Those separated at the two-celled stage lived to form plutei.

Those separated at the four-celled stage formed regular blastulae in most cases.

Those separated at the eight-celled stage also formed regular blastulae.

Experiment 4.—This is an experiment in artificial parthenogenesis in arbacia. Plutei six days old were reared by Dr. H. J. Hunter, of Kansas University. He carried on the work longer and he has specially reported on this, hence only this reference.

These experiments are very interesting and may be of considerable importance when we learn how to perfectly interpret them.

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## The Eye of Palæmonetes Antrorum.

Edwin Manson Neher.

Contributions from the Zoölogical Laboratory of the Indiana University, under the direction of C. H. Eigenmann. No. 47.

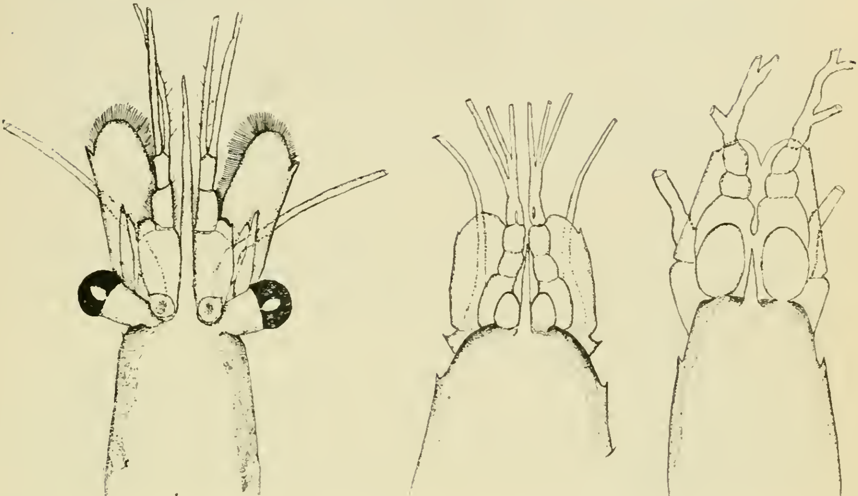
A blind shrimp, Palæmonetes antrorum, evidently occurs in abundance in the subterranean streams about San Marcos, Texas. It comes out of the artesian well of the United States Fish Commission at that place in large numbers. The well is about one hundred and ninety feet deep and has a yield of about one thousand gallons per minute.

A brief description of Palæmonetes was published by Benedict, 1896.

The material examined consists of young specimens, 5 to 5.5 mm. long from tip of rostrum to tip of telson and adult specimens measuring 15 mm. along the same line. Most of them were collected by Dr. C. H. Eigenmann at the San Marcos well in September, 1899. Others have since been sent by Mr. J. L. Leary, Superintendent of the United States Hatchery at that place.

The material at my disposal was preserved in 4 per cent. formalin. The anterior end of the cephalo thorax was dehydrated and imbedded in paraffin by the chloroform method. Sections were floated out on warm water and fixed to the slide with glycerin-albumen and stained with Mayer's haemalum, followed by eosine. Specimens of P. exilipes, which were used for comparison, were treated with Perenyi's fluid for forty-eight hours before imbedding and the sections were depigmented in 10 per cent. nitric acid for ten hours. The cuticle of the blind shrimp was found to section readily without softening in Perenyi's fluid.

According to Chilton, '94, the degeneration of the eyes of crustaceans may follow one of three lines. We may have—



1 2 3

4 5 6

1. Total atrophy of optic lobes and optic nerves, with or without the persistence in part of the pigment or retina and the crystalline lens.

2. Persistence of optic lobes and optic nerves, but total atrophy of the rods and cones, retina (pigment), and facets, or,

3. Total atrophy of the optic lobes, optic nerves, and all the optic elements.

The degeneration of the eye of the species under consideration has evidently followed the second of these lines. The optic stalk has suffered a foreshortening, and as a consequence the optic ganglia have become telescoped. The greatest reduction has taken place in the ecto-dermal portions of the eye, which are reduced to a group of cells not exceeding and probably fewer than 350. Inasmuch as a single normal ommatidium contains sixteen cells, the degree of degeneration reached is readily seen to be very great.

The extent of the modification of the eyes can perhaps be most readily described by a comparison of the eyes and optic stalk of this species with those of Palæmonetes exilipes, taken in the San Marcos River, but a short distance from the artesian well.

The eye and optic stalk of P. exilipes presents the general appearance of the crustacean eye. The stalk is a truncate cone (Fig. 1), attached by its smaller end. On the distal end is the large, dark, conspicuous, hemispherical eye. It is wider than the widest part of the stalk.

