Long-distance migration may help reduce infectious disease risks for many animal species

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It's a common assumption that animal migration, like human travel across the globe, can transport pathogens long distances, in some cases increasing disease risks to humans. West Nile Virus, for example, spread rapidly along the East coast of the U.S., most likely due to the movements of migratory birds. But in a paper just published in the journal *Science*, researchers in the University of Georgia Odum School of Ecology report that in some cases, animal migrations could actually help reduce the spread and prevalence of disease and may even promote the evolution of less-virulent disease strains.

Every year, billions of animals migrate, some taking months to travel thousands of miles across the globe. Along the way, they can encounter a broad range of pathogens while using different habitats and resources. Stopover points, where animals rest and refuel, are often shared by multiple species in large aggregations, allowing diseases to spread among them.

But, according to Odum School associate professor Sonia Altizer and her co-authors, Odum School postdoctoral associates Rebecca Bartel and Barbara Han, migration can also help limit the spread of some pathogens.

Some kinds of parasites have transmission stages that can build up in the environment where host animals live, and migration allows the hosts to

periodically escape these parasite-laden habitats. While hosts are gone, parasite numbers become greatly reduced so that the migrating animals find a largely disease-free habitat when they return. Long migratory journeys can also weed infected animals from the population: imagine running a marathon with the flu. This not only prevents those individuals from spreading disease to others, it also helps to eliminate some of the most virulent strains of pathogens.

"By placing disease in an ecological context," said Odum School dean John Gittleman, "you not only see counterintuitive patterns but also understand advantages to disease transmission. This is a classic example of disease ecology at its best."

Altizer's long-term research on monarch butterflies and a protozoan parasite that infects them provides an excellent demonstration of migration's effects on the spread of infectious disease. Monarchs in eastern North America migrate long distances, from as far north as Canada, to central Mexico, where they spend the winter. Monarchs in other parts of the world migrate shorter distances. In locations with mild year-round climates, such as southern Florida and Hawaii, monarchs do not migrate at all. Work by Altizer and others in her lab showed that parasite prevalence is lowest in the eastern North American population, which migrates the farthest distance, and highest in non-migratory populations. This could be because infected monarchs do not migrate successfully, as suggested by tethered-flight experiments with captive butterflies, or because parasites build up in habitats where monarchs breed year-round. Other work showed that parasites isolated from monarchs that flew the longest were less virulent than those found in monarchs that flew shorter distances or didn't migrate at all, suggesting that monarchs with highly virulent parasites didn't survive the longest migrations.

"Taken together, these findings tell us that migration is important for

keeping monarch populations healthy—a result that could apply to many other migratory animal species," said Altizer.

But for monarchs, and many other species, migration is now considered an endangered phenomenon. Deforestation, urbanization and the spread of agriculture have eliminated many stopover sites, and artificial barriers such as dams and fences have blocked migration routes for other species. These changes can artificially elevate animal densities and facilitate contact between wildlife, livestock and humans, increasing the risk that pathogens will spread across species. As co-author Han noted, "A lot of migratory species are unfairly blamed for spreading infections to humans, but there are just as many examples suggesting the opposite—that humans are responsible for creating conditions that increase disease in migratory species."

And as the climate warms, species like the monarch may no longer need to undertake the arduous migratory journey to their wintering grounds. With food resources available year-round, some species may shorten or give up their migrations altogether—prolonging their exposure to parasites in the environment, raising the rates of infection and favoring the evolution of more virulent disease strains. "Migration is a strategy that has evolved over millions of years in response to selection pressures driven by resources, predators and lethal parasitic infections—any changes to this strategy could translate to changes in disease dynamics," said Han.

"There is an urgent need for more study of pathogen dynamics in migratory species and how human activities affect those dynamics," Altizer said. The paper concludes with an outline of challenges and questions for future research. "We need to learn more in order to make decisions about the conservation and management of wildlife and to predict and mitigate the effects of future outbreaks of infectious diseases."

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