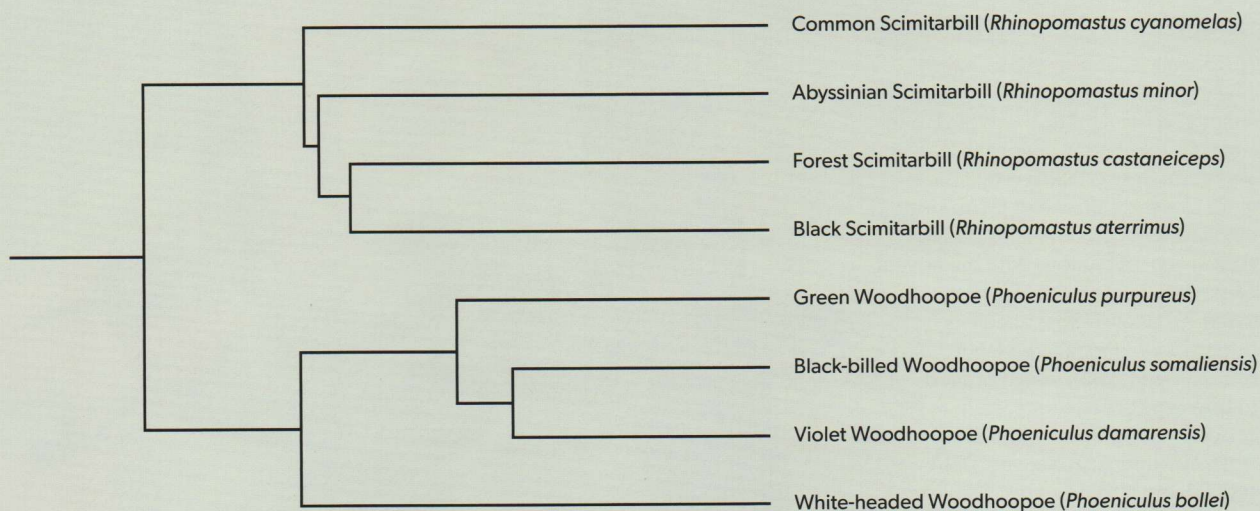


Avian Phylogeny: An Evolutionary Tree for Birds

A phylogeny shows how species are related to one another and displays information about how long ago two or more species shared a common ancestor, revealing the greater patterns at play in evolution.



A **clade** is a portion of an evolutionary tree in which all the species descend from a common ancestor. In the snippet above from the phylogenetic tree in the order Bucerotiformes, any grouping of species that can be traced in their roots back to a single point form a clade—such as all of the scimitarbills and all of the woodhoopoes, or just Forest and Black Scimitarbills and just the Black-billed and Violet Woodhoopoes. Clades indicate direct lines of evolutionary descent.

Who is the closest relative of the Chimney Swift? (SEE ANSWER ON NEXT PAGE)



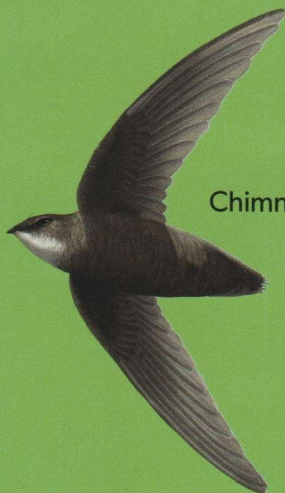
Lynx Edicions illustrations: Chimney Swift and Northern Rough-winged Swallow by Alex Mascarell Llosa, Leach's Storm-Petrel by Juan Varela, and Ruby-throated Hummingbird by Dave Nurney. Note: bird illustrations not drawn to scale.

DNA Tech Is Making Phylogenies Easier to Construct—and More Accurate

Historically scientists constructed phylogenies of birds by identifying shared physical traits; if two birds had similar beak shapes or vocal organ structures, it was inferred that they were closely related. But those kinds of inferences could be false due to convergent evolution. With the advent of modern genetic analysis techniques in the 1970s and '80s, scientists began looking for shared DNA sequences instead, which proved to be a far more accurate way of determining which birds are close evolutionary relatives. DNA sequencing also provides scientists with thousands of times more data, which means evolutionary comparisons can be conducted at much larger scales—resulting in larger and more accurate phylogenies.



