V. Genus *Anomotaenia* mihi.

Cystoidotaenien mit zwei Hakenkränzen, unregelmäßig abwechselnden Genitalporen und zahlreichen Hoden am Hinterende der Proglottis. Das Rostellum besteht aus zwei in einander geschachtelten musculösen Säcken (im Gegensatz zu den Davaineen mit unregelmäßig alternierenden Genitalporen).

Typische Art: *Anom. microrhyncha* (Krabbe).

3. Notes on Asterid development. No. 2. The development of the coelom in Asterina gibbosa.

By E. W. MacBride, Prof. of Zoology McGill University, Montreal.

(With 3 figs.)

eingeg. 2. Januar 1900.

In a former number of this journal[1] I published a criticism of the results obtained by Mr. Seitaro Goto in his work on the development of *Asterias pallida*[2]. I pointed out that these results in many points could not be reconciled with observations, which I had previously made on the development of *Asterina gibbosa*[3]; and whilst admitting the possibility of the development of *Asterias* being very different from that of *Asterina*, I stated that there was reason to suspect that many of the apparent differences might be due to the imperfection of the methods employed by Mr. Goto.

Since then, I am glad to say, Mr. Goto has turned his attention to the development of *Asterina gibbosa*, and has published a paper on this subject[4] dealing principally with the modifications undergone by the coelom. It is now possible to institute a more exact comparison of our results; and since the differences between us, although materially reduced, are still of great theoretical importance, I have made a renewed study of the later stages of development and can produce further evidence in favour of my position.

In order to make the issue clear to all, I shall briefly recapitulate

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[1] McBride, E. W., Notes on *Asterid* development. A criticism of Seitaro Goto's work on *Asterias pallida*. Zool. Anzeiger, 12. Dec. 1898. No. 575.

[2] Goto, S., The Metamorphosis of *Asterias pallida* with special reference to the fate of the Body-Cavities. Contributions from Zool. Lab. at Harvard-College. No. 88.

[3] McBride, E. W., The Development of *Asterina gibbosa*. Quart. Journ. Micr. Sc. 1896. Vol. 36.

[4] Goto, S., Some points in the Metamorphosis of *Asterina gibbosa*. Journ. Imp. Coll. Sc. Tokio. Vol. 12.

the original points of difference between the two accounts of Asterid development given by Goto and myself.

I asserted that in *Asterina gibbosa*:

1) The rudiments of the aboral surface of the adult make their appearance partly on the right side and partly on the posterior aspect of the larva, and consequently the plane of the disc of the adult makes an angle of from 60° to 70° with the frontal plane of the larva, and no correspondence exists between the planes of symmetry of the larva and adult.

2) The coelom of the larva consists of an anterior portion filling the praeoral lobe and sending back two tongues lying one at each side of the gut which eventually meet one another below so as to form a ventral mesentery.

A transverse mesentery or septum makes its appearance first on the left side of the gut, and then on the right: and in this way the hinder portions of the two coelomic tongues referred to above, become separated off and form closed sacs denominated by me left and right posterior coeloms respectively. The unpaired portion of the coelom together with the anterior portions of the two tongues constitute the anterior coelom of the larva.

Subsequently two openings — a dorsal and a ventral[5] — are formed in the left transverse septum, but these are temporary and become closed before the end of the metamorphosis.

3) The sac situated, both in the larva and adult, close to the madreporic pore, is a rudimentary water-vascular system or hydrocoele belonging to the right side; so that at first the water-vascular system is represented by a pair of rudiments, the left of which gives rise to the water-vascular system of the adult, whilst the other remains a small sac. This sac arises in the larva as a very thick-walled outgrowth from the hinder wall of the anterior coelom to the right of the middle line: its cavity is at first a mere slit which becomes at once shut off from the anterior coelom. The cavity subsequently enlarges so that the right hydrocoele becomes a thin walled sac but never again is in communication with the anterior coelom or with the axial sinus which is derived from the anterior coelom.

4) The radial perihaemal canals and the outer perihaemal ring-canal which connects them with one another, originate as 5 interradial evaginations of the coelom, four arising from the left posterior coelom, and one from the anterior coelom.

