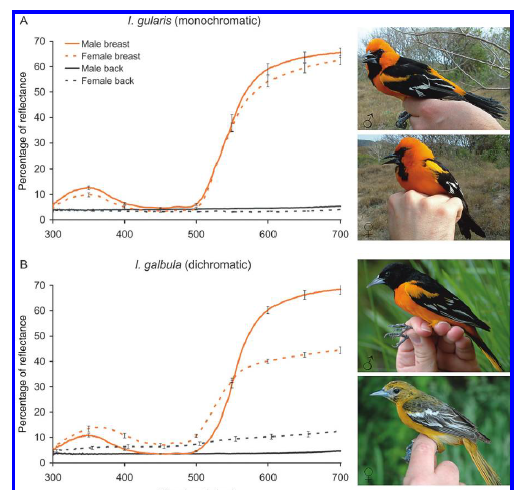
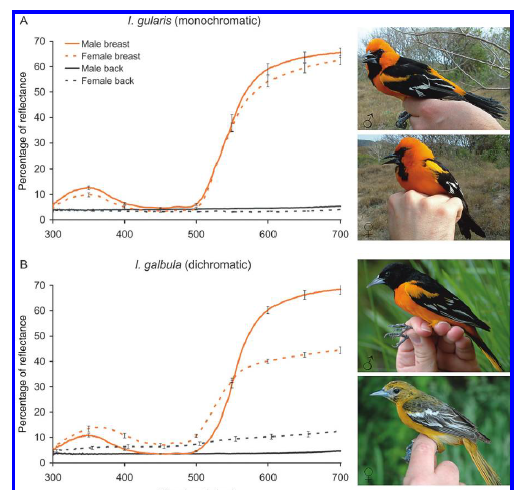
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**Building Evolutionary Trees**:

How did the color patterns in New World Orioles evolve?

**Background**

The New World Orioles are a large family of birds that live throughout the tropical and temperate habitats of North America. All males are various shades of yellow and orange contrasting with black feathers. Females range from dull yellow to bright yellow-orange. Evolutionary biologists, Hofmann, Cronin, and Omlin, wanted to know how female colors evolved in this group. Below we’ll explore this question using 7 species from the New World Oriole family.

**Part 1: Building a tree using physical traits**

**Make a prediction**: Was the female ancestor brightly colored or dull? \_\_\_\_\_various answers\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Instructions***

1. Using the **table of traits** below, the **species cards**, and the **blank tree** on the next page work with your group to arrange the species in the order you think they evolved. Your goal is to minimize the number of trait changes on the tree.
2. When you’ve decided on a solution, write the species names at the tips of each branch.
3. Every time a trait changes, draw a dash on the tree where this happens and write the new trait next to the line (i.e. “female-gray back”). If multiple traits change in one spot, draw multiple dashes and write out all traits.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Male Back** | **Male Color** | **Female Back** | **Female Color** |
| Altimira Oriole | black | yellow-orange | black | yellow-orange |
| Audubon’s Oriole | black | bright yellow | gray | bright yellow |
| Baltimore Oriole | black | orange | gray | medium yellow |
| Black-backed Oriole | black | bright yellow | gray | light yellow |
| Scott’s Oriole | black | bright yellow | gray | medium yellow |
| Yellow Oriole | black | bright yellow | black | bright yellow |
| Yellow-backed Oriole | black | bright yellow | black | bright yellow |
| **Totals** | black = 7 | bright yellow = 5  yellow orange = 1  orange = 1 | black = 3  gray = 4 | yellow-orange = 1  bright yellow = 3  medium yellow = 2  light yellow = 1 |

