

Sunset/early night compass conflict experiments on Christiansø, autumn 2006

Introduction

These experiments were not considered in doc. Dron06b, www.jorgenrabol.dk which only treated the night experiments. Another reason – rendering the results less interesting - was the obvious spurious orientations influenced by the experimental set up. However, with the improvement of this set up in autumn 2007 the 2006 experiments attain more interest.

Together with the usual night experiments **sunset/early night testings in the funnels** with and without "windows" in the upper funnel sides were carried out in autumn 2006. Without "windows" has been our normal funnel set-up for many years and means that the lower about 10° of the sky is screened away as seen by the bird inside the funnel. Sunset/early night experiments are frequently carried out by other people (e.g. Sandberg et al. 2000), but usually not by us because we always suspected (and in fact also - in several unpublished experiments - experienced) a strong phototaxic influence of the sunset sky on the orientation. Such a spurious directional influence more or less masks/dominates for the interactions between the migratory compasses.

The purpose of the sunset/early night experiments was to investigate whether a sunset- or a magnetic compass was the calibrating/dominating compass. Another purpose also was to find out whether sunset-taxes could be avoided by low/no shielding.

Material and methods

The normal procedure (28 Sep. was the only exception, see later) for the **sunset/early night** experiments was to transfer the birds directly from the garden (where caged in the local, natural magnetic field and screened above for the sunny sky) into the funnels at about sunset time (i.e. there was no intermediary basket/cage stage on the test site), and then register the activity during the next about one hour. Otherwise the experimental set up and procedure were as described for the night experiments (docs. Dron06b and Conflict, www.jorgenrabol.dk), i.e. the birds were used only once and normally on the day of trapping (and arrival to the island).

In the sunset-experiments we both used normal funnels and four **funnels with windows**, i.e. in the upper 5 cm cylindrical part of the funnel we cut 8 rectangular windows (covered with cloth/mesh) 6 times 3 cm, and with 5.25 cm between the windows. A bird standing on the pad in the lower part of the funnel probably had a down to horizon view through the windows – or at least have if stretching its neck a little or fluttering up in the funnel.

As earlier described the orientation within the deflected magnetic fields is initially given in reference to paper-N (see Tab.1).

Results (and short discussions)

The results of the **sunset-experiments** are found in Tables 1 through 8, and Figs.1 through 4.

In short and unfortunately, **spurious** orientation was prominent: The (long axis of) the tree-frame housing the magnetic coil field influenced the orientation into a bimodal E/W way in reference to paper-N – in particular during sunset, but possibly also slightly so during night. Furthermore, there was a clear influence of a positive "sunset-taxis" in the sunset experiments.

On the average the orientation of the **controls** is directed into the sunset (Figs.1-2). However, on a single occasion (7 Sep.) the sample mean was directed ENE-E, and on another (12 Sep.) was observed dis-orientation/weakly bimodal E/W orientation.

For a superficial observation it looks like the orientation is strongly influenced by a positive phototaxis.

However, on two occasions the sunset cloud cover was 8/8 (on one of these, 28 Sep., there was a trace of blue sky in about 15 min.s a half hour before sunset), but on both occasions the orientations were towards the (at least for human eyes) invisible sunset (276° and 280°).

As remarked the birds were placed in the funnels around the time of the sunset. However, on 6 Sep. about 50 min.s later and in cloud cover 8/8 the orientation was still (though insignificantly so) westerly. On the next day the birds were placed in the funnels about 20 min.s before sunset, and in 7/8 and clear traces of the sunset position the orientation was easterly! On the whole there was a positive correlation between the degree of unimodal westerly orientation and the transfer time into the funnels ($r = 0.610$, NS), i.e. clear westerly orientation was found mostly in the late transfers – so the response is obviously not just a simple phototaxis. The two westerly orientations under an overcast sky add to the same interpretation.

In the **exp.s** there was a very clear bimodal "E"/"W" orientation (Fig.3) which obviously has nothing to do with the magnetic fields as it also was very clearly observed on 13 Sep. where the magnetic fields were switched off. Obviously, it is a spurious response influenced by the pattern of the tree-frame as seen by the bird in the funnel (Fig.4).