In P. antrorum the eye stalk is much smaller (Fig. 2), as may be seen from the following table:

| | exilipes. | antrorum. |
|---|---|---|
| Length of specimen | 17 mm. | 15 mm. |
| Length of stalk to retina | 787 $\mu$ | 525 $\mu$ |
| Width of stalk at retina | 700 $\mu$ | 175 $\mu$ |
| Width of stalk at base | 387 $\mu$ | 387 $\mu$ |
| Width of retina | 962.5 $\mu$ | 0 |

Nothing appears to remain of the eyes except the short, colorless, delicate stalks. The stalks are conical, being attached by their larger end. The axis of the stalk is parallel with that of the body.

The distal end of the optic stalk of P. antrorum is covered with a single layer of indifferent hypoderm with nuclei 7.2 $\mu$ by 3.6 $\mu$, except at a short distance from the distal end of the outer lower quarter of the stalk, where a group of slightly modified hypodermal cells, three deep, replace the single series of outer parts. The nuclei in this group of cells are rounded, measuring about 6 to 8 $\mu$ in diameter. This group of cells measures about 50 $\mu$ by 70 $\mu$. There is no indication of an arrangement of these cells into anything resembling the arrangement of the cells in an ommatidium.

The following data gives the number of retinal cells found in each of a series of cross sections. Sections are $6\frac{2}{3}$ $\mu$ thick and counted from in front:

| No. of Sections. | No. of Cells in Retina. |
|---|---|
| 1 to 8 | 0 |
| 8 | 11 |
| 9 | 19 |
| 10 | 20 |
| 11 | 27 |
| 12 | 33 |
| 13 | 33 |
| 14 | 28 |
| 15 | 27 |
| 16 | 26 |
| 17 | 7 |
| 18 | 7 |
| 19 | 5 |
| 20 | 6 |
| 21 | 11 |
| 22 | 13 |
| 23 | 10 |
| 24 | 10 |
| 25 | 5 |
| 26 | 6 |
| 27 | 6 |
| 28 | 8 |
| 29 | 4 |
| 30 | 2 |
| 31 | 0 |
| 32 | 0 |
| Total | 327 |

In P. exilipes there is a space between the basement membrane of the hypoderm and the membrana propria of the optic ganglia, which is occupied by the fine fibers which connect the ommatidia and optic ganglia. In P. antrorum this space is filled with coagulated haemolymph (Fig. V). This haemolymph is in circular or angular blocks. These blocks begin about 40 $\mu$ from tip of eye and extend back through a space of about 60 or 70 $\mu$ to the cells of the optic ganglia. Small particles of coagulated haemolymph also extend down the outside of the eye for about half of its length.

Only a very few specimens of the young shrimp, P. antrorum, could be obtained. These were from 5 to 5.5 mm. long. The optic stalk and eye are much larger in proportion to the size of specimen (Fig. III) than in the adult antrorum, but they are actually not as large as in the adult. The internal structure showed no greater differentiation than in the eye of adult.

I am very grateful to G. H. Parker for assistance in the interpretation of the structure of this eye.

## EXPLANATION OF FIGURES.

Figure 1. Dorsal view of the front end of P. exilipes.

Figure 2. Dorsal view of the front end of P. antrorum, showing the small eyes.

Figure 3. Dorsal view of the front end of a young P. antrorum about 5 mm. long.

Figure 4. Photograph of a cross section through the optic stalk of P. antrorum, showing the group of retinal hypodermal cells of the right eye.

Figure 5. Photograph of a longitudinal section through the optic stalk of P. antrorum, showing the group of retinal hypodermal cells.

Figure 6. Enlarged view (photograph) of group of retinal hypodermal cells shown in Fig. 5.

Figure 7. Photograph of another group of retinal hypodermal cells. Horizontal section.

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## The History of the Eye of Amblyopsis.

C. H. Eigenmann.

[Abstract.]

### A. DEVELOPMENT.

The eye of Amblyopsis appears at the same stage of growth that it appears in fishes developing normal eyes.

The eye grows but little after its appearance.

All the developmental processes are retarded and some of them give out prematurely. The most important of the latter is the cell division and the accompanying growth that provides the material for the eye.

The lens appears at the normal time and in the normal way, but its cells never divide and never lose their embryonic character.

The lens is the first part of the eye to show degenerative steps and it disappears entirely before the fish has reached a length of 1 mm.

The optic nerve appears shortly before the fish reaches 5 mm. in length. It does not increase in size with the growth of the fish and possibly never develops normal nerve fibers.

The nerve does not increase in size with growth of the fish.

The optic nerve gradually loses its compact form, becomes flocculent, dwindles and can not be followed by the time the fish has reached 50 mm. in length. In the eye it retains its compact form for a much longer time, but disappears here also in old age.

The scleral cartilages appear when the fish is 10 mm. long; they grow very slowly—possibly till old age. They do not degenerate at the same rate as other parts of the eye if they degenerate at all.