**Questions:**

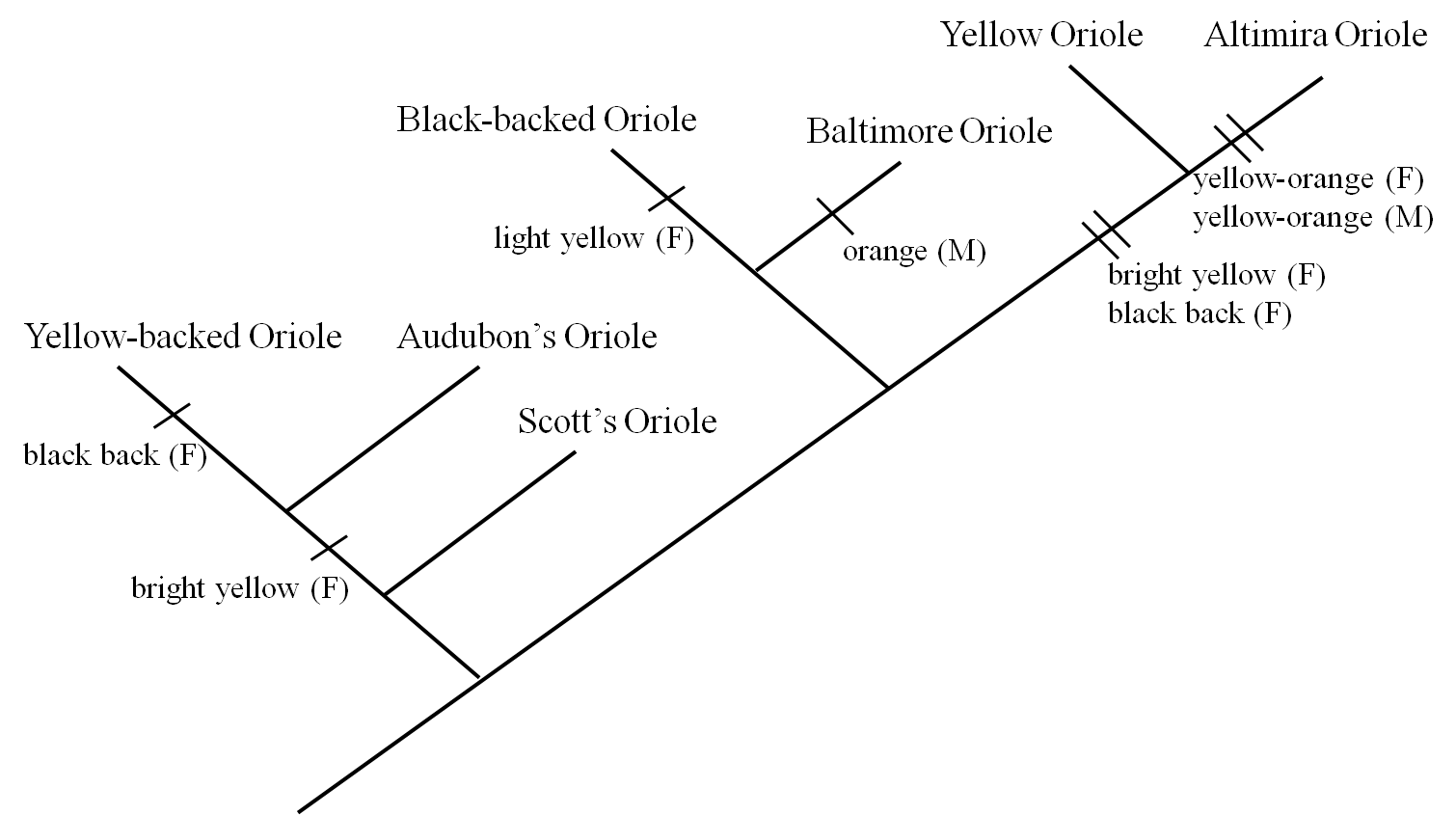
1. What color was the female ancestor to the group?\_\_\_\_\_\_various answers, but should match their tree\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Write a sentence to describe the evolutionary changes, in the order they occurred, to get from the ancestor to the Baltimore Oriole according to your tree. \_\_\_\_\_\_various answers, but should match their tree\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2: Comparing trees built with physical traits vs genetic data**

