Evolutionary Exemplars

Using cavefishes to address misconceptions about evolution

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Categories of Evolutionary Misconceptions

- Evolutionary Theory
- Natural Selection
- Evolutionary Trees
- Population Genetics
- The Nature of Science
- Acceptance of Evolution
- Implications of Evolution
- Evolution and Religion
- Teaching Evolution

- For more complete information on all of these categories visit:

UC Berkley Misconceptions Around Evolution
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Evolutionary Theory Misconceptions

- Evolution is about the origin of life
- Evolution is random
- Evolution is progressive or leads to improvement
- Individuals can evolve over a lifetime
- Evolution only occurs slowly
- Humans cannot influence evolution
- Genetic drift only occurs in small populations
- Humans are not evolving
- Species are distinct entities with clear definitions

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Evolution as a Non-Random Process

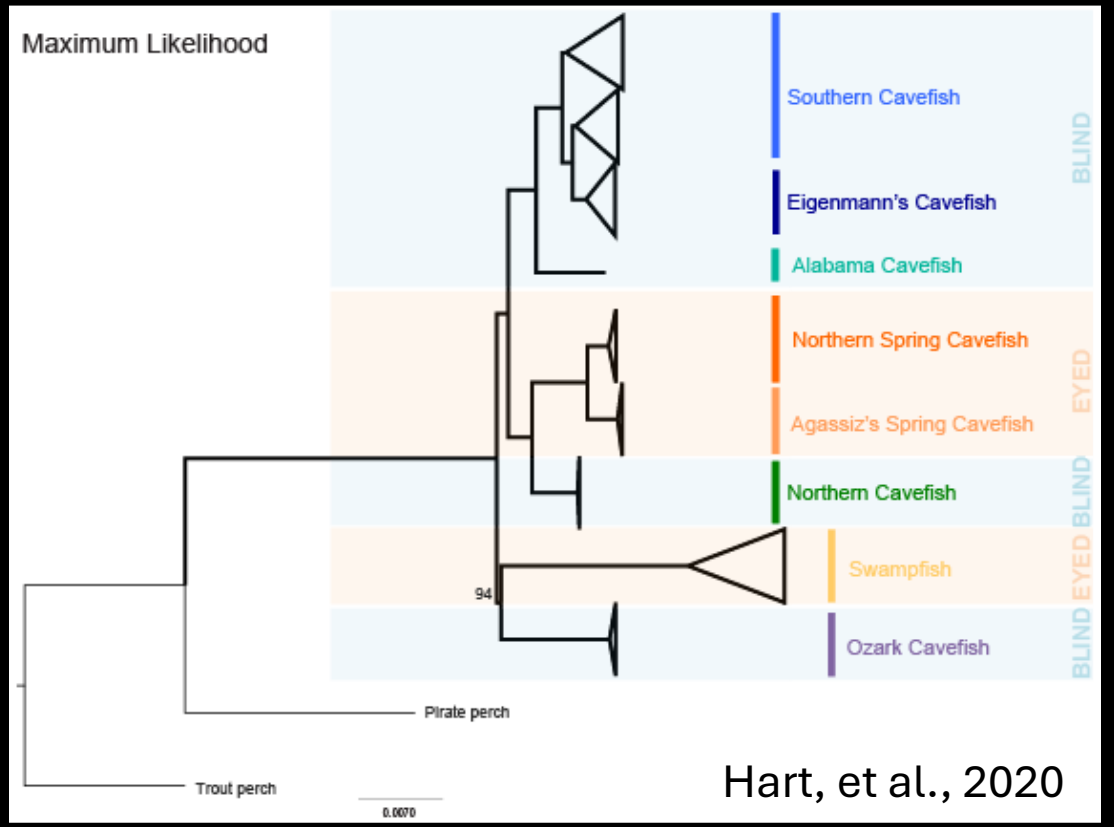
- The most fundamental unit of evolutionary change is mutation
  - The genome within an organism undergoes specific changes over time
  - Such changes ARE random; though the longevity of the organism as a result is not….
- Many mutations have no noticeable impact, some are negative, very few are beneficial
- The total of all mutations within an individual determines how well they survive within an environment
  - We call this natural selection
  - Natural selection is then by definition not random

Evidence of Non-Randomness

- Convergent evolution represents possibly the strongest evidence for the non-random nature of evolution
  - Unrelated groups of organisms will often develop similar traits in response to similar environmental conditions
- Cave dwelling organisms are found all over the world and occur in across the tree of life
- The traits shared by cave dwelling organisms are so prevalent that they have their own name: Troglomorphies

