PLATE XXX.

Cystodytes aucklandicus and *C. perspicuus.*

Fig. 1. Portion of test showing spicules, calcareous trees (*c.t.*), fibres (*c.f.*), and calcareous bodies (*c.b.*). Enlarged 7 diameters.
Fig. 2. Zooid of *C. aucklandicus*. Zeiss *a**, enlarged.
Fig. 3. Detail of test in *C. perspicuus*. Z. C, camera.
Fig. 4. Calcareous spicule (tree) of *C. aucklandicus*. Z. A, camera.
Fig. 5. Calcareous crystals of *C. perspicuus*. Z. A, camera.
Fig. 6. Detail of form seen in fig. 4 under high magnifying power (Z. E). Drawn without reference to scale.
Fig. 7. Detail showing calcareous bodies forming radiating branches. Seen in unstained sections.
Fig. 8. Crystalline branching calcareous bodies from the region of the capsule. Z. A, much enlarged. Glycerine.
Fig. 9. Spicules from *C. perspicuus*. Z. A, camera.
Fig. 10. Surface-vessel in the test from *Cystodytes aucklandicus*. Z. C, camera.
Fig. 11. Branchial siphon with part of branchial basket of *C. perspicuus*. The upper part of the basket has been removed in sectioning, leaving the lower surface visible from inside. Z. C, camera.

ART. XXVI.—*On the Structure of* Boltenia pachydermatina.

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Plates XXXI.–XXXIV.

THIS species of *Boltenia* is found attached to rocks, piles, shells, &c., or lying loose on the sea-bottom. In the latter case, as a general rule, the specimens have become detached by the breaking of the stalk some distance from the base. Very often they are seen in bunches in masses of seaweed, in which cases, however, they are not directly attached to the seaweed itself, but have become united to it by the entangling among the seaweed of the shell or other base of attachment to which they have united themselves. The members of this species are often seen growing in bunches, when either a number have attached themselves to a shell or some such small base of attachment, the stalks becoming fused at their bases, or a number of younger specimens have fixed themselves to the stalk of a larger.

ANATOMY.

A. *External Characters.*

A.—The body is somewhat ovate in shape, compressed laterally, slightly concave on the dorsal border, convex on the ventral. The posterior end is bluntly pointed, the anterior is narrow, becoming gradually continuous with the stalk. The

apertures, which are close together, are conspicuous, but not prominent; the oral aperture is more prominent than the atrial, and is always directed towards the stalk. A characteristic appearance is given to the members of this species by the surface of the thick test being thrown into longitudinal folds, of which there are, as a rule, two or three on each side, with a distinct ventral fold. Very often the number on the sides is unequal, there being probably two on the one side, one on the other, with a ventral fold. Round each of the apertures there are three or four folds. The colour of the body-wall is lodged in a thin external layer of the test, the remainder of its thickness being of a glistening white. The body is sometimes of a creamy-white colour which is sometimes streaked with purple-brown, sometimes of a light-brown colour, or, again, of a purple-brown streaked with white, or there may be a combination of all three colours. In the young state the body is generally creamy-white in colour. In harbour-water, where the water is foul, the colour of the body is dirty-brown, and it is covered with slime, often with a green growth which adheres very closely to the surface of the test, and cannot be removed.

B. *Processes on Test.*—In the young state, on the test there are, as a general rule, spinous processes, which are often of great length compared with the size of the body itself. These, in many cases, are so numerous that the test is fairly bristling with them. They generally disappear during growth, but in a fairly large proportion of specimens which appeared to be almost, or quite, full-grown (varying from 2½in. to 3¼in. in length), I found these spines present on the test. They were, however, not numerous, and not large compared with the size of the body. In many full-grown individuals, in place of these spines there are on the test squarish or oblong processes.

