Art. III.—*The Body Spaces and so-called Excretory Organs of Ibla quadrivalvis.*

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(With Plate VI.).

[Read 12th March, 1908.]

Since the publication of Darwin's Monograph of the Cirripedia [2] a great deal of work has been done on these forms, which have a number of organs whose function is either unknown or disputed. The following work on the body spaces and so-called excretory organs of *Ibla quadrivalvis* has been done in the Biology School, University of Melbourne, at the instigation and under the supervision of Professor Baldwin Spencer, in order to try and clear up, for this form at least, some of these uncertain points. So far as I am aware, this species has not been worked before, and I have been fortunate in having a practically unlimited number of specimens at my disposal, as it is common near Melbourne. The investigation has been carried on by means of a series of serial sections cut transversely and longitudinally, but the toughness of the tissues renders it exceedingly difficult to secure good serial sections.

Ibla quadrivalvis grows attached to rocks in smaller or larger clusters below high-water mark. It is a pedunculated Cirripede, the peduncle being surmounted by two pairs of valves, and containing in its upper part the body of the animal.

The general body cavity is, as in all Arthropoda, a hæmocœle forming more or less irregular spaces in the loose tissue which connects the various organs of the body. In all the series, however, in addition to the hæmocœle, two definitely walled spaces attract attention at once, and it is these and their relations to other structures which are the subject of the present work.

Attached to the base of the second maxilla, and between it and the inner maxilla, on each side of the mouth, is a tubular

prominence (Plate VI., Fig. 1, t.p.) projecting at right angles to the mouth parts. In section each prominence is seen to contain a duct which serves for communication between the exterior and a large internal space. (Plate VI., Figs. 2, 3 and 5, A.) The two spaces, one on either side of the body, are most noticeable in sections, being symmetrical, and, in marked contrast to the ordinary irregular body spaces in the animal being lined throughout by a definite layer of flattened epithelium. They are situated ventral to the œsophagus, and are quite separate, only approaching one another at one place. Though Gruvel says that in *Balanus tintinnabulum* there is a connection between them at this point [Gruvel, 5], I have been quite unable to detect any in *Ibla* after careful examination of continuous series of sections of several specimens. If the spaces (A) are traced through such a series, each of them is found to open towards its own side of the body into another large cavity (Plate VI., Fig. 5, C.), the outer part of which is in contact with the body wall, and which is evidently the equivalent of the nephroperitoneal sac present in certain Decapods, e.g., Palaemon and Pandalus [Weldon, 17]. Into the large cavity (C.A.) opens on each side a space (Plate VI., Figs. 2, 3, 4 and 5, B.), lined by somewhat irregular cubical-shaped granular cells. They are apparently heaped upon the walls, and in addition form irregular partitions running across the cavity. Where this space opens into the large cavity (C.A.), these granular cells and their partitions disappear and the cavity is lined by pavement epithelial cells (Fig. 4, y.) resembling those of the portion into which the duct first opens.

We see then, that each of the organs in question consists of a glandular part (B), opening into a large saccular bladder (C. A.), which communicates with the exterior by a duct opening at the base of the second maxilla (Plate VI., Fig. 5).

The tube which opens to the exterior, is lined near to the external opening by a single layer of cells with their nuclei parallel to the length of the lumen. After some distance the character of the lining of the duct changes, the cells becoming cubic, and finally almost columnar in shape, though there is still only a single row present. The nuclei are arranged very distinctly with their greatest length at right angles to the lumen of the duct. As the tube recedes from the surface it becomes slightly wider, and in one of my series is distinctly funnel-

shaped where it opens into the definitely lined sac. The exterior cuticle is continuous over the cells lining the lumen of the tube and funnel, ending suddenly just where the cubic cells pass into the simple pavement epithelial cells lining the large sac. (Plate VI., Fig. 3, x).

The following structures are also well marked in my series of sections; and are indicated in the figures:—

1. A large gland situated between the openings of the two ducts, but having no connection with the organs in question. (Plate VI., Figs. 2, 3 and 5, g.l.)

2. Two nerve masses cut in transverse section close to space (A), but with no connection of any kind with the organs treated above. Hence the latter are not sensory in function, as Darwin [2] thought. (Plate VI., Figs. 2, 3 and 5, t.n.)

3. Definite bands of muscle on each side enter where the body of the animal is attached to the peduncle, and pass to the wall of cavity (A). (Plate VI., Figs 2, 3 and 4, l.m., o.m.)

4. On each side of the body a tubular looking structure, apparently lined by chitin, passes from the exterior to the side of the space (A). I can find no opening from it into (A), and can suggest no function for it. (Plate VI., Fig. 2, z.)

These sacs and their various accompanying parts are apparently common to all Cirripedes, and their function and significance have given rise to much discussion among all who have worked at them, many varying opinions being held.

