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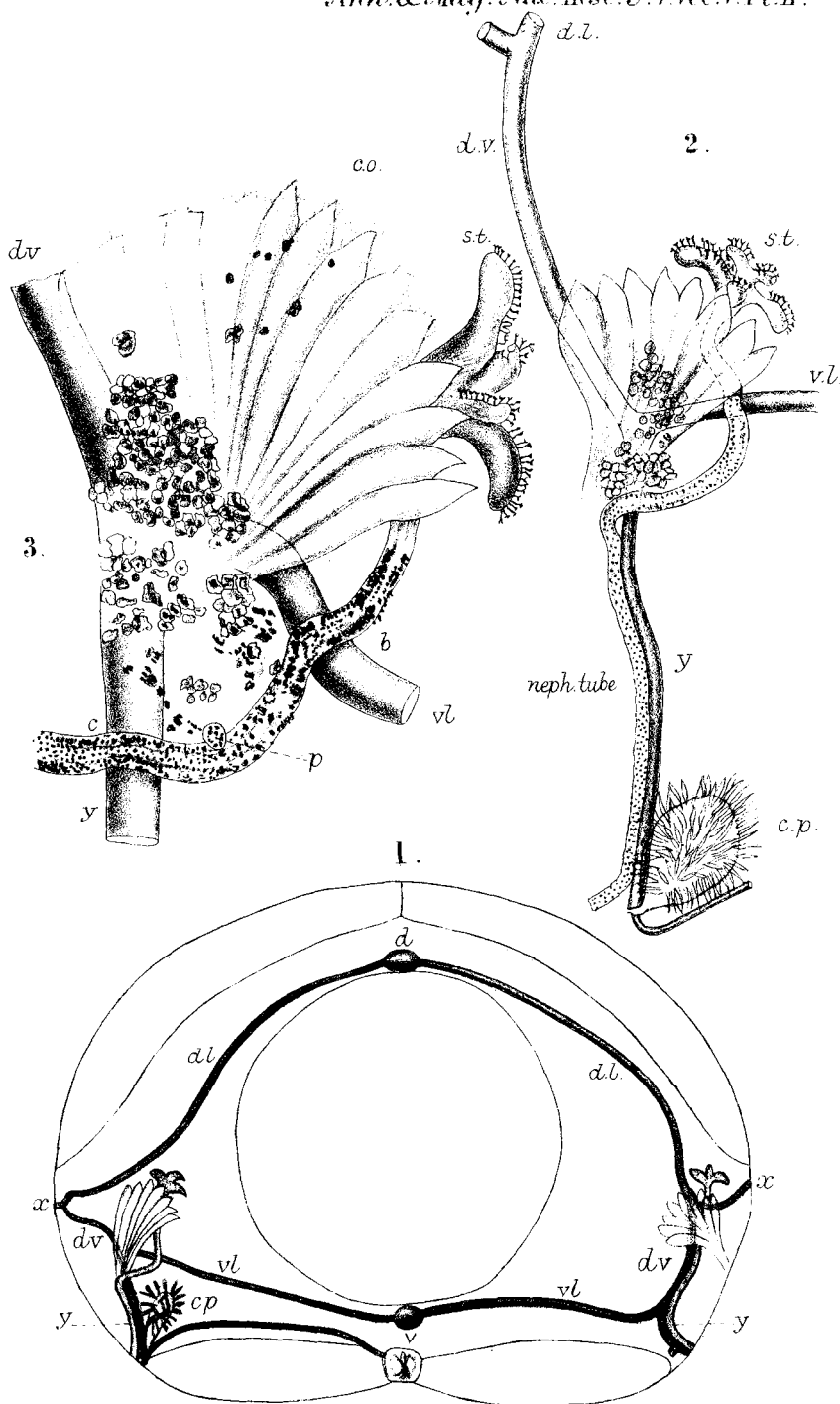
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XVIII.—*On the Nephridium of Nephthys cæca, Fabr.* By
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[Plates II. & III.]

DURING the summer of 1899, while working at the Gatty Marine Laboratory, St. Andrews, it was suggested to me by Professor M'Intosh that, in view of the wonderful supply of living material obtainable in St. Andrews Bay, it might be profitable to continue the work of Mr. Edwin Goodrich on the nephridium of *Nephthys* (Q. J. M. S. no. 157). In so doing I have been able to confirm Mr. Goodrich's results in all points except one—the position of the organ relative to the blood-vessels. This, as described and figured by him, is briefly as follows:—The ciliated organ lies in the angle between the dorso-ventral vessel and the branch *x* (Pl. II. fig. 1); the nephridial tube passes down the dorso-ventral and along the branch *y*, the solenocyte-bearing tuft resting in the angle between the dorso-lateral and the branch *x*.

After a most careful examination of the subject, I have come to a different conclusion. The ciliated organ rests, not between the dorso-ventral and *x* (Pl. II. fig. 1), but at the junction of the ventro-lateral, the dorso-ventral, and *y*; the solenocyte-bearing tuft lies in the angle between the ventro-lateral and the dorso-ventral, not between the dorso-lateral



and x ; while the nephridial tube runs along the branch (y) which passes to the vascular tuft ($c.p$) (not figured by Goodrich), and does not in any part of its course touch the dorso-ventral.