ANSWER: Ruby-throated Hummingbird



Chimney Swift



Ruby-throated Hummingbird

Swifts and hummingbirds look and behave very differently. Swifts are insect-eating swoopers that catch flies and airborne bugs on the wing, whereas hummingbirds are nectar-eating flower-sippers that can hover in midair. Yet swifts and hummingbirds are connected in evolution by a common ancestor and classified in the same clade.

The anatomy of swifts and hummingbirds holds clues that they're related; both birds have tiny feet covered in bare skin, and both have short, thick humerus bones in their wings that facilitate their impressive flying abilities.

Swallows and storm-petrels somewhat resemble swifts and hummingbirds, but that's a case of convergent evolution. The cigar-shaped bodies shared by swifts and swallows are favored for cutting through the air in search of prey. Storm-petrels independently evolved a favorable wing structure for hovering, though in the case of petrels they hover to snatch zooplankton off the surface of the sea.

Who is the closest relative of the Downy Woodpecker?



Downy
Woodpecker



Hairy
Woodpecker



Lesser Spotted
Woodpecker



White-headed
Woodpecker

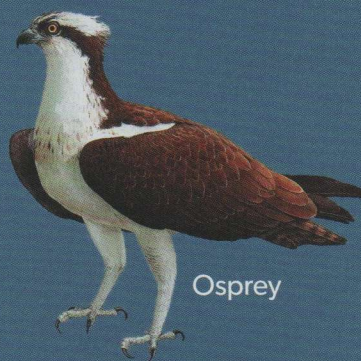
Who is the closest relative of the Peregrine Falcon?



Peregrine
Falcon



Sharp-shinned Hawk



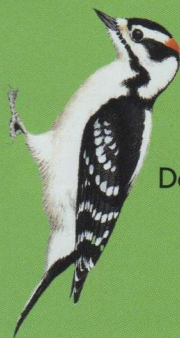
Osprey



Red-lored Parrot

Lynx Edicions illustrations: Downy Woodpecker, Hairy Woodpecker, Lesser Spotted Woodpecker, and White-headed Woodpecker by Ian Willis, Peregrine Falcon by Hilary Burn, Sharp-shinned Hawk by Alan Harris, Osprey by Lluís Sanz, and Red-lored Parrot by Norman Arlott

ANSWER: Lesser Spotted Woodpecker



Downy Woodpecker



Lesser Spotted Woodpecker

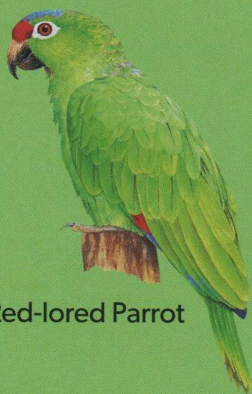
It's easy to confuse a Downy and a Hairy Woodpecker at a bird feeder; the Downy looks like a black-and-white mini-doppelganger of the Hairy. For many years scientists were confused, too—as Downy and Hairy Woodpecker were classified as close relatives, both considered to be members of the genus *Dryobates*. But it turns out, that perfect matching plumage is another case of convergent evolution. The Downy likely evolved feather patterns to make it look like a Hairy so it can confuse predators or competitors for food. By looking like the bigger Hairy Woodpecker, the Downy gains a bit of dominance advantage in the pecking order with other birds.

Recent molecular DNA research has revealed that Downy and Hairy Woodpeckers split apart about 6.5 million years ago. The Downy belongs to a clade that includes Lesser Spotted Woodpecker (which ranges across Europe, Asia, and North Africa), while the Hairy is in a clade with other American woodpeckers like White-headed and Red-cockaded that, somewhat strangely, bear little family resemblance.

ANSWER: Red-lored Parrot



Peregrine Falcon



Red-lored Parrot

Twenty years ago, most taxonomists thought that falcons, hawks, and other birds of prey were closely related. But recent DNA analyses support the classification of falcons in a separate clade from hawks and eagles.

In fact, scientists now know falcons are more closely related to parrots than to any other bird of prey. Falcons and parrots share some features of skeletal anatomy that are likely a vestige of a common ancestry before they split around 68 million years ago.

Hawks and Osprey are more closely related to owls, hoopoes, motmots, and hornbills than they are to falcons.

Who is the closest relative of the Western Tanager?