In a number of specimens I collected I observed on the test large protuberances, which in some cases were almost one-third or one-fourth the size of the animal itself. These, when examined, were found to be due to small bivalves (*Crenella discors*, Lamarck; *Modiolacra impacta*, Gray) imbedded in the test. These were, on an average, a little over ½in. in length. In some cases they were not completely covered. The byssus was in all cases more deeply imbedded than the shell, so that it appeared as if the mollusc had become attached to the surface of the body by the byssus, and that the irritation produced had caused the *Boltenia* to secrete fresh layers of test-substance around it. Similar instances to this are given in Sutton's "Evolution and Disease," p. 29. In the cases where the lamellibranchs were not completely covered by the test, they seemed to be still alive. When they were completely imbedded there was, as far as I could make

out, no decomposition, so that the secretion must have taken place with great rapidity.

To give an idea of the frequency with which this imbedding may occur, I may instance one collection of full-grown specimens made at haphazard along the shores of Otago Harbour. I collected between twenty and twenty-five specimens, and, of these, five had these shellfish imbedded in the test of the body. In all cases they were completely imbedded. This frequency is above the average, but I have never yet gone collecting in the harbour without getting at least two or three *Boltenicæ* with shellfish imbedded. I may mention that in two or three collections on the open sea-shore among the rocks I was unable to get any instances of it. The processes may occur all over the body except on the dorsal surface between the apertures; their occurrence on the stalk is comparatively rare. In cases of complete imbedding the apex of the process ends in a corkscrew-like arrangement. The colour is generally more or less bleached out on the processes, sometimes of a pure-white. In one instance I found two shells imbedded in the same process. This shellfish belongs to the family Mytilidæ. In Brown's "Mollusca of the Firth of Clyde" a very closely allied species—*Crenella marmorata*—is spoken of as being found in the integument of *Ascidia mentula*: it is there mentioned that over two dozen specimens have been extracted from the test of a single individual.

One of the most characteristic features of this species lies in the very great thickness of the test, which, in ordinary full-grown animals from 3in. to 4in. long, is from $\frac{1}{4}$in. to $\frac{1}{2}$in. The test is always thicker on the folds than on the interspaces, the folds corresponding only in a slight degree to folds on the surface of the body itself.

c. *Stalk.*—The stalk is closely wrinkled transversely, is twisted and creased, and rather tapering distad towards the point of attachment. It may become thicker for short distances of its length than it is at the proximal end. It is of a light-brown colour, and is often overgrown with seaweed, sponges, &c.

The stalk is generally round in section, sometimes compressed, in some cases so much so that it becomes almost ribbon-like in appearance. The thickness, just as the length, varies greatly: in full-grown specimens between 3in. and 4in. long it is between $\frac{1}{4}$in. and $\frac{1}{2}$in.

In one specimen, in which the stalk, which was oblong in section, was for a short distance of its length $1\frac{1}{2}$in. broad by $\frac{7}{8}$in. thick, I found imbedded a small shellfish. In another, in which there was also a shellfish in the stalk, the stalk had grown corkscrew fashion around the shellfish, and then covered it with test-substance. In still another specimen,

in which the stalk at the proximal end was greatly thickened, the delicate anterior prolongation of the body, instead of running straight into the stalk, formed for a little distance a very close spiral.

The greatest amount of variation exists with regard to the length of the stalk, which is always greater than that of the body. To illustrate this I will give a few examples:—

	Length of Body. Inches.	Length of Stalk. Inches.
Specimen 1	$3\frac{3}{4}$	$11\frac{1}{2}$
" 2	$4\frac{5}{8}$	7
" 3	$4\frac{1}{4}$	$15\frac{1}{4}$
" 4	$3\frac{1}{8}$	55
" 5	3	40
" 6	4	12
" 7	$3\frac{5}{8}$	$9\frac{1}{2}$
" 8	$2\frac{1}{2}$	11
" 9	3	56
" 10	$2\frac{1}{2}$	24
" 11	$2\frac{5}{8}$	12
" 12	$3\frac{1}{4}$	$16\frac{1}{2}$
" 13	4	36

When the test has been removed the body is seen lying within its delicate anterior prolongation, proceeding for a little way into the stalk. This prolongation narrows away gradually distad till at last it ends in a fine point. The apertures (oral and atrial) are at the end of tubular prolongations of the body, which are surrounded by powerful sphincter muscles. In the fresh state the body is almost transparent, with the exception of the bright-orange digestive gland, the dull-green gonads, and the posterior part of the intestine, which, from the sand, fine mud, &c., it contains, is always of a dark colour.

