

Im Gegensatz dazu haben wir bei *Cassidaria* gesehen, daß die Entwicklung gewisser abnormer Eier sehr weit geht und daß in den Eikapseln die Zwergembryonen wie die normalen Embryonen zum Bau eines typischen Veligers gelangen, ein Fall, für welchen bislang kein Analogon in der Litteratur besteht. Ebenso merkwürdig ist weiter der Umstand, daß bei *Cassidaria* der Eizellenrest sich nicht furcht, wie das abnorme Ei der *Neritina*, d. h. sich nicht in zwei gleich, oder annähernd gleich große Zellen theilt, sondern daß der Zellhaufen, welcher aus der Eizelle durch Theilung hervorgeht, aus ungleich kleineren Zellen besteht, so daß man den Vorgang vielleicht als eine Knospung aufzufassen hätte.

Was nun die Ursache dieser sonderbaren Vorgänge betrifft, so scheint mir von Blochmann keineswegs der Beweis geführt worden zu sein, daß dieselbe im Unterbleiben der Befruchtung zu suchen sei. Bei *Cassidaria* könnte man allenfalls noch annehmen, daß bei der enormen Menge von Eiern das Sperma nur für eine geringe Anzahl von Eiern in jeder Kapsel gereicht hätte, warum würden aber dann einige der unbefruchteten Eier eine weit höhere Entwicklungsstufe erreichen als die übrigen? Bei *Neritina* dagegen ist es höchst befremdend, wie Blochmann selbst zugiebt, daß bei Ablage einer einzigen Kapsel nur ein einziger Samenfaden aus dem dem Weibchen bei der Begattung zugeführten Quantum zur Geltung gekommen sei.

Mein Material ist leider zu lückenhaft, um eine Ausarbeitung dieses interessanten Gegenstandes zuzulassen. Ich hoffe gelegentlich diese Lücken ausfüllen zu können. Vorläufig muß ich mich damit begnügen die Aufmerksamkeit Anderer auf diese merkwürdigen Verhältnisse zu lenken. Besonders interessant dürfte die Entwicklung der *Cassidaria* für solche Forscher sein, welche sich mit experimenteller Entwicklungsgeschichte befassen, d. h. künstliche Miss- und Hemmungsbildungen zu erzeugen bestrebt sind.

Heidelberg, den 26. October 1892.

2. On the Eyes, Subneural Gland, and Central Nervous System in *Salpa*¹.

By Maynard M. Metcalf, Johns Hopkins University, Baltimore.

eingeg. 30. October 1892.

It has been my good fortune to be enabled to study the chain and solitary forms of eleven species of *Salpa*. I have given my attention almost wholly to the anatomy and the development of the eyes

¹ My fully illustrated paper on this subject is now in press. It will appear as a portion of Professor Brook's »Monograph of the Genus *Salpa*«.

and the subneural gland and to the metamorphosis in the nervous system by which the adult condition is reached. I published in the Johns Hopkins University circulars for April 1891 a brief preliminary note of some of my results. I wish here to call further attention to a few facts and offer a few theoretical considerations.

In the solitary form of all species of *Salpa* the eye is horse-shoe shaped. The chain forms of no two species of *Salpa* have the same shaped eye, but each species has its own characteristic eye. I will not attempt without figures to describe these most decided variations. The eyes of the chain forms, though so diverse, still show a fundamental conformity to a definite type. For this reason the study of the eyes gives good evidence as to the nearness of relationship between species.

Salpa pinnata and *Salpa Chamissonis*, Brooks (n. sp.), each have five eyes in the chain form: one, large, on the dorsal side of the brain (the only one known previous to my studies); the other four, smaller and arranged in pairs, one pair on the antero-dorsal face of the ganglion, the other pair in the middle of its posterior face. One or both pairs of the smaller eyes are usually represented in the chain individuals of other species, being often, however, in a somewhat degenerate condition. The large dorsal eye is a complex structure. In its anterior half the rod cells are ventral and the pigment cells dorsal: in its posterior half this arrangement is reversed. The optic nerve arises from the non-cellular core of the ganglion and passes up over the dorsal surface of the posterior part of the eye, innervating there the dorsally lying rod cells: then it pushes ventralwards through the eye to innervate the ventrally lying cells of its anterior portion.