We also investigated for the influence of "**windows**" in the funnels, but there was absolutely no difference between orientation in normal funnels and window-funnels. Furthermore, no lessening of the "E"/"W" bimodality occurred when adding the two cross-bars (Fig.4).

Finally, we investigated for the position on the **magnetic table**. On each table the two funnels were about 1 meter apart from each other, and perhaps there was an attraction or

repulsion between neighbouring funnels. There was an insignificant tendency of attraction in the W-funnels, but no tendency at all in the E-funnels, so in conclusion there seems to be no such neighbour effects.

Surprisingly, there was no tendency for a positive sunset-taxis in the exp.s. In both W- and E-funnels "E" in reference to paper-N is the leg most directed into the sunset direction, but as observed on Fig.3 the amount of "E" and "W" orientation is about the same. In conclusion, in the exp.s the sunset orientation is (close to) 100% dominated by a spurious "E"/"W" response produced by an upward sight of the bilateral pattern of the tree-frames.

References

Sandberg, R., J. Bäckman, F.R. Moore & M. Lohmus 2000: Magnetic information calibrates celestial cues during migration. – *Anim. Beh.* 60: 453 – 462.

Controls: 310 b S/M, Z, 210 c S/M, dis S/M, 300 b S/M, 60 c S, 235 b M, dis M/L
W-exp.s: 75 b/275 b M, 90 a/(290 b) M/L, **85 a/265 a L**, **80 a/(265 a) L**
E-exp.s: 90 a M, 265 a/(90 a) L, **70 a VL**, **165 c S**

Tab.1: 6 September 2006. Sunset experiments. All birds were juv. Robins. The orientation/migratory activity of 8 controls and 8 exp.s. The mean orientation is given to nearest 5° (N = 0° = 360°). Sometimes the orientation is bi(tri)-modal, and minor peaks are denoted within brackets. a, b and c means high, medium and low concentration, respectively. The activity is labelled as zero (Z), very small (VS), small (S), medium (M), large (L) or very large (VL), respectively. The controls were caged and tested in the natural magnetic field, whereas the W-exp.s and E-exps. were caged and tested in a resultant magnetic field where magnetic N was deflected towards W or E, respectively. In the W- and E-exps. the directional reference is paper-N. In order to convert to geographical N or magnetic N 135° or 45°, respectively, have to be subtracted (W), or added (E), respectively. The sequence of the birds in this table and in the following tables in each category (always 4 or 8 birds) is first an odd number, then an equal number, followed by an even number and so on. The last two W-exp.s and two last E-exp.s were tested in window-funnels with a sight down to the horizon. **Fat** types mean tested in window-funnels, i.e. sight down to the horizon.

Controls: GW 70 b L, GW 340 c L, RS 30 b L, RS 130 a M, RS escaped, RS 110 c M/L, RS 65 b M/L, RS 170 b M/L
W-exp.s: GW 270 b M/L, RS 280 b/(100) c M, **GW 270 b VL**, **RS 300 b L/VL**
E-exp.s: GW dis S/M, RS 260 a L, **GW 90 c/270 c VL**, **RS 100 b/270 c L/VL**

Tab.2: 7 September 2006. Sunset experiments. GW and RS are Garden Warblers and Redstarts, respectively. All birds were juveniles. Text as Tab.1.

Controls: 275 a L, 280 a L, 255 b L, 280 b M/L, 5 b VL, 150 c M/L, 290 b VL, 260 a VL
W-exp.s: 265 a/(80 b) L, *95 a/270 b L*, **270 a VL**, **290 c VL**
E-exp.s: 270 a/(95 b) L, *270 a/(75 a) S/M*, **40 b L/VL**, **315 c VL**

Tab.3: 8 September 2006. Sunset experiments. All birds were juv. Robins. Text as Tab.1 except that the four birds in *italics* were tested under two cross-bars on top of the tree-frame (see Fig.4).

