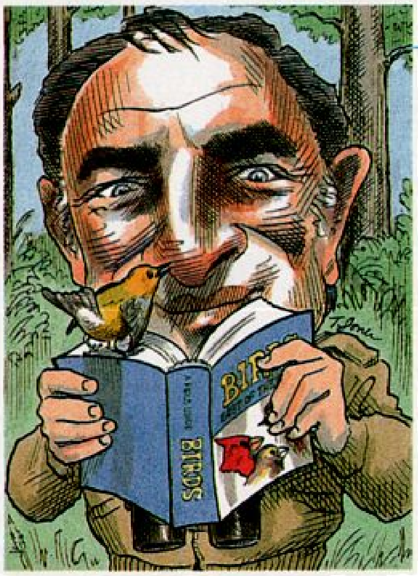


Paul R. Ehrlich

Evolutionary Theory and Birding

> ***"Knowing something about evolution adds a great deal to the enjoyment of the avian world because it helps us understand and interpret the things we see...Why does the Northern Cardinal framed in my binoculars have a thick,stubby bill when the Black-and-white Warbler I was just looking at have a slender one?***

NOW WHAT COULD EVOLUTIONARY theory have to do with birding, and especially with beginning birders? Well, it turns out that the answer is, "quite a lot." Knowing something about evolution adds a great deal to the enjoyment of the avian world because it helps us understand and interpret the things we see.

For example, the notion that birds sing to give people enjoyment wasn't doomed until Darwin developed the theory of evolution by natural selection. In essence, Darwinian theory says that the name of the game is to out-reproduce the members of your population carrying genes different from yours. Whoever has more surviving, reproducing offspring is the winner in the evolutionary game, since his or her characteristics will become more common in future generations of the population. Singing for human pleasure could not have evolved unless everywhere in the world, for millennia, people had been feeding or protecting the best singers in each bird population and ignoring or harassing the others. So with the publication of his evolutionary theory in 1859, Darwin destroyed the notion that the warbler twittering overhead or a mockingbird loudly mimicking the sound of a squeeking hinge is doing so to please or amuse us.

Theories are simply explanatory models that scientists build—tools they use to help them understand the natural world. The first stage of theory construction usually involves producing a hypothesis, which one can simply think of as a preliminary theory. Hypotheses require extensive testing to see if they can be falsified, since neither hypotheses nor theories can ever be "proved"—just disproved. They can, of course, be *supported* by evidence, particularly by repeated tests that don't disprove them. After a hypothesis has stood many tests, it gradually develops into a theory. Science can be viewed as a webwork of hypotheses and theories that ties together our observations of the world and tries to make sense of them.


ILLUSTRATIONS/DARRYL WHEYE

Northern Cardinals take primarily insects when they are breeding, while a wide variety of weed seeds is the mainstay of their winter diet. They may weather up to 15 winters.

Some theories are so well tested that they seem unlikely ever to be totally overturned. Examples of this would be the theory that the earth revolves around the sun and the general theory of evolution—that all life on Earth today evolved from preexisting life, all of which traces back to one or a few origins of life from inanimate matter billions of years ago.

Other theories, like the theory that natural selection is the dominant evolutionary force, are somewhat less secure. There is some debate even today about how much the process of evolution is controlled by natural selection and how much by other evolutionary forces, although no knowledgeable biologist would claim that selection is not an important evolutionary process. Similarly, not enough is known about how much evolution is constrained by past "decisions." We know that the "decision" of hominids to have large brains (and thus large bodies) makes it highly unlikely they will evolve forms in the future that can fly without the aid of artificial devices. Our descendents almost certainly won't be able to flap around in the treetops following birds they want to add to their life lists! But there is much less certainty about many other possible historical constraints.

The next time you're peering at a bird's bill, trying to figure out if it belongs to a warbler or a vireo remember that it is the product of a long and fascinating evolutionary history."

Understanding a little about the theory of evolution usually leads us to ask the question "why?" more frequently. Why does the Northern Cardinal framed in my binoculars have a thick, stubby bill when the Black-and-white Warbler I was just looking at have a slender one? The powerful triangular bills of cardinals are excellent for husking seeds; the finely pointed tweezers of the warblers are great for snatching up insects. But cardinals eat a great many insects, in spite of their "seed-eating" bills.

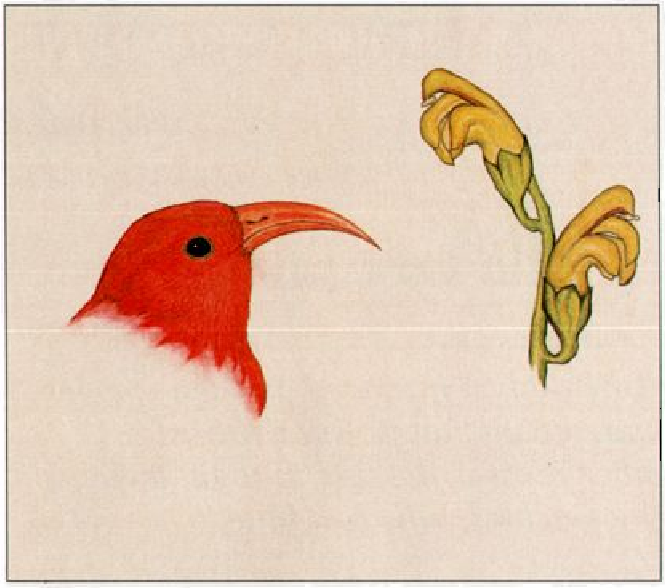
Black-and-white Warblers eat mostly wood-boring insects, bark beetles, moths, and dormant insect larvae. They may survive as many as 11 migrations, traveling as far as northern South America.

