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Avian Biodiversity: Dynamic Informatics on Urban and Regional Scale

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Abstract- *However, a number of studies have recently found discrepancies between the timing of geological events and phylogenetic patterns using out-of-date evolutionary ideas. Because of this, the current distribution patterns of some avian groups can only be explained by past dispersal events, which frequently occurred over great distances and across seas. Generally speaking, changes to the landscape might not cause consistent temporal diversification patterns among various bird groups. It stands to reason that an avian lineage has more time to colonize a region on the other side of a barrier the older it is. As a result, there is a higher chance that populations may disperse across the barrier and then diversify on both sides of the divide. Additionally, lineages of bird species with lower dispersion capacities are anticipated to accrue genetic variations among populations more quickly than lineages with higher dispersal capacities. Therefore, ecological characteristics of various avian lineages and their environment, as well as the age of a given lineage, interact to produce diversification patterns. Birds' geographic ranges are typically constrained by a variety of biotic and abiotic reasons. In addition to being a crucial first step in speciation, range expansion affects the number of coexisting species and, as a result, shapes the turnover of biodiversity through time and space.*

Keywords *Avian diversification, Avian diversity, Avian distribution , Vicariance , Dispersal, Colonization , Range evolution etc*

I. Introduction

Following the extinction of the nonavian dinosaurs and pterosaurs at the Cretaceous-Paleogene boundary, the majority of contemporary bird orders originated and diversified over the course of the last 65 million years. From approximately 50 million years ago onward, the diversification rates of birds surged, driven by notable rate increases in many clades dispersed across the whole phylogeny. The general pace of diversification has not slowed down, and equilibrium diversity may not have been attained. Birds have adapted to practically every habitat and can breed on every continent of the world. The diverse species exhibit significant variation in their patterns of distribution, ranging from narrow-range endemics that are confined to a single oceanic island or to a specific habitat within a constrained geographic area to species with a nearly global distribution that reproduce on practically all continents. The diversity of bird species is highest in tropical areas close to the equator and declines toward the poles, as it does in most groups. The latitudinal diversity gradient is a pattern that cannot be explained by a single explanation and may be affected by both ecological and evolutionary processes. In general, speciation, extinction, and dispersal are the causes of species richness within a certain area. The emergence of reproductive isolation between populations marks the end of speciation, which begins with the accumulation of genetically based divergence between populations. Allopatric speciation, a process that often entails a phase of geographic separation of populations without interaction, is involved. In particular, sympatric speciation—the evolution of reproductive isolation without geographic separation—and parapatric speciation—speciation with ongoing gene flow between populations—appear unusual in birds. For a very long time, the distribution patterns of various bird groups, notably in the Southern Hemisphere, have been thought to be the product of vicariance evolution. Vicariance is defined as the division of a species' geographic range by a barrier brought about by a historical occurrence, such as the uplift of mountains or the tectonic rifting that created the oceans. Congruent biogeographic patterns should be produced among different clades as a result of allopatric speciation episodes being encouraged by the establishment of such barriers.

Modern Birds' Spatial and Temporal Diversification

Although contemporary birds, Neornithes, are the only surviving lineage of dinosaurs and form a well-supported monophyletic lineage, they bear little resemblance to Tyrannosaurus or Stegosaurus. The split between the remaining lineages known as Neognathae and the Palaeognathae, which included the ratites and tinamous, was the first instance of divergence within Neornithes. Within the latter, there is a division between the Neoaves, a clade that includes all other living birds, and the Galloanseres, which includes all land- and waterfowl. Both morphological and molecular data strongly support the basic evolutionary relationships of modern birds.

The majority of bird species still living today and various groupings like gulls, herons, hummingbirds, owls, parrots, penguins, pelicans, raptors, and songbirds are all members of the clade of Neoaves. Even when using genome-wide molecular data, the evolutionary relationships between the many basic lineages within Neoaves remain debatable and have not been conclusively resolved. Because of their fast and seemingly near-simultaneous radiation after the Cretaceous-Paleogene (K-Pg) mass extinction 65 million years ago, the early branching pattern in the development of the many Neoaves lineages may be difficult to resolve. One of the three biggest mass extinctions of the Phanerozoic (the last 541 million years) occurred towards the end of the Cretaceous and was brought on by the collision of a giant asteroid in Chicxulub, Mexico. All dinosaur species—aside from modern birds—went extinct as a result, including pterosaurs, ammonites, and rudists. The theory that modern birds developed by an explosive radiation among the few remaining lineages after this global disruption was based on a study of the fossil record. major molecular phylogenetic proposals, however, which dated the divergence among major crown clades of current avian taxa, including Passeriformes, before the K-Pg boundary, called into doubt this scenario. Lineages in Australia, Southeast Asia, Africa, and Madagascar exhibit overall comparatively low diversification rates, whereas parts of Northern Asia, high-latitude North America, and southwest South America showed generally high diversification rates and a relatively high prevalence of clades with exceptional rates.

