

THE EAR AND HEARING OF THE BLIND-FISHES.* BY CARL H. EIGENMANN
AND ALBERT C. YODER.

The following words of Prof. Cope are frequently quoted: "They (*Amblyopsis*) are unconscious of the presence of an enemy, except through the medium of hearing. This sense, however, is evidently very acute; for at any noise they turn suddenly downward and hide beneath stones, etc., on the bottom."

Miss Hoppin (Garman, 1889) was the first to cast doubt on this statement. She failed to get any response from *Troglichthys* as long as noises only were resorted to.

Our own observations (Proc. Brit. Ass. A. Science, Toronto Meeting) on *Amblyopsis* confirm those of Miss Hoppin on *Troglichthys*. No noises produced had any effect on *Amblyopsis*. Whistles, tuning forks, clapping of hands, shouting in the reverberating caves, were alike disregarded. Not one observation was made that would indicate that these fishes can hear. This does not imply that the auditory organs of this fish are not fully developed. Nor is it an indication that the auditory function of this fish is degenerate, for Kreidl and Lee have both shown that fishes as a class are unable to hear. Kreidl's observations were made on fishes which were blinded or from which the operator was hidden by some contrivance. Neither of these devices need be resorted to with the present species.

Anatomically considered, the ear of *Amblyopsis* is normal. Numbers of ears together with the brains have been dissected out. These were treated either with Flemming's strong solution or with Hermann's fluid, either of which stained the nerve matter black.

In the first place, the three semi-circular canals are present and each has its ampulla fully developed. The three ampullæ and the sinus utriculus superior communicate with the utriculus in front, behind, and above. Below, the utriculus communicates with the sacculus, which terminates posteriorly in an appendage, the lagena.

The three ear bones are present, one in the recessus utriculi, one (the largest) in the sacculus, and the other in the lagena.

The auditory nerve divides into two branches, the ramus anterior and the ramus posterior. The ramus anterior divides into three branches—the ramulus ampullæ anterioris, which extends to the anterior ampulla;

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the ramulus ampullæ externæ, which extends to the external ampulla; the ramulus recessus utriculi, which extends to the recessus utriculi. The ramus posterior gives off a heavy branch, the ramulus sacculi, which extends to the sacculus. The rest of the ramus posterior divides into the ramulus lagenæ, which extends to the lagena; and the ramulus ampulla posterioris, which extends to the posterior ampulla. Another branch, the ramulus neglectus, which is normally given off where the ramus posterior divides into the ramulus ampulla posterioris and ramulus lagenæ, has not been identified.

The normal fish ear has seven auditory spots—the macula acusticus recessus utriculi, three cristæ acusticus ampullarum, macula acusticus cacculi, papilla acusticus lagenæ, and the macula acusticus neglecta. In *Amblyopsis* all of these auditory spots are present:

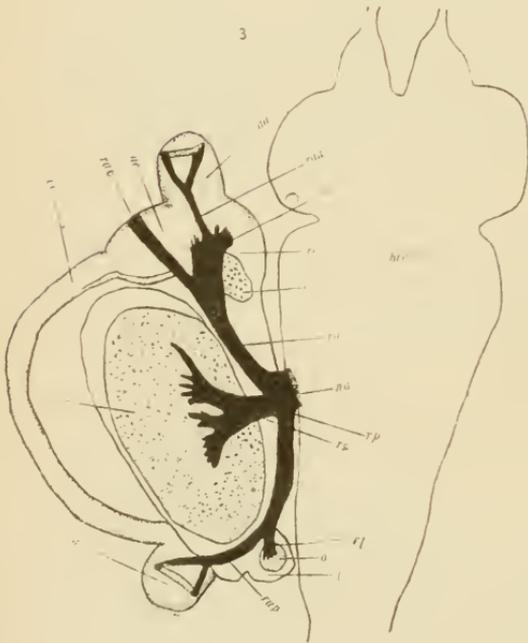
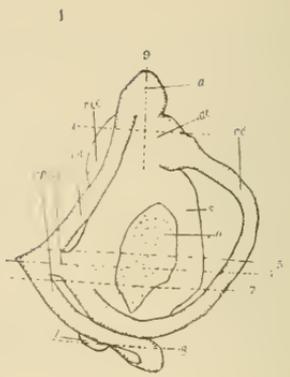
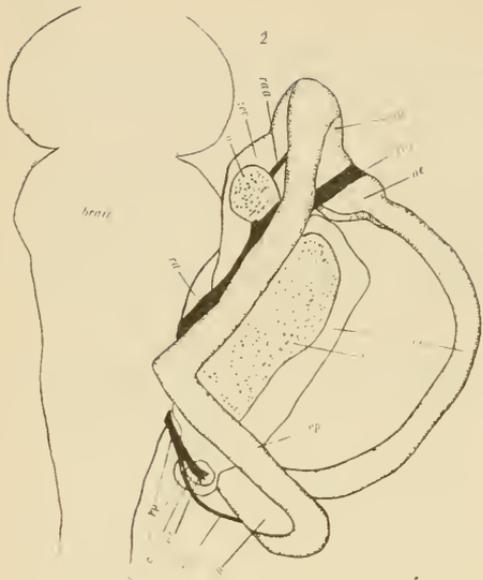
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EXPLANATION OF FIGURES.

