On **borrowed** wings

A scientific project in the Arctic archipelago of Svalbard investigates whether the flight pattern of migratory birds is responsible for the introduction of new invertebrates in these Norwegian islands. **Associate Professor Steve Coulson** explains the implications of this project on biodiversity in the region

To begin, what are the key objectives of the 'Avian Vectors of Invertebrate Faunas' (AVIFauna) research project?

The insect, spider and mite fauna of Svalbard numbers over 500 species. This fauna is vital in how ecosystems function, playing key roles in, for example, nutrient cycling and the formation of organic soils required by plants. However, the history of invertebrate colonisation of the Arctic following the last glacial maxima (LGM) is unclear. It is likely that few, if any, invertebrate species survived the glaciation in situ, but that all re-invaded the Arctic during the recent Holocene, ie. the past 10,000 years. We wish to know if birds played a role and if so to what extent. Using Svalbard as a model we can extrapolate the concept to cover much of the Arctic.

What questions does your research seek to answer regarding the colonisation of remote Arctic islands by wingless invertebrates?

Several routes by which the fauna could have arrived in Svalbard have been proposed but little is known. We wish to determine how common soil animals are under the plumage of the birds, if this is a possible immigration route for soil animals, whether bird migration routes may play a role in how soil invertebrates assembled following the LGM and how the system may be altered by projected climate change.

What threats do alien species of invertebrates pose to ecosystems in the Svalbard area? How have you incorporated assessments of human activity into your research?

At the moment there are few confirmed alien invertebrate species in Svalbard and around 60 species of introduced alien plants. However, as part of the AVIFauna project we surveyed the soil invertebrates from a location in the Russian town of Barentsburg, in Svalbard. Of the 46 species identified, these 11 were new to the archipelago and we believe these to have been imported. We can assess the invasive potential of these species by studying currently known biogeography. It would appear than none are common in the Arctic and that the invasive potential is slight, but there are many other locations that should be surveyed.

How have you collaborated with other institutions both in the region and internationally in order to trace the path of invertebrate faunas?

This will take place in phase two of the project. One target bird, the snow bunting, is thought to travel to southern Russia, the other two species to Europe. Once we start to find invertebrates we will collaborate with researchers in the overwintering regions. We hope to be able match DNA sequences of invertebrates collected from birds in Svalbard with those from animals collected from the soils in the overwintering regions, thus demonstrating a source population for the Svalbard animals.

What will the next stages in your research involve in order to reach your overall goals?

The next stage is Fieldseason II. After that we will start to match flight paths with invertebrates and commence the barcoding work. This research is bringing together a diverse group of ecologists and taxonomists. This strengthens the group's considerable expertise in birds, invertebrate ecology and taxonomy, molecular techniques and barcoding. The links created by this project are already producing spin-off benefits with smaller projects, including studies of the external parasites of the seabirds.

How will your research inform the wider knowledge base on the topic? Do you expect it to influence policy makers in any way, and if so, how?

It will shed light on how the biodiversity observed in the Arctic came to be about. It will also feed into predictions on how species distribution will change in the light of current environmental change. Not all species can track the changes observed at a similar speed. There is an asynchrony: for flightless species having to cross expanses of ocean there may well be a significant time delay in reaching new regions to colonise. However, migrating birds may give such species lift, reducing expected colonisation times.

How does this research relate to the NOR RUSS funding call to link Nordic and Russian research into biological problems in the region?

The funding was provided in order to better link the Norwegian and Russian research activities in Svalbard. We have three Norwegian institutions involved (UNIS, the University of Bergen and the Norwegian Polar Institute). In Russia have we four researchers from two institutions (the Komi Science Centre in Syktyvkar and the Southern Science Centre, Rostov-on-Don). In addition we are collaborating with colleagues from The Netherlands and Poland.

Polar pioneers

Tracing back the interaction of migratory birds and invertebrates, a new line of investigation opened by **AVIFauna** might bring about a breakthrough in knowledge on Arctic biodiversity

SVALBARD IS THE northernmost part of Norway, 700 km from the mainland, with glaciers accounting for around 60 per cent of its territory. Its fjords speak of a more inhospitable past during the glacial age. In these islands the midnight sun gleams all day over the horizon during summer. In winter, they are engulfed by never-ending polar nights. This Norwegian enclave where polar bears and other Arctic animals roam free is home to Ny-Ålesund, an international research station. Ny-Ålesund is also one of the headquarters for a team of scientists studying 'Avian Vectors of Invertebrate Faunas' (AVIFauna). The project is primarily devoted to study the microarthropods, insects and mites of Svalbard. But this is not an average investigation on invertebrates – the researchers aim to answer a truly intriguing question: how have fauna with no wings or backbones managed to arrive at the remote Arctic islands?

BLOWING IN THE WIND

The project, led by Associate Professor Steve Coulson, has opened a line of investigation that focuses on bird phoresy (ie. hitch-hiking provided by birds) to explain part of the rich biodiversity of invertebrates in Svalbard. Effectively, this theory maintains that invertebrates from wintering areas have been borrowing the wings of migratory birds to reach the Norwegian islands: "Many ornithologists believe that soil-dwelling animals are rare on birds and if so they drop off fast," Coulson explains. "However, the conditions under the plumage of the birds seem on the face of it perfect for many soil-based animals: moist, sheltered and with food in the form of dead organic material like skin and fungae."

