Appendix 1 for J. Rabøl 2023: Displacement experiments in night migrating passerines. – Dansk Orn. Foren. Tidsskr. 117: 37-46.

Does the magnetic declination acts as an E/W navigational parameter? Funnel experiments with nocturnal migrant passerines on Christiansø, Denmark, autumn 2016 and spring 2017

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(*Med et dansk resumé: Indgår misvisningen som en Ø/V-navigations-komponent i nattrækkende småfugles orienterings-system?*)

Abstract Using a biological clock as basis for E/W-navigation seems difficult or even impossible for a 1st year migratory bird – in particular in the final stage of spring migration when the task (presumably) would be to locate the imprinted position of the site left the previous year eight to ten months earlier at the start of the autumn migration. Therefore, the magnetic declination is an obvious candidate for an E/W gradient in a navigation system, which of course may be used in autumn too by a migrant bird progressing in a goal area navigation system. Two autumn experiments and a single spring experiment were carried out using funnels placed within deflected magnetic fields: one group experienced a declination of -9º and another group +15º (the magnetic declination on Christiansø is +3º). In spring, rather clear evidence for compensatory orientation was observed; in autumn no tendency. So perhaps, the magnetic declination in spring was used as an E/W navigational parameter.

Introduction

It is an open question whether the progress of the migration in juvenile birds is steered by a vector orientation (clock and compass) or a gradient/coordinate navigation system. The large majority of scientists believe in the first system partly because of confidence in experimental results but also because it is considered impossible for a bird to navigate towards a so called ‘unknown’ position. However, ‘unknown’ is not necessarily the same as ‘a position not previously visited’, and that makes a whole lot of difference.

It is well known that adult birds – and in particular the males – return to the same site for breeding year after year (e.g. Ouwehand *et al.* 2016). However, second calendar year birds are much less inclined to return to the site where they hatched. Apparently, when reaching independence of their parents they disperse and establish new home-sites where they probably imprint the position for return (for breeding) next spring. The imprinting parameters are not known but N/S-related (latitudinally) cues are easily envisioned (e.g. altitude of the Polaris star, angle of the ascending/descending sun, the magnetic inclination and/or intensity). E/W-related (longitudinally) cues are much more difficult to imagine if not – as used by humans – very accurate clocks are involved. However, biological clocks functioning with sufficient precision for longer time than a few months (or even a few weeks) are not easy to imagine and accept. Therefore, the magnetic declination is an obvious candidate as an E/W navigational parameter (Fig.83 in Rabøl 1988, Kishkinev *et al.* 2013).

Here I report on three experimental series shifting the declination both W and E. In spring 2017, but not in autumn 2016 some evidence for magnetic declination navigation was found.

Material and methods

Magnetic field and test procedure

Funnel experiments were carried out on Christiansø (55ºN, 15ºE) in the Baltic Sea with birds trapped as grounded migrants on the island in autumn 2016 and spring 2017. The birds were tested within magnetic coil fields (for a description see Rabøl 2010, 2014) the horizontal component of which was turned 20º clockwise (four fields) or 20º counter-clockwise (another four fields) in reference to magnetic N (mN) of the local magnetic field. The intensity of the coil fields could be manipulated within two rather narrow ranges cantered around: 1) square-root two times the intensity of the horizontal vector component of the natural magnetic field in Denmark, or 2) two times the intensity of the vertical vector component of the natural magnetic field. The reason for this basic set ups were: 1) If the horizontal component of the coil field was directed 135º clock- or counter-clockwise in reference to magnetic N of the natural magnetic field the resultant horizontal component would be directed towards magnetic E or magnetic W with the same intensity and inclination as the horizontal component of the natural magnetic field. 2) If such a vector is added vertically pointing upwards the resultant magnetic field will be inverted but otherwise unchanged, compared with the natural magnetic field (same intensity and inclination). Set up 1) was used for compass conflict experiments and testing for use of a magnetic polarity compass (Rabøl 2010, 2019, Appendix 3 in Rabøl 2022), while set up 2) was used for testing the inclination compass hypothesis (Rabøl *et al.* 2002, Appendix 2 in Rabøl 2022).

