Note on the Cœlomic Cavity of the Spider.

by

K. Kishinouye, *Rigakushi.*

Zoologist to the Department of Agriculture and Commerce.

With Plate X.

The species investigated belong to the genera, *Lycosa* and *Agalena*.

My object in undertaking this investigation was to ascertain whether the stercoral pocket is mesodermic in origin as I described in my former paper* or ectodermic and a part of the proctodæum, as is generally believed.

When the embryo has reached the stage in which there are nine segments in the ventral plate, *i.e.*, seven segments between the cephalic and caudal lobes, the mesoderm is divided into as many segments, while a pair of the cœlomic cavities appears almost simultaneously in each of the first five segments, exclusive of the cephalic lobe (Fig. 1).** As at this stage the segment of the cheliceræ is not yet formed, the cœlomic cavities now formed belong to the segments of the pedipalpi and the four ambulatory appendages. The rudiments of appen-

* On the Development of Araneina. This Journal. vol. IV.

** As the segmentation of the ventral plate seems to take place simultaneously with the division of the mesoderm into somites, I will hereafter for the sake of brevity, simply describe the formation of a segment and will not mention every time the formation of the corresponding mesodermic somite.

dages make their appearance in these five segments as small round knobs. The cœlomic cavities of the same segments are just below the evaginations for the appendages.

In the next stage the segment of the chelicerae is cut off from the cephalic lobe, and three new segments are added between the last segment and the caudal lobe (Fig. 2). By this time the cephalothoracic appendages have become much elongated, and the mesoderm has spread into them. The cœlomic cavity extends to the distal end of each appendage ; in fact the larger part of the cavity is now found within the appendage. It spreads a little at the base of the appendage, so that three portions may be distinguished in it in a cross section of the embryo (Fig. 5) as Schimkewitsch* observed—one portion in the appendage, a second extending a little in the dorsal direction, and the third extending a little ventrally. The last two are the horns of the basal enlargement. In the abdominal region, the provisional appendages are not yet formed ; but the mesodermic somites develop rapidly, and in each of the first and the second abdominal segments a pair of cœlomic cavities is produced. Thus seven pairs of the cœlomic cavities are now found.

Subsequently two more new segments are added between the last formed segment and the caudal lobe. A pair of the cœlomic cavities is formed in this stage in each of the following segments: the cephalic lobe, the segment of the chelicerae, and the third to the seventh abdominal segments (Fig. 4). These seven newly formed pairs of cœlomic cavities together with the seven pairs already existing make in all fourteen pairs, the caudal lobe alone being now devoid of any. In the cephalic lobe the mesoderm is not divided into two lateral parts, therefore the two cœlomic cavities, right and left, are separated

* Étude sur le Développement des Araignées. Arch. de Biologi . Tome XI. 1887.

by the median partition of mesodermic cells ; while the right and left cœlomic cavities of the other segments are separated by the yolk (Figs. 3, 5).

The cephalothoracic appendages, with the cœlomic cavities in them, elongate very much, and bend towards the ventral median line (Fig. 5). The mesodermic somite and also the cœlomic cavities of the first abdominal segment have developed little since their formation. Korschelt and Heider state in their text book that in this segment a pair of the provisional appendages is formed as in the four succeeding segments. Though a pair of slight elevations is found in this segment, they are very much lower than the provisional appendages of the succeeding segments, and moreover they are chiefly of the ectodermic thickening (Fig. 4). I am therefore inclined not to call them provisional appendages. In each of the second to fifth abdominal segments, a pair of provisional appendages appears. They are short elevations of the ectoderm, into which the cœlomic cavity enters, as in the case of the cephalothoracic appendages. The cœlomic cavities of these segments develop in the dorsal direction: hence in cross sections of the embryo these abdominal somites differ from the thoracic segments in having a shorter branch of the cœlom in the appendage, and a longer one towards the dorsal side (Fig. 5). The ectodermic cells covering the mesoderm somites are always high and columnar in shape, and are easily distinguished from the cells of other parts.