Controls: 345 a M/L, 270 a M/L, 355 b M, 300 a L, dis/120 c M, dis/180 c M/L, 345 b M, 195 b S
W-exp.s: 90 a L, *80 a M/L*, **250 a/(90 c) M/L**, **40 b/(270 c) M/L**
E-exp.s: 270 b/(105 b) M/L, *80 a/(260 b) M/L*, **70 a/(295 b) L**, **70 a L**

Tab.4: 9 September 2006. Sunset experiments. All birds were juv. Robins. Text as Tabs.1 and 3.

Controls: 260 b M, 100 b/240 b S/M, 300 a M, 185 a M/L, 285 a L/VL, 300 a M/L, 250 b/(100 b) M/L, 270 b L
W-exp.s: 275 a L, *360 a M/L*, **285 b M/L**, **260 b L**
E-exp.s: 110 a L, *95 a/(300 b) M/L*, **285 a/(70 b) L**, **85 a L**

Tab.5: 10 September 2006. Sunset experiments. All birds were juv. Robins. Text as Tabs.1 and 3.

Controls: RS dis VS, RS 270 a M/L, RS 340 c M, RS 240 b VS, RS 280 c S/M, GW 95 b/(240 c) M/L, RS 80 b S, GW 160 b/(300 b) M/L
W-exp.s: RS Z, *GW 120 b S/M*, **RS 260 a M**, **GW 80 c M/L**
E-exp.s: GW 90 a M, *RS 290 a/(45 b) M*, **GW 250 b M/L**, **RS 75 b S/M**

Tab.6: 12 September 2006. Sunset experiments. RS and GW mean Redstarts and Garden Warblers, respectively. All birds were juv. Text as Tabs.1 and 3.

Controls: GW 255 c/90 c M/L, GW 245 b S/M, PF 260 c M/L, PF 330 b M, RB 275 a L, RB 315 b M/L, RB 285 b M, BC 105 b/280 b S/M
W-exp.s: RB 75 a/(265 b) M/L, *GW 80 a M/L*, **RB 100 b/(240 c) L**, **RB 85 a/(280 a) L/VL**
E-exp.s: RB 290 a/(70 b) L, *GW 95 b/265 b S/M*, **RB 80 a VL**, **RB 290 a/(60 b) L/VL**

Tab.7: 13 September 2006. Sunset experiments. GW is Garden Warbler, PF Pied Flycatcher, RB Robin, and BC Blackcap, All birds were juv. The magnetic coil fields were not activated. This means that magnetic N = geographical N in the W- and E-exp.s. Text otherwise as Tabs.1 and 10.

Controls: 280 a L, 220 b/75 c M, 300 a L/VL, 300 a VL, dis M/L, 240 c/135 c M/L, 245 b M, 275 b S/M

W-exp.s: 90 b M, 275 b/110 c M/L, Z, 85 a M

E-exp.s: 100 a L, 110 a M, 270 a/60 b M/L, 75 c M/L

Tab.8: 28 September 2006. Sunset-experiments. All birds were juv. Robins. Overcast sky and testing postponed until start a half hour after sunset.

