Catalog of bird shapes yields ecological ‘gold mine’

Measurements offer a new window into ecosystem health

By Erik Stokstad

In 2012, evolutionary biologist Catherine Sheard started an ambitious Ph.D. project: measuring the shape of every kind of passerine, or perching bird, in the world. “I thought, ‘This is about 6000 species, that almost seems doable,’” Sheard says. It was, and her project catalyzed an international effort to measure all the world’s birds.

Now, a team of 115 researchers from 30 countries, led by Sheard’s Ph.D. adviser, Imperial College London ecologist Joseph Tobias, has published anatomical measurements of all 11,009 living bird species—not just passersines such as robins, but everything from ducks and penguins to vultures and ostriches. “It’s a gold mine,” says geneticist Nancy Chen of the University of Rochester, who was not involved in the project.

The open-source data set, called AVONET, debuts this month in a special issue of Ecology Letters along with papers describing its value for studying bird evolution and ecology, as well as the impact of changes in climate and habitat on vulnerable species. “For the first time, we are gaining a global, quantitative perspective on bird biodiversity, which is really amazing,” says ecologist Brian Enquist of the University of Arizona.

Tobias drew inspiration from a massive database of plant measurements called TRY, which contains millions of records on leaf shape, chemical composition, average blooming dates, and more. By correlating these records with other types of data such as remote sensing, plant ecologists have studied a wide array of issues, including how steeply plant diversity declines when habitats are fragmented. Yet TRY has details for fewer than half of the world’s 391,000 plant species, limiting its ability to answer some questions.

Assembling a complete data set for birds began to seem feasible after Sheard completed her effort, carefully wielding calipers on sometimes-fragile specimens to measure about 80 birds per day at five major museums in the United Kingdom and United States. All told, authors contributed data from 78 collections and some field studies. On average, they measured eight to nine individuals for each species. To fill in the last few hundred missing species, Tobias networked and cold-called researchers all over the world. “By that stage it was a labor of love,” he says.

The AVONET data set contains 11 morphological traits, such as beak shape and wing length, for 90,020 individual birds from 181 countries. “It’s phenomenal what they’ve done,” says Çağan Şekercioğlu, an ornithologist and conservation ecologist at the University of Utah, who created a database of bird ecological traits, including diet and habitat. Earlier, incomplete versions of AVONET have already yielded insights. Sheard reported in 2020 in Nature Communications that species’ geographical distributions, documented by earlier studies, correlate with flight ability, as revealed by the ratio of hand to wing length. Compared with migratory birds in temperate regions, sedentary birds in the tropics have stubbier wings, poorer flight, and more restricted ranges. That link between wing anatomy and flying range could help researchers gauge species’ vulnerability to harm from habitat destruction or climate change, as poorer fliers might not be able to disperse from inhospitable environments, Şekercioğlu says.

Papers in the special issue report new findings. One shows that the evolution of flight reduced birds’ reliance on weapons, such as bony spurs, likely because these defenses add extra weight. Another confirms that communities of bird species with more diversity of shapes, such as beaks specialized for niche diets, tend to have lower risks of extinction.

Other teams can apply the data to new questions. “This is really democratizing the data housed in museums,” says Sahas Barve, a postdoc at the Smithsonian National Museum of Natural History. “Not only is it available for students everywhere, but it’s available to scientists in the countries from where these specimens were originally taken.”

Future studies can combine body shape measurements with genetic data, geographical distributions, and environmental conditions to test theories about birds’ evolution and their role in ecosystems, says AVONET co-author Carsten Rahbek of the University of Copenhagen. For example, AVONET measurements can help estimate the maximum size fruit a species can eat and roughly how far it might travel before defecating the seeds—clues to which plants it might spread, and how efficiently.

Researchers could then use the data set to predict the ecological consequences of global changes, such as deforestation and warming. “This is the door to the future,” Rahbek says. For example, using data on species with beaks specialized for unusual flowers, researchers could predict which plant species are at higher risk of extinction if their avian pollinators vanish. In some tropical countries, large fruit-eating birds are hunted intensely, and their loss could reduce seed dispersal. Around the world, conservation decisions “are going to have to come fast and furious,” Enquist says. “Data sets like this are enabling us to anticipate what will happen and helping inform what to do.”

Tobias and others plan to continue improving the data set by filling in missing data for roughly 100 species. They will also measure more individuals and add other kinds of information about life history and behaviors. For now, the data set exists as a spreadsheet in a supplemental file to a paper. Creating a community-driven database and website like TRY would require new funding, as well as mechanisms to validate newly uploaded data, such as measurements taken when researchers or volunteers capture and band living birds. “If you put it all together,” Tobias says, “you could get an amazing resource.”

AVONET collaborator Marcus Chua measures a Salvadori’s nightjar (Caprimulgus pulchellus).
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