In fresh specimens the body is kept in close connection with the test by the ectoderm which secretes the latter; but in specimens preserved in spirit the mantle (muscular tunic) shrinks away from the ectoderm and test, the only connection being at the apertures and at the place where the two blood-vessels to the test leave the body.

B. *Muscular Tunic (Mantle).*

The second layer is the muscular and connective-tissue part of the body-wall. It is formed of connective tissue uniting and enclosing the bundles of muscular fibres and blood-vessels, and in the region of the dorsal surface also the nerves.

The muscular fibres are arranged in two layers—an external circular round each of the oral and atrial siphons, and an internal transverse.

The circular layer is external to the transverse, is arranged round the siphons from their apex downwards, and extends for a short distance on to the surface of the body.

The transverse layer arises in two bands, one from the apex of each siphon beneath the circular, and spreads out fanwise on each side over the surface of the body. The muscles of this layer unite to form networks, especially towards the ventral surface. At the anterior end the muscles are very feebly developed, and are covered by a tissue which spreads from the anterior end of the body, and which in spirit changes colour with the gonads. This tissue may spread in scattered patches over the entire surface of the body. I shall refer to it more particularly in speaking of the gonads.

Into both the oral and atrial siphons are produced delicate lining invaginations of the external coloured surface of the test. In the oral siphon the invagination ends against the circlet of tentacles at the base of the siphon; in the atrial siphon it is produced for a little way into the interior of the body, hanging loosely in the peribranchial cavity, and from the free edge is produced for a little way a delicate transparent membrane. This arrangement seems to assist in effectually closing the atrial aperture when the animal is above tide-mark, &c.

C. *Digestive Organs.*

A. *Tentacles.*—The posterior edge of the invagination of the test lining the oral cone ends against a stout ring-like pad, bearing a circlet of tentacles on its lower surface. The tentacles are numerous and compound. There are sixteen chief tentacles, placed larger and smaller alternating, but external to these is a large number of smaller tentacles, some of which approach closely in size the smaller tentacles mentioned above. Of the eight large tentacles there is generally one, sometimes two, considerably larger than the others. The one generally much larger is that adjacent to the oral end of the endostyle, while the one which often approaches it very closely in size is that opposite—namely, the one adjacent to the dorsal tubercle. In the eight smaller tentacles alternating with the larger, there seems, as in the larger, to be no uniformity in size. In the tentacles external to these I cannot make out any particular arrangement. Each tentacle consists of a main axis greatly compressed, concave on the central, convex along the peripheral border. From the lateral border the branches are given off arranged in a double row. From each of the branches are given off branchlets which consist each of a main stem giving off little processes at right-angles. There are also on the main axis of the tentacle, among the branches, branchlets similar to those on the branches.

Following on the tentacles comes part of the mouth-region, spoken of by Herdman as the præbranchial zone, bounding which on the posterior side are the two peripharyngeal bands. These surround completely the præbranchial zone, surrounding on the one side the dorsal tubercle, on the other adjoining the oral end of the endostyle. Following upon the peripharyngeal bands comes the wall of the branchial sac proper.

B. *Peripharyngeal Bands.*—The two peripharyngeal bands, as before stated, bound the præbranchial zone on the posterior side—*i.e.*, on the side far removed from the tentacles. On the one side these bands immediately surround the dorsal tubercle, then run in a somewhat wavy manner around the circlet of tentacles, and join the endostyle at its oral end. The anterior band forms a complete ring; the posterior is complete only at the sides. At the anterior end its right and left halves become immediately continuous with the marginal ridges of the endostyle; at the posterior, they are continued into the anterior end of the dorsal lamina.