My Study System

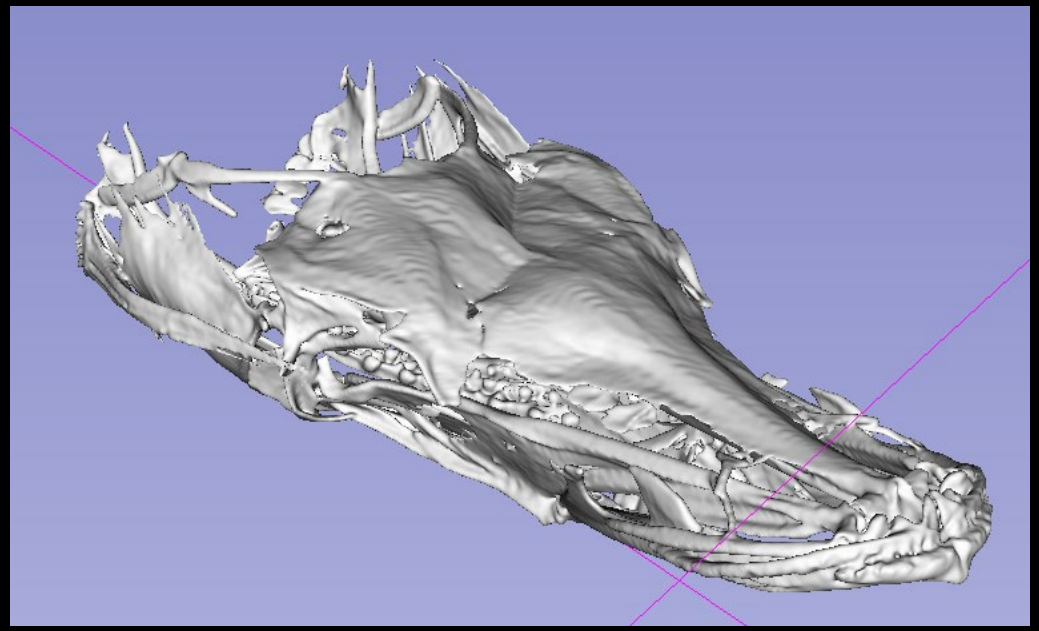
- Fishes within the family Amblyopsidae are endemic to North America and have the greatest number of cave dwelling species on the continent
- Amblyopsids have colonized cave habitats on three independent occasions

