tions. In the calculations fractions of less value than one-half were dropped and those of a value of one-half or more were called one. It will be observed from the groups described—and the same is true of the other groups—that when the number of scales is the same on each side or not more than a difference of one, the actual column exceeds the calculated, and as the difference increases, the calculated column exceeds the actual. A comparison of the corresponding groups in the two columns in every case gives the same results as in those described, all of which demonstrates the tendency to bilateral symmetry or a marked correlation in the variation of the two sides.

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## Preliminary Note Upon the Arrangement of Rods and Cones in the Retina of Fishes. By C. H. Eigenmann and George Hansell.

[Abstract.]

A variety of fish eyes were examined, and it was found that in most cases the rods and cones are arranged in a regular pattern. This pattern is either that described by Hannover and Ryder for fishes or a slight modification of this pattern.

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## Degeneration in the Eyes of the Amblyopsidæ, Its Plan, Process and Causes. By Carl H. Eigenmann.

[Summary only.]

1. There are at least six species of "blind fishes," Amblyopsidæ, inhabiting North America, three with well-developed eyes and three with mere vestiges.

2. The three species with vestigial eyes are descended from generically distinct ancestors with well-developed eyes.

3. These species can be more readily distinguished by the structure of their eyes than by any other characteristic.

4. The most highly-developed eye is much smaller and simpler than the eye of normal-eyed fishes.

5. The structure of their eyes may be represented by the following key to the genera and species.

a. Vitreous body and lens normal, the eye functional. No scleral cartilages. Eye permanently connected with the brain by the optic nerve. Eye muscles normal. No optic fibre layer. Minimum diameter of the eye .700 $\mu$.

* Chologaster.

b. Eye in adult more than 1 mm. in longitudinal diameter. Lens over .5 mm. in diameter. Retina very simple, its maximum thickness 835 $\mu$ in the old; the outer and inner nuclear layers consisting of a single series of cells each; the ganglionic layer of isolated cells. Maximum thickness of the outer nuclear layer 5 $\mu$; of the inner layer 8 $\mu$ ..... ..... cornutus

bb. Eye in adult less than 1 mm. in longitudinal diameter. Lens less than .4 mm. Outer nuclear layer composed of at least two layers of cells; the inner nuclear layer of at least three layers of cells, the former at least 10 $\mu$ thick, the latter at least 18 $\mu$.

c. Pigment epithelium 65 $\mu$ thick in the middle-aged, 102 in the old. papilliferus.

cc. Pigment 49 $\mu$ thick in the middle-aged, 74 in the old; 24–30 per cent. thinner than in papilliferus. Eye smaller ..... agassizii.

aa. The eye a vestige, not functional; vitreous body and lens mere vestiges: the eye collapsed, the inner faces of the retina in contact; maximum diameter of eye about 200 $\mu$.

d. No scleral cartilages; no pigment in the pigment epithelium, a minute vitreal cavity; hyaloid membrane with blood vessels. Pupil not closed. Outer nuclear, outer reticular, inner nuclear, inner reticular, ganglionic and pigment epithelial layers differentiated. Cones probably none. No eye muscles. Maximum diameter of eye 180 $\mu$. Eye probably connected with brain throughout life ..... ..... Typhlichthys.

dd. Scleral cartilages; pigment in the pigment epithelium; vitreal cavity obliterated; no hyaloid membrane. Pupil closed. Some of the eye muscles developed. No outer reticular layer. Outer and inner nuclear layers merged into one. Eye in adult not connected with the brain.

e. Pigment epithelium well developed; cones well developed; ganglionic cells forming a funnel-shaped mass through the center of the eye. Pigmental epithelium over the front of the eye without pigment. Maximum diameter of eye about 200 $\mu$ ..... Amblyopsis.

ee. Pigment epithelium developed on distal face of the eye, rarely over the sides and back. No cones. Nuclear layers mere vestiges; the ganglionic layer restricted to the anterior face of the eye just within the pigmented epithelium. Maximum diameter of the eye about 85 $\mu$ ..... Troglichthys.

6. The structure of the vestigial eyes differs much in different individuals.

7. The eye of Chologaster is an eye symmetrically reduced from a larger normal fish eye.

8. The retina in Chologaster is the first structure that was simplified.

9. Later the lens, and especially the vitreous body, degenerated more rapidly than the retina.

10. The eye of Typhlichthys has degenerated along a different line from that of Amblyopsis, its pigmented epithelium having been most profoundly affected.

11. The eye muscles have disappeared in Typhlichthys.

12. Troglichthys shows that the steps in the degeneration of the muscles were in the direction of lengthening their attaching tendons, finally replacing the muscles with strands of connective fibres.

13. The scleral cartilages have not kept pace in their degeneration with the active structures of the eye.

14. The lens in the blind species is, for the most part, a small group of cells without fibres.

15. The proportional degeneration of the layers of the retina is shown in diagram j.

16. With advancing age the eye of Amblyopsis undergoes a distinct ontogenic degeneration from the mature structure.

17. The phyletic degeneration does not follow the reverse order of development. None of the adult degenerate eyes resemble stages of past (phyletic) adult conditions.

18. The degenerate eyes do not owe their structure to a cessation of development at any past ontogenic stage, *i. e.*, at any stage passed through in the development of a normal life.

19. Cessation in development occurs only in the reduction of the number of cell generations produced to form the eye not in cessation of morphogenic processes.

20. In some cases (Typhlichthys) there is a retardation in the rate of development, the permanent condition being reached later in life than is usual in fishes. (It is possible that the pigment of the pigment epithelium never comes to develop at all. It is, however, impossible to assert this until the embryos of this species are examined. It is possible that the pigment degenerates before the stages are reached that I have examined.)

21. The degenerate condition of the eye appears in the embryo. The crowding back has followed the law of tachygenesis.

22. The conditions in the eyes of the Amblyopsidæ can only be explained as the result of the transmission of disuse effect.