., 2012; Bairlein et al., ;Kristensen et al., 2013) and satellite tracking [Geo Location Sensor (GLS),Eraud et al., ;López-López, 2016;Lormee et al., 2016]], are now used for tracking Afro ...

European Turtle-Dove *Streptopelia turtur* in Northwest Africa: A Review of Current Knowledge and Priorities for Future Research

[Full-text available](#)

7 · ARDEOLA

Hanane

Over the past decades, a general decline in Palearctic-African migrant birds has been recorded over

as of the Palearctic. The European Turtle-dove *Streptopelia turtur* has undergone a rapid

Show more

to 30 million figures

[Join for free](#)

hGate to access over 30 million figures and 118+ million publications – all in one place.



About

[News](#)
[Company](#)
[Careers](#)

Support

[Help](#)
[center](#)
[FAQ](#)

Business solutions

[Recruiting](#)
[Advertising](#)