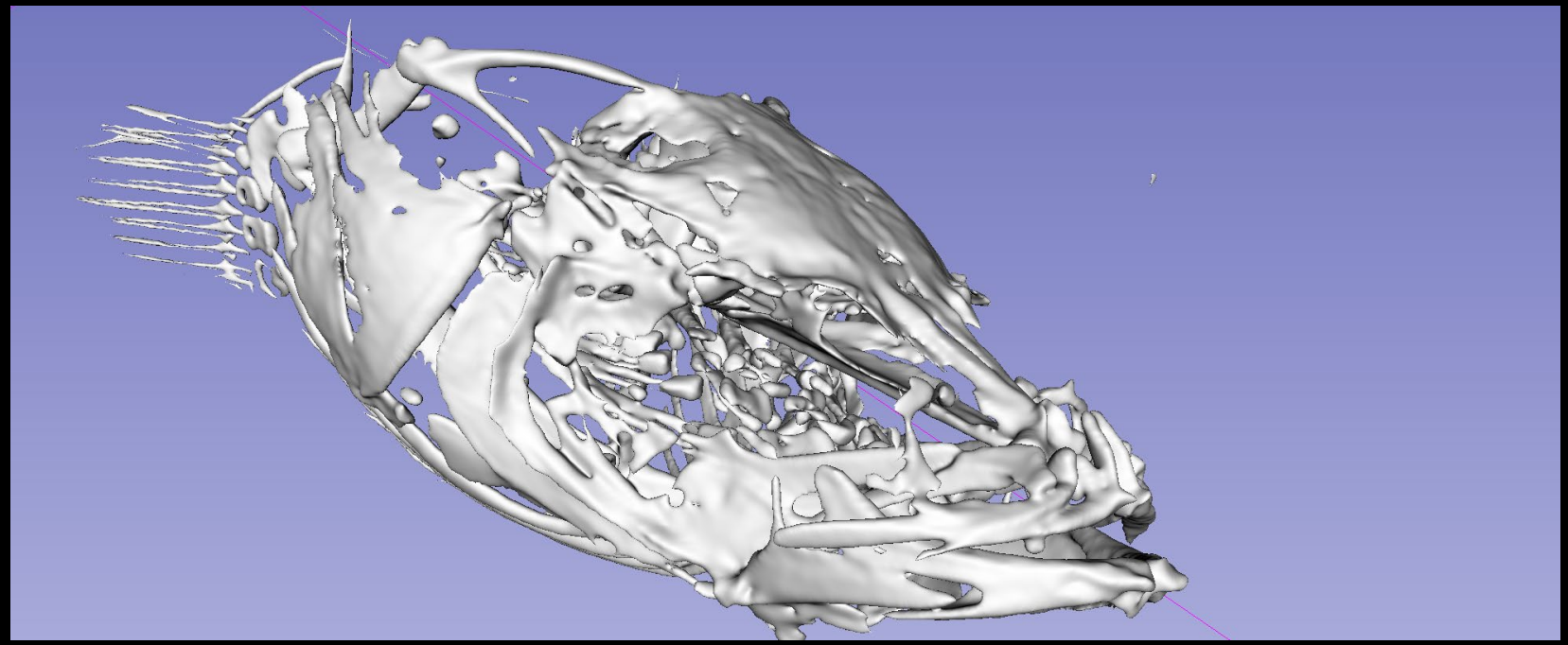


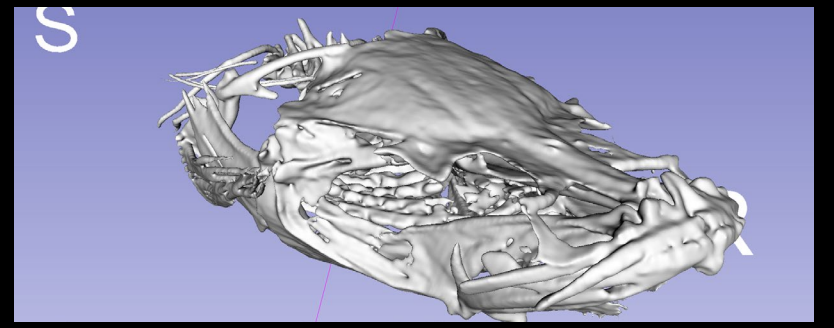
Hart, et al., 2020

My Lesson Plan

- 3D printed skulls of fishes throughout Amblyopsidae with one or two outgroups can be printed (and color coded if desired)
- Students can be asked to examine the skulls and group them based on how they think they are related
- If multiple groups are used; students can share their tree with the class to show the different results
- Once all trees have been presented; the currently known relationships between all species can be shown along with images of the skulls the students used
- This would show how these fishes developed highly similar traits in the presence of similar conditions; which can in turn be applied to other cave organisms from earlier in the lesson



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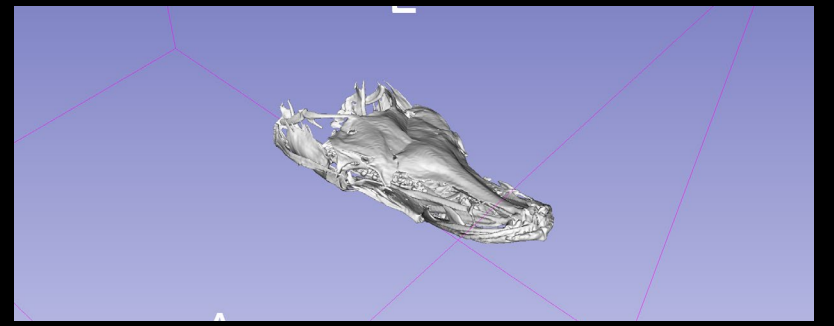