Soon afterwards one more new segment is cut off from the caudal lobe, and in its mesodermic moieties a pair of cœlomic cavities appears. At this stage, the ventral plate attains the greatest antero-posterior extension round the egg, so that the cephalic and the caudal lobes almost touch each other (Figs. 3, 6). The caudal lobe is raised a little above the general surface of the egg. I stated erroneously in my first paper that the mesoderm of the caudal lobe is split to form

an unpaired cavity in this stage. In the abdomen the growth of the mesodermic somites, except that of the first abdominal segment, is enormous, extending rapidly towards the dorsal median line. Thus in the abdomen, the dorsal portion of the cœlomic cavities develops rapidly, while their ventral portion as well as the portion which enters into the appendage remains only slightly developed. In the cephalothorax, on the contrary, the portion of the cœlomic cavities which enters into the appendage develops rapidly, while their ventral and dorsal portions remain undeveloped.

The reversion of the embryo now begins, and when the process advances a little, the two nerve cords and the appendages of both sides of the ventral plate, or the two lateral divisions of the germinal band, begin to separate from each other. This lateral extension of the ventral plate, together with the rapid growth of the dorsal portion of the mesodermic somites in the abdomen, causes the dorsum of the embryo to elongate longitudinally. At this stage the mesoderm of the cephalothorax shows no noteworthy changes. The cœlomic cavities of the cephalic lobe develop anteriorly, or towards the dorsal region (Figs. 7, 8). The first abdominal segment begins to degenerate ; its mesodermic moieties and ganglia may however be seen with some difficulty. In the second to fifth abdominal segments the mesodermic moieties develop greatly towards the dorsal median line, so that they nearly meet each other at that line (Fig. 7). The ectoderm covering these mesodermic somites is elevated a little, and forms the so-called tergal portion of the abdominal segment. Locy* illustrates his paper with a figure (Pl. II. Fig. 9) in which a pair of terga may be seen before the second abdominal segment ; but he gives no description of them. I myself am unable to find them. He says

* On the Development of Agalena nævia. Bull. Mus. Comp. Zool., vol. XII. 1886.

also that at first "the only dorsal elements developed were the five pairs belonging to the abdominal somites (second to sixth), but during this stage the dorsal elements of the limb-bearing somites begin a more rapid growth." But according to my observation this is not the case, the dorsal elements of the limb-bearing somites remain undeveloped as in the previous stage.

Between two consecutive terga there is a furrow. This furrow was described by Schimkewitsch* as having no relation with the mesodermic somites. He says that it is due to the mesodermic somites fusing together, before they develop dorsally to cover the dorsal surface. He says moreover that the number of these furrows never corresponds with that of the somites. My observations as given above do not corroborate these statements.

The last three abdominal segments (sixth to eighth) gradually degenerate and their cœlomic cavities seem to fuse together into one pair. The pair of the cœlomic cavities thus formed by fusion is pushed into the protuberance of the tail as the process of reversion proceeds (Fig. 7). I find that fusion of the cœlomic cavities does not take place before this stage though Schimkewitsch says that it does in the cephalothorax and in the abdomen and I also erroneously stated that it occurs in the thorax before this stage.

A cavity is produced in the mesoderm of the tail lobe. It is unpaired (Figs. 7, 8). The unpaired cavity thus made cannot be conceived otherwise than as a homologue of the cœlomic cavity. Though the cavity is certainly not formed by an invagination, I thought that the cells in the tail lobe might be produced by the proliferation of the ectoderm. But I found that the cells enclosing the unpaired cavity are the remnant of the mesoderm cells which gave rise to the meso-

* loc. cit.

dermic somites of many preceding segments and that they are entirely separate from the ectoderm. Previous authors who have studied the development of the spider, overlooked this cavity in the mesoderm of the caudal lobe, and observing the stage at which the unpaired cavity communicates with the proctodæum consider the former as a portion of the latter. If the cells enclosing the unpaired cavity are ectodermic in origin, the numerous mesoderm cells in the caudal lobe must disappear all at once, as there are no cells in the lobe except those surrounding the last fused pair of cœlomic cavities. But the disappearance of many cells at once is quite impossible.

As the process of reversion proceeds still further, each half of the pair of the cœlomic cavities in the cephalic lobe is divided into two portions—one at the side of the stomodæum (Figs. 9, 10, *1 cœl. b*), the other below the anterior border of the semicircular groove of the brain (Figs. 9, 10, *1 cœl. a*). The former disappears soon afterwards but the latter elongates towards the dorsal median line (Fig. 11), and the mesodermic walls of the cavities of two sides meeting at the median line fuse together, leaving, however, a canal between them. This canal is the aorta.