If a horizontal component of square-root two times the horizontal component of the natural magnetic field is added 20º to the right of natural mN the resultant horizontal vector will be directed 11.73º to the right of natural mN and the intensity will be 2.38 times stronger than the natural horizontal component. Added to the (unchanged) natural vertical component the resultant magnetic field will then attend an inclination of +49.16º (the natural inclination is +70º) and an intensity 1.24 stronger than the natural intensity. As the magnetic declination in Denmark (temporarily) is +3º, this means that the resulting mN points about 15º to the right of geographic N (gN). If the horizontal coil field component instead is directed 20º to the left resulting mN points about 9º to the left of gN. In this way geographical displacements were simulated E-wards (declination +15º) or W-wards (declination -9º) and the research hypothesis was compensatory orientation towards 'W' or 'E', respectively.

The control funnels were oriented in a way where a mark inside the funnel was pointing N (mN, but the small difference between gN and mN is in this context considered unimportant). However, when placed within a coil field the mark is oriented towards coil N which in the present case is 20º to the right or left of mN, respectively. This means that in case of the E-funnels the mean orientation recorded is 23º to the right of gN. If the orientation is recorded as e.g. 45º we have to subtract 23º ending up with an orientation directed towards 22º in reference to gN. In case of the W-funnels 17º has to be added to the direction in reference to coil N in order to express the direction in reference to gN.

Autumn 2016, Africa-migrants

Experiments were carried out with Common Redstarts *Phoenicurus phoenicurus* (25 juv., 1 ad.), European Pied Flycatchers *Ficedula hypoleuca* (11 juv., 3 ad.), and Garden Warblers *Sylvia borin* (4 juv.) on four nights 30 August, 5, 6, and 7 September. These three species were considered interchangeable as their migratory routes at least in Europe and the timing of the progress is more or less identical.

The birds were trapped in the morning hours of the same date as tested during night or one or two days before as grounded migrants on the island. The birds were caged in plastic baskets in a garden in the middle of the island covered in daytime with a plywood plate to protection against the sun and rain, and Eurasian Sparrowhawks *Accipiter nisus*.

Before tests in the funnels the birds were placed in plastic baskets on the experimental site before sunset to experience and couple the sunset/stellar sky and the magnetic field before the transference to the funnels two hours after sunset. The test time was about 1.5 hours with full access to the stellar sky and the magnetic field.

Sometimes, it was not possible to use the optimal set up, i.e. eight controls, four experimentals in E-funnels, and four experimentals in W-funnels). The number tested were 8, 4, and 4, respectively (30 August), 0, 4, 4 (5 September), 4, 4, 4 (6 September), and 0, 4, 4 (7 September), i.e. a total of 12 controls, 16 W-experimentals, and 16 E-experimentals.

Autumn 2016, medium-distance migrants

Experiments were carried out with 50 (34 juv.,16 ad.) European Robins *Erithacus rubecula* on five nights (22, 24, 25, 26, and 27 September) under conditions as outlined above. The number of birds tested were 0, 4, 4 (22 September), 0, 3, 3 (24 September), 4, 4, 4 (25 September), 4, 4, 4 (26 September), and 4, 4, 4 (27 September), i.e. a total of 12 controls, 19 W-experimentals and 19 E-experimentals. All birds on the first two dates were adults, whereas the rest were juveniles except single adults among both E- and W-experimentals on 26 September.

Spring 2017, Africa migrants

Experiments were carried out 20 May (4 Garden Warblers and 4 Redstarts), 22 May (6 Garden Warblers and 2 Redstarts), 24 May (6 Garden Warblers and 2 Redstarts), and 26 May (8 Garden Warblers). No controls were included. Numbers in W- and E-funnels were 16 in both.

The procedure was partly as already described except that the birds also spent one full night under a starry sky in the resultant magnetic field before tested in the funnels on the following starry night as described above. On the last three days, the birds spent the intervening daytime in the resultant magnetic fields on the test-site covered with a plywood plate. However, on the first date the daytime was spent in leeway in covered baskets on the test outside the magnetic coil fields because of rainy and windy weather. The prolonged time within the deflected fields should increase the possibility of detecting the discrepancy between gN and resultant mN and thus the magnetic declination.

