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Inhalt:

- | | |
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| <p>I. Wissenschaftliche Mitteilungen.</p> <p>1. Curtis, The Location of the permanent Pharynx in the Planarian Embryo. (With 2 figs.) S. 169.</p> <p>2. Nussbaum, Die Lappenbildung des Hodens einheimischer Urodelen. S. 175.</p> <p>3. Toldt jun., Asymmetrische Ausbildung der Schläfenmuskeln bei einem Fuchs infolge einseitiger Kautätigkeit. (Mit 4 Figuren.) S. 176.</p> | <p>4. Herdman, Ascidian Classification. S. 191.</p> <p>5. Enderlein, Läusestudien IV. Über einen auffälligen Sexualdimorphismus bei <i>Polyplax spinulosa</i> (Burm.) (Mit 4 Figuren.) S. 192.</p> <p>6. Enderlein, <i>Rhammura</i>, eine neue Braconidengattung mit außerordentlich langem Legerohr des Weibchens. S. 195.</p> <p>7. Enderlein, Einige Bemerkungen zur Kenntnis der Trigonaliden. (Mit 1 Figur.) S. 198.</p> <p>Literatur. S. 73—88.</p> |
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I. Wissenschaftliche Mitteilungen.

1. The Location of the permanent Pharynx in the Planarian Embryo.

By W. C. Curtis, Assistant Professor of Zoology, University of Missouri, Columbia, Missouri, U.S.A.

(With 2 figs.)

eingeg. 27. März 1905.

In his recent account of planarian embryology, Mattiesen¹ describes the permanent or adult pharynx of *Planaria torva* as appearing just posterior to the temporary or embryonic pharynx and some time before the latter has disappeared. He thus finds both the pharyngeal structures located close together, on what is destined to be the posterior part of the ventral surface in the adult worm. This fact he is careful to state very explicitly as follows (p. 340): »Wenn man den noch immer die Gestalt einer dünnwandigen Hohlkugel besitzenden Embryo nach seiner späteren Längsachse orientiert, so scheint die Pharyngealhöhle stets unmittelbar hinter dem zugrunde gehenden Embryonalpharynx aufzutreten.« His figure 72 illustrates this condition in which the two structures are coexistent. Again, p. 343, he says: »Hierbei will ich aus-

¹ E. Mattiesen, Ein Beitrag zur Embryologie der Süßwasserdendrocoelen. Zeitschr. f. Wiss. Zool. LXXVII. Bd. 1. u. 2. Heft. 1904.

drücklich bemerken, daß die beiden Pharyngealbildungen stets von vornherein auf die Ventralseite zu liegen kommen. «

Save for the minor point that the second pharynx appears just behind instead of actually within the area occupied by the embryonic structure, Mattiesens observations on this point are a confirmation of what Ijima² thought was the relation in *Dendrocoelum lacteum*, though Mattiesen has rendered his description quite conclusive by the care with which he has studied and figured the histological details at each stage of the development. The determination of the exact position of these two organs in *P. torva* was made easy by the fact that the degenerating embryo-pharynx still persists at a stage when the anlage of the adult pharynx is clearly recognizable, whereas Ijima found that in *D. lacteum* the embryo-pharynx entirely disappeared before the first sign of the adult organ could be detected.

At the close of his description, Mattiesen notes that I have described and figured³ (see fig. 1 of this paper) the embryonic pharynx of the American *Planaria maculata* as located on the future dorsal surface of the body and immediately above the point at which the adult pharynx takes its origin, but he dismisses this as hardly worthy of serious consideration and doubtless to be explained on the basis of poor preservation or of the observation being made upon a single abnormal individual⁴.

In replying to this intimation that my record of the facts in *P. maculata* can hardly be taken seriously, I shall present a brief resumé of the observations to date upon this point in the embryology of *P. maculata* and the other planarians in which it has been definitely established. I will then state what in my opinion is the view that should now be taken of this particular feature in planarian embryology.