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[5] These openings are shown, the ventral in Fig. 1, the dorsal in Fig. 3, in the present memoir.

The basal portions of the evaginations taken together constitute the perihaemal ring-canal; the distal portions become produced each into two tongues which commence to penetrate the rays and form the radial perihaemal canals. The two canals lying side by side found in each ray originate from the evaginations situated in the two adjacent interradii.

On the other hand Mr. Goto asserts that: —

(1) The rudiments of the aboral surface of the adult called collectively the aboral disc make their appearance on the right side and posterior aspect of the larva in both *Asterias pallida* and in *Asterina gibbosa*. In the former case the aboral disc becomes displaced until it occupies the posterior pole of the larva; in *Asterina gibbosa* the same thing really occurs but is masked owing to the circumstance that the prae-oral lobe becomes bent to the right side in consequence of the unequal rate at which the atrophy of its two sides proceeds. As a result in *Asterina gibbosa* the aboral disc remains throughout the metamorphosis apparently obliquely inclined to the sagittal plane of the larva, whereas in *Asterias pallida* this plane eventually cuts the disc at right angles, so that the assertion may be made that the planes of symmetry of the larva and adult are identical.

(2) In the young larva of both *Asterias pallida* and *Asterina gibbosa* the coelom (or enterocoele) consists of two cavities communicating widely with one another in the prae-oral lobe. From the left cavity a posterior division, the left posterior enterocoele, is completely (*Asterina gibbosa*) or incompletely (*Asterias pallida*) divided off. The original ventral mesentery separating the right and left coelomic sacs becomes partly absorbed and replaced by a new oblique mesentery which cuts off entirely a portion of the right sac, called by Goto the "Epigastric coelom" since it gives rise to the coelom lying above the stomach in the adult. In the case of *Asterina gibbosa* Goto has seen the secondary perforation of the septum on the left side, as described by me.

(3) The sac denominated by me the right hydrocoele is stated by Goto to arise from the left coelomic sac, at the level of the madreporic pore, which he regards as the boundary between the anterior and posterior coelomic sacs. In the case of *Asterias pallida* he denied that the sac was identical with the closed space found near the madreporite in the adult; this statement he retracts when dealing with *Asterina gibbosa*, but still asserts that in *Asterias pallida* the sac opens at a late period into the axial sinus. According to him the origin of this sac from the left coelomic sac negatives the idea that it can be a right hydrocoele.

(4) The radial perihaemal canals and the outer ring-canal connecting them arise in *Asterias pallida* as blocks of mesenchyme which subsequently become hollowed out; in *Asterina gibbosa* the ring-canal and the basal portions of the radial canals arise in the manner described by me[6], but the distal portions of the radial canals arise by the hollowing out of masses of mesenchyme having no connection with the coelomic evaginations which give rise to the proximal portions of these same canals.

With regard to 1) I have to record that I have been utterly unable to find any trace of such a secondary bending of the prae-oral lobe of *Asterina gibbosa* to the right as Goto asserts. The original long axis of the larva is indicated for a considerable part of the metamorphosis by the direction of the larval intestine: — speaking generally the long axis of the praeoral lobe is coincident in direction with the intestine — sometimes it is bent a little to the right — oftener on the whole to the left. These flexures I believe to be due to the action of preservatives, they are quite inconstant in amount and direction. We may therefore dismiss the far fetched supposition which Goto has put forward in order to conjure up a coincidence of planes of symmetry where there is an obvious want of correspondence between them. — Further let it be remarked that if in the case of *Asterias pallida*, the aboral disc really does eventually come to occupy the posterior pole of the larva so as to be perpendicular to both the frontal and sagittal planes of the larva, this must be looked on as an isolated and exceptional phenomenon, from which no conclusions can be drawn — since it is opposed to all observations which have heretofore been made for the development of *Asterids*, *Ophiurids* and *Echinids*. From Johannes Müller down every observer has figured a marked obliquity of this disc corresponding to the condition found in *Asterina gibbosa*.