Western Tanager



Northern Cardinal



Red-crested Cardinal

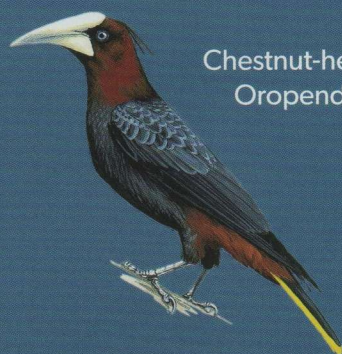


Brazilian Tanager

Who is the closest relative of the Eastern Meadowlark?



Eastern Meadowlark



Chestnut-headed
Oropendola



Yellow-throated
Longclaw



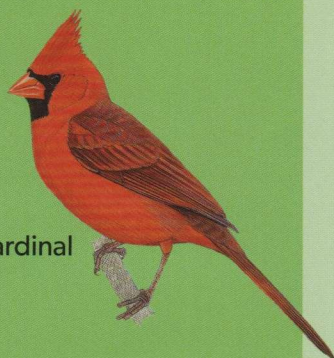
Horned Lark

Lynx Edicions illustrations: Western Tanager and Brazilian Tanager by Hilary Burn, Northern Cardinal and Red-crested Cardinal by Brian Small, Eastern Meadowlark, Chestnut-headed Oropendola, and Horned Lark by Tim Worfolk, Yellow-throated Longclaw by Ren Hathaway

ANSWER: Northern Cardinal



Western Tanager



Northern Cardinal

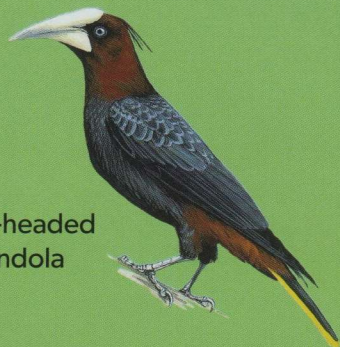
For years, the Western Tanager and other North American birds with tanager names—like Scarlet and Summer Tanager—were thought to be northern representatives of the diverse true tanager clade, which is centered in Central and South America. Recent DNA analyses have revealed, however, that North American tanagers are in fact members of the cardinal family (Cardinalidae).

The true tanagers are in the Thraupidae family, which includes hundreds of colorful birds such as the Brazilian Tanager and the Seven-colored Tanager. Interestingly, a bird called the Red-crested Cardinal in South America—and several other red-crested, seemingly cardinal relatives of that continent—are also in the tanager family.

ANSWER: Chestnut-headed Oropendola



Eastern Meadowlark



Chestnut-headed
Oropendola

When digging into avian phylogeny, it turns out a meadowlark isn't a lark—it's a blackbird.

Eastern and Western Meadowlarks are actually more closely related to Red-winged Blackbirds and grackles (in the family Icteridae) than to the Horned Larks that also occupy open-country grasslands in North America.

Icteridae birds are particularly diverse in South America, where another meadowlark relative can be found. The Chestnut-headed Oropendola is a large bird of tropical forests from Mexico to Ecuador that sports an impressive casque, an extension of its ivory-colored bill that reaches up to the forehead.

The Horned Lark is the only regularly occurring bird in the Americas from the Alaudidae family, which includes so-called true larks such as the Eurasian Skylark and the bush-larks of Southeast Asia. The Yellow-throated Longclaw is a meadowlark look-alike that lives in Africa and is classified in the family Motacillidae, which includes wagtails and pipits (including the American Pipit).

Who is the closest relative of the American Goldfinch?



American Goldfinch



Saffron Finch



Liwi



Verdin

Who is the closest relative of the Kagu?



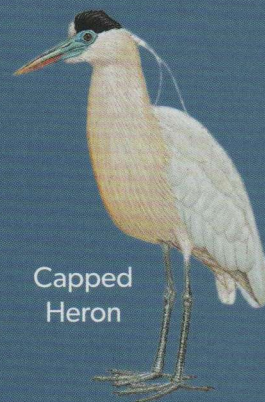
Kagu



Sunbittern



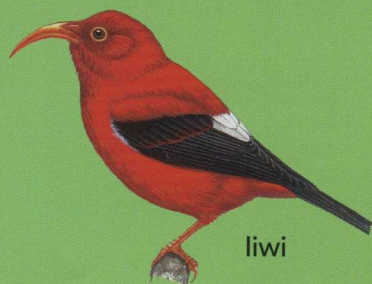
Sungrebe



Capped Heron

Lynx Edicions illustrations: American Goldfinch by Hilary Burn, Saffron Finch by Brian Small, Verdin by Norman Arlott, Liwi by Doug Pratt, Kagu and Sungrebe by Lluís Sanz, Sunbittern by Alex Mascarell Llosa, and Capped Heron by Francesc Jutglar

ANSWER: liwi



The American Goldfinch—a true finch of the family Fringillidae—is one of the most common birds seen at backyard feeders around North America. People love goldfinches because of the breeding male's stunning black-and-yellow plumage.