Ijima⁵ who first gave an approximately correct account of the origin of the permanent pharynx studied the embryo of *Dendrocoelum lacteum*. After describing the formation of the spherical embryo and its distention by the yolk cells which are taken through the pharynx of

² J. Ijima, Untersuchungen über den Bau und die Entwicklungsgeschichte der Süßwasserdendrocölen. Zeitschr. f. wiss. Zool. XL. Bd. 1884.

³ Curtis, The Life History etc. of *Planaria maculata*. Proc. Boston Soc. Nat. Hist. Vol. 30, No. 7, p. 515—559, Pl. 9—19. (See fig. 51 of plate 17.)

⁴ »Es wundert mich daher sehr, daß die von Curtis beschriebene *P. maculata* hiervon eine Ausnahme machen soll. Dieser amerikanische Autor glaubt nämlich gefunden zu haben, daß der sich bildende definitive Pharynx tatsächlich auf die Ventralseite des Embryo zu liegen kommt, während der degenerierende Embryonal-pharynx, der in diesem Falle sogar hinter dem definitiven liegen soll, sich dorsal am äußersten Hinterende befindet. Curtis bildet auch einen derartigen Embryo im Längsschnitt auf seiner Fig. 51 ab. Ich halte es jedoch für sehr möglich, daß dieser entweder durch die Konservierung stark deformiert oder vielleicht einfach mißgebildet ist, was eine richtige Orientierung ausschließt.«

⁵ op. cit.

the embryo, he describes the fate of this organ as follows (p. 448): »Das Mesoderm⁶ in der Umgebung des Embryonalpharynx scheint unterdessen in einen aktiven Vermehrungsprozeß eingetreten zu sein. Es übt einen Druck auf den mit Lücken erfüllten Embryonalpharynx aus, infolgedessen dieser immer kleiner wird. Das Körperepithel wächst über der äußeren Öffnung des Pharynx zusammen. Ebenso wird die innere Öffnung von dem Mesoderm bzw. dem Darmepithel überwachsen. Die Überreste des Pharynx rücken gegen das Körperepithel hin.« Again he says (p. 449): »Nach einiger Zeit tritt ein vollständiges Verschwinden des Embryonalpharynx ein. Die Stelle, welche derselbe einnahm, ist freilich immer noch zu erkennen, indem das Mesoderm dasselbst eine bedeutende Verdickung zeigt (Fig. 17—19). Gleich darauf tritt in der Mitte dieser Verdickung, etwas näher dem Körper als dem Darmepithel, eine anfangs nur kleine Höhle auf (Fig. 18 *ph.t*), die erste Anlage der Pharyngealtasche.« In his figures as above cited he clearly

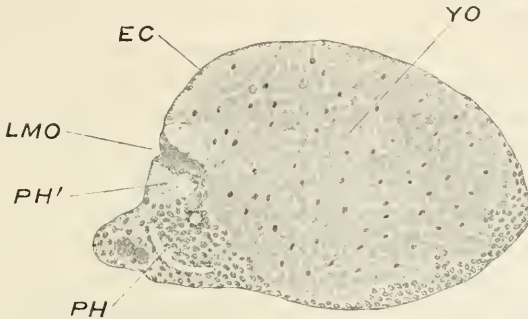


Fig. 1. A reproduction of the figure which I originally published, showing the orientation at the time the definitive pharynx makes its appearance. *ec*, ectoderm; *lmo*, larval mouth; *ph'*, embryonic pharynx; *ph*, pharynx of adult showing the cavity of the sheath and the beginning of the lumen within the mass of the pharynx proper; *yo*, the central mass of disintegrating yolk cells.

shows that the last remnant of the embryonic pharynx disappears shortly before the first anlage of the adult pharynx becomes visible. His evidence that the two occupy almost the same region rests upon the fact that the mesodermal thickening in which the adult organ appears has been recognizable for some time previous to the disappearance of the temporary pharynx. Indeed he thinks in one of the sentences above quoted that it is the pressure of the developing mass of „mesoderm“ which causes the shrinking together of the cells comprising the embryo-pharynx. At a little later stage the „mesoderm“ has become thickened over a much