With regard to 2) Goto has apparently entirely failed to recognize the real character of the changes which take place in the coelom. Had he commenced his observations on *Asterina gibbosa* at an earlier stage, he might have seen that exactly the same process takes place on each side of the larva. A transverse septum is formed first in the dorsal region, and is then prolonged ventrally until the posterior coelom is entirely separated from the anterior. It must be remarked however that Goto uses the term "posterior coelom" in a very misleading

[6] Goto apparently thinks that he has made a correction of my account of the coelomic rudiments of the perihaemal spaces, by calling attention to the fact that one of these rudiments originates from the axial sinus; he has apparently read my paper carelessly or he would have seen that this fact was described (loc. cit. p. 360) therein.

sense. He applies it to the whole of the coelom lying at the side of the gut. As defined by me the term includes only the portion cut off by the transverse septum. The space in front of this is always in open communication with the anterior coelom, of which I regard it as forming a part. Only in this anterior region is the ventral mesentery ever absorbed.

At a very early date the left posterior coelom becomes much more bulky than the right one, and tends to sweep under it on the ventral side. This process takes place whilst the left coelomic sac is completely closed, and has for its effect the bending of the ventral part of the left transverse septum so that it becomes almost longitudinal. Shortly

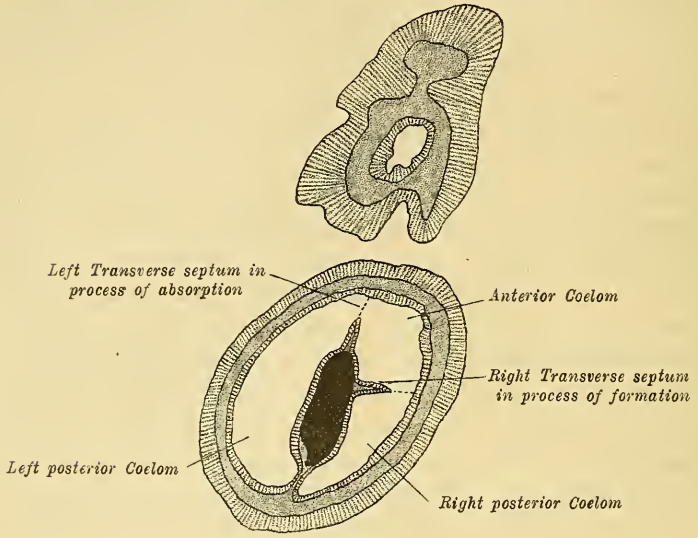

fig. 1.

afterwards a perforation is formed in this longitudinal part of the left transverse septum, putting the sac again in communication with the anterior coelom. This occurs just before the right transverse septum is complete so that for a brief space all parts of the coelom are again in open communication with one another. I have no doubt that it is this secondary dissolution of the left septum which has been mistaken by Goto for an absorption of the longitudinal ventral mesentery.

Figure (1) is an instructive section taken from a larva of about this age. It is a frontal section taken near the ventral surface and it shows the left septum in process of absorption, and the right one in process of formation. The identity in the nature of the two transverse septa is shown by their mode of formation and, we may add, by the dientical position at which they are formed on each side; a point shown by all good frontal sections.

Coming now to the consideration of the third point, I may remark that Goto's mistake as to the origin of the right hydrocoele is due to two circumstances viz., first, he has not seen the earliest stages in its development and secondly he has not recognized the true nature of the division of the coelom. — Figure (2) which shows the inception of the right hydrocoele, should I think convince any unprejudiced person that it is an organ belonging to the right side. On each side the transverse septum has been formed; in the morphological middle line the gut is still in open communication with the anterior coelom and to

