

STIMULATION BY ADRENALIN OF THE LUMINESCENCE OF DEEP-SEA FISH*

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Collecting deep sea animals in good living condition is very difficult. Whether affected by change in pressure, or temperature, or asphyxiation in the bottles at the end of the nets, it is unfortunately true that most deep sea forms come up quite dead and motionless. Occasionally they are living.

Through the great kindness of Dr. William Beebe, Director of the Bermuda Oceanographic Expedition of the New York Zoological Society, I have recently had an opportunity of studying the luminescence of a large deep sea fish, *Echiostoma ctenobarba*, two specimens of which, about one foot long, were brought into the laboratory in iced sea water in the living condition. They were caught at eight hundred fathoms.

In *Echiostoma* there is a prominent cheek organ and two rows of large photophores along the ventral and lateral walls besides numerous minute photophores scattered over practically the whole body including the dorsal surface. The cheek organ is partially pink in life and was observed to flash with a decidedly bluish luminescence when the fish was handled, especially when lifted out of the sea water. No other luminescence of any kind could be noted, however, despite the fact that the fish was squeezed and twisted to stimulate it strongly. A hypodermic needle was then inserted but no luminescence additional to that of the cheek organ appeared. However, when a little adrenalin (1:1000 in physiological salt) was injected with the hypodermic into the side about one-third toward the tail end, there immediately appeared a yellowish luminescence of photophores locally, near the point of injection and soon practically all of the photophores of the fish were luminescing with a yellowish moderately intense continuous glow. This lasted a few minutes and then went out and could not be excited again by rubbing or handling but appeared as before on a second, third and fourth injection of adrenalin. The last injection was of ten minims and excited all or-

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gans and also the pectoral and ventral fins. There is no doubt of the luminescence of these fins despite the fact that they do not possess any marked organs. No luminescence was observed in the tail, anal fins, long pectoral rays, or barbel on lower jaw. The cheek organ flashed at intervals after adrenalin injection but did not change in rhythm or in any noticeable way. The flashing of this organ is not due to unscreening of a continuously luminous surface. The light appears and disappears on the organ itself and for this reason we may presume that *Echiostoma* is self luminous and does not harbor luminous bacteria as is the case in the Dutch East Indian fish, *Photoblepharon* and *Anomalops*, which also possess cheek organs.¹

There is no doubt of the stimulating action of adrenalin on these photophores. The observations add a second example of luminous fishes known to be excited to luminescence by adrenalin. The first was the California toad-fish, *Porichthys*, described by Greene and Greene.² It is a surface form, difficult to stimulate in other ways but which gives a brilliant long lasting glow of its eight hundred odd photophores after injection of adrenalin. The fire-fly also glows continuously and brightly after adrenalin injection.³

As the photophores of *Porichthys* receive a very sparse nerve supply, Greene believes that adrenalin acts directly on the photogenic cells. I can state, however, that it does not cause luminescence of the worm, *Chaetopterus*, or of hydroids. In the fire-fly there is considerable evidence of a nerve-muscle mechanism controlling the flash.⁴ Studies of the photophore nerve supply of deep sea fish would be very valuable and are much needed.

It should be mentioned that adrenalin is not a stimulant for light production after a fish has been dead some time. Other dead deep sea fish, and even a feebly moving *Linophryne arborifera* could not be made to light by injecting adrenalin. For the physiologist, the great problem is to get the material in good living condition. It is my belief that increased temperature is the chief lethal factor. When we remember that temperatures a mile deep are four to five degrees Centigrade while the

¹Harvey, E. N. The Production of Light by the Fishes. *Photoblepharon* and *Anomalops*. Pub. No. 312 Carnegie Institution Washington, p. 43, 1922. *Natural History* 25, 353, 1925.

²Greene, C. W. and Greene, H. H. Phosphorescence of *Porichthys notatus*, the California Singing Fish. *Amer. Jour. Physiol.*, 70, 500, 1924.

³Creighton, W. S. The Effect of Adrenalin on the Luminescence of Fire-flies. *Science*, 63, 600, 1926.

⁴Dahlgren, U. The Production of Light by Animals. *Jour. Franklin Inst.* March and May, 1917.

surface water is twenty-five degrees Centigrade, and also that it takes over an hour to haul in the nets, we realize the unfavorable conditions to which these deep sea forms are subject. Perhaps we are lucky to observe luminescence under any circumstances.



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