⁶ He considers the wall of the embryo to be made up of very much flattened ecto- and endoderm layers and between these scattered mesoderm cells.

greater area along the future ventral and posterior regions, as is seen below in fig. 2 *B*, of this paper which is a copy of Ijima's figure 28, Plate XXIII. This more extensive thickening begins in *D. lacteum* and other planarians (see figure 2) about the time that the first anlage of the adult pharynx becomes evident. In view of this extension of the mesodermal thickenings it seemed to me, when I found in *Planaria maculata* the adult pharynx not originating in the place previously occupied by the embryonic pharynx, that the most probable explanation of Ijima's account was not a difference in orientation between two such closely related forms, but rather a mistake on the part of this author which arose from the fact that the two structures were never present together in the embryo of *D. lacteum*. It seemed to me that if the point at which the last trace of the temporary pharynx disappeared was not quite so near the region of the adult structure's origin as Ijima supposed, i. e. if it was located a short distance up along the ventro-posterior surface of the body as shown in figure 2 *A*, *C* and *E*, then the case of *D. lacteum* would not be radically different from the condition which was so clearly to be made out in *P. maculata*. Accordingly I suggested this in my description of these organs in that species, not as a criticism of Ijima's conclusion, but merely to point out an error into which it seemed likely he had fallen through the difficult nature of the material.

In view of the care with which Mattiesen has followed out all of his work I do not for a moment doubt the absolute correctness of his statement that the adult pharynx of *P. torva* appears immediately posterior to the degenerating embryonic structure. Now that this is established we may I think believe that Ijima was quite right in his orientation of these organs in *D. lacteum*. But I think it is now equally well established that the same relation does not exist in *P. maculata* and probably in another American form *P. simplicissima*. Since Mattiesen seems unwilling to accept my description as reliable I will say this regarding the basis upon which it rests. In the first place the account was not based upon any single but upon a number of embryos, and moreover I have carefully reexamined all my preparations without finding anything which would lead me to change my account. Second, it has been confirmed by Bardeen⁷ who discovered it independently but shortly after I did. For comparison with my own figure I have reproduced (fig. 2 *A*) the outlines of Bardeen's figure of this stage, and quote the sentence in which he refers to this. On page 263 he says: „The hitherto spherical embryo now becomes flattened dorso-ventrally and elongated in the an-

⁷ C. R. Bardeen, Embryonic and Regenerative Development in Planarians. Biological Bulletin Vol. III. No. 6. Nov. 1902.

