

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).

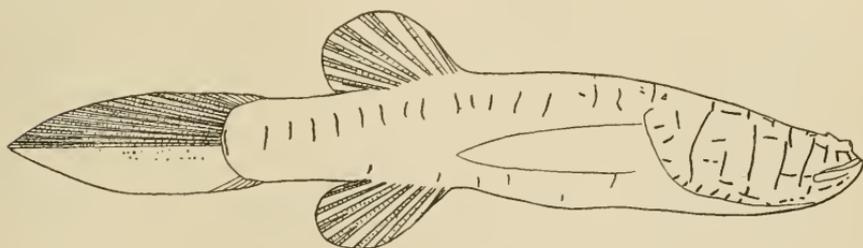
Fig. 11. The three otoliths drawn to the same magnification. The largest belongs to the sacculus; the smallest to the lagena, and the other to the recessus utriculi.  $\times 23$ .

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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

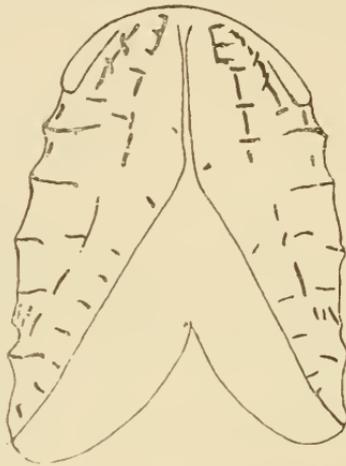
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\* Contributions from the Zoölogical Department of the Indiana University, No. 27.

of development in as many different locations, starting from the same species and leading to such practical identity of result."

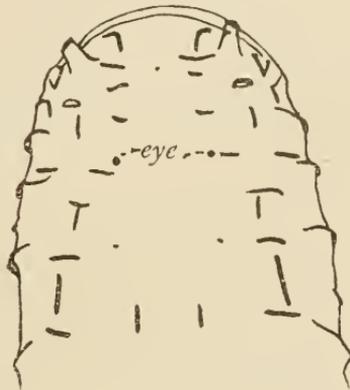
Ably arguing the case from the data on hand, Garman came to the conclusion "that these blind fishes originated in a particular locality, and have been and are being distributed among the caves throughout the valley" (of the Mississippi).

Two of the specimens from Missouri served Kohl ("Rudimentäre Wirbelthieraugen," 1892) for his account of the eyes of North American



blind fishes. At my request Mr. Garman sent me two of the Missouri specimens. He urged me at the same time to make a more extensive comparison between them and the Mammoth cave specimens. A comparison of the eyes of specimens from the two localities not only proved that they represented distinct species, but that they are of separate origin. An announcement of the species without further description was published (Proc. Ind. Acad. Sci. for 1897, p. 231, 1898). The species was named *rosa* for the rediscoverer of the California *Typhlogobius*, a pioneer in the study of biology among women, Mrs. Rosa Smith Eigenmann." In the spring of 1897 I visited various caves in Missouri to secure additional material of what was recognized as in many ways the most interesting member of the North American fauna. No specimens were secured, but a liberal number of bottles of alcohol and formalin were scattered over the country. During this fall, through a grant from the Elizabeth Thomp-

son Science Fund and through the courtesy of the officers of the Monon, the L. E. and St. L. and the Frisco R. R. lines, I was enabled to visit the cave region of Missouri again. This time I visited nine caves and secured eight specimens. I have since received an additional number from a correspondent. From information gathered it would seem that this species (or similar ones) has a wide distribution in the subterranean water of the southern half of Missouri and northern Arkansas, probably also the eastern part of Kansas.



On the surface the specimens very closely resemble *Typhlichthys subterraneus* from Mammoth Cave, differing slightly in the proportion and in the pectoral and caudal fins. These fins are longer in *rosæ*. It is, however, quite evident from a study of their eyes that we have to deal here with a case of convergence of two very distinct forms. They have converged because of the similarity of their environment and especially owing to the absence of those elements in their environment that lead to external protective adaptations. The details of the structure of the eyes of all the members of the Amblyopsidæ will be published shortly, and I need call attention here only to the structures that warrant the conclusion that the cis and transmississippi forms of blind fishes without ventral fins are of distinct origin. The blind fish *Amblyopsis* may be left out of consideration, since it is the only member of the family that possesses ventral fins. Otherwise, it would be difficult to distinguish specimens of similar size of this species from either *subterraneus* or *rosæ*.