C. *Branchial Sac.*—The peripharyngeal bands bound the commencement of the branchial sac. This organ extends from the anterior to the posterior end of the body. Its ventral edge is formed by the endostyle, which is attached to the mantle along the whole ventral surface. Along the dorsal edge the branchial sac is free between its attachment to the body (immediately posterior to the peripharyngeal bands) and the gullet. On the dorsal surface of the body, at the posterior end, the branchial sac opens into the gullet. The wall of the branchial sac is thrown into large folds, projecting into the interior of the sac, and running from the peripharyngeal bands to the neighbourhood of the œsophageal aperture. These folds are directed towards the dorsal lamina; there are always six of them on each side.

In the walls of the branchial sac are the following sets of vessels: (1) transverse, (2) fine longitudinal, (3) internal longitudinal, (4) large transverse. (1.) The *transverse* vessels run at right-angles to the length of the sac. (2.) The *fine longitudinal* are in the same plane as the transverse, but run longitudinally, and serve as a means of communication between the transverse. (3.) The *internal longitudinal* vessels—larger vessels than the transverse—occupy a plane internal to them, and run at right-angles to them from the anterior to the posterior end of the branchial sac; they are connected with the transverse by short wide connecting-ducts placed at the points of intersection. The rectangular meshes visible to the naked eye are formed by the latter vessels and the transverse. (4.) External to the transverse vessels, and connected with them by the fine longitudinal, are vessels of much stouter calibre. These radiate from the dorsal free edge of the

branchial sac to the ventral, and carry the blood to the vessel running along the dorsal edge. On the folds we can see that the meshes are narrower than in the interspaces between the folds. This is due to the fact that the internal longitudinal vessels are always more closely placed on the folds than on the interspaces, becoming more closely approximated the nearer we get to the crest of the fold.

D. *Gullet, Stomach, and Intestine.*—The branchial sac opens into the gullet, which is attached to the dorsal body-wall at the posterior end of the body. The œsophageal aperture is overhung by a large valvular projection of the left inferior wall of the gullet. The gullet passes down the left side of the body, attached to the body-wall, makes a bend forwards when nearer the ventral than the dorsal edge, and at this point passes into the tubular stomach. This, after running forward for rather less than one-third of the length of the body, passes into the intestine, the diameter of which is very little less than that of the stomach itself. This, like gullet and stomach, is firmly attached to the body-wall. It runs straight along the left side to the anterior end of the body, at the anterior end of the body makes a bend dorsalwards, turns backwards, and runs parallel with its former course. When it comes beneath the atrial aperture it turns dorsalwards at right-angles to its course, and, after running for a short distance, opens into the atrial siphon. All along the attached side of the stomach and intestine is a large typhlosole, which is continued right to the anus. The posterior end of the intestine on its attached side projects very little from its attachment to the body-wall; but on its free side the end of the intestine projects for a considerable distance, overhanging the attached side like a great flap.

These general relationships are shown clearly in Plate XXXIV., figs. 1 and 2, where the body-wall of the right side and entire branchial sac are removed.

E. *Digestive Gland.*—Attached along the right side of the stomach are a number of little tree-like structures. Each consists of a stem giving off branches, which branch again and again, the distal ends of the twigs bearing little tufts of cœca. In living specimens the colour of the digestive gland is bright-orange; this colour in spirit changes first to dull-red, then to a yellowish-red, and at last gets bleached out to a yellowish-white. There is no great variation in the number of the stems, there being from 13 to 17 present. The arrangement differs somewhat in different specimens, but there is always a smallish stem towards the ventral edge of the right side at the beginning of the stomach, and another stem (the largest of all) at the end of the stomach towards the dorsal edge. Between these the other stems are arranged in a double row,

the one towards the dorsal, the other towards the ventral edge.

F. *Problematical Organs.*—Attached along the dorsal edge of the dorsal limb of the great intestinal loop are structures of which I shall say more in the histological part. There is usually a large number of them, varying in size from blocks resembling in shape and size small gonads down to little structures barely distinguishable, appearing as slight folds of the intestinal wall. They lie, as before stated, along the dorsal edge of the dorsal limb of the intestine, always extending on the posterior side to the ventral end of the last bend of the intestine. On the anterior end they may reach to the middle of the first bend of the intestine, but in this case when they reach this point they are visible only as very slight folds. As a general rule, however, they extend only along the dorsal limb. They are present in all specimens, but the greatest amount of variation exists with regard to their size and arrangement in different specimens. In some they are of fairly even size throughout, tapering away towards the anterior end to slight folds. In others they are largest at the posterior end, becoming smaller towards the anterior, though they may swell out in size towards the middle of their course. In others, again, they are largest about the middle of the dorsal limb, diminishing in size in front and behind.