The Excretion of Solid Matter and the Function of the Ciliated Organ.

In examining under the microscope a nephridium which has been carefully dissected out from a hardened specimen, the nephridial canal will be seen as a conspicuous green tube lying along the blood-vessel y (Pl. II. fig. 2) on its outer and posterior side. Up this blood-vessel it runs until it reaches a point opposite the base of the ciliated organ; here it bends sharply round in front of y , passes across to the ventro-lateral branch, and forming a semicircle round this, it appears on the posterior and inner side of the ciliated organ, where it terminates in the solenocyte-bearing tuft (Pl. II. fig. 2, *s.t.*).

It is the portion of the tube between the ventro-lateral and y that demands special attention, for here alone is it in close contact with the ciliated and grooved side of the ciliated organ. Indeed it here forms a miniature barrier at the exact point where the grooves and the streams induced by the ciliary action converge (figs. 3 & 4).

The importance of this disposition is extremely well illustrated by placing a living nephridium in a drop of sea-water laden with carmine particles. The red grains may be seen carried by the currents down the grooves of the ciliated organ, and deposited against the barrier of the nephridial tube until a solid mass is formed.

Again, I observed that the yellow-green coloration caused by the presence of excretory matter in the walls of the tube extends only as far as the ventro-lateral vessel (b , Pl. II. fig. 3), and is not continued up to the solenocyte-bearing tuft.

These considerations suggested that it would be in the short stretch of the tube between the ventro-lateral vessel and y that solid excretory matter would be taken up.

The following facts appear to confirm this view :—

(1) When a nephridium is extracted it may be noticed that there is always present against this barrier a mass of phagocytes from the coelomic fluid filled with yellow-green excretory matter (figs. 3 & 5). These are evidently carrying waste products to this part of the tube, and I have actually observed one of these cells entering the wall at this point (Pl. III. fig. 4, p).

(2) In specimens injected with powdered carmine (in seawater) the phagocytes laden with the grains collect here, forming a prominent scarlet mass; but only in one case have I found a carmine granule in the wall of the tube.

Before describing the process of excretion some notice of the coelomic fluid is necessary.

Floating free in the fluid are found two varieties of cells:—

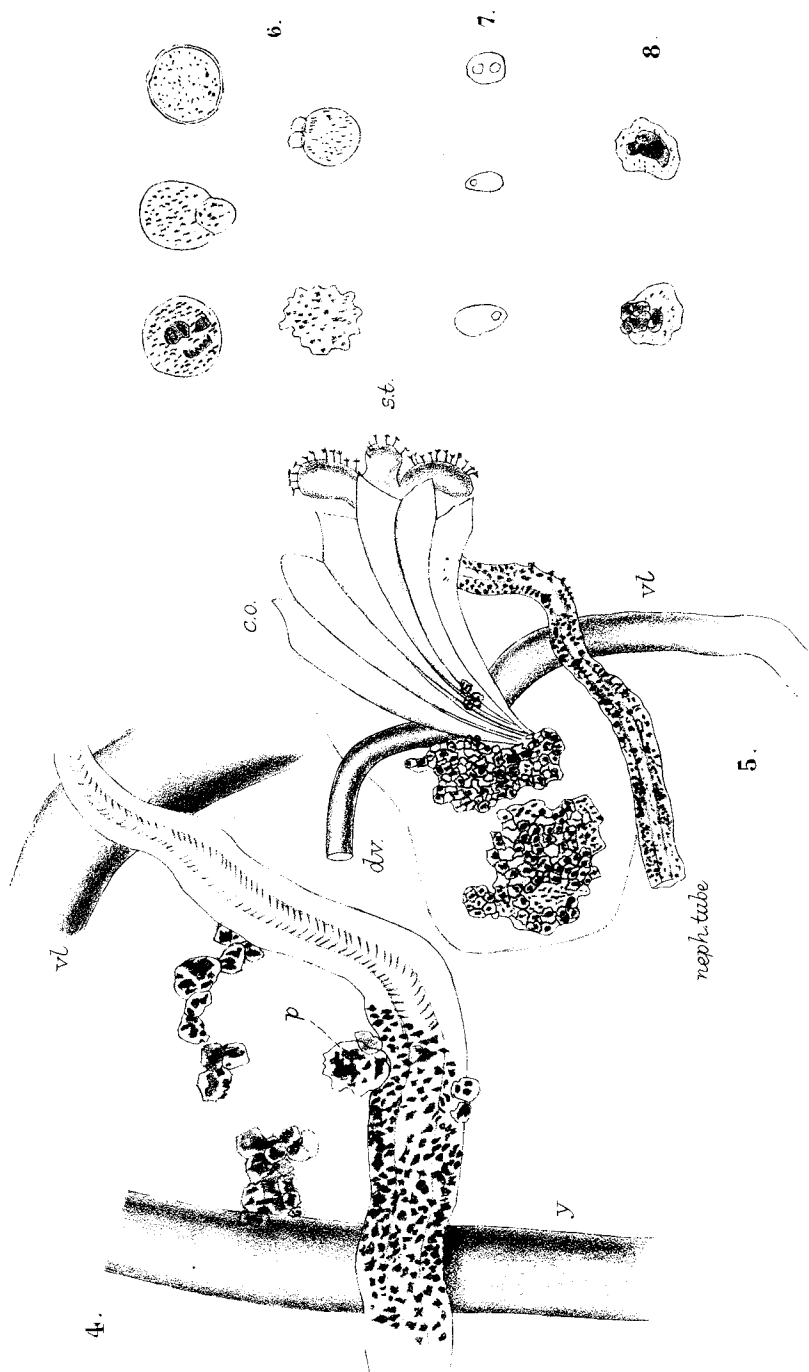
(1) Cells of highly granular appearance (Pl. III. fig. 6), which usually present a rounded form, but on careful inspection prove to be amoeboid. In some there is the appearance of a firm ectosarc or cuticle, in others small bud-like outgrowths occur, and in several cases I have found them in a state of degeneration when loaded with excretory matter (Pl. III. fig. 8). These cells are the phagocytes already referred to. In almost every case they contain the characteristic yellow-green matter, and in injected specimens are filled with carmine grains.