The portion of the egg which is not covered by the ventral plate or the abdominal terga is characterised by the absence of the mesoderm cells and by the presence of the secondary endoderm cells or the fat cells instead. The secondary endoderm cells are directly under the ectoderm. Most of them are enclosed between the walls of the mesodermic moieties of the abdominal somites and become the blood corpuscles.

The cœlomic cavities in the segments of the cheliceræ and the pedipalpi degenerate and disappear. The greater portion of the cœlomic cavities of the four ambulatory appendages degenerates, the mesoderm cells forming their wall becoming gradually changed into muscles.

Their proximal and outer portions remain distinct at the base of each leg (Fig. 9). The cœlomic cavity of the first ambulatory appendage communicates with the exterior by means of a duct which is produced by an ectodermic invagination. The first abdominal segment disappears entirely.

The mesodermic moieties of the second to fifth abdominal segments, or the segments bearing the provisional appendages, meet one another at the dorsal median line and form there the wall of the heart. The wall of the cœlomic cavity of the second abdominal segment meets that of the cephalic lobe (Figs. 9, 10). The formation of the dorsal circulatory system, in which some thoracic somites do not take part, resembles greatly that of Limulus.* As a lateral slit or ostium is made where two consecutive somites meet, the number of the slits in the adult heart shows approximately the number of the segments which took part in the formation of the heart.

The sixth to eighth abdominal somites are entirely degenerated, their mesoderm cells are disintegrated and fill the caudal lobe at the sides of its unpaired cœlomic cavity (Figs. 9, 10). The latter becomes wide, and over its posterior end, the ectoderm is slightly invaginated (Fig. 9). The invagination is the rudiment of the proctodæum, so that the unpaired cavity of the caudal lobe is produced independently of the proctodæum.

In the next stage in which the embryo assumes the ventral flexure and the constriction between the cephalothorax and the abdomen appears, the cœlomic cavities undergo great changes. In the cephalothorax, they all disappear, except the small portions at the outer bases of the first to third ambulatory legs. These remnants fuse together and form the coxal gland (Fig. 12). The lumen or the

* Kishinouye—On the Development of Limulus longispina. This Journal, vol. V.

cœlomic cavity of the gland is so small at this stage that the gland seems almost solid. In the abdomen also, all the cœlomic cavities disappear except the unpaired one in the caudal lobe, which, inexplicable as it may seem, remains as the stercoral pocket, as was described and figured in my former paper. At this stage the mesoderm cells at the intersegmental portions grow inward into the yolk and form the dissepiments, these, being specially well developed between the second and the third, the third and the fourth, the fifth and the sixth abdominal segments (Fig. 12).

Those portions of the embryo which were destitute of the mesoderm in the stage of Fig. 9 now dwindle, according as they are encroached on either by the ventral plate or by the abdominal terga in their growth: in the cephalothorax, the cephalic lobe is bent towards the dorsum and its lateral margins fuse with those of the ventral plate of the thorax, while in the ventral portion of both the cephalothorax and the abdomen, the two lateral cords of the nervous system with the underlying mesoderm meet each other at the ventral median line.

PLATE X.

Explanation of Figures.

Reference Letters.

abd. seg.	abdominal segment.	*pedip.*	pedipalpi.
br.	brain.	*proct.*	proctodæum.
ch.	cheliceræ.	*sem. gr.*	semicircular groove.
c. l.	caudal lobe.	*st. p.*	stercoral pocket.
cœl.	cœlomic cavities.	*stom.*	stomodæum.
cox. gl.	coxal gland.		

FIG. 1. Side view of an embryo at the stage in which the first rudiments of appendages have appeared.

FIG. 2. Side view of an embryo at the stage in which all the cephalothoracic appendages have appeared.

FIG. 3. Dorsal view of an embryo at the stage of the maximum ventral flexure.

FIG. 4. Sagittal section of an embryo at the stage of Fig. 3.

FIG. 5. Cross section of an embryo at the stage of Fig. 3.

FIG. 6. A portion of the median sagittal section of an embryo at the stage of Fig. 3.

FIG. 7. Oblique side view of an embryo at the stage of reversion.