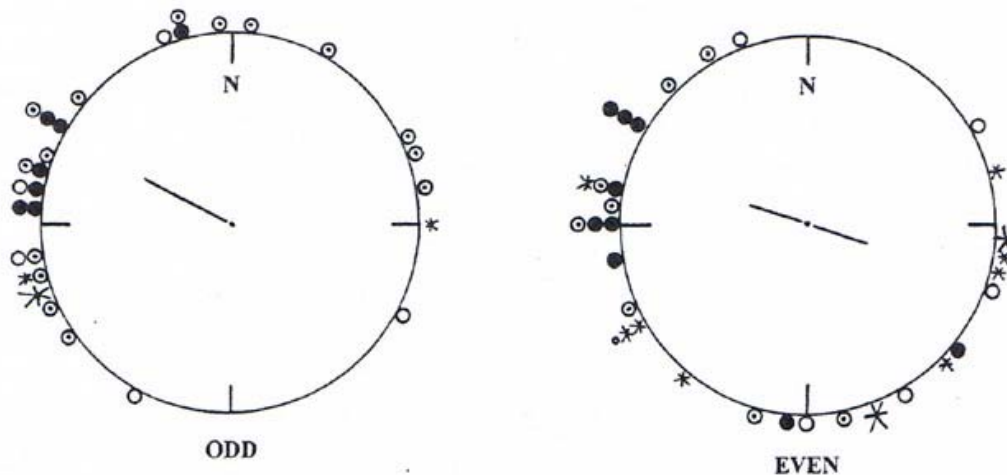


Fig.1. The **sunset**-orientation of all **controls** tested in the natural/normal magnetic field. In order to investigate the possible influence of position in the pair-wise funnels the **left** figure depicts the orientation of the birds in the **N**-funnels. The sample mean vector is $298^\circ - 0.524^{***}$ ($n = 28$). The **lower** figure depicts the orientation in the **S**-funnels. The sample mean vector is $251^\circ - 0.365^*$ ($n = 25$), or if doubling the angles $288^\circ/108^\circ - 0.330^*$ ($n = 29$). Both figures look bimodal with a major peak towards and a minor peak away from the sunset. Some indications of influence of funnel-position are also found ("N" in upper and "S" in lower figure).

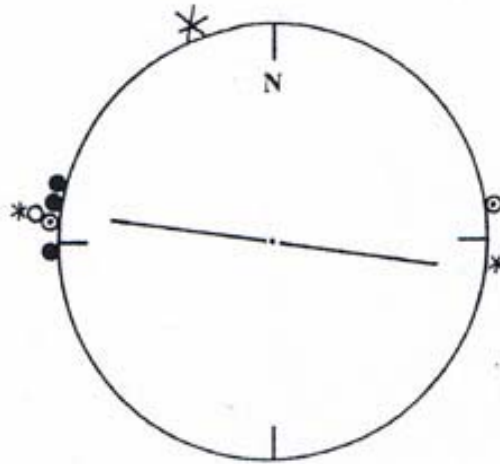


Fig.2. Same material as Fig.1, but now daily mean directions (or bimodal peaks after doubling the angles) are depicted. The grand mean vector is $291^\circ - 0.660^*$ ($n = 7$), or after doubling the angles $278^\circ/98^\circ - 0.773^{**}$ ($n = 8$). The sample mean vectors on the eight sunsets (sample size, and cloudiness in parentheses) are: $276^\circ - 0.419$ (5, 8/8), $81^\circ - 0.561$ (7, 7/8), $275^\circ - 0.661$ (8, 0/8), $339^\circ/(159^\circ) - 0.441$ (8, 0/8), $267^\circ - 0.817^{**}$ (7, 1/8), $96^\circ/276^\circ - 0.413$ (7, 0/8), $285^\circ - 0.872^{**}$ (6, 0/8), $280^\circ - 0.939^{**}$ (5, 8/8).