D. *Vascular System.*

The heart lies on the right side, attached to the inner surface of the mantle, in close relation with and parallel to the endostyle. It is long and tubular. From its anterior end goes off a vessel which we may call the ventral vessel. This runs along the right side, and is, like the heart, connected by transverse vessels (paired) with the branchial sac. When it reaches the place where the endostyle makes its bend dorsalwards it breaks up into three chief vessels—one to the test, one running back along the endostyle, another running forwards. The vessel running forwards gives off branches to the anterior prolongation, and when it reaches the oral end of the endostyle it divides into two vessels running round the circlet of tentacles. The vessel from the posterior end of the heart (dorsal vessel) runs to the posterior end, bends dorsalwards, and when it reaches the point where the gullet passes into the stomach it divides into two vessels, one passing along the ventral surface of the stomach, the other passing round the gullet on to the dorsal surface of the stomach, crossing diagonally to the ventral surface, and giving off in its course branches to the different stems of the digestive gland. This vessel reaches the ventral surface about half-way between the oral and atrial apertures, and, after giving off a large vessel running along the

free surface of the intestine, goes to the test. Along the dorsal free edge of the branchial sac runs a large vessel, to which radiate from the ventral edge of the branchial sac the large transverse vessels. The posterior end of this vessel, on reaching the gullet, divides into several vessels, of which one passes along the free edge of the gullet and stomach, and joins (after giving off branches to some of the stems of the digestive gland) the vessel that goes to the test. Another vessel from the dorsal branchial vessel runs along the attached side of the gullet, and joins the dorsal vessel just before its division. The anterior end of the dorsal branchial vessel joins the mantle in close relation to the brain. From the branchial sac to the mantle, the gonads, the intestine, the digestive gland, pass very numerous vessels, which serve also as suspenders to keep the lateral portions of the branchial sac in position.

Of the vessels to the test, that on the right side (which I mentioned as leaving the ventral vessel at the point where the endostyle makes its dorsal bend) runs directly into the stalk. The left vessel (which, as before stated, leaves the body about midway between the anterior and posterior ends from the vessel passing across the stomach) runs forward, turns gradually dorsalwards, enters the stalk along with the vessel from the right side, both vessels running right down the stalk. Both these vessels in their course through the test give off vessels, in their turn giving off smaller vessels, which finally break up into terminal twigs, ending in little dilatations or bulbs. These twigs are more closely aggregated in connection with the external surface. A transverse section of the stalk shows the same arrangement as in the test—the vessels break up into small twigs ending in dilatations or bulbs, two twigs usually opening into one bulb (as in the test).

The anterior prolongation of the body, which is full of blood-vessels, gives off chiefly one large vessel, which after a time unites with one of the vessels from the test.

E. *Reproductive Organs.*

Gonads consist of a double series of somewhat rectangular blocks attached along the body-wall of each side. When I say "somewhat rectangular" I refer to the fact that the larger gonads, at least, are more pyramidal in shape, with the apex attached. The free surface of the larger gonads is also often deeply marked by folds or creases. In young specimens, or those not sexually mature, the gonads are of a light-cream colour, but in sexually mature individuals during most of the year they are of an olive-green colour. Each cut in section shows a central white mass—the spermary—with the green part—the ovary—wrapped completely round it. The green colour of the gonads changes in spirit first to a pink, then

slowly to a yellowish colour. The gonads of the right side lie along the body-wall, rather nearer the ventral than the dorsal surface. They extend from the anterior to the posterior end of the body, at the posterior end make a bend dorsalwards, and when adjacent to the dorsal surface send off a duct running forwards, and opening into the atrial cavity opposite to the duct from the left side. The gonads of the left side lie in the intestinal loop, their duct opening into the atrial cavity immediately behind the anus. The blocks of both sides are not uniform in size: they diminish in size from the anterior to the posterior end. This diminution in size is often somewhat abrupt, so that we can distinguish on each side a larger and a smaller series. The gonads of the right side are, as a rule, more developed than those on the left. The total number of blocks on each side is on an average very nearly equal, there being about thirteen or fourteen on each side; but on the right side there are about eight larger blocks, on the left only about five.