Given that several ancient radiations have Australian or African origins, this may be the result of impacts of density on diversification. It is generally accepted that diversity (species richness) within a clade does not increase continuously with age but instead may reach an equilibrium diversity regulated by ecological limits in a given area, leading to a decoupling of clade age and species richness as well as speciation and extinction rates dependent on diversity. According to certain studies, there are still prospects for bird diversification from the late Eocene (about 50 Ma) onward, and equilibrium diversity may not have been reached yet. A general characteristic of (adaptive) radiations among single clades of birds at greater geographic scales, such as in dynamic continental ecosystems with continuous ecological opportunity, may be the absence of any pause in diversification.

Patterns of Global Distribution and Diversity

Birds are now found practically everywhere on Earth, they can nest on every continent, and they can survive in a wide variety of environments. But no one bird species can be said to be really cosmopolitan, that is, to exist on every continent. However, some species, like the Osprey Pandion haliaetus, which breeds on five continents and visits South America as a nonbreeding visitor, are almost cosmopolitan. These include the Peregrine Falcon Falco peregrinus, which breeds on all continents except Antarctica.

Pelagic and long-distance migratory birds may also go farther afield throughout their annual migration cycles. The term "narrow endemic" refers to a species that has a very limited range and is confined to a small oceanic island or a specific environment within a constrained geographic area. For instance, the Sombre Rock Chat Oenanthe dubia is only likely to exist in a tiny area of Ethiopia's Upper Awash Valley, where it exclusively inhabits rocky slopes with a few patches of grass and plants. Hawaiian honeycreepers and white-eyes on Pacific Ocean islands are well-known examples of unusual oceanic island endemic passerine species with extremely constrained ranges and very low populations.

Geography of Speciation

In general, speciation, extinction, and colonization are the causes of species richness within a particular area. The latter step entails the spread of a species to a region where it has never before been found, followed by the formation of a healthy breeding population. The creation of reproductive isolation among populations marks the end of speciation, which is characterized by the buildup of genetically based divergence between them. The many stages of this speciation continuum are the subject of several species conceptions, and various mechanisms might result in reproductive isolation. There are various ways to approach the speciation process. One examines the causes and processes that lead to reproductive isolation, whereas the other takes speciation within a geographic context. Allopatric speciation, which occurs when diverging populations are geographically separated from one another without any gene flow, occurs in birds and many other animals. Range extension, range fragmentation, the evolution of reproductive isolation between the geographically separated populations, dispersal into a secondary contact zone, and finally cohabitation in sympatry are the various processes involved. If the range is split by the establishment of a physical barrier as a result of geological events like montane uplift, range fragmentation may progress via vicariance. As was the case periodically during Pleistocene glacial cycles over the previous 2.5 million years, and notably over the last 1 million years when climate changes were at their most intense, populations can also become split by habitat fragmentation due to climate change. The colonization of an isolated, formerly uninhabited location can also lead to allopatry. It is frequently referred to as peripatric speciation if it involves a subset of the original population colonizing a small new location, such an oceanic island, as a result of a founder event.

Divergent selection pressures brought on by ecological differences in the separated populations may hasten their divergence, but the lack of gene flow between separated populations during allopatric speciation per se favours divergence. Allopatric speciation appears to be the most prevalent method of bird speciation since the majority of speciation episodes in birds entailed some phases of allopatry without gene flow, according to widely held beliefs. Despite continued gene flow at least at the beginning of their divergence, two geographically separated populations can still become reproductively isolated from one another; this process is known as parapatric speciation. There have been identified three types of parapatric speciation. In a clinal speciation model, adaption to local environmental factors may cause population divergence along an environmental gradient. Speciation can also simply happen from a population's geographic location, with populations in the middle and at either end of a continuous distribution area gradually diverging while still exchanging genes. Two populations are divided by a barrier in the island model of speciation, but the barrier is permeable, so the populations still exchange genes to some extent. When immigrants (and their descendants) have poor reproductive success or when movement between nearby groups is curtailed, reproductive isolation may develop. The ring species model is a particular instance of distance-based speciation.

Adjacent populations may continue to exchange genes as an ancestral population grows around a barrier, while gene flow between distant populations steadily decreases. When the populations at the expansion front's opposite ends finally meet after spreading out around the barrier, they may have achieved reproductive isolation from one another.

II. Discussion

Most significantly, it must be demonstrated that there was no allopatric stage during the divergence of two current and sympatric sister taxa. In other words, the possibility of geographic isolation must be ruled out and the first divergence must have happened sympatrically. African indigobirds of the genus Vidua are one of the bird species where sympatric speciation seems to have occurred most frequently. They are all host-specific brood parasites and this group of songbirds, which includes waxbills, munias, and allies (Estrildidae), is widespread in Western and Southern Africa. The host species, or their foster parents, is where male indigobirds acquire their songs. Females favor mating with males who imitate the song of their adoptive parents. The assortative mating process in indigobirds definitely results in high cohesiveness between hosts and parasites, in contrast to several parasitic cuckoo species where distinct "host-specific" females mate freely with males. As a result of learnt behavior, a female switching to a new host may cause simultaneous sympatric divergence. Her children are likely to mate with siblings or the offspring of another female who switched to the same new host species, and they will pick up the song from their new host. Allochronic speciation, which has been suggested to occur on several archipelagos in the Pacific and Atlantic Oceans home to the Band-rumped Storm Petrel Oceanodroma castro, occurs when two sister populations diverge due to temporal separation of their breeding periods. This is another example of speciation without geographic separation.

