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elemente der Spicula zu deuten sind. Sie liefern die Form des zukünftigen Spiculum und scheiden dann in sich die Kalksubstanz ab, in der erst noch die Kerne zu erkennen sind, die aber schließlich das Ganze so erfüllt, daß von der organischen Grundlage nichts mehr zu sehen ist und das Gebilde homogen und glänzend erscheint. Diese Umbildung vollzieht sich im Mesoderm.

Neapel, am 5. Juli 1891.

3. The Lateral Eyes [1] of Spiders.

By Kamakichi Kishinouye, Science College, Imperial University, Tōkyō, Japan.

eingeg. 10. Juli 1891.

In order to compare *Limulus* and the spider with respect to the development of their eyes, I re-examined my sections of spiders and found that I had overlooked a very important stage in the development of the lateral eyes of spiders in my recent paper [2], so that my views on this point were in part incorrect. This obliges me to write briefly about the new conclusion I have arrived at.

All the lateral eyes of spiders, generally three pairs, arise from a common thickening of the hypodermis on each side at the posterior, external corner of the lateral vesicle when it is not yet completely cut off from the general ectoderm — at about the stage of the reversion of the embryo. The thickening is slightly invaginated and consists of cells arranged in many irregular rows (Fig. 1).

After the process of the reversion of the embryo has greatly advanced, the invagination disappears and the hypodermic thickening is now flat above the lateral vesicle, which is at this time separated from the general ectoderm.

When the reversion of the embryo is almost over, a differentiation occurs among the nuclei of the hypodermic thickening. At three places in the thickening, nuclei become a little larger and

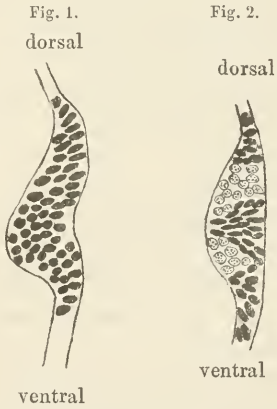

Fig. 1. Longitudinal sections through the »optic area« of the lateral eyes. Fig. 2 shews only the »anterior lateral eye« and the »posterior lateral eye«. Zeiß. 2 D.

[1] »Nebenaugen« of Bertkau. Arch. f. Mikr. Anat. 1886.

[2] On the Development of *Araneina*. Journal of Science College, Japan. vol. IV. 1890.

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stain slightly less than those found elsewhere which latter are pressed together and are of a long ellipsoidal shape (Fig. 2).

These three groups of larger nuclei form the retinal portion of the three lateral eyes. They are spindle-shaped or rather wedge-shaped, narrower towards the exterior surface. Later they are separated from the surrounding nuclei at the narrower end by a ring-like furrow, peculiar to the lateral eyes, and the surrounding nuclei grow and meet together over the retinal portion forming a layer of cells — the vitreous body.

The lateral eyes receive their nerves from a portion of the brain, formed by the lateral vesicle. Thus the latter is the optic ganglion, formed from an invagination independently of the semicircular cephalic groove which gives rise to the brain proper.

The common hypodermic thickening of the lateral eyes of spiders is most probably homologous to the hypodermic thickening of the lateral compound eye of *Limulus*[3], as the position is just the same and an invagination similarly produced in both cases. Then, are the peculiar groups of larger nuclei of the former homologous to the ommatidia of the latter? I am inclined to believe that it is the case and the lateral eyes of spiders are separated, enlarged, and modified ommatidia of a compound eye of their ancestor.

In Pl. IV illustrating Parker's paper »The Eyes in Scorpions« we distinctly see that all the lateral eyes of the scorpion also arise from a common thickening of the hypodermis. Thus we see that this interesting phenomenon does occur not only in spiders, but also in an allied order Scorpionidea. Parker, however, does not seem to consider this interesting fact as of much value, if he did not indeed overlook it.

Lankester and Bourne arrived at the same conclusion as mine from the study on the structure of the eyes of adult *Limulus* and *Scorpio*; but they wanted the embryological proof. After these authors much work has been done on the development of spiders, scorpions and *Limulus*; but no one has confirmed the conclusion of Lankester and Bourne.

The facts that the number and the relative position of the simple eyes of spiders and scorpions are very much variable and that they are placed more close together in the embryonic than in later stages, speak in favor of my conclusion.

[3] The detailed description of the development of the lateral eye of *Limulus* I reserve to a paper on the embryology of our king-crab, which will be published in the course of time in the Journal of the College of Science, Imperial University, Tōkyō, Japan.

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The separation and modification of the ommatidia of a compound eye into simple eyes are probably the effects of the change of the animal's habit — from the habit of wandering about in pursuit of prey to that of lying in wait for it.

The lateral eyes of spiders were called »Augen mit präbacillärem Kern« by Graber, and »Nebenaugen« by Bertkau; but as they are homologous as a whole to the lateral eyes of scorpions and to the lateral compound eyes of *Limulus*, I propose to call them lateral eyes as I have used in this paper.

Zoological Institute, May 25, 1891.

4. Die Widerstandsfähigkeit des Frosches gegen das Einfrieren.

Von W. Müller-Erzbach in Bremen.

eingeg. 10. Juli 1891.

Da Herr K. Knauthe im Zool. Anz. vom 23. März 1891 (p. 104 u. folg.) die Behauptung ausspricht, daß Fische, Frösche oder Kröten völliges Einfrieren bis zum Erstarren nicht überdauern können, so sehe ich mich veranlaßt meine früheren Versuche über denselben Gegenstand in Erinnerung zu bringen. Einige derselben habe ich in Reichert's und du Bois-Reymond's Archiv vom Jahre 1872, p. 754 veröffentlicht und auch die späteren hatten bei den dort angegebenen Vorsichtsmaßregeln den gleichen Erfolg. Bei der Bestimmung der Sauerstoffmengen, welche die verschiedenen Froscharten im Sommer und im Winter, an der Luft und im Wasser beim Athmen verbrauchen, wurde ich auf jene Versuche geführt, und es lag mir daran festzustellen, ob ein Frosch lebend erhalten werden könnte, wenn er mehrere Stunden lang in einem Eisklumpen fest eingefroren gewesen wäre, so daß dabei jede Aufnahme von Sauerstoff aus dem Wasser oder aus der Luft ausgeschlossen werden müßte. Diese höchst auffällige Erscheinung konnte ich nun wiederholt beobachten. Das erste Mal wurde ein brauner Grasfrosch, der zu Respirationsversuchen im Wasser benutzt war, in einer kleineren mit Wasser gefüllten Flasche zum Einfrieren an die kalte Luft gebracht. Als die Eisbildung bis zu seinem Körper fortgeschritten war, suchte er durch matte Bewegungen die Oberfläche des Wassers zu gewinnen, aber durch ein Stäbchen unter derselben gehalten, war er bald außer Stande sich zu befreien, so daß er mitten in der Eismasse festsaß. Nachdem alles Wasser fest geworden, blieb die Flasche noch fünf Stunden lang bei einer Lufttemperatur von — 6 bis — 8,7° C. im Freien. In einem mäßig warmen Zimmer löste sich der noch steif gefrorene Frosch in der zweiten Stunde vom übrigen Eise ab. Er zeigte keine Spur von

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