Results

Autumn 2016, Africa-migrants

The controls were bimodally oriented 345º/165º – 0.275 (N = 6) (Fig. 1). The E-experimentals oriented 295º – 0.341 (N = 16), and the W-experimentals 43º – 0.242 (N = 16). Applying a Mardia-Wheeler-Watson test the two samples were not significantly different (0.10 < P < 0.20). The three adult birds oriented 257º (E-experimental) and 7º and 242º (W-experimentals). All differences were insignificant, but one should notice the westerly component in the E-experimentals and the easterly in the W-experimentals. Summing all the three samples the combined sample mean vector was calculated as 336º – 0.15 (N = 43). Hence, it appears that all birds/samples were disoriented.

Autumn 2016, medium-distance migrants

The Robins showed nothing like a response of compensation for displacements in declination (Fig. 2). The sample mean vector of the controls was 236º – 0.422 (N = 6), and of the E- and W-experimentals 258º – 0.104 (N = 16) and 252º – 0.543 (N = 13, P < 0.05), respectively. The sum of all three groups lead to 249º – 0.312 (N = 35, P < 0.05), which is significant and close to the standard direction (about SSW-SW; Rabøl 1981).

Both controls and W-experimentals look bimodally oriented. Doubling the angles leads to 234º/(54º) – 0.472 (N = 7) in the controls, and 274º/(94º) – 0.513 (N = 16, P < 0.05) in the W-experimentals.

In the experiments, no significant differences were found between adults and juveniles. Both distributions look bimodal and doubling the angles leads to 275º/(95º) – 0.430 (N = 15) in the adults and 279º/(99º) – 0.219 (N = 16) in the juveniles. It appears that both adults and juveniles were disoriented.

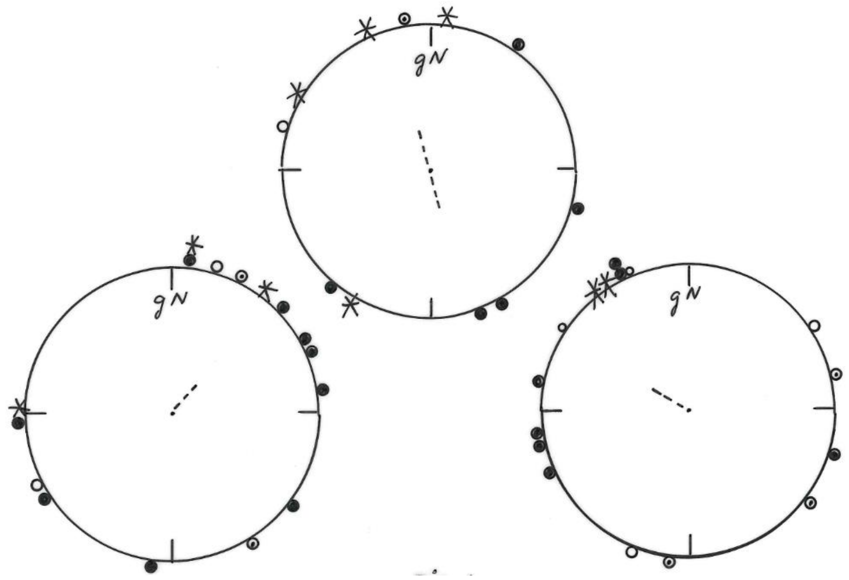

Fig. 1. Africa-migrants autumn 2016. The upper/middle distribution shows the controls tested in the unchanged, local magnetic field. The orientation looks mildly bimodal with peaks in about NNW and SSE. The distribution in the lower left shows the experimentals 'displaced' towards W to a declination of -9º. There is an insignificant tendency to NE-orientation. The distribution in the lower right shows the experimentals 'displaced' towards E to a declination of +15º. There is an insignificant tendency to WNW-NW orientation. The difference between the two lower distributions is not significant (Mardia-Wheeler-Watson test, 0.10 < P < 0.20).
Afrika-trækkere, efteråret 2016. Kontrollerne testet i det normale magnetfelt er vist i midten for oven. Orienteringen ser tilfældig ud; den svagt to-toppede fordeling er langt fra signifikant. Nederst til venstre ses orienteringen af fugle testet under en negativ, vest-forskudt misvisning. Til højre fugle testet under en positiv, øst-forskudt misvisning. Måske reagerer fuglene kompensatorisk på ændringerne i misvisning, men det er ikke signifikant og det nordlige islæt er uventet.