(2) Oval cells of clear protoplasm (Pl. III. fig. 7). At the narrower end occurs a clear highly refractive nucleus. These cells do not appear to be concerned in excretion, and I have never observed any foreign bodies in them. They are identical in appearance with the corpuscles of the blood.

To sum up, the process of excretion appears to be as follows:—

Whenever a particle of solid excretory matter appears in the coelom it is immediately engulfed by one of the phagocytes. This, when it has become sufficiently loaded, passes into the neighbourhood of the ciliated organs, either by its own amoeboid motion or by the agency of the currents raised by the cilia. Here it is swept down one of the grooves, and joins the little mass of its fellows raised against the barrier of the nephridial tube. Partial degeneration now sets in, and the phagocyte appears to bodily enter the protoplasmic wall of the canal (Pl. III. fig. 4, *p*), carrying the foreign matter with it. The latter then passes out either by the lumen of the canal, assisted by the cilia, or by passing along through the wall itself.

The whole nephridium is in a state of constant motion, the ciliated organ swaying up and down, the tube also moving upward and downward on the blood-vessels to a limited extent. These movements no doubt facilitate the ingestion of refuse into the tube, bringing different parts of it into action consecutively.



I have not been able definitely to determine whether the solid excretory matter before being transferred to the nephridial tube is dissolved by the phagocyte or not; but most of the evidence suggests that it is. The green matter in the walls of the canal has the appearance of minute droplets rather than of solid granules, while only in one case have I been able to detect a solid carmine particle in the wall, notwithstanding the fact that great masses of carmine were raised against it by the action of the ciliated organ. In addition, the process at this point is extremely slow—specimens which I have allowed to live for several days after injection still showed great masses of carmine-laden phagocytes at the barrier, although there were none free in the coelom. This delay seems to point to something more complicated than simple transference of solid particles.

The importance of the above process can only be fully appreciated by noting the resemblance to that in the *Glyceridæ*, as described by Mr. Goodrich (Q. J. M. S. no. 163). Indeed, if we substitute for the nephridial sac of *Glycera* the short stretch of the nephridial tube between the ventro-lateral vessel and γ , the processes are largely identical. This portion of the tube is evidently the physiological equivalent of the sac. Morphologically it is also easy to connect the two organs, the tube-barrier of *Nephthys* having broadened and become cup-shaped, while the ciliated organ has grown in as a lining, forming a much more efficient lodgment for the laden phagocytes while discharging their burdens than the more primitive apparatus in *Nephthys* (Q. J. M. S. no. 163, p. 446).

EXPLANATION OF PLATES II. & III.

Reference letters.

<i>d.</i> Dorsal blood-vessel.	<i>c.p.</i> Vascular tuft.
<i>v.</i> Ventral blood-vessel.	<i>neph.tube.</i> Nephridial tube.
<i>dl.</i> Dorso-lateral.	<i>c.o.</i> Ciliated organ.
<i>vl.</i> Ventro-lateral.	<i>s.t.</i> Solenocyte-bearing tuft.
<i>dv.</i> Dorso-ventral.	<i>p.</i> Laden phagocyte.

Fig. 1. Diagrammatic transverse section of *Nephthys cæca*, showing position of nephridium relative to the blood-vessels. To the right, as given by Goodrich.

Fig. 2. Diagrammatic reconstruction of the nephridium.

Fig. 3. Ciliated organ and terminal portion of the nephridium. Corrosive sublimate, sat. sol. Zeiss D.

Fig. 4. Nephridial barrier from same. Zeiss F.

Fig. 5. Ciliated organ and terminal portion of nephridium. From specimen injected with carmine.

Fig. 6. Phagocytes from coelomic fluid. Zeiss F.

Fig. 7. Hyaline corpuscles from coelomic fluid. Zeiss F.

Fig. 8. Laden phagocytes. Zeiss F.