The larger dorsal eye of the chain form of *S. runcinata-fusiformis*, *S. Africana-maxima*, *S. cylindrica*, *S. hexagona*, *S. costata-Tillenii*, *S. cordiformis-zonaria*, *S. democratica-mucronata*, *S. pinnata*, and *S. Chamissonis*, develops as a disc-shaped plate of cells pushed up from the dorsal surface of the ganglion toward the ectoderm. The fibres of the optic nerve rise from the dorsal part of the ganglion and enter directly the centre of the ventral face of the eye disc. In the course of its development this disc tips forward, suffering a reversal by which the originally anterior edge becomes posterior and vice versa, while its ventral surface becomes dorsal. By this same reversal the optic nerve comes to lie along the dorsal surface of the posterior half of the eye. The corresponding eye of the chain *S. scutigera-confederata* and *S. bicaudata* does not suffer this reversal, indicating that these two species belong in a separate group.

Previous to the assumption of the disc-like form the developing eye of the chain *Salpa* passes through a stage when it resembles in

shape the eye of the solitary *Salpa*; i. e. it is for a time horse-shoe shaped. This is seen even in *S. pinnata*, the most modified species I have studied.

Each of these eleven species of *Salpa* shows, either in the chain or solitary form or in both, a more or less well developed **subneural gland** consisting of two chambers beneath the brain, one on each side of the middle line of the body, each connected with the peribranchial chamber by a comparatively large cylindrical duct. Both the chambers and the ducts are formed from the wall of the peribranchial chamber. These structures are apparently homologous with the lateral ducts found in *Phallusia mammillata* connecting the subneural gland with the peribranchial chamber. Probably the lateral chambers which in *Molgula ampulloides* open into the duct of the sub-neural gland are also related to these organs in *Salpa*. The sub-neural gland is most highly developed in *S. africana-maxima*.

The nervous system of *Salpa*, in its development, passes through a *Doliolum* stage where it almost exactly resembles the nervous system of a nearly mature *Doliolum*. *S. Africana-maxima* retains in the adult a remnant of this stage. There is a solid wart-like antero-ventral protuberance from the ganglion. A solid rod of cells is continued forward from this protuberance, soon fusing with the pharynx wall in connection with which it can be traced for a considerable distance. It finally dwindles to a small hollow tube within the basement membrane of the pharynx wall in which it can be traced to the ciliated funnel. *S. Africana-maxima* is, in this respect, the most primitive of the species studied, retaining in the adult a character seen only in the embryos of other species.

The ganglion of *Salpa* is homologous with the visceral portion of the larval Ascidian nervous system. (I emphasize this point both for its own sake and also in reference to my next point.) Van Beneden and Julin have shown that the dorsal wall of this portion of the Ascidian tadpole's neural tube proliferates cells which become the ganglion of the adult, while the thickened ventral wall of the same region gives rise to the subneural gland. There are two portions of the embryonic *Salpa* nervous system: 1) an anterior thin walled tube opening to the ciliated funnel (this atrophies), and 2) a posterior portion with thickened ventral wall. The cells of the dorsal wall of this region proliferate to form the dorsal $\frac{2}{3}$ of the ganglion; the ventral $\frac{1}{3}$ is formed by the thick ventral wall, which persists after the obliteration of the lumen of the neural tube. The sense vesicle and the caudal portion of the larval Ascidian nervous system degenerate. *Salpa* has no tail and no caudal nervous system; neither has *Salpa* any sensory

vesicle. The cells that would correspond to it are in the thin-walled anterior portion of the neural tube and all of this portion atrophies. Salpa's ganglion is, then, homologous with both the ganglion and the subneural gland of Ascidians (provided Van Beneden's and Julin's account of the development of the gland be correct). An added proof of this point is that from the ventral portion of the ganglion of Salpa certain cells push out ventralwards with no apparent purpose, recalling the migration of the homologous cells in the Ascidian larva to form the gland.