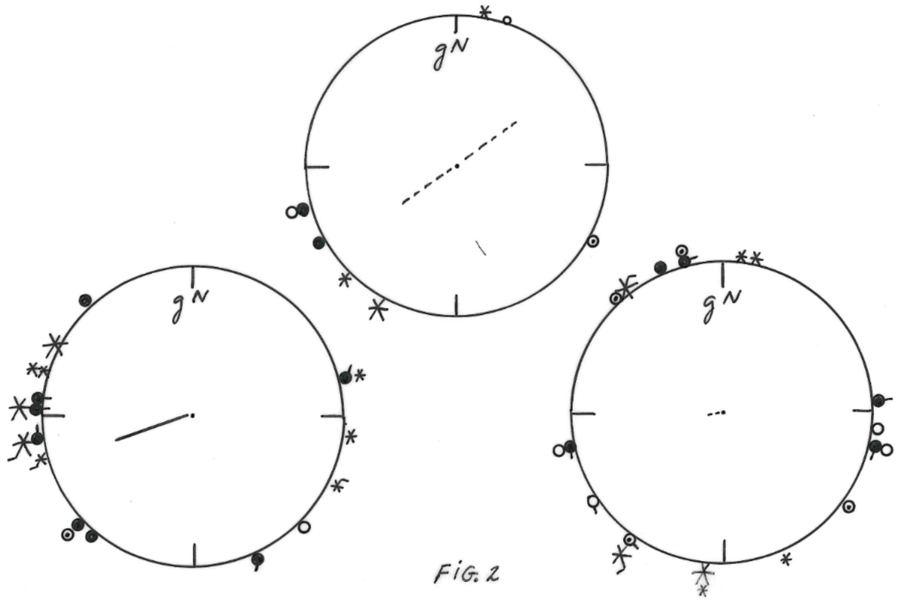

Fig. 2. European Robins autumn 2016. The upper distribution shows the controls and looks a little bimodal SW/(NE). The lower distributions to the left and right show the W- and E-experimentals, respectively. The significant ($P < 0.05$) orientation towards WSW in the former should be noted. If using the declination as a navigational parameter, the orientation in the lower left should had been easterly. A mark on the dots or crosses means an adult bird.
Rødhalse, efteråret 2016. Kontrollerne testet i det naturlige magnetfelt er vist øverst i midten. Det viser en ikkesignifikant tendens til normalorientering mod SV. Nederst til venstre ses orienteringen af fugle testet under en negativ, vest-forskudt misvisning. Til højre fugle testet under en positiv, øst-forskudt misvisning. De vest-forskudte fugle reagerer noget uventet med en signifikant vest-rettet orientering, medens de øst-forskudte fugle var uorienterede.

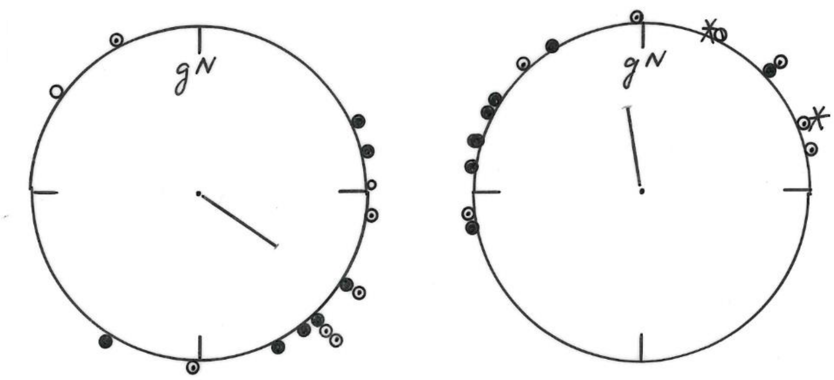

Fig. 3. Africa-migrants spring 2017. The left distribution shows the W-experimentals and the right distribution the E-experimentals. Both mean vectors are statistically significant, and the difference between the distributions is statistically significant ($0.01 < P < 0.02$).
Afrika-trækkere, foråret 2017. Til venstre ses orienteringen af fugle testet under en negativ, vest-forskudt misvisning. Til højre fugle testet under en positiv, øst-forskudt misvisning. Forskellen mellem de vest- og øst-forskudte fugle er statistisk signifikant og går i den forventede retning. Så sandsynligvis reagerer fuglene kompensatorisk på ændringerne i misvisning, men det henholdsvis noget sydlige (W) og (for) nordlige (E) islæt var uventet.