The Saffron Finch, which ranges from Colombia to Argentina, shares many of the goldfinch's physical features, but it's not a true finch (surprise, it's also a member of the South American tanager family). The Verdin is the only North American member of the Remizidae family, which includes the so-called penduline-tits (like Chinese Penduline-Tit and Yellow Penduline-Tit) that are otherwise all found in Eurasia and Africa.

Meanwhile, the spectacular honeycreepers of the Hawaiian Islands—including the blazing red liwi—are alongside goldfinches in the Fringillidae family. An ancestor of the liwi is thought to have arrived on the islands from Asia about 5 to 7 million years ago, and relatively rapid evolution turned that ancestor into dozens of Hawaiian honeycreeper species.

ANSWER: Sunbittern



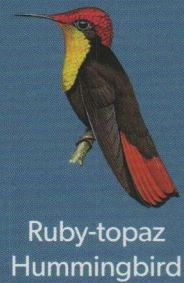
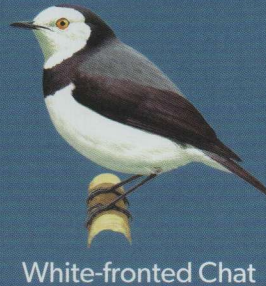
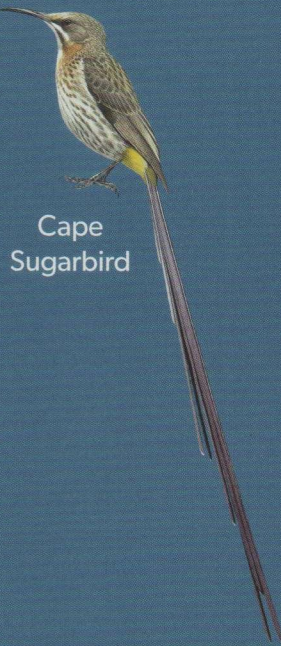
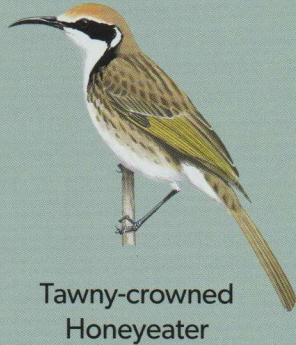
The Kagu is one of the oddest-looking birds in the world—a large flightless species that can perform an impressive spread-wing display to show off boldly patterned wing feathers. A flashy display with flared wings is also a habit of their evolutionary cousin, the Sunbittern.

Kagu are an isolated island endemic species on New Caledonia, an archipelago about 900 miles off the eastern coast of Australia. Sunbitterns, meanwhile, live on the other side of the world, in a range that stretches from northern Central America to Brazil. Both species are also somewhat isolated on the avian evolutionary tree as the only members of their respective families (Rhynochetidae for Kagu, and Eurypygidae for Sunbittern).

Their evolutionary connection goes back to a prehistoric common ancestor that lived on the ancient supercontinent of Gondwana. After the supercontinent broke apart and that ancestor died off (along with most of its relatives), the Kagu was left stranded on remote islands in the South Pacific, and Sunbittern in the forested heart of Central and South America.