This homology is important. The eye of Salpa is formed from the ganglion. The eye, therefore, can not be homologous with the eye of the Ascidian tadpole, since the latter is found in the sense vesicle and not in the visceral portion of the nervous system. Neither is the eye of Salpa homologous with the lateral or pineal eyes of Vertebrates or with the pigment spot of *Amphioxus*. These latter develop from the most anterior portion of the neural tube (the first primary vesicle). The eye of Salpa develops from a secondarily acquired ganglion, which is derived not from the homologue of the first primary vesicle, but from a more posterior portion of the nervous system, and which is not represented in the nervous system of *Amphioxus* or Vertebrates. The eye of the Ascidian tadpole may be phylogenetically related to the eye of *Amphioxus* and Vertebrates: the eye of Salpa can not be.

Professor Bütschly recently published a short note in this journal in which he claimed that the primitive Salpa eye is a little hillock (»hügelartiger Vorsprung«) on the dorsal side of the ganglion consisting of a mass of vertically placed rod cells innervated from below directly from the ganglion. He claimed also that from this »hügelartig« eye the horse-shoe-shaped eye is derived in a manner which suggests the probable phylogenetic mode of development of the Vertebrate lateral eyes. Let me call attention to one or two points that oppose this view.

1) Professor Bütschli's description of the »primitive« eye does not correspond to the condition of any eye I have seen. The word »hügelartig« might, however, be loosely applied to the large dorsal eye of the chain form of several species, though not to the eye of the solitary form of any species, for these always have distinctly horse-shoe-shaped eyes. In the posterior portion of the »hügelartig« eye the rod cells are dorsal and the pigment cells ventral: in its anterior portion this arrangement is reversed. The optic nerve does not enter the eye directly from below, but runs up over the dorsal surface of its posterior portion in all the nine species which show the reversal spoken of

above. The other two species show just as complicated an eye except that it is not turned upside down.

2) The horse-shoe-shaped eye (found only in the solitary form) does not arise ontogenetically by a tripartition of a simple eye, but is distinctly horse-shoe-shaped from its first appearance.

3) The only eyes that could be described as »hügelartig« are found in chain Salpae. As I before pointed out, the large dorsal eye (the only one hitherto known) of the chain Salpa passes through a stage where it has the characteristic horse-shoe shape seen in the solitary Salpa. The latter would therefore be the more primitive.

4) Most important of all is the fact that the eye of Salpa arises from a much modified secondarily acquired portion of the nervous system represented in the Vertebrates and can therefore not be homologized with the Vertebrate eyes.

Professor Bütschli's hypothesis is, then, opposed by the character of the eye of the chain form, by the manner of development of the eye of both chain and solitary forms and by the fact that the Salpa eye is derived from a portion of the nervous system not represented in the Vertebrates.

Baltimore, Nov. 17th 1892.

3. L'absorption chez les Actinies et l'origine des filaments mésentériques.

Par Victor Willem, Assistant de Zoologie à l'Université de Gand.

eingeg. 8. November 1892.

Si on donne à des *Actinia* ou à des *Sagartia* de l'albumine carminée, on constate au bout de quelques heures la présence de particules de carmin dans les cellules du revêtement de la cavité entérique. Et ce n'est pas, à proprement parler, dans les entéroïdes que se fait cette absorption, comme l'émettent Krukenberg¹ et Metschnikoff²; mais, tout d'abord et principalement, dans la région des cloisons rayonnantes qui confine à ces filaments, région où l'épithélium forme un épaississement parallèle au bord du Septum³; on rencontre encore les grains de carmin dans les cellules des gouttières qui séparent soit les bandes latérales ciliées de la bande à nématocystes médiane, soit les bandes latérales l'une de l'autre⁴.

¹ Krukenberg, Über den Verdauungsmodus der Actinien. Vergl.-phys. Studien a. d. Küste der Adria. 1. Abth. 1880.

² Metschnikoff, Über die intracelluläre Verdauung bei Coelenteraten. Zool. Anz. 1880. p. 261.

³ Voir Hertwig, Die Actinien. Jenaische Zeitschrift, 1879. Taf. XXI. fig. 13.

⁴ Ibidem, Taf. XXI. fig. 10 et 14.

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Zeitschrift/Journal: [Zoologischer Anzeiger](#)

Jahr/Year: 1893

Band/Volume: [16](#)

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