Spring 2017, Africa-migrants

Unfortunately, there were no controls. However, the difference between the E- and W-experimentals (Fig. 3) was clearly significant ($0.01 < P < 0.02$, Mardia-Wheeler-Watson two sample test). In reference to gN, the sample mean vector of the E-experimentals was 347º – 0.500 (N = 16, $P < 0.05$), and the W-experimentals 125º – 0.557 (N = 15, $P < 0.01$). The difference between the E- and the W-experimentals was in the direction expected if the magnetic declination was involved as an E/W navigatory coordinate. However, the orientation of the W-experimentals was surprisingly southerly, and there were ‘too many’ E-oriented birds in the E-experimentals. Probably, compensatory orientation in reference to the arrival winds on Christiansø are involved. In the start of the period easterly winds prevailed. Later on, the winds shifted to westerly, and the general orientation shifted from more east in the start to more west at last. Here, it looks like the declination acts as an E/W-coordinate.

Discussion

The Christiansø experiments

Clearly, the experimental results of the Christiansø-experiments in autumn 2016 are not or only weakly supporting the hypothesis of E/W-navigation based on the declination. In particular the Robins (Fig. 2) – also the adult birds – show no tendency of declination-based navigation. In the Africa-migrants (Fig. 1) there is an insignificant tendency to easterly orientation in the W-experimentals and westerly orientation in the E-experimentals, which could be considered as a weak support for the hypothesis in charge. However, the northerly component should be noted – also in the controls – making the interpretation of the results further complicated.

In spring 2017 (Fig. 3) no control birds were tested, but the orientation of the E- and W-experimentals was significantly different in the direction expected if the declination was used as an E/W navigatory parameter.

The results could be interpreted in such a way that perhaps the birds sometimes use the declination as an E/W navigatory parameter, but further experiments are needed. The number of control birds were for various reasons too low or even lacking (I was sick), but if the declination is influential, one should expect strong reactions on the simulated values. A declination of -9º corresponds to a displacement to a longitude between the Faroes and Iceland, and +15º to a longitude of about the Ural Mountains (according to Fig. 2 in Chernetsov *et al.* 2017).

Perhaps the resultant magnetic field used (inclination 49º and intensity 24% above normal) was not suitable for compass orientation and/or navigation in response to a change in the declination (no-one really knows). Based on the ancient results of European Robins and Garden Warblers tested in Frankfurt cages, Wiltschko (1968, 1974) estimated that the intensity of the magnetic field should not be increased or decreased more than 20-30% for normal compass orientation to arise – for birds caged in the normal magnetic intensity until transferred to the funnels[1] in the changed magnetic field. However, according to W. Wiltschko the birds may adapt after a few days to much stronger or weaker magnetic intensities. Anyway, Wiltschko *et al.* (2006) and Winklhofer *et al.* (2013) brought recent evidence that birds may adapt much faster to changed intensities than earlier considered. In this connection one should recall that the spring birds in the present experiments spent more than one day and night in the resultant magnetic field before tested in the funnels. Therefore, the resultant magnetic intensities and inclinations are not considered to be an obstacle for the experiments carried out.

Chernetsov et al. *(2017)*

Chernetsov *et al.* (2017) considered simulated displacement of juvenile and adult Common Reed Warblers trapped on migration in autumn. The birds were 'displaced' from Rybashy, Kaliningrad in Russia (declination +5.5º) to about Dundee in Scotland and a magnetic declination of -3º.

