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Observations on blastogenesis and alternation of generations in the Salpæ and Pyrosomata

M.L. Joliet

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These two views are fundamentally different. Besides affecting our belief as to the manner in which bilateral symmetry arose, the acceptance of one or the other is the foundation of our understanding of the homologies which are to be found in the two groups.

Evidence for the one or the other of the views is to be looked for in embryology; but very few animals give an opportunity for such research, owing to secondary changes which have acted upon the ova and the embryos. For this reason no direct evidence has been hitherto obtained. At Beaufort, during the last summer, some work was done upon *Thalassena*, a species of worm which possesses a very primitive development, and enables a direct study of the origin of bilateral symmetry from radial symmetry to be made. The results of the observations were satisfactory upon the point in question, and showed that, as far as this group of animals is concerned, the second of the above views, viz. that of Balfour, is in all essential respects correct. The radially symmetrical gastrula elongates nearly at right angles to its long axis, and gives rise to a bilateral larva, of which the ventral surface has been from the first indicated by the position of the mouth. The acquisition of a direct motion occurs some time after the animal is truly bilateral, an indirect revolutionary motion being gradually changed into a direct motion with its anterior extremity in advance.—*Johns Hopkins University Circulars*, April 1883, p. 73.

Observations on Blastogenesis and Alternation of Generations in the Salpæ and Pyrosomata. By M. L. JOLIER.

In 1868 Kowalevsky traced with precision the principal features of the blastogenetic development of the *Salpæ*. According to him the stolon consists, as in the *Pyrosomata*, of two tubes, one within the other, prolonging the ectoderm and endoderm of the parent. In the free space left between them run four cords—two lateral, derived from the cloaca, two median (one inferior, the other superior), derived from two masses of mesodermic cells. According to the same author the skin, the branchio-intestinal tube, and the cloaca of each of the aggregated *Salpæ* are derived from the corresponding parts of the stolon, and, consequently, of the parent; the nervous system and the genital organs, formed at the expense of the median cords, result from the development of two groups of mesodermic cells.

Since this very precise exposition three chief memoirs have appeared upon the same subject; these have again brought into question the whole problem of gemmation and alternation of generations.

Thus, according to Salensky, the inner tube as well as the lateral cords have only a transitory function: the latter are derived from the pericardium; and the intestine is formed at the expense of the inferior cord.

Brooks attributes their real function to the genital cord and the endodermic tube of the *Salpæ*; but he does not recognize a true alternation of generations in the *Salpæ*. Ova being visible in the genital cord of the stolon before the different individuals of the chain are distinct, he concludes from this that the so-called agamic form is a female producing by gemmation not hermaphrodites, but incubatory males, each containing an ovum.

Todaro did not recognize the fact of the original distinctness of the four mesodermic cords; he described a homogeneous middle layer, which, originating from a germoblast, would form the entire body of the bud to the exclusion of the endodermic and ectodermic tubes. As the germoblast is, with him, the equivalent of the ovum itself, the aggregated individuals which originate from it would be, not the sons but the younger brothers of the solitary individual, and there would be in the *Salpæ* neither an alternation of generations nor true gemmation.

My observations enable me to confirm and complete the statements of Kowalevsky; they also compel me to support the old theory of gemmation and the alternation of generations.

If in a very young solitary embryo of *Salpa democratica mucronata* we examine the germinal point, we see a thickening of the ectoderm, against which a diverticulum of the endoderm of the parent abuts internally. In front, towards the placenta, there is a small transparent mass of mesodermic cells, the origin of the neural cord; behind, towards the cleoblast, another more voluminous one, the origin of the genital cord; and lastly, on each side, a thickening is attached directly by a long peduncle to the lateral lamellæ destined to form the muscles of the solitary embryo; these are the rudiments of the lateral cords. Their connexion with the muscular plates is at first very distinct; subsequently the attachments break and return upon themselves, and it is no longer possible to distinguish any thing of them. Upon this point alone my observations are in disagreement with those of M. Kowalevsky, who makes the lateral cords originate from the cloaca of the parent; the lateral cords, at least in *Salpa democratica*, originate neither from the cloaca nor from the pericardium, but from the muscular lamellæ. In the section of a young stolon the lateral cords appear as two homogeneous cellular masses; later on each of them splits into a hollow cloaca, cord and a mass of mesodermic cells. These cells multiply greatly, and form the lateral or muscular plates of the buds. Further, each segment of the cloacal tube gives origin directly to the cloaca of each bud. As to the central endodermic tube, Brooks is right in his description of the sacs which it emits at each side, and which serve as the origin of the branchio-intestinal tube of the buds. These sacs, enveloped and often masked by the muscular plates, are none the less recognizable in properly made sections.

In the *Salpæ*, as in the *Pyrosomata*, the endoderm, the ectoderm, and the mesoderm of the bud are therefore derived from the corresponding lamellæ of the parent, and serve to form the same organs.

With regard to Brooks's opinions, I have very strong reasons for believing that the genital or inferior cord of the stolon does not serve to give origin solely to the ova or female elements which are seen in the aggregated *Salpa*, but also to the spermatozoids; if, therefore, we are to see in this cord a sexual gland, it will not be a female but an hermaphrodite gland. Hence it follows that the solitary *Salpa* is not a female but an hermaphrodite form.

Moreover, Brooks is wrong in thinking that the ova with germinal vesicle and spot, which are observed already sketched out in the young buds, are true ova. In each bud of *Salpa* or *Pyrosoma* there exists at a certain moment a single one of these bodies; it is seen to divide several times before any fecundation. Only one of these segments becomes the definitive ovum; the others constitute a mass of cells already observed in the *Salpæ* by Leuckart (who was not aware of its origin), and destined to form the proper walls of the oviduct and follicle. There is consequently no reason to be surprised, as has often been the case with reference to the *Salpæ* and *Pyrosomata*, at seeing the ovum precede in development the individual which has to bear it; this body, which nevertheless in its dimensions and constitution presents all the characters of an ovum, is not a definitive ovum, but one of those bodies which the English call "*germinal cell*" and the Germans "*Urei*," and which it may be useful to designate in our language by the name of *proovum*.

To sum up. The gemmation of the *Salpæ* is a true gemmation, but rendered particularly complex by the fact that organs already differentiated take part in it, each on its own behalf.

The solitary form, hitherto regarded as agamic, is not a female; it does not contain an ovary; nor does it contain an hermaphrodite gland, but at the utmost the sketch or rudiment of such a gland; it therefore perhaps merits the denomination of an agamic form.

To avoid all ambiguity it will be well to define the sense which should be attached to this term.

The stock agamic form is that which, produced sexually and possessing sexual tissue, either not yet differentiated and simply in potentiality, or already differentiated and recognizable, *but being incapable of conducting it to the term of its evolution*, confides it for this purpose to one or more successive forms, the last of which at least is sexual.

This formula applies to the *Salpæ*, to the *Pyrosomata* (in which the third bud alone is capable of reproduction), to the *Doliola*, to the compound *Ascidia* (which may present still more complex processes), and, lastly, to several other animal forms.—*Comptes Rendus*, June 4, 1883, p. 1676.