PHOTORECEPTORS IN THE EARTHWORM, LUMBRICUS TERRESTRIS.

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By means of a small beam of intense light it was possible to show: that all segments of the earthworm are sensitive to light; that the prostomium is most sensitive, and that sensitivity decreases gradually from this region posteriorly toward the middle of the body; that the posterior portion of the animal is more sensitive than the middle region; and that the ventral and intersegmental regions of the body are not sensitive to light except at the anterior and posterior ends of the animal.

The cells in the epidermis of the earthworm that have been described by previous workers have been designated as tactile-sense cells, covering cell, gland cells, supporting cells, basal cells and "Lichtzellen". Hesse[1] thought that these latter cells, the "Lichtzellen", might be light receptors.

In order to determine the distribution of each of these cells in the photosensitive and non-photosensitive regions of the earthworm's body, two definite regions were selected for study; one that had been found to be very sensitive to light, the dorsal region of the prostomium; the other in a region that was not sensitive to light, the ventral region of segment 40. Each type of cell referred to above was found in both regions in abundance except the "Lichtzellen" which were absent from the ventral region of segment 40.

The above data led to a more extensive survey of the distribution of the "Lichtzellen", and it was found that they are the only cells that do not occur in the non-photosensitive regions, that are present in the photosensitive regions. Moreover, the number of these cells was found to vary in accordance with the photosensitivity of the animal, which is very suggestive of their being photoreceptor cells.

In addition to occurring in the epidermis, these cells were also found in certain nerve enlargements of the prostomium, and the caudal segment.

Individual cells as well as nerve enlargements containing groups of these cells were removed from the animal, placed in two-thirds strength Locke's solution, and observed under the microscope in the living state. Various methods of throwing light upon these cells, both laterally and ventrally, were employed, and it was found that irrespective of the direction of illumination the inner regions of these cells cause the rays of light to be brought to a focus at the outer border of a characteristic intracellular structure which we propose to designate the optic organelle. In every case the focal point of light was on the opposite side of the organelle from where the illumination entered the cell.

[1] Hesse, R. 1896. Untersuchungen über die Organe der Lichtemfindungen bei niederen Thieren. I. Die Organe der Lichtemfindungen bei den Lumbriciden. Zeit. f. wiss. Zool. Bd. 61, pp. 394-419.

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It is possible to rupture these cells when they are mounted in culture media, by applying pressure to the cover glasses. Under such conditions a dense liquid which is very refractive to light remains, while the remaining parts of the cell disintegrate.

Preparations by silver nitrate technique show that the optic organelles are composed of a large inner hyaline region that is surrounded by a network of anastomosing neurofibrils. Moreover, these preparations also show that this network is connected with the neurofibrils of a nerve that enters each cell.

The fact that the inner region of the optic organelles refract light, and the fact that this refracted light is brought to a focus upon the neurofibrillar network which forms the outer border of the optic organelle in such a way as to suggest that this network is directly concerned in the reception of nerve stimulation, leads us to call the inner hyaline region a lens and its outer neurofibrillar border a retinella.

The optic organelles vary considerably in size, shape and location within the individual cells. Some appear more or less ellipsoidal but they are usually cylindrical in form. These cylindrically shaped optic organelles are frequently bent within the cell, and not infrequently the bending is so intricate that a single organelle occupies three different planes. No matter what the shape and position of the lenses of the optic organelles may be, they usually focus light upon a portion of the network of the retinellae.

We are led to state that these data support the suppositions that the "Lichtzellen" function in light reception; that the inner structure of these cells, the optic organelle, is the primary functional agent in light reception; that the inner hyaline portion of the optic organelle is a lens; and that its outer neurofibrillar border functions in the reception of nerve stimuli and hence is a retinella. Moreover, since these cells function in light reception they must be photoreceptors, and the names indicating a visual function that we have used in our description of the optic organelle and its parts within the photoreceptor cells are thus justified.

A comparison of the different structures in the photoreceptor cells of the earthworm with those of leeches shows that the two types of cells, except for pigment, contain homologous structures.