The adult birds shifted the orientation from WSW to ESE, whereas the SW-orientation of the juveniles on the declination of Rybashy (at least apparently) shifted to random at the simulated position in Scotland. Clearly, the ESE-orientation of the adults is not directed towards the wintering area in Western Africa but could be considered as navigation towards a goal-area on the migratory route somewhere in Germany – or as navigation back towards Rybashy.

However, one may wonder why the juveniles were not displaying unchanged SW-orientation after the simulated displacement. Chernetsov *et al.* offered an 'explanation': the juveniles were confused because they never before had experienced a negative declination. I wonder: why confused, because according to Chernetsov *et al.* (2017) juveniles are only able to perform vector orientation, where magnetic N and/or stellar N are used as compass references. A more reasonable explanation could be that the 'confusion'/randomness of the sample appears because the individual birds try to navigate using the declination but with much variance between individuals. Chernetsov *et al.* (2017) also speculated that the juveniles were confused because of "a combination of negative declination values, suggesting Iberian Peninsula or West Africa, and steep inclination and high total intensity suggesting northern-central Europe." However, there is no logic in their argumentation – if the juveniles (as Chernetsov *et al.* believe) are only equipped with a vector-orientation programme.

Anyway, the orientation of the juveniles looks marginally bimodal SSE-S/NNW-N i.e. in about right angles to the Rybashy orientation, and one has to consider the possibility of a heterogeneous response among the individuals in the sample. Perhaps, the 'random' orientation is a mixture between compass orientation in the standard direction (SW) plus a navigatory response back towards Rybashy (about E). I simulated a half/half scenario with two subsamples of each 12 individuals and

[1] This 20-30% 'rule' was estimated for birds tested in octagonal Frankfurt cages with eight radial perches, and no one including the Wiltschkos (?) knows whether the 'rule' could be translated without modifications to Emlen funnels.

a concentration of 0.69. If the two subsample mean directions were 240º and 90º, respectively, the sample mean vector 169º – 0.19 has to be considered random.

The question also is how the results of Chernetsov *et al.* (2017) should be understood in connection with Kishkinev *et al* (2013) where trigeminal nerve-sectioned Reed Warblers (spring) were 'displaced' from Rybashy about 1000 km towards east to Zvenigorod in Moscow Oblast, Russia. Contrary to non-operated birds these birds did not compensate the 'displacement', i.e. their orientation remained unchanged NE. The conclusion is that the declination was used as an E/W-navigatory parameter – but how does this connect to the adult Common Reed Warblers of Chernetsov *et al.* (2017) who – if navigating – are supposed to use a retina-based magnetic compass. Do Reed Warblers have two kind of magnetic navigation systems, and was the magnetic response used by the warblers of Chernetsov *et al.* (2017) mediated through *Nervus trigeminus*?

Chernetsov et al. *(2020)*

Chernetsov *et al.* (2020) recently published another paper concerning shift in magnetic declination during autumn. Adult European Robins and Garden Warblers together with juvenile Robins were trapped and tested at Rybachy under the same conditions as formerly the Reed Warblers (Chernetsov *et al.* 2017), i.e. the experimentals were 'displaced' magnetically 8.5º towards W to a position about Dundee in Scotland. Contrary to the adult Reed Warblers none of the three groups showed any tendency of compensation for the 'displacement'. All groups oriented significantly. The adult Robins oriented WNW and W in the controls and experimentals, respectively. The corresponding figures in the juvenile Robins and adult Garden Warblers were WSW and SW, and SSW and SSW, respectively. In conclusion, the experimentals showed no sign of a shift in migratory orientation to the shift in magnetic declination. As already mentioned, experiments in spring should be recommended. It seems like the system has maximal possibility for a positive response during the final stage of the spring migration (navigation towards an imprinted home-area).

Final considerations

In order to be a 'good' navigational parameter, the magnetic declination should be 'sensitive', i.e. shifts of 1º of declination should be (relative) short in distance/kilometres compared with potential 'competitors' such as the rotational phase of the stellar sky. According to the map in Rabøl (1988, Fig. 63) the declination in our region of the world (some years ago) shifted from about -10º in Scotland to +20º on the same latitude as the longitude of Novaya Zemlya. This is 30º compared with 65º in the stellar rotational phase. So, the declination is not an outstanding 'sensitive' navigational parameter. According to Chernetsov *et al.* (2017) the difference in declination between Rybashy and Dundee (the simulated position) is 8.5º. However, the difference in longitude (24º) is about three times larger. Of course, such calculations do not necessarily invalidate the magnetic declination as a navigational parameter.