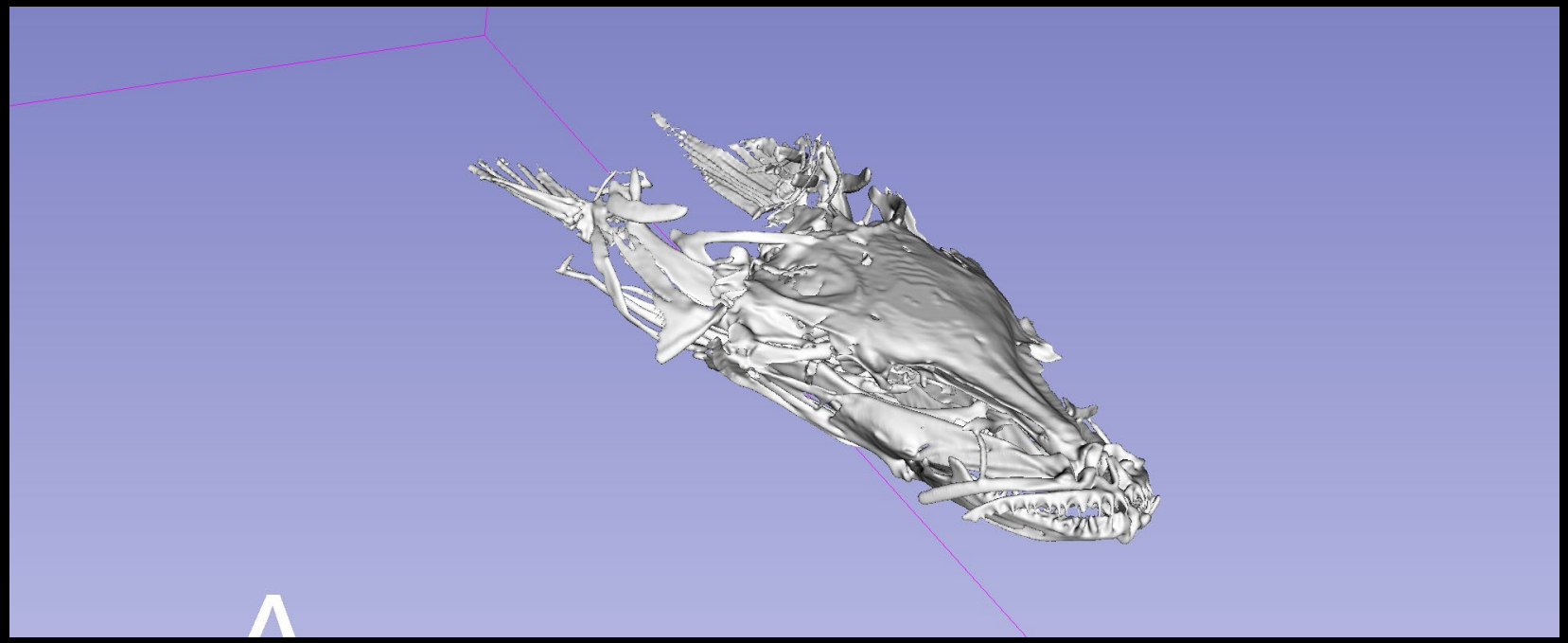
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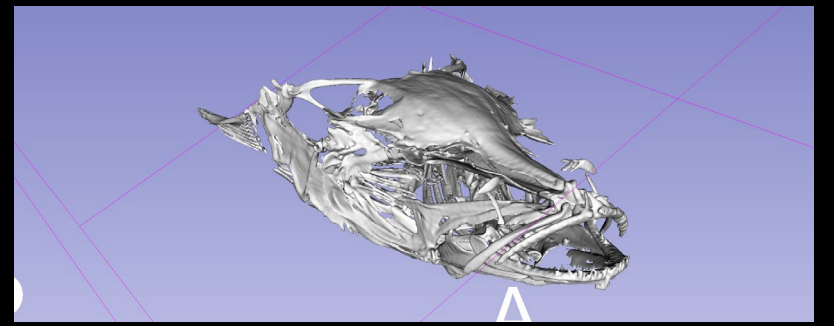
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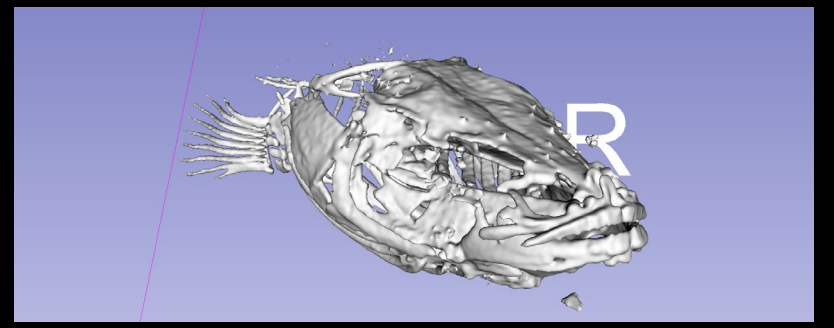
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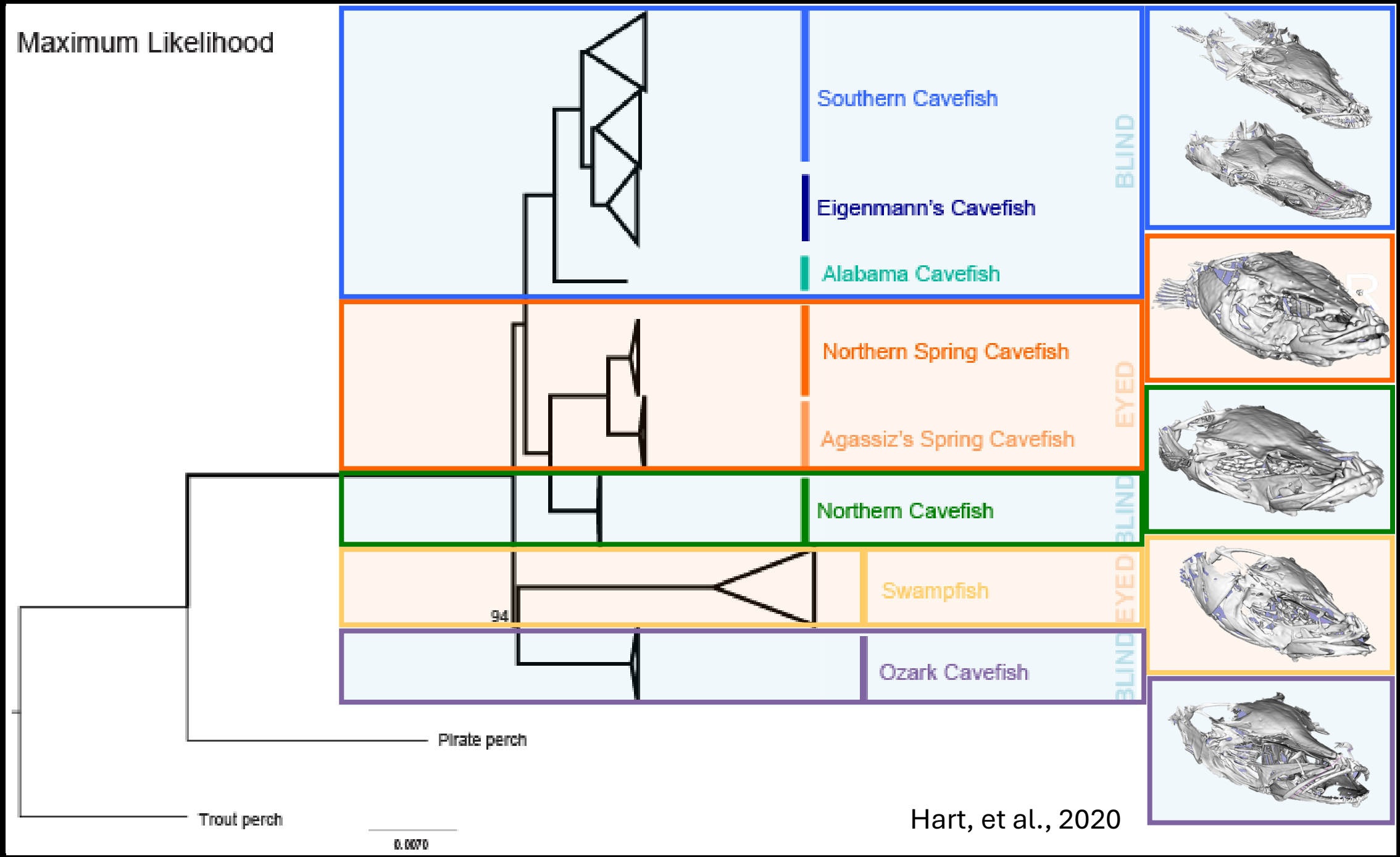

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Evolution Leads to Improvement

- After going over the relationships between Amblyopsids and the skull shapes have the students break into groups and discuss the challenges of a surface fish going into a cave or a cavefish coming to the surface:
  - Do they think blindness or reliance on sight could be an issue?
  - How about the relationship between skin pigments and sunlight?
  - What are the other challenges that caves might impose and how might they be addressed?
- Have the groups share their thoughts in a class wide discussion
- Summarize with the traits that make cavefish so suited for life underground would be extremely unsuitable in surface habitats; just as surface traits are unsuitable for life underground.
  - While surface organisms do successfully colonize underground habitats, such events are very rare as typically the organisms do not survive.