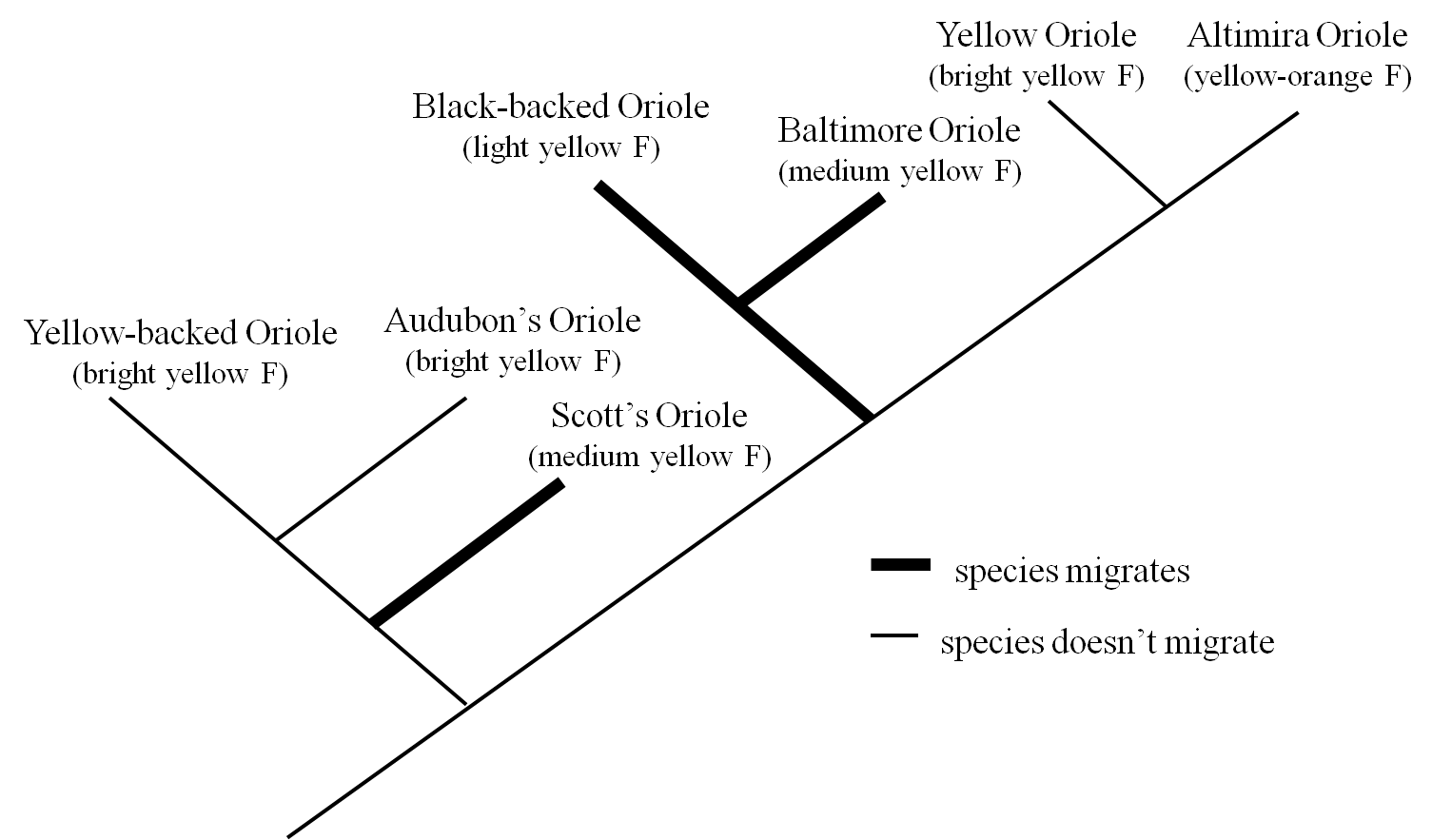
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Above is the published tree that Hofmann, Cronin, and Omlin built using several different oriole genes.

**Questions**

1. What color was the female ancestor on this new tree? How does this compare to your original prediction? \_\_\_\_\_\_female ancestor: medium yellow, gray back; this should be different from original tree in most groups\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. How many times did color traits change on your tree? various answers (Should match tree)\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. How many times did coloration change on this tree built from genetic data? \_\_\_\_8\_\_\_\_\_\_
4. Why might the published tree differ from the one your group built?\_\_genetic data has much more information; contains changes you can’t always see; (more advanced nuance) evolution isn’t always parsimonious – trait may in fact be changing back and forth multiple types for adaptive reasons\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 3: Using trees as tools for new hypotheses**



Evolutionary trees can be useful trees for figuring out if certain traits evolve more frequently in certain environments or with certain life styles than others. On the published tree above migratory behavior is shown in black. All other species spend the whole year in the same area in warm habitats closer to the equator.

**Questions**

1. In which lifestyle are brighter female colors more common? \_\_\_no migration\_\_\_\_\_\_\_\_\_
2. Explain one way that bright female colors could be adaptive in this lifestyle (or that dull colors could be adaptive in the opposite lifestyle)? \_\_\_various answers- just has to make sense\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

References: Hofmann, C.M, Cronin, T.W., Omland, A.E. 2008. Evolution of sexual dichromatism 1. Convergent losses of elaborate female coloration in New World Orioles. *The Auk*. 125:778-789

Friedman, N.R, Hofmann, C.M, Kondo, B., Omland, K.E. 2008. Correlated evolution of migration and sexual dichromatism in the New World Orioles (*Icterus*). *Evolution* 63:3269-3274.