Darwin's description for *Ibla cumingii* [2] of the orifice opening between the outer and inner maxillae and leading into a sac lined by a pulpy corium, and over part of which the outer integument is inflected, appears to me to be quite correct as far as structure goes, though his supposition as to the olfactory function of the sac is not now generally accepted. The absence of any nerve to the sac shows that it cannot be of a sensory nature.

Hoek [12] points out that Darwin's sac is not closed at the bottom, but gives entrance to the body cavity of the animal. I cannot help thinking that Darwin intended by this sac the space called body cavity by Hoek, and in that case Hoek's description agrees with that of Darwin.

In comparing my figures with those of Hoek for *Scalpellum* [12] several differences can be seen. In the first place, Hoek

figures the organ (B) as an "organ of unknown function," with no communication with cavity (A). In my preparations of *Ibla* this organ opens without doubt into the space (A). From the nature of the cells composing the walls, i.e., granular irregular cells, I conclude that the organ is glandular and probably excretory in function. Hoek also regards the group of cells lining the entrance of the body cavity into the duct, as a segmental organ, and believes it to be excretory in function. He figures this as composed of more than one layer of cells, and, though a doubt is expressed, believes this to be the case. Further, he distinctly states and shows in his figures that the cuticle does not continue over these cells, but ends further up the duct. In my sections, after careful examination, I have found no trace of more than one layer of cubical cells, and in more than one case I have distinctly seen the cuticle passing over these cells and ending, as stated above, at their junction with the flattened epithelial cells lining the cavity (A).

Gruvel [5] regards these cells as " mere annexes " to the main apparatus, and from the above description it will be seen that this is apparently the case here, as presumably no excretion could take place from them through the chitinous cuticle. They are very distinctly marked and prominent in all sections, but what their function is it is impossible to say.

Comparing these organs with structures present in other forms, there appears to be little doubt that they fall into the same category as the coxal glands of *Limulus* [Gulland, 11], the shell glands of Crustacea which open in the same position, viz., at the base of the second maxilla, and the glands of certain Decapod Crustacea [Weldon, 17].

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EXPLANATION OF PLATE.

A.—Coelomic space on each side of the body opening to the exterior by the segmental duct and lined by flattened epithelium.

B.—Space lined by granular irregular cells, which opens into space (A), and the outer part of which is in contact with the body wall.

C.—Space lined by flattened epithelium, the outer part of which is in contact with the body wall.

Labrum.	1.
Palp.	2.
Mandible.	3.
Inner or first maxilla.	4.
Outer or second maxilla.	5.
Place from which first cirrus has been removed.	6.
Body wall.	b.w.
Cubical epithelium lining lower portion of segmental duct.	c.e.
Irregular coelomic spaces.	c.s.
Irregular connective tissue filling up the spaces between the various organs of the body.	c.t.
Mouth of segmental duct.	d.u.
External cuticle covering body wall.	e.c.
Flattened epithelium lining space (A).	e.s.
Flattened epithelium lining upper part of segmental duct.	f.p.
Granular cells lining organ opening to space (A).	g.c.
Large gland situated in the outer maxillae, with no communication with the space (A), or segmental duct.	g.l.
Cuticle lining the segmental duct and continuous with that covering the body wall.	i.c.
Muscles cut longitudinally.	l.m.
Wall of mantle cavity in which body of the animal lies	m.w.
Oesophagus cut transversely.	oes.
Muscles cut obliquely.	o.m.
Pancreatic duct passing from the pancreatic gland to the alimentary canal.	p.d.
Pancreatic gland.	p.g.
Segmental duct passing from space (A) to the exterior.	s.d.
Segmental funnel.	s.f.
Supraoesophageal nerve ganglion.	sup. oes.
Muscles cut transversely.	t.m.
Nerves cut transversely.	t.n.
Tubular prominence at base of second maxilla on which the segmental duct opens.	t.p.

Male reproductive organs. t.s.

Point at which the cuticle lining the segmental duct ends. x.

Point at which the granular cells lining the organ (B) pass into the flattened epithelial cells lining (A.C.) y.

Organ of unknown function. z.

Figure 1.—Mouth parts of *Ibla quadrivalvis*, to show the position of the tubular prominences (t.p.) situated at the base of the second maxilla, and on which the segmental ducts open. From a dissection.

Figure 2.—Semidiagrammatic section through the body to show the general position and relation of the parts described in the text. The section is cut somewhat obliquely, showing on both sides the opening of the segmental duct to the exterior, and on one side the glandular organ (B), cut at the place where it is most fully shown. The muscles (l.m. and o.m.) are shown supporting the coelomic spaces (A). On one side the organ of unknown function is shown (z).

Figure 3.—Semidiagrammatic section of the coelomic spaces and parts related to them, showing the character of the epithelium lining the various parts mentioned in the text. The segmental duct is lined throughout by a single layer of cells, over the surface of which passes a continuation of the cuticle covering the external surface of the body.

Figure 4.—Semidiagrammatic section showing the glandular organ (B) opening into space (A).

Figure 5.—Diagram illustrating the parts treated in the text.