Migratory birds on a perilous journey

Migratory species are particularly vulnerable to the effects of climate change, habitat loss and environmental pollution. Several research groups at the university and the Institute of Avian Research are joining forces to gain new insights into the behaviour of migratory birds and improve their protection.

By Tim Schröder

Common terns are long-distance migrants and overwinter in Africa. The Institute of Avian Research has been monitoring a colony on Lake Bant near Wilhelmshaven since the mid-1980s.

When the sun sets over Norderney in late summer and the island is gradually swallowed by darkness, a strange spectacle begins. One by one, young northern wheatears fly up from the dunes into the night sky. Some circle gracefully over the island for just a few minutes before landing again; others stay in the air for up to two hours. Some birds even repeat this exercise several times a night. "We don't yet know exactly why the young birds do this," says biology professor Heiko Schmaljohann, who researches bird migration. "But we suspect they are memorising Norderney as their home and at the same time training their "magnetic map" so that they can navigate with pinpoint precision when they return from their African wintering grounds the following year."

Northern wheatears are sparrow-sized songbirds. A fascinating trait of these birds is that, like many other songbird species, they always migrate at night and alone – without parents, siblings or conspecifics, which means that the young birds making the long journey from Norderney to Africa for the first time must find their way to their destination all on their own. "The genetic basis of this behaviour is still relatively unclear – but what we do know is that the birds' genes essentially 'tell' them when, how long and in which direction to fly," Schmaljohann explains. A particularly exciting aspect for scientists is that many migratory birds have a kind of "magnetic map" which they use to navigate between their breeding and wintering grounds. However, little research has been done on this to date, he adds.

Schmaljohann's work is part of the University of Oldenburg's research in the focus area of animal navigation. One objective here is to apply the results more extensively in nature conservation – in measures such as reintroductions of endangered species, for example. But to do this, he and his team must first find out how and when migratory birds learn where their home is. To track the northern wheatears' flight routes around Norderney, the scientist attaches a tiny radio transmitter tag to the birds' backs (see the photo series on page 24). Receiving stations dotted along the North Sea coast then automatically log the birds' location as they fly past. Using this still relatively new technology, Schmaljohann's team discovered how the young birds circle over Norderney and even beyond at night.

In a parallel project, his colleague Professor Miriam Liedvogel is investigating the genetics and metabolic mechanisms that control and regulate this fascinating behaviour at the molecular level. Migratory birds are known to develop "migratory restlessness" in late summer, shortly before they set off on their journey. During this phase they flutter their wings frequently and gradually switch from daytime to nocturnal activity. "In the coming years we want to study in greater detail what goes on at the cellular level – which genes are activated, what metabolic processes are triggered in the brain, the eyes and throughout the body," Liedvogel, a professor of ornithology and Director of the Institute of Avian Research (IAR) in Wilhelmshaven explains.

> Instead of migrating south, blackcaps now spend the winter in British gardens

Liedvogel also works in robins and blackcaps, two other songbird species, but together with Heiko Schmaljohann she now plans to also study the northern wheatear in more detail. For this she will use various methods, including virtual displacement experiments, which involve placing the caged birds in an altered magnetic field by means of large magnetic coils. The experiments will simulate a magnetic field corresponding to the field along the birds' natural migratory route at pre-determined times, and the team will then analyse how this affects the birds' migratory restlessness in terms of timing, intensity and activity, as well as how their metabolism correlates.

Miriam Liedvogel is excited to see what the experiments reveal about the underlying genetic and metabolic processes. She is convinced that the genetics of migratory behaviour are far more complex than ornithologists long believed. Her research on blackcaps, a common songbird species in Germany, has already confirmed this. In early summer, its melodious song fills gardens everywhere, but in the colder months the birds migrate as far as Africa. However, in recent decades interesting observations have been made in the UK. Since the 1960s, many blackcaps that spend the summer months on the continent have stopped migrating south in the autumn and are instead heading northwest to winter in British gardens, where they are fed regularly and thrive. This new trend has sparked Miriam Liedvogel's interest. "We want to understand how this change in migratory behaviour became genetically anchored in a population within such a short time."

