Birds of a feather flock together, but only in similar climates

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A Himalayan rubythroat (Calliope pectoralis) carries a juniper berry at 4600m in the Paddar Valley in Kishtwar, Jammu and Kashmir, India. Credit: Suresh Kumar Rana

One might assume that birds of flight are cosmopolitan travelers, and bird species should be distributed far and wide, spread across long distances—continents even. However, a study led by Alex White, Ph.D., a former University of Chicago graduate student now at National

Museum of Natural History in Washington, D.C, shows that a bird has strong ties to the climate patterns of its habitat. As a result, the geographical distribution of birds may be more restricted than we think.

Bird's eye view

Scrutinize the distribution of birds across the globe and it is obvious that land birds, for example, have ranges that abruptly end at coastlines. You may not notice a similar turnover of bird species within continents, but in fact one is present at the freezing line, the boundary between the tropics and cooler, temperate areas. White's study shows that despite no significant physical barriers stopping them from spreading out, bird species are strongly confined to their habitats as demarcated by the freezing line.

Nowhere in the world does the freezing line loom as drastically as the Himalayas. Here, though, it is not the world's tallest mountain peaks that serve as the boundaries of avian habitats and movement. Instead, it is the freezing line, which cuts across the subalpine slopes at an elevation of about 1600 m, less than a fifth of the way up to Mount Everest's peak.

White conducted the study as part of his Ph.D. thesis at UChicago, working with advisor Trevor Price, Ph.D., professor of ecology and evolution. Focusing on the Himalayas, they examined the distribution of 305 species of open-habitat and tree-dwelling birds out of the known 621 species present in the region. The numbers of species were estimated from reported sightings and vocalizations across 38 sites in the Himalayan forests. This survey was performed over a ten-year period during the annual warm breeding months, when seasonal migrant birds were present and species numbers were at their highest.

The researchers analyzed their field data by developing what's called a grade of membership model. In this model, bird species were assigned to

a few groups based on their geographical patterns of coexistence. Then, the model can help determine if a particular location predominantly consists of one group, or a mixture. It's a bird distribution equivalent of ancestry genetic testing services such as 23andMe and Ancestry.com. These companies associate a client's DNA profile to a country of origin, and White's grade of membership model links bird observations to geographical origin and climate across the Himalayas.

Not exactly as free as a bird

The model allows for the possibility that each bird group be from multiple geographical areas, but it still showed little mixing of groups across the tropical-temperate divide. Moreover, the researchers discovered that bird groups within the same climate zones also have the same evolutionary roots. This means that climate has had a long history in shaping population distributions.

"The abundances of birds that cross the freezing line seem to change according to whether or not their region of origin was the temperate or tropics," White said. "This is surprising because the freezing line in the Himalayas—the sharpest in the world due to the extremely steep elevation gradients—spans only tens of kilometers. You can imagine that this distance should seem incredibly short to a bird. Our results highlight the importance of climatic barriers to bird population distributions."

Strong, indirect, and fragile correlation

Temperate regions are not freezing all year round, only during the winter season. Furthermore, birds are warm-blooded and generate body heat, so they should be able to withstand freezing temperatures. On top of that, some of the surveyed birds are migratory.

Why aren't Himalayan birds distributed more uniformly across the freezing line, especially during the warmer breeding months? The answer may lie in the flora of a bird's habitat.

Unlike birds, plants have very particular adaptations to freezing, and birds rely closely on the plants in their habitat. Birds are picky eaters, consuming locally-specific foods, such as insects associated with the vegetation in their home.

"Our study demonstrates that bird distributions are strongly connected to a given environment, and the freezing line is really the underlying component that's changing the habitats," White said. "Birds may just be overlaid on to their habitats."

In the future, White wants to study the impact of climate on the distribution of ecological attributes of birds such as beak shape, using the same model. A bird's beak shape is very telling of its ecological niche. White wants to investigate a new angle to the ecology–evolution complex: In the competition between genetic history and environmental factors to determine a bird's physical attributes, which dominates?

For now, this study points to how one of the factors, the environment, drives the distribution of bird populations across the globe. The study also underscores how human impact on the environment might inadvertently affect multiple species.

"Our results show that bird communities are contained by much more discrete boundaries than maybe we had previously appreciated," White said. "The movement of these discrete boundaries could have serious implications for the functioning of the ecosystem, leading to instabilities if we alter the environment that birds rely on.

"One thing to note," he added, "the climatic patterns in this study

evolved under a regime of change that was much less extreme than climate change that exists now."

Birds—albeit just a few species—survived one environmental catastrophe when an asteroid wiped out the dinosaurs. However, White's study shows that the fragile interconnectedness between birds—hardy as they might once have been—and the environment should not be taken for granted.

The study, "Regional influences on community structure across the tropical-temperate divide," was published in the June 14, 2019 issue of *Nature Communications*.

More information: Alexander E. White et al. Regional influences on community structure across the tropical-temperate divide, *Nature Communications* (2019). DOI: 10.1038/s41467-019-10253-6. www.nature.com/articles/s41467-019-10253-6

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