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Report

Migratory Birds as Vectors for Influenza Dispersal

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Migratory birds are looked upon with suspicion now that H5N1 is rapidly spreading across the globe. To increase our understanding of the problem this short communication seeks to provide ecological information on bird migration. It will address questions like: what is it that actually makes birds migrate? How far may they fly? Why do waterfowl receive the most attention as a vector for avian influenza dispersal?

The spread of the H5N1 subtype of avian influenza can take place in multiple ways. The role of humans in this process may be considerable, notably as a result of the transportation of birds and bird products. The most striking example of this is probably that of the "London Parrot". This bird, originating from South America, was infected by H5N1 while in quarantine with parrots coming from south-eastern Asia. But it remains a fact that wild migratory birds can also be an important vector for dispersal, notably if migrating over long distances. In fact there are many zoonoses that are dispersed by birds.

Migrants are tracking their food

Why birds migrate is notably a matter of food availability. For most Arctic breeding birds spending the winter at high latitudes is not only a cold and therewith energy craving business, but it is foremost an impossibility since their food is no longer available at that time of year. The same is true for insecteating songbirds from temperate areas that have to move toward the tropics before winter in order to be able to eat insects year round. That all these birds have to literally track their food results in massive migrations of all sorts of birds over sometimes enormous distances.

Here are a few examples taking my home turf, The Netherlands, as a point of departure: Arctic Terns migrate to Antarctic waters to spend the "winter", Garganeys move to Western Africa and Barn Swallows favour Southern Africa. But not all northern hemisphere birds go as far south as that. There are also birds that happen to favour what I would call miserable weather conditions and come to The Netherlands during winter. These birds originate from an enormous area that stretches from northeastern Canada to the western half of northern Siberia. Birds like Knots from Arctic Canada, Pinkfooted Geese from Svalbard and Brent Geese from Taymir. It is quite remarkable that The Netherlands appears to be such a hot spot for migratory birds, notably waterbirds. This activity has a number of reasons. First, The Netherlands is a water-rich delta with a mild marine climate at relative proximity to the northern breeding grounds of these species. Moreover, its highly intensive agricultural industry offers many feeding opportunities for these preferentially herbivorous birds. Clearly, for the same reasons, other major delta systems worldwide act as magnets for migratory waterbirds. These are areas that are also highly populated.

One-way journeys of up to 15,000 km

All long-distance migratory movements are mainly under endogenous control, day length being the crucial stimulus. Instantaneous food availability can have an important impact on migratory movements. For instance, food shortages in the Russian taiga may lead to winter invasions of Crossbills, Waxwings and Siskens into Western Europe. Frost and snowfall may set in motion massive migrations since the birds' food is no longer available. Distances covered during such events may be huge: Mute Swans from the Baltic are known to fly all the way south to the Adriatic.

Thus, bird migrations may involve very long journeys indeed, where some individuals may cover up to 30.000 km a year. The various migratory routes form a kind of

network, however not all places are directly connected. Again taking The Netherlands as an example, migratory flyways linking The Netherlands with areas in a south-eastern direction hardly exist. A bit north and east of The Netherlands birds are breeding that migrate in a south-easterly direction, wintering in eastern Africa and in India. There they might meet birds that do migrate back to The Netherlands in spring. Thus, via stepping stones, many connections can be made. One could easily imagine that if sufficient contact exists between various species and populations of migratory birds, zoonoses may ultimately disperse across the whole world. If and when this will happen is ultimately dependent on the extent of contact and the way infections between migratory birds take place.

Why are waterfowl in the spotlight?

In the mean time we know that almost any species of bird may become infected with avian influenza. However it is notably waterfowl (ducks, geese and swans) and to a lesser extend waders (sandpipers, plovers) that seem to be the most hard-struck birds and therewith also receive most attention as health hazards (for the poultry industry). There are four factors that potentially play an important role in the fact that waterfowl are so important in the dispersal of avian influenza viruses:

1. Many of these birds are (long-distance) migrants.
2. They preferably reside in water-rich areas.
3. They are very social and
4. Many of these birds are herbivores.

Migratory birds use far larger areas during an annual cycle than resident birds. Therefore, the chance to bump into a source of infection is far larger for a migrant than for a resident bird. Moreover, a social life style will increase the odds of becoming infected. Influenza viruses are shed via the faeces in large quantities. Outside the host the virus may very well survive in water, notably at low temperatures. After a month in ice water the virus may still be virulent. Waterfowl, as the name already indicates, spend an important part of their life in and around water. Furthermore they are extremely social during large parts of the year, especially outside the breeding season. Also many waders can often be found in wetlands, although they prefer to be on the shorelines rather than in the water. The exchange of viruses via water is thus also less likely for these species. Often, they also reside in brackish and salt water bodies, where influenza viruses have a poorer survival. An additional aspect in the ecology of waders that may explain why they do not play such a paramount role in the dispersal of influenza viruses is the fact that they are less social than most waterfowl.

Most waterfowl are largely, and sometimes even exclusively, herbivorous. Herbivores need to eat large quantities of food to fulfil their daily energy and nutrient requirements. Consequently they produce large amounts of faeces. Foraging geese normally produce a faecal pellet every 5 minutes. Thus, infected birds shed viral particles at very high rates. Herbivorous birds typically require highquality plant material; to maximise flight capacity they cannot afford to build a large and heavy digestive system capable of digesting poor-quality food. However, good feeding grounds are scarce, leading to high concentrations of birds at the good spots. But irrespective of the high quality of good feeding grounds, a large proportion of the day must be spent foraging. This comes at the expense of vigilance, which can in turn be compensated for by increased sociality. All in all, the feeding ecology of herbivorous waterfowl makes them exquisite vehicles for influenza-virus dispersal.

Cautiousness should prevail

Given their ecology, waterfowl are justly being considered to be the ideal reservoirs and vectors for dispersal of avian influenza viruses. Their precise role in spreading the H5N1 virus is difficult to assess since little research has specifically been targeting the interaction between the ecology of influenza viruses and their avian hosts. Attempts to reconstruct the current spreading of H5N1 with a leading part for migratory birds are being hampered by the fact that more reservoirs and vectors for dispersal not involving migratory birds may be acting simultaneously. But in the absence of a full understanding of the current influenza dispersal processes, it is at any rate a good thing dealing cautiously with waterfowl.

The Netherlands, water rich and offering excellent feeding opportunities, is an attraction for migratory waterfowl, such as these Bewick's Swans (picture M. Klaassen)