Color Vision Phenotype as a Driving Factor in the Evolution of the Lake Malawi African Cichlids
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INTRODUCTION
1. The 700 species of African cichlids of Lake Malawi are known for their extraordinary variation, although their common ancestor existed only one million years ago.1
2. Color vision enables an animal to distinguish between different wavelengths and frequencies of light. Malawi cichlid species differ from each other with regard to color vision; i.e., certain species can detect certain colors very well, whereas other species cannot.2
3. The diversity of color vision phenotypes in cichlids, in conjunction with the high frequency of colorblindness in human populations, raises the question of whether colorblindness can be advantageous.3,4
4. Colorblind primates, including humans, can distinguish camouflaged objects (prey and inanimate) from their surroundings more easily than color-normal individuals.3,4

In this study, we explored the idea that colorblindness enables an individual to better detect a predatory risk, and that it is an evolutionary advantage that may have driven cichlid speciation.

TABLE 1. Basic characteristics of the two cichlid species in this study.

<table>
<thead>
<tr>
<th>LWS opsin expression</th>
<th>Common name</th>
<th>Habitat</th>
<th>Diet</th>
<th>Temperament</th>
<th>Appearance</th>
<th>Mature size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyrtocara moorii</td>
<td>&quot;Blue dolphin&quot;</td>
<td>Shallow, open, sandy areas</td>
<td>Carnivorous</td>
<td>Mildly aggressive</td>
<td>Less patterning</td>
<td>20 cm</td>
</tr>
<tr>
<td>Cynotilapia afra</td>
<td>&quot;Dogtooth cichlid&quot;</td>
<td>Deeper rocky areas</td>
<td>Vegetarian</td>
<td>Mildly aggressive</td>
<td>Distinct patterning</td>
<td>7 cm</td>
</tr>
</tbody>
</table>

HYPOTHESIS
We predicted that red-blind cichlid species, like Cynotilapia afra, are better able to see red-camouflaged predators than other species, like Cyrtocara moorii.

METHODS
1. Prepare tank with water, bubbles, background, substrate, heater
2. Randomly catch subject and allow temperature acclimation inside beaker (10 min)
3. Release into trial tank and allow environmental acclimation (45 min)
4. Turn off light, remove barrier blocking visual stimulus
5. Turn on camera, turn on light, record trial (5 min)
6. Stop recording, return subject to home tank, clean up trial and scrub tank

RESULTS

CONCLUSIONS
1. Species were equally active during control trials.
2. Both species were less active when the predator was not camouflaged.
3. The red camouflage alone did not have an effect on the activity levels of either species.
4. The red-blind Cynotilapia afra exhibited less activity when the predator was camouflaged; however, the color-normal Cyrtocara moorii showed normal activity levels.

Since the colorblind species was better able to detect the camouflaged object, this phenotypic variation in ability suggests that opsin sensitivities were one of the traits that drove the evolution of cichlids in Lake Malawi.

REFERENCES

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