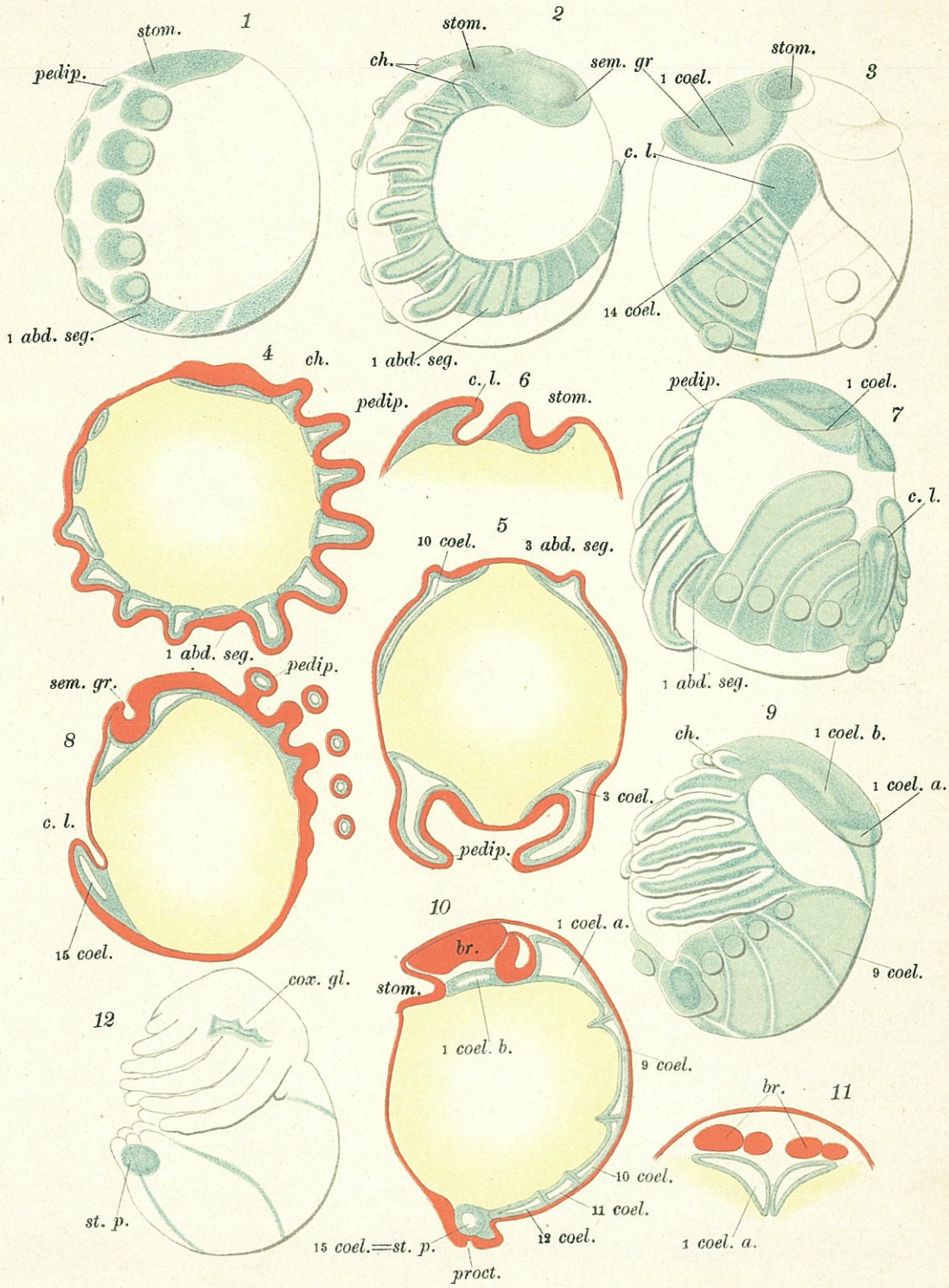
FIG. 8. Oblique sagittal section of an embryo at the stage of Fig. 7.

FIG. 9. Side view of an embryo at the stage in which the process of reversion has greatly advanced.

FIG. 10. Oblique sagittal (about median) section of an embryo at the stage of Fig. 9.

FIG. 11. Frontal section of the cephalic region of an embryo at the stage of Fig. 9.

FIG. 12. Side view of an embryo at the end of the process of reversion.



K. Kishinouye del.

Lith. & Imp. The Tokio-Seishibunsha.