The key questions for Oldenburg's animal navigation research – how do songbirds find their way to their destination? How do they learn where home is? And how do they find their way back when they fly alone? – also play an important role in nature conservation practice, for example, when reintroducing birds to areas where they have become extinct. "These reintroduction projects only work if the animals actually adopt the new location," Heiko Schmaljohann explains. One such example is a reintroduction project involving the aquatic warbler, a small moorlands species which has disappeared from Germany entirely as a breeding bird and is now considered the rarest songbird in Europe. In an EU project in 2018, several young birds were brought to a nature reserve in Lithuania from a neighbouring country with a stable population. The following spring, when eleven of the birds which had all been fitted with geolo-

Young wheatears (image: a young bird being ringed) circle over Norderney at night. They are presumed to be imprinting the location of their home on an internal map.

cator tags returned after wintering in Africa, the project was hailed as a success. "In reality, however, at least half of these projects fail because the animals do not recognise the reintroduction site as home. They migrate away from the new site, presumably to return to their birthplace," the ornithologist reports. This means that reintroduction projects can only succeed if scientists understand when and how young birds imprint and learn their birthplace, as the young northern wheatears on Norderney do.

A fifth of all migratory species are threatened with extinction

A recent United Nations study highlights just how precarious the situation of migratory animal species has become. It shows that across the globe 44 percent of all migratory populations are in significant decline, with a fifth facing extinction. There are many factors that can contribute to this negative trend, including habitat loss. In the case of migratory birds, one additional key factor is light pollution, which can disrupt nocturnal orientation and lead them astray during migration. Another is the accumulation of pollutants in the birds' tissues.

Professor Sandra Bouwhuis, Scientific Director of the IAR and a lecturer at the University of Oldenburg, is investigating this latter phenomenon. In 2017, her team began measuring mercury levels in the blood and feathers of common terns, a species that is "highly endangered" in Germany – not least because wetlands and near-natural river landscapes are becoming ever rarer. The IAR has probably done more research on the common tern than any institution worldwide. Every spring, hundreds of these slender birds breed on a group of empty barges filled with gravel on Lake Bant in Wilhelmshaven, where the institute has its main headquarters. After they hatch, each chick is ringed and then, shortly before fledging, fitted with a transponder no larger than a millimetre in size. Over the years, 44 perching boxes fitted with antennas which register each time a bird lands on one of them have been installed on the barges. In addition, the breeding birds are registered at their nests using mobile antennas, so that parents and offspring can be linked together in family trees. The IAR keeps track of whether and when the birds return each year and how successfully they breed.

Until two years ago, the colony was home to around 750 breeding pairs and 2000 birds in total. Then it was hit by avian influenza. In 2023, Sandra Bouwhuis and her colleagues counted just 350 breeding pairs. "The influenza outbreak was a major blow, especially because common terns are already under pressure due to habitat loss and climate change. On top of that, pollutants, in particular mercury, are accumulating in their bodies." Bouwhuis's measurements show that blood levels of this heavy metal increase as the birds age. In the coming years she plans to conduct more detailed studies to determine whether the rising mercury levels affect the terns' migratory behaviour. Because one thing is clear: migration is extremely stressful for the birds. They burn enormous amounts of energy and lose a lot of weight. Heavy metals may take a further toll on their health. Sandra Bouwhuis now plans to expand her research on neurotoxins, and together with Heiko Schmaljohann and Miriam Liedvogel apply it to songbird species as well. After all, there are lots of pollutants in the environment. Not just mercury, but also pesticides, which can contaminate cereal crops and insects – the main food sources of many songbirds.

How can we make products more sustainable?

Outlooks

Prof. Dr Christian Busse

Sustainability and Supply Chain Management

Currently, a product's life cycle is generally a linear process: raw materials are extracted, components are manufactured, the product is used, then at some point it ends up on the scrap heap. A circular system in which products are fed directly back into the manufacturing process at the end of their lifespan makes more sense. Unfortunately, this circular economy is not well established and remains little more than a vision.

It would be good to extend the use phase, for example with companies not selling their products but offering services instead. So rather than buying a printer, you lease it and pay for the operating hours while the printer itself remains the property of the manufacturer. This would have the advantage that manufacturers develop a vested interest in producing durable products and remanufacturing them at the end of their lifespan.

Of course, it's vital that products are designed to cause as little damage as possible throughout their life cycle and across all social and environmental dimensions. I firmly believe that this can only be achieved through government regulation: in the long term, governments must set out a clear, reliable framework – and ensure that it aligns corporate and societal interests.