Long-distance journeys are out of fashion: Global warming is causing evolutionary changes in bird migration

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The locomotory activity (restlessness) of migratory birds can be recorded quantitatively in environment-controlled chambers. Such cages are equipped with movable perches, which are coupled to micro-switches. Image: Max Planck Institute for Ornithology

(PhysOrg.com) -- The results of genetic studies on migratory birds substantiate the theory that in the case of a continued global warming, and within only a few generations, migratory birds will - subject to strong selection and microevolution - at first begin to fly shorter distances and at a later stage, stop migrating, and will thus become so-called "residents".

In a selection experiment with blackcaps from southwest Germany, Francisco Pulido and Peter Berthold at the Max Planck Institute for

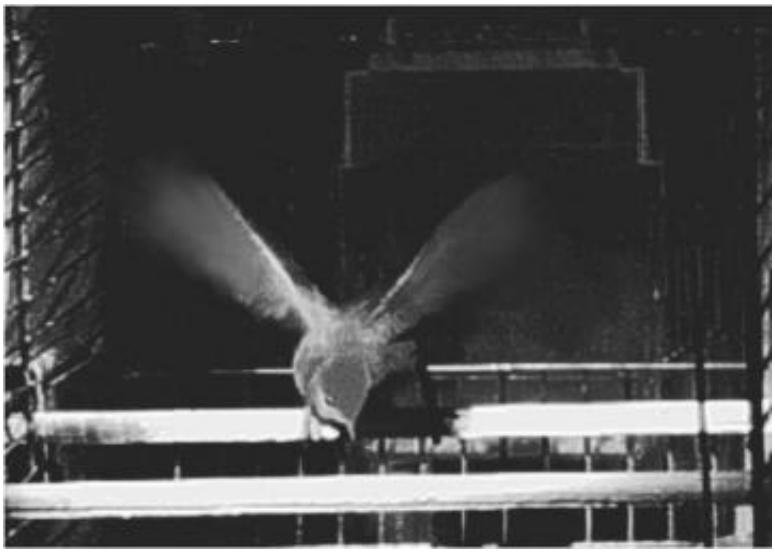
Ornithology in Radolfzell were able to show that first non-migratory birds are to be found in a completely migratory bird population after only two generations of directional selection for lower migratory activity. The strong evolutionary reduction in migration distance found in this study is in line with the expected adaptive changes in bird migration in response to environmental alterations caused by climatic change. (*Proceedings of the National Academy of Science, PNAS*, April 5, 2010)

For generations, humans have been watching flocks of migrating birds flying to their winter quarters in the autumn, and awaiting their loud songs announcing their happy return in the spring. The timing of their migration is adjusted to the availability of resources, such as food and habitats, in the stopover areas as well as in the non-breeding and breeding areas. For migratory birds it is essential to be in the right place at the right time.

For some years, it has been possible to demonstrate using data collected in the wild that some species of migratory birds respond to the increase in temperature and to the subsequent changes in the environment. The blackcap is one of the species where changes in migratory behaviour have been most consistent. Today, blackcaps return to their breeding sites earlier, lay their eggs earlier, and leave us later in the autumn. One population even established a new wintering area in the British Isles, instead of flying all the way to Spain. Because of its large genetic variation, the researchers expected rapid adaptation to altered environmental conditions in this species, which is a model for investigating the evolution of bird migration.

The scientists at the Max Planck Institute for Ornithology wanted to find out what the mechanisms were for adjusting to global warming, whether there were measurable changes in migratory behaviour within a period with a strong temperature increase, and whether these changes, above all

the reduced migratory distance, were an individual adjustment to altered environmental conditions, or whether the genetic composition of the populations would change.



A blackcap displaying symptoms of migratory restlessness, a kind of "migrating while perching". Since these animals are nocturnal migrants they are filmed under infrared light. Image: Max Planck Institute for Ornithology

During the period 1988 - 2001, which were years with particularly high temperatures, blackcap nestlings were taken from their nests each year (757 birds in total) and reared by hand in the lab. The seasonal changes in light-dark transition were simulated and the migratory restlessness of the inexperienced young birds was measured in autumn. The duration of their restless behaviour during the night, i.e. the fluttering and hopping along the perch corresponded approximately to the duration of the flight to their winter quarters.

The birds that were taken from their natural habitat during these 14 years showed a significant reduction in their migratory activity. In their

natural habitat this would be equivalent to a shortening of flying distance. This reduction, as the researchers were able to prove, was based on a change in the genetic composition of the population, i.e. evolution.

In a second experiment, the scientists simulated the selection process they had observed in nature in the laboratory, but in "time lapse". The birds with the least migratory activity and their offspring were paired over four generations. In order to avoid inbreeding, the researchers paired 50% of this line with birds in their natural habitat that showed a particularly weak migratory restlessness. After two generations, the first "resident" birds were already to be found in this population. Hence, directional selection for lower migratory activity leads to the evolution of partial migratory populations and, finally, to populations that do not leave their breeding areas at all.

The advantages for the birds are obvious: The shortening of migration distance saves energy and time. Moreover, because shorter days, as experienced in more northern wintering areas, induce an advancement of migratory activity and reproduction, birds migrating shorter distances will occupy the best breeding territories and may produce multiple broods in a year. "We assume that the reduction in migration distance is the first and most significant evolutionary mechanism that migratory birds have for adapting to changed climatic conditions," explains Francisco Pulido. "For birds that migrate short to average distances of approximately 1,000 km, and in which migratory behaviour is genetically determined, as is the case with most songbirds, this can be a successful strategy for survival. However, for long-distance migrants, for which successful migration will depend on overcoming ecological barriers such as desert or sea, this mechanism of adaptation cannot work, as a reduction of migration distance would mean spending the winter in a hostile environment, in which they cannot not survive."

More information: Francisco Pulido and Peter Berthold, Current selection for lower migratory activity will drive the evolution of residency in a migratory bird population, *Proceedings of the National Academy of Sciences (PNAS)*, published on April 5, 2010. doi:10.1073/pnas.0910361107

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