

Avian Navigation in Polar Regions

Susanne Åkesson

Centre for Animal Movement Research, Department of Biology, Lund University, Ecology Building, SE-22362 LUND, Sweden

Navigating in Polar Regions is a great challenge for animals as well as for humans. Birds may use several biological compasses based on information from the stars, the sun and the related polarization pattern of the sky and the geomagnetic field (Åkesson et al. 2014), to find their migratory direction, however, the navigation capacity are put to extreme challenge in Polar Regions. The steep geomagnetic field lines make it difficult to use an inclination compass based on the geomagnetic field, there are no stars visible in the polar summer, and a time-compensated sun compass might be difficult to use in constant daylight. Secular variation cause magnetic field parameters to drift over time and the temporal variations of magnetic parameters might sometimes be severe resulting in so-called magnetic storms. How animals navigate when moving across Polar Regions, and how young animals born in the area learn to use their biological compasses is still largely a mystery.

We have performed several displacement experiments in the high Arctic (Åkesson et al. 1995, 2001, 2005) and studied albatross movements by tracking technology in the Southern Ocean (Åkesson and Weimerskirch 2014) focusing on navigation in first year birds compared to adults. We have further investigated the compass-calibrations of songbirds migrating at high latitudes (Åkesson et al. 2002, Muheim et al. 2006), but also measured the celestial polarization patterns by full-sky imaging polarimetry available for compass orientation during natural sky conditions in high-arctic Polar Regions (Hegedüs et al. 2007a,b).

In a displacement experiment with young northern wheatears (*Oenanthe oenanthe*) we investigated their ability to find a meaningful migratory orientation in the most extreme polar region, at different locations at and near the geographic North Pole. The birds were captured at breeding sites in northeast Russia (Provideniya) and displaced by an icebreaker to 12 experimental sites on land at Wrangel Island and at sea ice along a transect crossing the North Pole where the birds' orientation were recorded repeatedly in circular orientation cages under natural sky conditions. We investigated the birds' orientation in relation to site of displacement and geomagnetic parameters, and measured the availability of celestial orientation cues based on polarized skylight, and our results suggest the birds were able to at some site locate their position and choose relevant migratory directions presumably predominantly based on geomagnetic information. Here I will discuss general animal navigation principles, challenging compass orientation in Polar Regions, and results from our work, predominantly in songbirds in the high Arctic.

References

- Åkesson, S. and H. Weimerskirch, Evidence for Sex-Segregated Ocean Distributions of First-Winter Wandering Albatrosses at Crozet Islands. PLoS ONE 9(2), e86779, 2014. [doi:10.1371/journal.pone.0086779].
- Åkesson, S., U. Ottosson, and R. Sandberg, Bird orientation: displacement experiments with young autumn migrating wheatears, *Oenanthe oenanthe*, along the Arctic coast of Russia. Proc. R. Soc. Lond. B, 262, 189-195, 1995.
- Åkesson, S., J. Morin, R. Muheim, and U. Ottosson, Avian orientation at steep angles of inclinations: experiments with migratory White-crowned Sparrows at the magnetic North Pole. Proc. R. Soc. Lond. B, 268, 1907-1913, 2001.
- Åkesson, S., J. Morin, R. Muheim and U. Ottosson. Avian orientation: effects of cue-conflict experiments with young migratory songbirds in the high Arctic. Anim. Behav., 64, 469-475, 2002.
- Åkesson, S., J. Morin, R. Muheim and U. Ottosson, Dramatic orientation shift of displaced birds in response to the geomagnetic field. Curr. Biol., 15, 1591-1597, 2005.
- Hegedüs, R., S. Åkesson and G. Horváth, Polarization patterns of thick clouds: overcast skies have distribution of the angle of polarization similar to that of clear skies. J. Opt. Soc. Am. A, 24, 2347-2356, 2007a.
- Hegedüs, R., S. Åkesson, R. Wehner, and G. Horváth. Could Vikings have navigated under foggy and cloudy conditions by skylight polarization?, On the atmospheric optical prerequisites of polarimetric Viking navigation under foggy and cloudy skies. Proc. R. Soc. Lond. A, 463, 1081-1095, 2007b.
- Muheim, R., J. B. Phillips and S. Åkesson, Polarized light cues underlie unified theory of cue integration in migratory songbirds. Science, 313, 837-839, 2006.