Rabøl (1997) refers to a funnel-experiment in spring in the Steno Planetary, Aarhus, Denmark. A sample of Pied Flycatchers and Redstarts were tested first under the contemporary rotating 'stellar' sky of Aarhus (55ºN/10Eº) and displayed significant NNE-NE orientation. Then a stellar displacement to 70ºN/10ºE was simulated, and the birds showed a bimodal response with the major peak in about SE-SSE and a smaller peak in about N. Afterwards displacements to the 'stellar sky' positions 70ºN/60ºE and 55ºN/60ºE were simulated. In both cases the sample mean vector was significant and directed towards NE/ENE and ENE/E, respectively. Clearly, the two last orientations were disappointing, if stellar-based navigation was the expected outcome (it was!). However, the easterly orientation could be understood as a response to a declination of -11º (mN was 11º to the left of rotational/stellar N of the planetary 'stellar' sky).

Summing up, navigation based on the magnetic declination seems a serious possibility. Anyway, we need many more tests. Most scientists have a strong belief in magnetic compass orientation and magnetic navigation. However, I have my personal idiosyncrasies against everything magnetic. I am a disbeliever in magnetism, because almost everyone heralds magnetism in an uncritical way and on weak grounds rooted in opportunism and tribe-behaviour.

Acknowledgements

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Resumé

Indgår misvisningen som en Ø/V-navigations-komponent i trækfugles orienterings-system?

Chernetsov *et al.* (2017) simulerede en forflytning af unge og voksne Rørsangere om efteråret fra Rybashi (tæt på Kaliningrad ved Østersøen) til Dundee i Skotland. Simuleringen gik ud på ved hjælp af et kunstigt magnetfelt i Rybashi at ændre misvisningen, så den svarede til, hvad den er i Dundee.

Misvisningen er defineret som vinkelforskellen mellem retningerne mod geografisk N og magnetisk N. Hvis sidstnævnte ligger til højre angives vinkelforskellen med et plus. Ligger den til venstre – som i Dundee – angives vinkelforskellen med et minus. I Rybashi ligger magnetisk N til højre for geografisk N, og her er misvisningen positiv.

Man kunne nu tro, at magnetisk N et givet sted på Jorden altid peger mod den magnetiske nordpol (dvs. følger storcirkelkursen/orthodromen), men det gør den ikke nødvendigvis. Den magnetiske nordpol angiver positionen af det sted, hvor de magnetiske kraftlinier dykker lodret ned i jorden.

Stedet flytter sig noget igennem årene og befinder sig i øjeblikket vest om Ellesmere i Nordøstcanada på langsom vandring mod Sibirien bag om den geografiske nordpol. Da Jordens magnetfelt er komplekst og består af flere interagerende felter, der befinder sig dybt nede i Jorden, er det ikke sådan, at den direkte retning (orthodromen) fra fx Rybashi til den magnetiske nordpol er helt identisk med den retning, som en kompasnål i Rybashi peger mod. Faktisk forløber orthodromen (storcirkelretningen) fra Rybashi til den magnetiske nordpol lidt til venstre for den geografiske nordpol.

Ved Rybashi var både unge og voksne Rørsangere signifikant SV-VSV-orienterede, når de blev testet i tragte i det normale magnetfelt og under stjernehimlen. Ved Rybashi var misvisningen på forsøgstidspunktet +5,5º. Man ændrede nu misvisningen til -3º – svarende til Dundee – uden at ændre den magnetiske intensitet og inklination (hældning).