The lettering is uniform throughout and in the main that used by Retzius in "Das Gehörorgan der Wirbelthiere."

- ca—Canalis anterior.
 ce—Canalis externus.
 cp—Canalis posterior.
 s—Sacculus.
 u—Utriculus.
 rec—Recessus utriculi.
 ss—Sinus utriculi superior.
 cus—Canalis utriculo-saccularis.
 l—Lagena.



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- aa—Ampulla anterior.
 ae—Ampulla externa.
 ap—Ampulla posterior.
 cra—Crista acustica ampullæ anterioris.
 cre—Crista acustica ampullæ externæ.
 mu—Macula acustica recessus utriculi.
 ms—Macula acustica sacculi.
 pl—Papilla acustica lagenæ.
 mn—Macula acustica neglecta.
 na—Nervus acusticus.
 ra—Ramus anterior.
 rp—Ramus posterior.
 raa—Ramulus ampullæ anterioris.
 rae—Ramulus ampullæ externæ.
 rs—Ramulus sacculi.
 rl—Ramulus lagenæ.
 rap—Ramulus ampullæ posterioris.
 ov—Oval opening into sacculus from the canalis utriculi-saccularis.
 bv—Blood-vessel.
 cap—Capula terminalis.
 ep—Epithelial lining.
 g—Ganglion cells.
 o—Otolith.

Fig. 1. Right ear. Viewed from the exterior and above. The dotted lines show the planes of sections. $\times 12$.

Fig. 2. Brain and right ear. Dorsal view. The nerves are shown black. The fibers for the most part are under the ear, but they were seen through the membranous parts. $\times 21$.

Fig. 3. Brain and right ear. Ventral view. $\times 23$.

Fig. 4. Cross section of utriculus and the crista in the external canal. $\times 195$.

Fig. 5. Part of a vertical section through the brain, ramulus sacculi, and saccul. The course of the ramulus sacculi is shown here. $\times 195$.

Fig. 6. Section showing canalis utriculo-saccularis and the oval opening through which there is communication between the utriculus and the sacculus. The sections were made parallel to the sinus utriculo-superior. $\times 195$.

Fig. 7. Utriculus and canalis externus. Cross section showing the macula neglecta. $\times 195$.

Fig. 8. Lagena. Cross section showing the capilla acustica. $\times 195$.

Fig. 9. Ampulla anterior. Longitudinal section. Cross section of crista. $\times 195$.

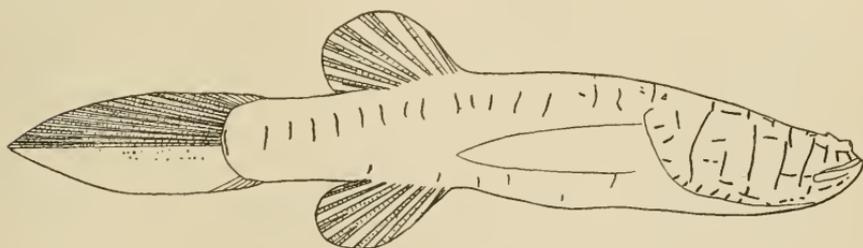
Fig. 10. Utriculus. Cross section showing the macula neglecta. $\times (\frac{1}{6}$ obj. 2 in oc).

Fig. 11. The three otoliths drawn to the same magnification. The largest belongs to the sacculus; the smallest to the lagena, and the other to the recessus utriculi. $\times 23$.

A CASE OF CONVERGENCE.* BY CARL H. EIGENMANN.

In 1859 Girard (Proc. Acad. Nat. Sc., Phila., p. 62) described a small blind fish, *Typhlichthys subterraneus* from Bowling Green, Ky. This species has since been found to be abundant in the subterranean waters east of the Mississippi and south of the Ohio.

In 1889 Garman (Bull. Mus. Comp. Zool. XVII, No. 6) gave an account of a blind fish from some caves in Missouri. Mr. Garman says: "Compared with specimens from Kentucky and Tennessee, they agree so exactly as to raise the question whether the species was not originated in



one of the localities and thence distributed to the others. * * * There is no doubt that the representatives of *Typhlichthys subterraneus* in the various caves were derived from a single common ancestral species. The doubts concern only the probability of the existence of three or more lines

* Contributions from the Zoölogical Department of the Indiana University, No. 27.