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Exploratory III

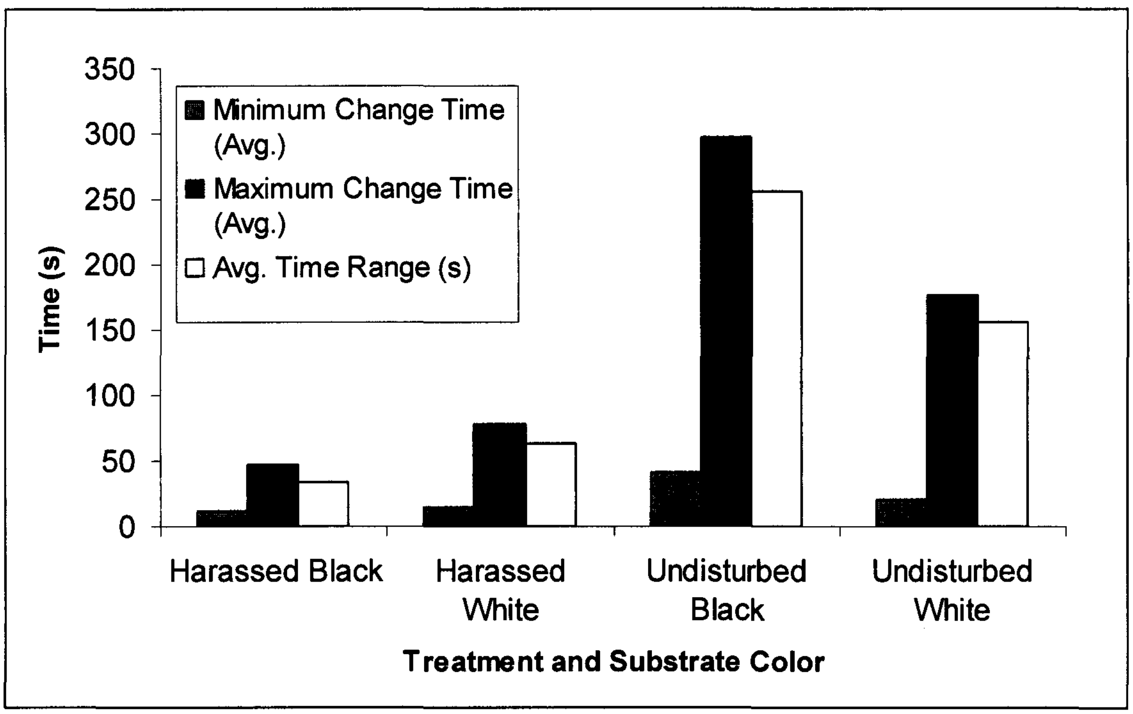
Substrate Color, Harassment, and Color Change in *Clinocottus globiceps*

Introduction: Crypsis, a general term referring to various methods of blending in with one's environment, is used as a predation avoidance tactic by a wide array of terrestrial and aquatic organisms. For a marine benthic fish, this means blending in with the substrate on which it resides. The mosshead sculpin, *Clinocottus globiceps*, is a small marine intertidal fish that can be found in a range of shades from light gray to black (pers. obs). Tidepool substrate also comes in a variety of colors and shades, and many tidepool fishes, such as the tidepool sculpin (*Oligocottus maculosus*), are camouflaged to match their substrate (Houtman and Dill, 1994). However, the tidepool sculpin cannot change its color, and its alarm response (motion vs. immobility) depends on whether it is on substrate that matches its body (Houtman and Dill, 1994). Other fish, such as some darters, have the ability to change color seasonally, but not as an alarm response, and must also select substrate that matches their color (Radabaugh, 1989). After *C. globiceps* was observed to actively change its shade, it inspired the following question: does *C. globiceps* always change its color to match its substrate as a preemptive measure, or is this an alarm response activated by threat of predation? My hypothesis is that *C. globiceps* changes color as an alarm response, and will only change color when harassed.

Materials & Methods: Four *C. globiceps* individuals were collected from Cape Arago's Middle Cove, Oregon, USA, and allowed to acclimate to laboratory conditions for over a week. Their "default" substrate color was that of the water table, which is a sandy yellow. For each trial, all four fish were moved into a glass bowl, which was then placed on whichever substrate color (light or dark) they did not already match. For the "undisturbed" treatment, they were placed on the substrate as carefully as possible and left alone; for the "harassed" treatment, they were placed on the substrate and then poked, picked up, stirred, etc. until all had changed colors. Elapsed time was recorded from the moment of placement on the substrate and the fastest and slowest color change times were noted; the elapsed time between these two values (time range) was also recorded. Values were averaged for all twelve trials of each treatment, as well as for trials on each substrate color within each treatment.

Results: Overall, there was a significant difference in time of color change between undisturbed and harassed treatments (*Fig. 1*).

Figure 1: Treatment and substrate color vs. color change speed in *Clinocottus globiceps*.



Harassed fish changed color faster than undisturbed fish on both substrate colors. No significant difference in color change time was found between different colored substrates when the fish were harassed. However, when fish were undisturbed, it took significantly longer for all individuals to match black substrate, and there was more variation between the shortest and longest color change times.

Discussion: The faster overall color changes in harassed fish supports the hypothesis that *C. globiceps* changes color as an alarm response. However, the hypothesis is not fully supported, as it does not change color exclusively as an alarm response; all individuals changed color within 10 min. regardless of whether or not they were disturbed. This suggests that they change color preemptively, but will speed up the process as an alarm response. Furthermore, the apparently greater readiness to change to light shades when undisturbed as opposed to darker shades suggests that changing to either shade involves differential levels of effort.

There are some sources of error in this data, however. For instance, although there were four fish, color change times were calculated only for the slowest and fastest of them. If the two "middle" fish changed color at times closer to, for example, the faster fish, then the slower one may just be an outlier rather than a contributor to a general trend; calculating all four times of color change would allow for a weighted curve of color change times and help identify trends more accurately. Furthermore, these fish change color along a gradient from light to dark; it is not a sudden change, so the time of color change is not accurate to the nearest second, as when a fish is "finished" with its color change is a subjective matter. This, however, is a difficult error to compensate for; one may have to simply make sure that the same person makes all observations and assume that this person will be consistent with their judgment.

References

Houtman, R., Dill, L.M., 1994. The influence of substrate color on the alarm response of Tidepool Sculpins (*Oligocottus maculosus;* Pisces, Cottidae). Ethology 96, 147-154.

Radabaugh, D.C., 1989. Seasonal colour changes and shifting antipredator tactics in darters. J. Fish Biol. 34, 679-685.