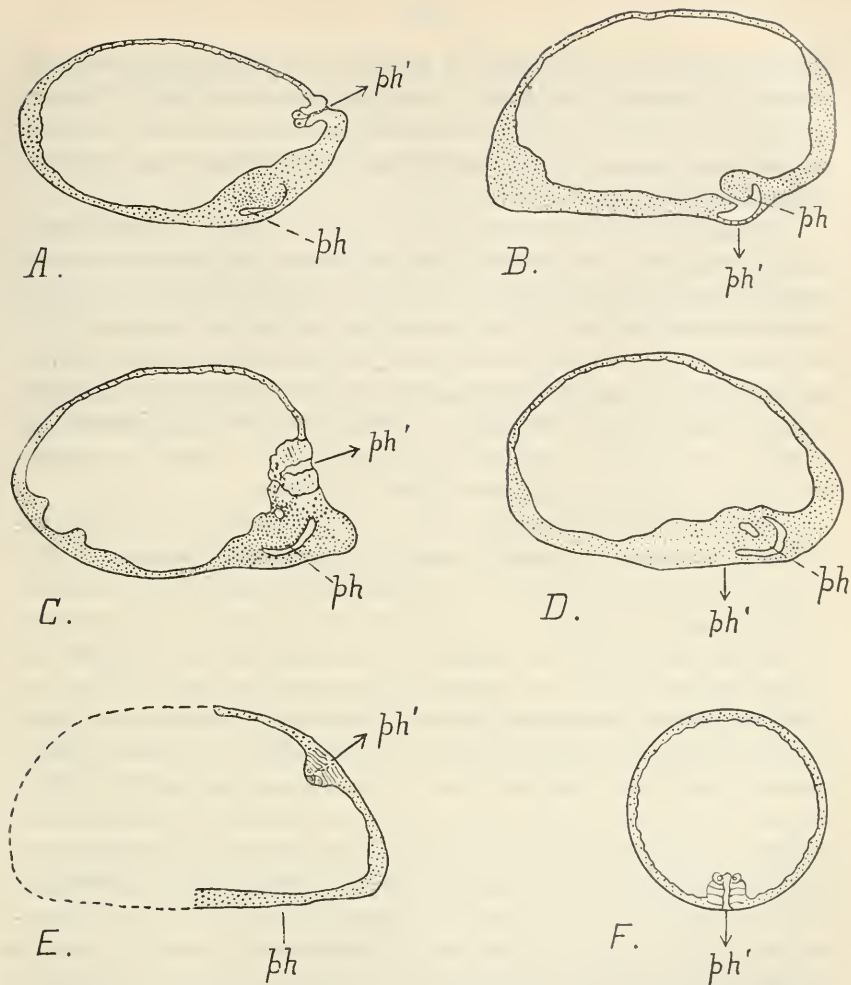


Fig. 2. A, B, C, D, E. Sagittal sections of planarian embryos at the period when the sphere is becoming flattened as the embryo assumes the definitive shape. In each figure the central clear space represents the area occupied by the mass of distintegrating yolk cells which have passed in by way of the embryo-pharynx. The outlines of the stippled area show the extent in different regions of the surrounding wall in which are contained the cells descended from the blastomeres. In each figure the anterior end is to the left and the future ventral side is the lower one. The thickening of the antero-ventral region of the wall marks the place at which the brain will later appear. The long axis of the embryo-pharynx is shown in each by the arrow marked *ph'* and at *ph* the anlage of the permanent pharynx is shown or its position indicated. A, Copy of Bardeen's figure of a *P. maculata* embryo. B, Copy of Ijima's figure of *D. lacteum*. C, My own figure of *P. maculata* reversed for the sake of more easy comparison with the others of this series. D, Represents the outline of a planarian embryo at this stage, and is inserted to show the condition which Mattiesen describes in *P. torva*. The outlines of this figure are not taken from any one of his figures for this stage would be about mid-way between his figures 72 and 73a. E, Shows the condition found by Stevens in *P. simplicissima* and is from the figure 45 of this author. The dotted line by which the outline is completed represents the portion of the embryo which is omitted from Stevens figure. F, Is a diagram of the spherical embryo cut in the long axis of the embryonic pharynx.

tero-posterior axis. This change in form is accomplished by a more rapid cell-multiplication in the ventral than in the dorsal body wall. The most rapid cell-multiplication takes place on the postero-ventral wall just below the embryo-pharynx. It is from this mass of cells that the permanent pharynx is developed."

In another North American form, *Planaria simplicissima* Stevens⁸, makes the following statement (p. 216) of the relation between these organs. „The embryonic pharynx disappears completely before the adult pharynx begins to form, but its relation to that structure appears to be the same as in *P. maculata* as recently described by Curtis. In fig. 45 the ventral side of the embryonic layer is easily distinguishable from the dorsal side by its greater thickness, and the degenerating pharynx (p') is on the dorsal side as in Curtis's fig. 51, pl. 17". Below I have reproduced Stevens fig. 45 as figure 2E of this paper.