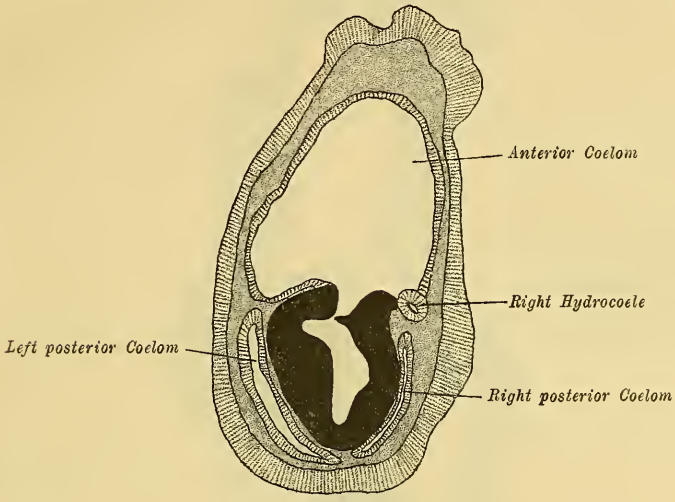

fig. 2.

the right of this the right hydrocoele is seen in process of being budded off from the anterior coelom.

The figures which Goto gives in order to prove the origin of this organ show it in an already advanced state of development: at this stage it has no real connection with any coelomic space, as Goto would have seen had his specimens been will preserved.

Having shown the mode of origin of the right hydrocoele the only additional proof of its nature which could be adduced would be to show that it occasionally underwent a similar development to that of its fellow on the left side. This proof was already furnished by me in my paper on the development of *Asterina gibbosa*. Figure (3) represents a larva not then described in which the right hydrocoele is large and thick-walled and has the histological characters of the left hydrocoele. It shows a tendency to become divided into two lobes. On the left side the dorsal gap in the left transverse septum can be seen.

Finally with regard to the origin of the perihaemal spaces in *Asterina gibbosa*, what is new in Goto's account is not true. The distal portions of the radial perihaemal canals are not formed by the hollowing out of blocks of mesenchyme but by the hollowing out of wedges of cells wich grow from the tips of the coelomic rudiments. The lumen appears secondarily, it is true, and is not a direct prolongation of the lumen of the coelomic pocket, but this is a matter of de-

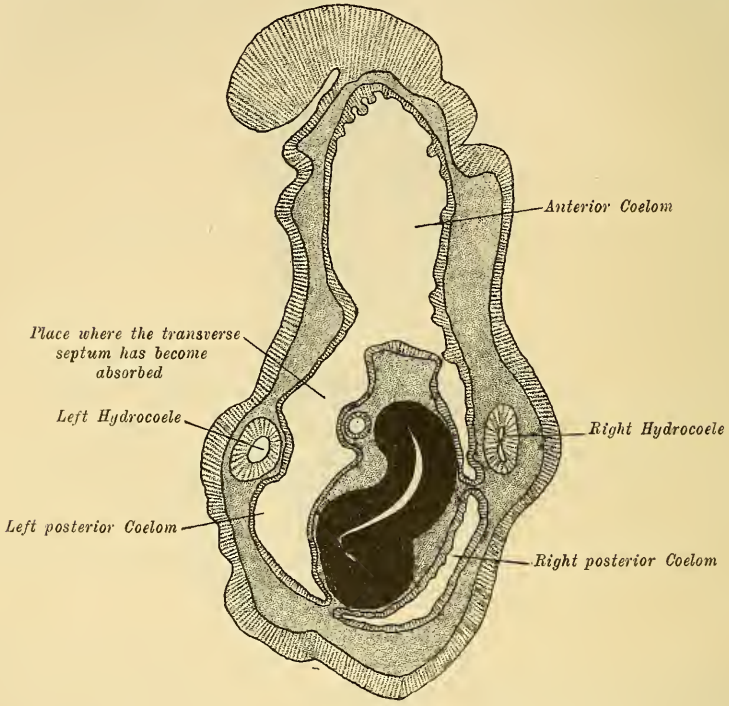

fig. 3.

tail rather than of principle. Had Goto examined sections parallel to the disc which were accurately orientated, he could not, I think, have given this mistaken account of the origin of these canals. —

To sum up —

A repeated study of the development of *Asterina gibbosa* has established the following points:

1) The coelom on each side of the larva is divided into an anterior and a posterior part by a transverse septum.

2) From the anterior coelom on each side a water-vascular rudiment is budded off.

3) The perihaemal spaces are coelomic in origin.

Montreal, Dec. 15. 1899.