I ’Dundee’ var de voksne fugle signifikant ØSØ-orienterede, medens ungfuglene – i hvert fald i følge Chernetsov *et al.* (2017) – var desorienterede. De voksne fugle kompenserede altså for ’forflytningen’, hvad der kunne tyde på, at de brugte misvisningen som en Ø/V-navigationskomponent. Russerne havde ’gode’ forklaringer på de unge fugles disorientering, men for mig er det tvivlsomt snak, der ikke matcher russernes tro på, at ungfuglene er genetisk udstyrede med et vektororienterings-system og således ikke navigerer frem mod et vandrende målområde på trækruten. Ungfuglene burde derfor ikke – som foreslået af Chernetsov *et al.* – lade sig påvirke af 1) den ændrede misvisning og 2) den unaturlige kombination af den magnetiske misvisning, intetsitet og inklination svarende til en position i Spanien. Hvis ungfuglene kun kan kompasorientere (svarende til udfaldet af et vektororienteringssystem) burde deres orientering i ’Dundee’ have været uændret i forhold til Rybashi-orienteringen.

Nok om det; det var et spændende forsøg, og der skal nu nye forsøg til, der kan belyse, om Chernetsov *et al.*’s resultater og konklusioner kan generaliseres. Jeg havde egentlig indstillet mine magnetforsøg på Christiansø i efteråret 2014, men gik så i gang igen i efteråret 2016 og foråret 2017.

Ved hjælp af mine kunstige magnetfelter ændrede jeg – i fire felter – den resulterende misvisning til -9º, og i fire andre felter til +15º. Det simulerede nogle gevaldige geografiske ’forflytninger’ henholdsvis vestpå til mellem Færøerne og Island, og østpå til Uralbjergene.

I efteråret 2016 ’forflyttede’ jeg først Afrika-trækkere (Rødstjert, Havesanger, Broget Fluesnapper) og senere Rødhalse. Hos Afrika-trækkerne ser kontrollerne desorienterede ud, og tendensen til normalorientering hos Rødhalsen er ikke signifikant. Hos Afrika-trækkerne ses de forventede Ø- og V-rettede orienteringer for ’forflytningerne’ hhv. mod vest og øst, men de har nordligt islæt og er slet ikke signifikante (Fig. 1). Hos Rødhalsene går det helt galt: de vest-’forflyttede’ fugle viser signifikant V-orientering (Fig. 2)!

I foråret 2017 ser det meget bedre ud for Afrika-trækkerne (Fig. 3). Der er beklageligvis ingen kontroller (jeg var for svækket efter sygdom til en fuld arbejdsindsats), men ’forflytningerne’ mod

V viser signifikant Ø-orientering (dog overraskende sydlig) og 'forflytningerne' mod Ø mere V- end Ø-orientering (den er dog overraskende nordlig). Jeg er derfor lidt forsigtig med at konkludere misvisningsbestemt Ø/V-navigation, men det er tæt på at ligne. Måske var det udslagsgivende, at fuglene – i modsætning til i efterårsforsøgene – stod i deres bure i de ændrede magnetfelter hele den foregående aften og nat, inden de blev tragttestede den følgende nat.

Misvisningsnavigation er mest forventeligt om foråret, når fuglene skal finde tilbage til yngleområdet, eller – for ungfuglenes vedkommende – til det område sidste efterår, hvorfra de startede deres efterårstræk (formentlig mestendels indenfor 100 km fra, hvor de blev ruget ud). Unge trækfugle – der trækker uden voksenassistance – indprenter sig formentlig en masse stedkarakteristiske 'ting', såsom landskabet, dufte, lyde, magnetfelt, sol- og stjernehimmel, inden de starter efterårstrækket. Medens der er flere mulige navigationskomponenter associeret med breddegraden, er det svært at finde andet end misvisningen associeret med længdegraden – medmindre man vil involvere meget stabile og langtidsvirkende indre ure, der forekommer selv optimistiske forskere (såsom mig) næsten umulige, hvis urene stadig skal virke nøjagtigt 8-10 måneder efter starten.

Konklusionen er, at objektivt ser det lovende ud for misvisningen som en Ø/V-positions-parameter for hjemstedet. Men jeg har mine subjektive ideosynkrasier overfor alt magnetisk. Jeg mistror magnetismen, fordi alle andre hylder den ukritisk og ofte på spinkle grundlag, der er flok-funderede og opportunistiske mere end objektivt rimelige. Der skal laves nogle flere forsøg, men det bliver ikke af mig. I en alder af 78 år blev tragt-forsøg i september 2018 (se Appendiks 4) fra min side et overstået kapitel.

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