times. By this means we hoped to have removed the greatest part of the neon, krypton, metargon and xenon. Then we liquefied the argon a fourth time, and as it boiled away collected six samples, each after one-fifth of the whole quantity had evaporated. These samples were carefully purified and weighed. The density referred to $0 = 16$ and the refractivity to air $= 1$ are as follows:

	Density.	Refractivity.
First fraction	19.65	0.962
Second "	19.95	0.969
Third "	19.95	.....
Fourth "	19.91*	.....
Fifth "	19.97	0.968
Sixth "	19.95	0.966

The first fraction possesses, as appears from the table, a lower density and also a lower refractivity. The other fractions vary very little from each other. Since these determinations were made by using only 30 cubic centimeters, we have weighed 160 cubic centimeters of the fifth and sixth fractions. The first determined density of the fifth fraction was 19.935, but at a pressure of 5 millimeters the spectrum of nitrogen was easily recognizable in a Plücker tube. After the gas had been again purified by sparking, until all the nitrogen had been removed, the density was 19.957. In two experiments the fourth fraction of gas gave 19.952 and 19.961. We must then accept the true density of argon as not far from 19.96. Independently Lord Rayleigh and I found the density of argon to be 19.94; so it is clear that the impurities of neon and the heavier gases have little influence. The somewhat greater density of pure argon arises from the fact that the neon, which is the chief impurity present, has been removed; the influence of the other gases cannot be recognized, owing to the insignificant quantities present. In fact, in 15 liters of argon we found no appreciable trace of xenon; it can be prepared only out of large quantities of liquid air.

I must take this opportunity of thanking you most sincerely for the honor you have done me in inviting me to deliver this address. It has been said by some scientist that the greatest joy of life lies in discovering something which is new. There is, however, another joy almost equally great, that of making known the results of an investigation to one's fellow scientists. This joy, my friends, you have given me to an extreme degree, and for this I express to you my warmest thanks.

* Contained nitrogen.

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*A CASE OF CONVERGENCE.**

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 of development in as many different locations, start-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 dis-

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

tributed 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 represent 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 *rosæ* 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 the fall of 1898, through a grant from the Elizabeth Thompson 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 waters 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 trans-Mississippi 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*.

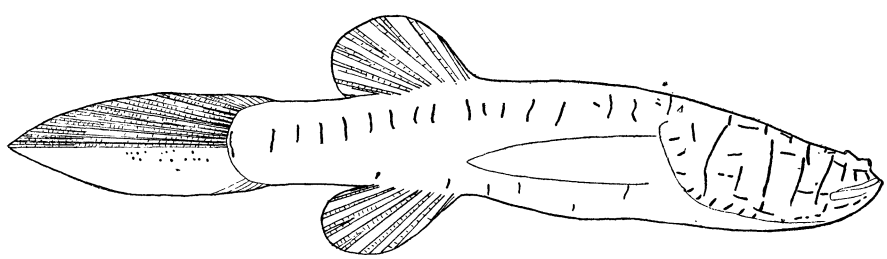

FIG. 1. Side view of Troghlichtys showing the extent and distribution of the tactile organs.

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

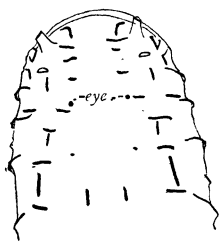

Fig. 2.

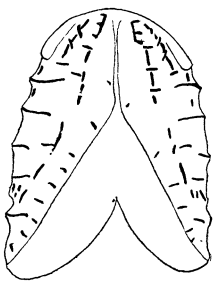

Fig. 3.

Fig. 2. Dorsal view of the head, with distribution of tactile organs and location of eye.

Fig. 3. Ventral view of the head.

descendant of a *Chologaster*. The intensity of coloration and the structure of the eye are the chief points of difference. The eye of *rosæ* is but about 1-3 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. This 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 Amblyopsidæ possesses scleral cartilages. The ancestry of *rosæ* is hence unknown. *Amblyopsis* possesses scleral cartilages and the eye of *rosæ* 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 *rosæ*. The epigean ancestry of *Amblyopsis* is also unknown. The ancestry of *Typhlichthys* being quite distinct from that of *rosæ*, the latter species may be referred to a new generic name *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. (*Ipnopes* being a deep-sea form is not considered.) More than this, *rosæ* 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 assistance rendered me by Mr. William 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.

Carl H. Eigenmann.

University of Indiana.

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