Dispersal vs. Vicariance: The Dynamics of Bird Range Evolution Every bird species is confined to a specific geographic area, which is referred to as its range, or it only exists in a specific habitat or climatic zone. Although the ranges of individual species vary greatly, there are some groupings where the distribution patterns are startlingly similar. Such global-scale biogeographic patterns in many bird groups have long been attributed to vicariance, which has historically dominated historical biogeography. Vicariance is defined as the geographic divide of a species' range caused by the creation of a barrier as a result of historical occurrences like ocean formation owing to continent shifting or montane uplift. It was believed that synchronous allopatric speciation events could have resulted from such historical events, causing congruent biogeographic patterns in several clades. It was believed that vicariant evolution caused by the breakup of the supercontinent Gondwana from c. 160-30 Ma would explain such biogeographic patterns as various species of taxa, including birds, had different Southern Hemisphere distributions. The contemporary landmasses of Africa, the Arabian Peninsula, Antarctica, Australia, the Indian subcontinent, Madagascar, and South America were all part of this ancient supercontinent in the Southern Hemisphere.

The fragmentation of the Gondwanan continent was believed to have influenced the diversification of the palaeognathae, which have been regarded as a textbook example of vicariant evolution. The rheas of South America, the ostriches of Africa and formerly the Arabian Peninsula, the emus and cassowaries of Australasia, the kiwis of New Zealand, the extinct elephant birds of Madagascar, and the tinamous of the Neotropical region are all members of the group that lack the ability to fly. Physical barriers as a result of terrain changes may still offer plenty of room for allopatric speciation in birds, even though the impact of vicariance, particularly through continental separation, has definitely been overstated in the past. However, a study of the temporal and spatial patterns of diversification in 27 lineages of widespread Neotropical birds showed that landscape alterations might not result in congruent temporal diversification among various avian taxa. The Andes, significant

Amazonian rivers, and the Panama Isthmus are just a few examples of the various landscape barriers that disrupt the distributions of the taxa in these lineages. But among the several taxa examined, no synchronous divergence across these various barriers was discovered, and as a result, no consistent impact of landscape alterations was detected.

Instead, within a matrix of a spatially oriented terrain, the barriers were semipermeable. The age of the relevant lineage was closely associated with diversity. This suggested that lineages that had endured within a particular terrain for a longer period of time had more time to distribute across obstacles and consequently more opportunity to differentiate across them. Lineage diversity was also significantly impacted by ecology. The diversity of lineages inhabiting the understory of tropical forests was much greater than that of more mobile groups residing in the canopy.

Genetic variations appear to have accumulated more quickly in lineages with poor dispersal capacity. Overall, the patterns of diversification in these Neotropical avian lineages are driven only indirectly by changes in the landscape and are the outcome of interactions between the ecological characteristics of the various lineages and their habitat as well as the age of a given lineage. This demonstrates how dispersal is a key factor in allopatric speciation in birds. The rate at which sister lineages reach sympatric ranges after speciation in spatial segregation is connected with their dispersion ability, and dispersal generally speeds up global range expansions in birds.Therefore, dispersion plays a key role in determining how species assemblages change through time and space. However, the dynamics of range expansions in birds are not just constrained by physical obstacles, time, and the capacity for dispersal.

Geographical ranges are typically constrained by a number of biotic and abiotic variables, including as competition, climate, habitat restrictions, feeding and nesting sites, predators, parasites, and infections. In general, winter temperatures may severely restrict bird ranges at higher latitudes, but competition may be more significant in tropical regions. Interspecific competition is challenging to identify in field investigations and is challenging to test for in controlled settings, therefore the relative role of biotic variables in limiting species ranges is debatable. To assess if competition plays a part in limiting species distributions, phylogenies and ecological data might be integrated. In a study of ovenbirds (Furnariidae), a family of ecologically complex and species-rich Neotropical birds that includes woodcreepers, Pigot and Tobias demonstrated that rates of secondary sympathy rise over time in pairs of sister species following diversification.

III. Conclusion

The explanation above suggests that, assuming that lineages become more ecologically diverse the further apart they are, biotic interactions may be significant in restricting range overlap between closely related species. In agreement, species pairs that differ in ecomorphology in relation to resource utilization and foraging strategy also showed rapid transition rates to sympatry. The expansion of species diversity at the level of communities among songbirds in the Eastern Himalayas is also influenced by biotic interactions. Due to competing biotic interactions brought on by the occupied niche space, diversification appears to be constrained by the inability of new species to enlarge their ranges and populate the local area (Price et al. 2014). Range expansion affects the number of coexisting species after lineages have split ecologically and/or acquired reproductive isolation in allopatry, making it a crucial second stage in the process of speciation as well. Thus, it influences how biodiversity changes across time and space. Therefore, one of the requirements for anticipating range shifts and biodiversity patterns under ongoing human-induced climate change is understanding the evolutionary processes of range expansions and range constraints.

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