considerable variation. The same animal was found early in the summer at South Harpswell, Maine, in a similar location. Over restricted areas every square meter held two or three individuals.

Whether this is identically the same species which H. J. Clark discovered in Charleston, S. C., in 1852 and Louis Agassiz first described in 1859 and which was named *americanus* by Verrill in 1862 can only be determined by a competent taxonomist. A number of discrepancies exist between the various accounts of this species in regard both to color and anatomical features (see Verrill, McMurrich and Carlgren). The latter authority has created a new genus, *Ceriantheopsis*, especially for this species.

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THE CONDITIONS OF ILLUMINATION OF THE EYE NECESSARY FOR INDUCING THE DIFFERENT MELANOPHORIC RESPONSES IN *FUNDULUS HETEROCLITUS*

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Previous investigations have established the fact that the upper region of the eye of *Fundulus heteroclitus* is related to the paling response of the body, and the lower region to the darkening (Butcher, 1938). When these different regions were illuminated by mazda electric lamps, it appeared that less illumination was necessary to induce darkening. Accordingly, experiments were undertaken to determine the illumination necessary for darkening and paling.

With a black background below, some animals became dark when receiving as little illumination as 2 footcandles from above. To induce darkening in a majority of the animals, 4 footcandles were necessary, however. Animals responded equally as well to light from a mazda lamp as to light diffused through opal glass. When the black background was removed and non-illuminated space existed below the glass bottom of the dish, the reflected light received by the fish from the glass bottom was usually sufficient to inhibit darkening, regardless of the illumination from above. Thus, the reflected light from below had to be reduced nearly to 0 before complete darkening could be induced by illumination from above.

When the top and sides of a crystallizing dish were black, and the fish were illuminated by an electric lamp from below, even though its brightness was 200 footlamberts, very few fish paled. However, if the light was diffused through white paper or opal glass, and the brightness of the paper was only 1 footlambert, or even less, most of the fish paled. Paling, therefore, depended upon diffuse illumination.

To determine how much of the upper region of the eye had to be illuminated to induce paling of the body, fish in glass tubes were placed so that their heads were over circular-shaped pieces of white paper (the rest of the background below being black). When fish, 50 mm. in length, were used and the illumination was either from above or below, it was found that the circle of paper must be 7 cm. in diameter on the average to induce paling of the body. Circles, 5 cm. in diameter beneath the fish, caused complete paling in some instances, while 9 cm. circles were necessary to induce paling in other fish. Fish paling over a 7 cm. circle usually became slightly pale over a 5 cm. circle and intermediate in shade over a 3 cm. circle. Fish paled equally as well over 7 cm. circles exposed to 450 f.c., as to 100 f.c., or 4.5 f.c. from above. These experiments showed that to induce a paling of the fish, a large area of the upper region of the eye had to be illuminated.

Previous experiments (Butcher 1938) indicated that paling was more easily elicited when the lower region of the eye was not illuminated. To demonstrate that illumination of the lower region inhibited paling, the size of the circle of white paper under the fish which was necessary for inducing paling was first determined. Then, using only half of the circle, the fish was so placed that its longitudinal axis corresponded with the diameter of the circle, leaving only one eye exposed to reflected light from below. In no instance was there a paling of the fish under these conditions. When the eye not over the half circle was enucleated, the fish soon paled. With both eyes intact fish seldom paled over semi-circles having diameters as great as 15 cm. In these experiments the lower regions of both eyes of the fish were illuminated from above when over a half circle while only the upper region of one eye was illuminated by reflected light from below. These experiments definitely showed that illumination of the lower region could inhibit paling.

To sum up the results of these experiments, it may be stated that

1. Illumination of the lower region of the eye by either light from a mazda lamp or diffuse light through opal glass results in darkening of the body;
2. Darkening cannot be induced with much illumination to the upper region;
3. Paling of the body can only be elicited when the upper region of the eye is illuminated by diffuse light;

4. A large area of the upper region of the eye must be illuminated to induce paling;
5. Paling is more easily elicited when the lower region of the eye is not illuminated.

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THE CAUSE OF *FUNDULUS HETEROCLITUS* ASSUMING A GRAY SHADE ON A BRIGHTLY LIGHTED GRAY BACKGROUND

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Sumner (1911, 1929), and Mast (1916) have investigated the cause of fish becoming paler in a white box, dimly illuminated from above, than in a gray box, brightly lighted from above. They have definitely shown that the assumption of the shade of the background by the fish does not depend upon a direct visual comparison between its own surface and the background. It appeared quite probable from their experiments that the ratio between the light reflected from the background and the light from above was the stimulus to the eye which enabled the fish to adjust the shade of its body to the shade of the background.

To learn if the ratio between the light coming from above to that reflected from below determined the shade assumed by *Fundulus*, the following responses of fish and light relations were ascertained with various papers beneath the fish.

TABLE 1.—Light relations and shade of fish's body with different shades of paper below the fish.

Shade of paper below fish (sides of container—black)	Brightness of paper in footlamberts when illuminated with 400 footcandles from above	Brightness of paper when illuminated only from below	Ratio	Shade of fish's body
white	220		400:220 or 50:27	pale
gray 1	160		400:160 or 50:20	pale
gray 2	80		400:80 or 50:10	50% pale 50% slightly pale
gray 3	24		400:24 or 50:3	gray or intermediate
white		1	0:1	pale
gray 3		1	0:1	pale

Gray 1, gray 2, and gray 3 were very close to neutral 6, 5, and 3, respectively, of the Munsell "Book of Color."