Until recently it was generally assumed that invertebrates dwelling on birds during migration periods have had a low incidence. The common belief was that these soil animals hopped off at the first opportunity, preferring to return to the environment they belong. But evidence produced in recent years by AVIFauna's co-leader, Professor Natalia Lebedeva, suggests that these invertebrates may spend considerable time, or whole life cycles, under the warm feathers of migratory birds. Certainly this theory remains

PROFESSOR NATALIA LEBEDEVA INSPECTS A BARNACLE GOOSE NEST

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contentious and other routes by which the fauna could have landed in Svalbard have been proposed. Rafting, aerial plankton or human traffic are among the alternatives suggested. However, AVIFauna is a concerted effort to verify how these invertebrates winged their way to Svalbard: "If birds are shown to be important in dispersing soil animals it would first offer an explanation for some of the current biodiversity in the Arctic but also for other regions in the world," Coulson observes. AVIFauna might well bring a significant breakthrough in the field of biogeographical sciences.

THE TIP OF THE ICEBERG

The history of invertebrate colonisation of the Arctic remains obscure. At the peak of the last glacial period when vast ice sheets covered much of the Northern Hemisphere, few of these invertebrate species are believed to have survived. Within the last 10,000 years of the current interglacial period they have re-invaded the Arctic. Today, there are over 1,000 species of terrestrial and freshwater invertebrates in the Svalbard archipelago. But the existing records are only representative of two locations on the west coast: Longyearbyen and Barentsburg. The east coast is still *terra incognita* and even in the studied areas new discoveries are likely to be made.

Hence AVIFauna's findings could be just the tip of the iceberg and its implications may have further significance. The communities of invertebrates are actively integrated in the ecosystem where they live. Nutrient cycling, energy flow, decomposition or parasitism are among the processes in which they are called to play a role. But in an era of global warming, AVIFauna raises yet another important question of how climate change could affect the biodiversity

SNOW BUNTING
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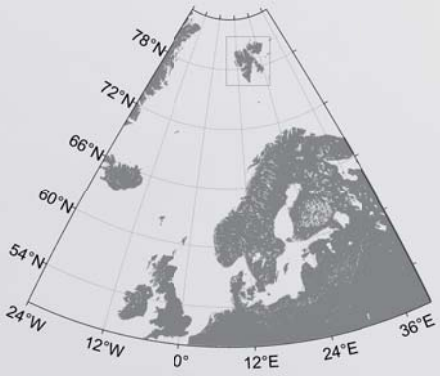

FIGURE 1. LOCATION OF SVALBARD, BOX UPPER RIGHT (PREPARED BY MALIN DAASE)

of particularly sensitive regions like the Arctic. Coulson says this is an issue in need of further investigation: "The greatest warming change will be during the winter. However, it is possible that warming summers will enable new species to establish. Given that all species have complex interactions it is hard to project what the results would be". In any case, the strategic location of Svalbard – bordering the Arctic sea – provides valuable data on how climate change may affect local ecosystems.

ON FIRM GROUND

Undertaking scientific investigations in the remote Arctic islands is not an easy task. Of course, the researchers involved in AVIFauna do not step on the same thin ice as the polar pioneers from the early 20th Century. However, the unbeaten track pursued with this project has echoes of the scientific endeavours from earlier times. Not by mere chance the monument of Amundsen, the great Norwegian explorer, stands in Ny-Ålesund.

Last summer the fieldwork of AVIFauna started in Svalbard. A collaborative team of Norwegian, Russian and Polish scientists conducted the first stages of the project. During this phase the collection of relevant samples commenced. Birds, nests and soils were examined using different techniques with promising results to date. More than 10 oribatid mite species, a microscopic-sized arthropod, have been found on the plumage and habitats of the snow bunting. Also known as the snowflake, the snow bunting is a migrant bird that winters in southern Europe and spend the breeding season in Svalbard. Other long-distance flyers like the purple sandpiper or the barnacle goose are among the targeted species.

One major challenge facing the AVIFauna project is to identify the invertebrates' origin recovered from the migratory birds. This will be carried out during the second stage of the project, opening up cooperation with other institutions and researches in the overwintering regions. This will be a crucial step for the final findings of AVIFauna and involves double-checking two different DNA sequences: one from the invertebrates found in Svalbard, the other from samples of those dwelling the regions where the migratory birds start their journeys. If the AVIFauna working group are able to match both sequences of DNA, the 'Avian Vector' enigma would be successfully deciphered. To round up the investigation, AVIFauna is also studying the invertebrates introduced by human activities such as mining or livestock supplies.

BUILDING BRIDGES

Another issue that AVIFauna tries to address is the fragmentation that affects this field of knowledge. As many as 600 articles have been published on the invertebrate fauna of Svalbard. Despite the extensive literature available, overall coordination is much needed to avoid misidentification of the species discovered. For instance, it has been the case that Russian scientists have reported as new discoveries species already cited in Western literature. Conversely, few Russian articles are published abroad. Last April, as part of the AVIFauna project, a workshop at the University Centre of Svalbard was held to bolster the communication between researchers. One aim of the workshop was to strengthen the Norwegian-Russian collaboration. Scientists from 10 countries had the opportunity to exchange materials, share knowledge and most importantly establish a network of professionals that will study specifically the invertebrate fauna of Svalbard. Its relevance has already drawn international attention and many eyes will be kept on the findings that AVIFauna will bring in the next year.

THE AVIFAUNA TEAM IN NY ÅLESUND, JUNE 2011

INTELLIGENCE

AVIFauna

OBJECTIVES

To describe and quantify the role of avian phoresy in the dispersal and colonisation of high latitudes by soil invertebrates which are not normally considered to be phoretic, primarily oribatid mites and Collembola.

KEY COLLABORATORS

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STEVE COULSON received his PhD in Insect Ecophysiology from the University of Leeds, UK, in 1991. He spent periods at Liverpool John Moores University and the University of Oslo before starting work as an Associate Professor at the University Centre in Svalbard (UNIS) in 2005. He teaches Arctic invertebrate ecology and wintering ecology.

UNIS