The eye of *T. subterraneus* is surrounded by a very thin layer of tissue representing the sclera and choroid. The two layers are not separable. In this respect it approaches the condition in the epigean-eyed member of the family *Chologaster*. For other reasons that need not be given here, it is quite certain that *Typhlichthys* is the descendant of a *Chologaster*. The intensity of coloration and the structure of the eye are the chief points of difference. The eye of *rosa* is but about one-third the diameter of that of *subterraneus*, measuring .06 mm. or thereabout. It is the most degenerate as distinguished from undeveloped vertebrate eye. The point of importance in the present instance is the presence of comparatively enormous scleral cartilages.\* These have not degenerated in proportion to the degeneration of the eye and in some cases are several times as long as the eye, projecting far beyond it or are puckered to make their disproportionate size fit the vanishing eye. The species is unquestionably descended from a species with well-developed scleral cartilages, for it is not conceivable that the sclera as found in *Chologaster* could, by any freak or chance, give rise during degeneration to scleral cartilages, and if it did, they would not develop several sizes too large for the eye. At present no known epigean species of the Amblyopsidae possesses scleral cartilages. The ancestry of *rosa* is hence known. *Amblyopsis* possesses scleral cartilages and the eye of *rosa* passed through a condition similar to that possessed by *Amblyopsis*, but the latter species has ventral fins and is hence ruled out as a possible ancestor of *rosa*. The epigean ancestry of *Amblyopsis* is also unknown. The ancestry of *Typhlichthys* being quite distinct from that of *rosa*, the latter species may be referred to a new generic named *Troglichthys*.

Judging from the degree of degeneration of the eye *Troglichthys* has lived in caves and done without the use of its eyes longer than any other known vertebrate. (*Ipnops* being a deep-sea form is not considered.) More than this, *rosa* is probably the oldest resident in the region it inhabits.

Since the specimens kindly sent by Mr. Garman, in the course of examination, have been reduced to sections, the specimens now in my possession, together with a few sent to the British Museum, all having come from the same cave, may be considered typical.

In addition to the acknowledgments made before I wish also to thank the officers of the Louisville and Nashville R. R. for transportation to Mammoth Cave. I must especially express my appreciation of the assist-

\* Kohl mistook the nature of these structures, as he did of every other connected with these eyes, except the lens and ganglionic cells.

ance rendered me by Mr. Willam McDoel, General Manager of the Monon, in enabling me to make explorations in the numerous caves of the Lost River region along his line and to visit caves at greater distances. Mr. H. C. Ganter, the manager of the Mammoth Cave Hotel, not only granted me leave to collect in the cave, but did everything possible to make my trip to this cave successful.

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CHOLOGASTER AGASSIZII AND ITS EYES. BY CARL H. EIGENMANN.

[Abstract.]

*Chologaster agassizii* has heretofore been known from the type specimen only. This came from a well at Lebanon, Tennessee. I have heard of other specimens, but neither persuasion nor a liberal cash promise was able to bring one of these specimens. Five specimens were recently caught by me.

*Chologaster agassizii* possesses this peculiar interest: The Amblyopsidæ, evidently the wreck of an ancient numerous family, are now represented by *Chologaster* with well-developed eyes, and the various blind fishes with greatly degenerate eyes. Of *Chologaster* there are three known species. One of these lives in the streams of the Atlantic slope and does not concern us. The other, *Ch. papilliferus*, lives in springs in southwestern Illinois, while the third, *Ch. agassizii*, lives altogether in subterranean streams. I wanted *Ch. agassizii* to compare its eyes with those of *Ch. papilliferus*. The interest is heightened by the fact that the two species are very similar, the eye of *agassizii* is, however, very much smaller and will, when examined, give us one of the steps of degeneration through which this structure passes.

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THE EYE OF TYPHLOMOLGE FROM THE ARTESIAN WELLS OF SAN MARCOS, TEXAS. BY C. H. EIGENMANN.

[Abstract.]

The eye of *Typhlomolge* has lost the lens and for the most part the vitreous body. The eye has, as a result, collapsed. The pupil is still open in the young but becomes closed in the adult, and in its region the pigment of the iris becomes much thicker than the pigmented layer at the back of the retina,