EXPERIMENTS ON THE NERVOUS CONTROL OF THE MELANOPHORES IN *FUNDULUS HETEROCLITUS*

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Experiments were undertaken to learn 1) if the melanophores of *Fundulus* in the 'intermediate' color phase, which is assumed in complete darkness or usually upon enucleation of the eyes, were resting or partially contracted; 2) if the melanophores were partially contracted in the 'intermediate' condition, whether it was due to continued excitation by nerves from a brain center in tonic activity; 3) by what path nerves from the C.N.S. reached the melanophores; 4) what parts of the brain controlled the melanophores and to what extent these parts could be demonstrated by section and stimulation; 5) whether nerves could be demonstrated and be stimulated which would cause a darkening and present conclusive evidence of a double innervation of the melanophore.

Cutting the spinal cord anterior to the level of the 10th vertebra with a fine knife caused almost an immediate darkening in 'intermediate' and light-adapted fish while cuts caudal to this level produced no effect. Fish which became dark after section of the cord cephalic to the 10th vertebra remained so for a week, after which they faded to some extent because of the gradual degeneration of the body caudal to the cut. It therefore appeared that in 'intermediate' fish impulses were continually coming down from a higher center which caused a partial contraction, and that when these stimuli were blocked by section of the cord at the appropriate level, the melanophores immediately expanded.

By sectioning the cord and the body at various levels, it was found that nerves emerged at the level of the 10th vertebra and coursed anteriorly and posteriorly in the sympathetic chains to innervate the melanophores. Darkening could be produced in any quarter of the body of a light fish when the part of the sympathetic chain innervating this quarter was cut. Fish with the cord cut caudal to the 10th vertebra, and the entire body wall incised down to the sympathetic chain were still able to adapt both light and dark. Electrical stimulation of the sympathetic chains in the different parts of the body of a dark fish resulted in a lightening of the innervated parts.

Exposure of the midbrain immediately prevented further adaptation, and the animal became 'intermediate', while exposure of the forebrain, cerebellum, and medulla was without effect. It would, therefore, appear that the midbrain region and, possibly, the diencephalon were involved in the mechanism controlling the dark and light phases, and that a center, probably situated in the medulla, continually emitted stimuli for the intermediate condition. Electrical stimulation of either the midbrain or the medulla of a dark fish resulted in a lightening. Cutting the cord caudal to the level of the 10th vertebra in a dark fish, and stimulating the medulla led to a lightening of the entire fish. Cutting only the sympathetic chains posterior to the level of the 10th vertebra in other dark fish and stimulating the medulla produced a lightening cephalad to the cut while the fish remained dark back of the incision. Cutting the sympathetic anterior to the 10th vertebra resulted in a darkening of the anterior end of the fish. Then, when the animal was dark adapted, stimulating the cord caused the animal to lighten caudal to the cut sympathetic.

Since the caudal region of a fish (caudal to the 10th vertebra) was able to adapt both light and dark with the cord destroyed, the body wall incised, and only the sympathetic chain intact, the only possible course of fibers, if any were present, that might cause a darkening when stimulated, would be by way of the sympathetic chain. The cord was cut in several fish anterior to the 10th vertebra, and they immediately became dark. They were then placed in a light tank, and after 10 days when some fading had occurred, the sympathetic chains were electrically stimulated, and immediately a complete lightening resulted rather than a darkening.

From these experiments, it seems logical to conclude that the melanophores in an 'intermediate' fish are in a partially contracted condition, due to stimuli from a center which is in tonic activity. Furthermore, it would seem plausible that inhibition of this tonic center leads to expansion of the melanophores. Supplementing the center with stimuli causes further contraction. Since no nerves have been found whose stimulation resulted in a darkening, it seems possible that the expanded melanophore is in a state of rest.

THE EFFECTS OF COVERING AND ROTATING THE EYES ON THE MELANOPHORIC RESPONSES IN *FUNDULUS HETEROCLITUS*

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To determine whether or not adaptation to light or dark backgrounds was related to stimulation of different portions of the retina, experiments were devised to cut off the light entering the eye from above or below.

In the first experiments thin copper half circles were blackened with paint and fitted into the front of the orbit. This proved unsatisfactory. The eye was depressed and practically no light could enter. Consequently, the fish responded variably when placed in light or dark vessels.

A second method proved satisfactory. A rectangular area around the eye was outlined with stitches under which the ends of thick paper blinders were slipped. These were easily adjusted, did not depress the eye nor produce any other injury and remained securely