Why, then, did the bill difference evolve? We can make an informed guess. Over millions of generations, the ancestors of cardinals that were most likely to survive and reproduce were those that were best able to husk seeds in the winter, when food was short. Unlike Black-and-white Warblers, which migrate to sunnier climes and continue eating insects, cardinals had to evolve the capacity to eat seeds efficiently in winter. It was, and doubtless still is, this stressful, insect-poor environment that favors cardinals with genes for bills that are the best shape for seed-husking. Those individuals whose bills are less efficient at handling seeds tend to die of starvation or become weakened by hunger, which doesn't lead to great reproductive success in the next breeding season. And differential reproduction of genetic types *is* natural selection.

But if that guess is correct, why didn't cardinals emulate Yellow-rumped Warblers, concentrate on berries for their winter sustenance, and evolve a bill like a warbler's? Could it be impossible for a bird with a fully developed finchlike bill to evolve a warblerlike one? In other words, were the structural "decisions" made by the cardinal lineage in the past too constraining? Alternatively, why didn't cardinals (and Yellow-rumpeds) evolve a migratory pattern like that of the Black-and-white Warbler? Is it really easier to face winter shortages than to be subjected to the multiple hazards of long-distance migration?

We have clues to the answer to one of these questions. It seems very likely that cardinals *could* evolve a warbler-like bill if that were to their advantage To see why, consider the Hawaiian honeycreepers, a group of birds related to finches (Johnson *et al.*, 1989, *Condor* 91:379–396). About seven or eight million years ago, an ancestral flock of finches colonized the Hawaiian Islands. The descendants of those colonists underwent an "adaptive radiation," a diversification into an array of species with different ecological niches or "life-styles." Some of the birds remained seed-eaters similar to the ancestral form, but in the absence of competitors, others evolved into nectar-feeders, foliage-gleaners, and creepers.

The different islands of the Hawaiian chain, not the present islands, but *their* ancestors (the archipelago is being continuously formed of lava flowing from volcanoes and being continuously eroded away by Pacific waves) were spaced sufficiently far apart to provide isolated habitats for speciation to occur. When populations are isolated from one another, as they would be with only rare movements of individuals between islands, natural selection can cause them to evolve along different paths. If they diverge far enough in isolation, populations descended from a common ancestor may be unable to interbreed should they regain contact. In that case the populations have gained the status of different species.



`I`iwi primarily feed on nectar, but when visiting the flowers of Clermontia arborescens, *it's native Hawaiian fruit flies they're seeking.*

Palila are most closely associated with mamani trees, feeding on their seed pods and on insects.

The evolutionary flexibility of bill shapes is dramatically illustrated by the variety of shapes found among the species descended from the ancestral Hawaiian finches. The `I`iwi, one of the most common honeycreepers (but one that is declining), has a long, slender downcurved bill which it uses to extract nectar from tubular flowers and also to take insects. The `Akialoa, now probably extinct, had a more slender, downcurved bill, proportionately about twice as long as that of the `I`iwi, which was used to probe for insect food in cracks and crevices. Stranger still is the bill of the endangered `Akiapola`au, which has a long, downcurved upper mandible and a straight lower one only half as long. The lower mandible is used to pry up bark to uncover insects, the upper to probe for prey.

Hawai`i Creepers have bills with a shape somewhat reminiscent of that of a Brewer's Blackbird, but they behave more like nuthatches. Maui Parrotbills have (guess what?) parrotlike bills which they use to split wood in search of insects. And the endangered Palila, which I was lucky enough to see last spring, has a very stubby finchlike bill which it uses to feed on the seed pods of the mamane tree as well as on insects, berries, blossoms, and seeds of other trees. Sadly, this largest of the honeycreepers had a population of only about 3,500 individuals in 1989.

I've only scratched the surface of the marvelous diversity of the Hawaiian honeycreepers, many of which, tragically, were forced to extinction as a result of human colonization of the archipelago. One of the greatest experiences available to a birder is to go to Hawaii and seek out the survivors of this spectacular evolutionary radiation, and see for oneself how unconstrained the evolution of bills can be. I'll not soon forget watching Hawai`i Creepers forage upside down, or holding a netted `I`iwi in my hand, admiring its sickle-shaped bill close up, or the moment just before dusk on the slopes of Mauna Kea when my colleague, Peter Vitousek, and I finally found a Palila and watched it for five minutes feeding ten feet over our heads.

So one evolutionary lesson for beginning birders is that the differences in bill shapes that we all find so convenient for separating LBJs into groups, evolved under natural selection so that those groups could exploit different resources. Indeed, recent studies by Peter Grant and his colleagues working with finches on the Galapagos Islands have clearly detected the process of natural selection fine-tuning the shapes of bills in response to changes in available foods during the onset of a drought.

Like the honeycreepers, these Galapagos finches are the product of an adaptive radiation, but one that has not proceeded nearly as far. The finches attracted the attention of Charles Darwin because they were all very similar to one another except for bill size and shape. They played a role in the generation of his theory of evolution by natural selection; indeed, they are often called "Darwin's finches." Had Darwin visited the Hawaiian archipelago, he might well not have recognized that an even more spectacular radiation had occurred there. Rather he might have assumed that the various honeycreepers, which are so extremely different in bill form, to be unrelated to one another.

So the next time you're peering at a bird's bill, trying to figure out if it belongs to a warbler or a vireo, remember that it is the product of a long and fascinating evolutionary history. Happenstance did not determine its present size and shape, and if the species you are observing continues to evolve, it may have a quite different bill configuration in the distant future.

Bird bills have not just played an important role in evolutionary history, but have also contributed to the development of ecological theory. So in addition to seeing bills in the field, you'll be running across them in this column again before long. ■

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