other lesions in themselves sufficiently grave to have caused death, had there been no associated tuberculosis. On the basis of this grouping it is found that five of the six indices (namely all those involving heart or spleen or both) show large and significant differences as between the two groups. These differences everywhere are of the sort which would arise if the effect of fatal tuberculosis was to lower the absolute weight of the heart and increase that of the spleen. The significance of these results, as well as that of the differences in mean age at death in the two groups will be discussed in the detailed paper, which will appear in the Reports of the Johns Hopkins Hospital.

The work is being continued with other pathological groups, and it is believed will become more interesting and significant as we become able to compare the results from different types of lesions.

1 Papers from the Department of Biometry and Vital Statistics, School of Hygiene and Public Health, Johns Hopkins University, No. 58.

THE EFFECT OF ETHER UPON THE MIGRATION OF THE SCALE PIGMENT AND THE RETINAL PIGMENT IN THE FISH, FUNDULUS HETEROCLETUS

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Communicated April 25, 1922

When an adult Fundulus is etherized the pigment in the scale melanophores shows a complete distal migration and the fish becomes dark in color. In this respect ether produces an effect the reverse of adrenalin. But adrenalin not only causes a proximal migration of the scale pigment; it induces a distal migration of the retinal pigment (Gilson, '22). Does ether also influence the retinal pigment and, if so, is its effect on that pigment the reverse of that of adrenalin? To test this question Fundulus was etherized either in the dark or in the light and its eyes prepared for study. Fish that had been some time in the light were etherized by allowing a stream of 5% ether to drip upon the gills from ten to fifteen minutes. Before etherization the scale melanophores showed a complete proximal migration of the pigment granules. Within one to four minutes after the application of ether had begun the melanophores were in a state of complete distal migration. At the end of ten or fifteen minutes the animals were killed and the eyes were prepared. The same procedure was carried out upon fish that had been kept in the dark. 5% ether was also applied to both light and dark fish by immersing the body as far as the gills in the ether solution for twenty or thirty minutes after which their eyes were prepared. The scale melanophores of light fish which were immersed
in this way showed a distal migration in from five to fifteen minutes wherever the ether solution touched the skin. As controls in each experiment eyes of unetherized fish that had been kept either in the light or in the dark were prepared.

The condition of the retinal melanophores of fish which had been etherized, either by applying the solution to the gills or to the body, differed in no way from those of normal fish kept under the same conditions of illumination. Those of light fish showed a distal and those of dark fish a proximal migration of the pigment granules. Ether was applied directly to the eyes by immersing excised eyes in a 5% solution for thirty minutes followed by immediate fixation. Very commonly the pigment in eyes which were treated in this way was extremely contracted and broken up into rather large round masses separated from each other by spaces much larger than any seen in normal eyes. This was probably a post mortem change due to the disintegration of the pigment cells. In eyes which appeared normal, however, the condition of the pigment was not different from that of retinas which had not been treated with ether. The post mortem change described above was often seen in eyes whose optic nerves had been cut before the application of ether. Here too the pigment cells did not seem to be affected at all by the ether.

Arey ('16) found that carbon dioxide and ether, both in darkness and in light, and in excised as well as in undisturbed eyes, completely check the movement of all the retinal elements in fishes. The retinal pigment of fishes anesthetized under one condition of illumination and then removed to another remained in the condition characteristic of the first state of light or darkness. Hence I conclude that ether does not have an action on the pigment cells of the retina in fishes the reverse of that of adrenalin. It merely arrests the retinal pigment in whatever condition it happens to be when the drug is administered.

An explanation for the differing effects of adrenalin and ether upon the scale and retinal melanophores in fishes may probably be found in the widely different methods of control of the two types of melanophores. The scale melanophores are controlled by the sympathetic nervous system and in the light they are held in the contracted condition by means of a tonus established by impulses in the central nervous system set up by light stimuli received through the eyes. The contracted state, then represents a state of stimulation. Spaeth ('16) thinks that melanophores are a physiologically modified type of smooth muscle tissue. Adrenalin, the effect of which upon smooth muscle tissue is comparable to sympathetic stimuli, causes a contraction of scale melanophores. Ether anesthetization removes the nervous tonus and allows the melanophores to expand. The melanophores of the retina, however, are not controlled by means of 'retino-motor' nerve fibres (Arey, '16, p. 180), but their activities are simply
"expressions of protoplasmic responses to definite stimulating agents."
The effect of adrenalin is the expression of the action of such an agent
from the blood. Ether inhibits the activities of the melanophores arrest-
ing them in whatever condition they may happen to be.

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THE DIVERSE EFFECTS OF ADRENALIN UPON THE MIGRA-
TION OF THE SCALE PIGMENT AND THE RETINAL PIGMENT
IN THE FISH, FUNDULUS HETEROCLITUS, LINN

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Communicated April 25, 1922

Bigney ('19), working with the frog, found that the injection into the
blood stream of this animal of small quantities of adrenalin caused a
proximal migration (1) of the granules in the dermal melanophores of the
skin and a distal migration of the granules in the melanophores of the retina.
The present investigation was undertaken to determine if similar effects
were to be found in fishes.

For these experiments, the animal used was the common kililfish, Fundu-
lus heteroclitus Linn. This fish shows a marked response, both in the
scale (dermal) and the retinal melanophores to light and to darkness.
When it is placed in the light over a white background, it shows a proxi-
mal migration of the scale melanophore granules and a distal migration of
the retinal melanophore granules. In the dark, these conditions are re-
versed, the scale melanophores showing a distal and the retinal melano-
phores a proximal migration.

The method adopted for stating the effects of the adrenalin upon
the retinal pigment was that of expressing the width of the retinal pigment ex-
tension, as measured along processes showing maximal extension in the
region measured, as a fraction of the total distance from the outer boundary
of the pigmented epithelium to the external limiting membrane, this dis-
tance being taken as 100. For purposes of brevity in this paper, the
terms light fish and dark fish will be used to indicate fish which have been
kept in the light and fish which have been kept in the dark, respectively.
In the typical light fish, the pigment shows an average extension of 83
units on this scale. Such light retinas show, in almost all cases, a secondary