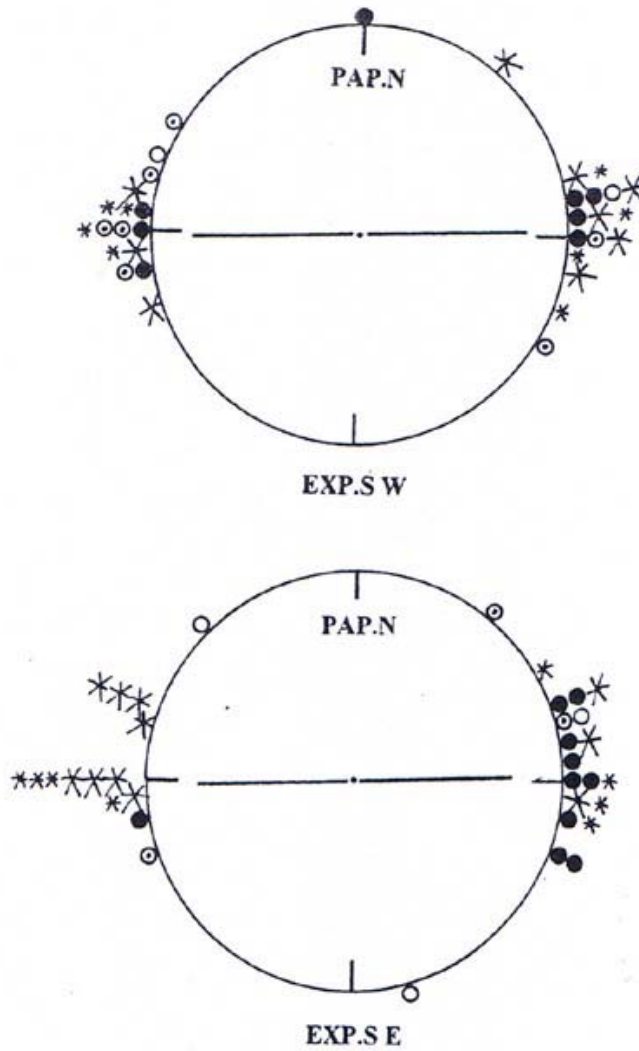


Fig.3. The sunset-orientation of all exp.s tested in the magnetic fields deflected towards **W** (upper figure) or **E** (lower figure). The reference direction, paper-N is towards geographically SW (upper figure), or towards geographically SE (lower figure). Both distributions display a very strong tendency for "E"/"W" orientation in reference to paper-N. After doubling the angles the upper orientation is $89^{\circ}/269^{\circ} - 0.811^{***}$ ($n = 30$), and the lower $89^{\circ}/269^{\circ} - 0.770^{***}$ ($n = 31$).

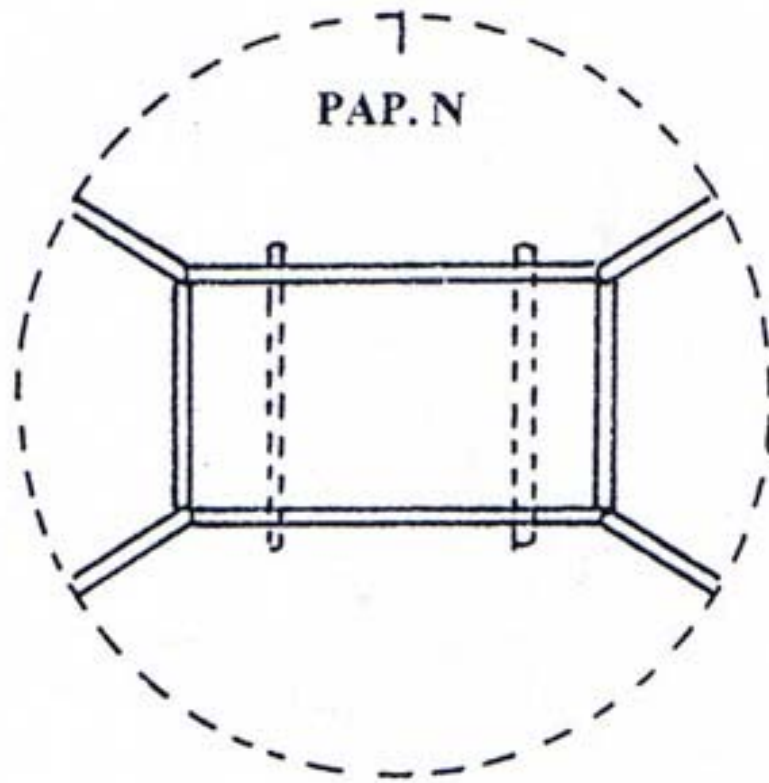


Fig.4. The tree-frame as seen from below by the bird inside the funnel. The bird is looking up through the funnel and observes a rectangle (80 times 45 cm), and four "legs" (as seen in perspective). The two hatched bars symbolize the attempt making the view as seen from below shifting from bilateral to radial symmetric (but obviously this treatment is only a small step in that direction). The long axis in the arrangement is "E"/"W" in reference to paper-N (compare the orientation of the exp.s at Fig.3).