In view of these confirmations by other workers I think it unnecessary to offer any further details of my own work to show that it was neither hasty nor careless nor published without the examination of more than one specimen. Assuming the account of the matter in *P. torva* is correctly given by Mattiesen and that this indicates the approximate correctness of the similar interpretation which Ijima put upon the facts as he observed them in *D. lacteum*, I think we may now regard it as well established that the relative position of these structures is not identical in all planarians, a possibility which does not seem to have occurred to Mattiesen. Certainly there is a marked difference in the cases above cited (*P. maculata* and *P. simplicissima* as contrasted with *P. torva* and *D. lacteum*). Since such a difference is known to exist in the same genus, is it not likely that a careful examination of this stage in a number of planarians would reveal a quite inconstant relation between these organs, if indeed forms were not found in which there was wide variability within the limits of a single species. Be this as it may, I think I have here presented data enough to sustain my point that the adult pharynx of *P. maculata* does not have the point of origin with reference to the embryonic structure which Mattiesen has shown obtains in *P. torva*.

While I was of the opinion in my previous paper⁹ that Ijima had been in error and was impressed with the idea that „it would be rather strange to have such an entirely different relation in forms so nearly alike in all their general structure as the planarians“, now that this difference has been shown to exist beyond all question, I think it is perhaps

⁸ N. M. Stevens, On the Germ Cells and Embryology of *Planaria simplicissima*. Proc. Acad. Nat. Sciences, of Philadelphia. February 1904.

⁹ op. cit. p. 556.

not so surprising after all, for we may regard it as simply another point in line with the great degree of plasticity which most planarians exhibit by their powers of regeneration and of form-regulation.

My desire for a restatement of the above facts in the embryology of *P. maculata* arises from the very high opinion I have of Mattiesen's exhaustive investigation which will I believe become a classic among the papers dealing with planarian embryology. Having such an opinion of this authors work I cannot allow to pass unchallenged the discredit which it throws upon my published observation of an important detail in the embryology of another form, and so I take the opportunity to justify my own description and to point out what should be our conclusion in the light of the four cases which give us a reliable statement of the orientation at this stage of a planarian's development.

The University of Missouri, Columbia Mo. March 15, 1905.

2. Die Lappenbildung des Hodens einheimischer Urodelen.

Von M. Nussbaum.

eingeg. 18. Mai 1905.

Die Entdeckung der ruhenden Spermatogonien in den reifenden und in Rückbildung begriffenen Ampullen unsrer einheimischen Urodelen mußte notwendigerweise zu einer Aufklärung der Erscheinung führen, daß die Hoden dieser Tiere bald einlappig, bald zwei- bis mehrlappig gefunden werden.

Es zeigte sich an einem großen Untersuchungsmaterial bei jungen Tieren von gewisser Größe nur ein Hoden und mit zunehmender Größe auch Zunahme der Hodenlappen.

Meine Vorgänger haben nicht unterschieden zwischen den einzelnen Lappen und der in jedem Lappen gleichmäßig wiederkehrenden Bildung verschiedenfarbiger und in verschiedenen Entwicklungsstadien befindlichen Abteilungen oder Zonen. Man gebrauchte Lappen und Abteilung als gleichbedeutend und kannte wohl die verschiedenen Zustände, in denen die einzelnen Abteilungen zu bestimmten Jahreszeiten sich befinden. Die Art der Vermehrung der Lappen mußte verborgen bleiben, weil der Regenerationsmodus unbekannt blieb. Der Wechsel von Form, Farbe und Inhalt eines Lappens wird von den Jahreszeiten, die Zahl der Lappen von dem Alter der Tiere beherrscht. Daher zerfallen alle Lappen in die gleiche Zahl von Abteilungen; verschieden große Tiere haben eine mit dem Alter zunehmende Zahl von Lappen.

Die Zunahme der Zahl der Lappen ist dadurch begründet, daß nach der Rückbildung der Follikelzellen in den entleerten Ampullen der caudalen Abteilung des zuerst einlappigen Hodens die ruhenden

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