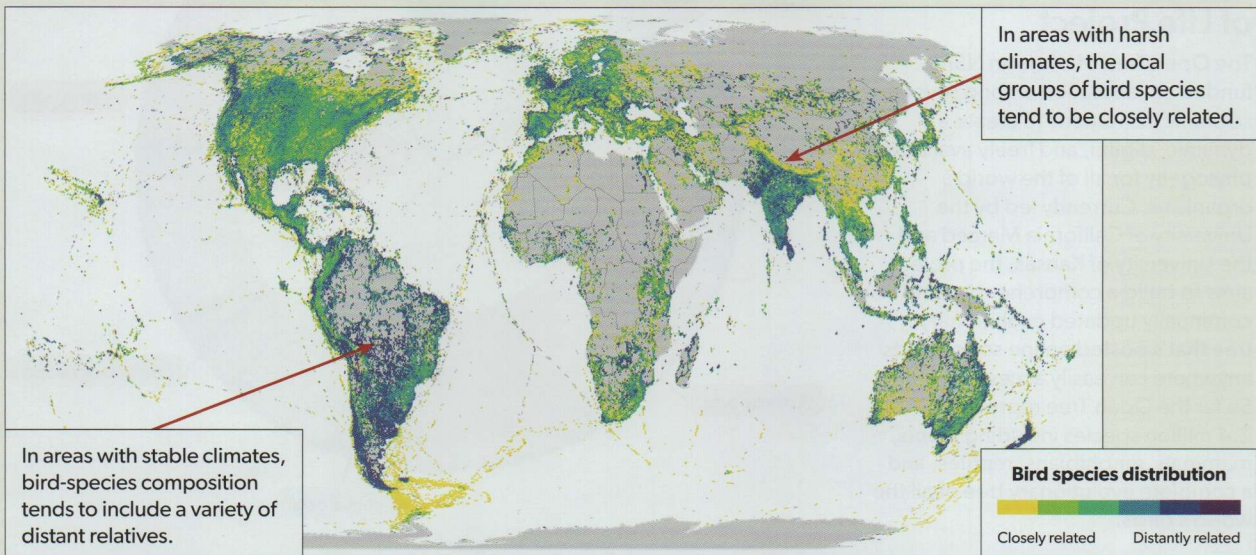
The Sungrebe (which isn't really a grebe) and Capped Heron are also evolutionary oddballs, the sole members of their own genera—*Heliornis* for the former and *Ptilerodius* for the latter.

Who is the closest relative of the Tawny-crowned Honeyeater?



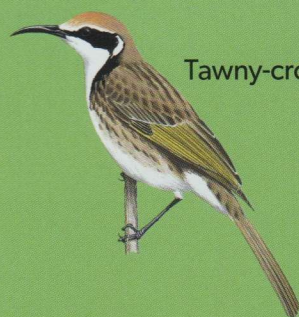
Phylogeny and Evolutionary Biology

Phylogenies can reveal how evolution plays out across space and time. For example, a geographic analysis of bird distributions ranked by their evolutionary relationships reveals that close relatives tend to be clustered together in their own groups in harsh climates and at high elevations (likely because these closely related birds all have traits that allow them to survive where other birds can't). On the other hand, stable climates seem to support a wider diversity of evolutionary lineages, resulting in communities of birds with more distantly related species.



Lynx Edicions illustrations: Tawny-crowned Honeyeater by Tim Worfolk, Cape Sugarbird by Ian Lewington, White-fronted Chat by Chris Rose, and Ruby-topaz Hummingbird by Hilary Burn; map from "A complete and dynamic tree of birds," posted on the bioRxiv preprint server for *Biology* on May 22, 2024.

ANSWER: White-fronted Chat



Tawny-crowned Honeyeater



White-fronted Chat

Nectar-feeding birds the world over provide an excellent case study of convergent evolution—hummingbirds, sugar-birds, sunbirds, honeyeaters, and honeycreepers have all evolved remarkably similar-looking long bills adapted for poking into flowers. Yet these five families of birds all come from far-flung regions of the avian phylogeny.

The nearly 200 species of the honeyeater family (Meliphagidae, which includes Tawny-crowned Honeyeater) live in Australia and islands of the surrounding region. Also in Australia lives another bird called the White-fronted Chat—which doesn't resemble a honeyeater much at all. White-fronted Chats are hardcore insectivores that only occasionally visit flowers. Notably, White-fronted Chats have brush-tipped tongues like honeyeaters and other nectarivorous birds (the better for slurping up nectar).

It turns out the White-fronted Chat is a long-lost honeyeater relative, and the brush-tipped tongue is a vestige of its nectar-sipping evolutionary history.



The Open Tree of Life Project

The Open Tree of Life is an NSF-funded collaboration among several scientific institutions to create a dynamic, digital, and freely available phylogeny for all of the world's organisms. Currently led by the University of California Merced and the University of Kansas, the project aims to build a comprehensive and continually updated evolutionary tree that's posted online so scientists anywhere can easily access it. So far the Open Tree represents 2.4 million species including plants, mammals, amphibians, reptiles, and a complete evolutionary tree of all the world's birds.