In Plate XXXIV., fig. 4, where a view is shown of the body opened from the ventral side, with the branchial sac removed, the gonads of both sides are shown.

Supplementary Notes on Gonads.—In specimens taken in winter the gonads are olive-green in external view. When cut in section, each is seen to consist of the central white portion, with the green part wrapped round it. Later on in the season white specks appear on the green surface of the gonad; and still later, in the beginning of summer, the gonads come to consist mainly of a clear-coloured tissue, with white specks imbedded, and with a small green portion gathered round the base. The green portion is seen to consist of small round green masses imbedded in gelatinous substance. These seasonal changes in the appearance of the gonad I shall try to account for in the histological part.

F. *Nervous System.*

The brain (nerve-ganglion) is oblong in shape, with one or more constrictions about the centre; gives off nerve-trunks anteriorly and posteriorly to the neighbourhood of the oral and atrial apertures. It lies about midway between the two apertures.

From the anterior end a pair of nerve-trunks are given off, which run one round each side of the oral siphon, giving off branches supplying the tentacles, &c. From the posterior end a pair also are given off which go to surround the atrial siphon, sending off nerves to the apex of the siphon. These two nerve-trunks I have traced more than half-way round the atrial siphon. The position of the dorsal tubercle, as I have stated before, is to the right of the brain, and slightly nearer the oral aperture.

The dorsal tubercle is very complicated, "apparently by the development of lateral branches from the original slit" (Herdman).

G. *Atrium.*

The atrium, or space surrounding the branchial sac, and communicating with the exterior by the atrial aperture, presents no essential differences from that in other Ascidians. The atrial aperture, which lies, as before stated, nearer the posterior end of the body, terminates a short tubular process of the mantle, and the atrial siphon is provided with a sphincter muscle, a lining prolongation from the test, and a partial diaphragm at its lower end.

The peribranchial cavity encircles the branchial sac except along its ventral edge, where the two lateral halves of the cavity are separated by the union of the endostyle with the mantle. The cavity is crossed by blood-vessels connecting the branchial sac with the sinuses of the mantle. Besides these, the branchial sac is united to the mantle by the œsophagus along the whole length of the endostyle (except at its posterior end), round the anterior end at the peripharyngeal bands, and along the first portion of the dorsal lamina.

The atrium is in free communication with the interior of the branchial sac through the stigmata, and is traversed by the water in its course to the atrial aperture.

The anus and genital ducts open into the peribranchial cavity in the dorsal median region, often called the cloaca.

Histology.

Histology of Test.

The matrix of the test, which is for the most part homogeneous, is, however, fibrillated in some places. Immediately beneath the external surface are round masses of various sizes. Round them lie, thickly scattered, ordinary cells, rounded in appearance. The rounded masses lie in a single row, either closely packed or having short intervals between them. I have not been able to make out their exact structure, but they appear to be formed of a large number of separate cells.

The small blood-vessels, with their terminal dilatations, which I described, in connection with the vascular system, as ramifying through the test, are lined by a layer of epithelium.

Histology of Endostyle.

The endostyle is in the form of a groove, bounded by parallel lips of considerable height, and projecting into the interior of the branchial sac. The groove is lined by a modification of the epithelium of the interior of the branchial sac. The branchial epithelium is continued on the lips of the groove

into more elongated cells, furnished with cilia. Following on these are small flattened cells, closely resembling the branchial epithelium, which run for some little distance down the groove. Then come the cells of the *first glandular mass*, which is much greater in size than the other two glandular masses. These glandular cells are followed by elongated cells with small cilia, after which comes the *second glandular mass*. This, as before stated, is of considerably less extent than the first glandular mass, and is followed by elongated cells with small cilia. Next comes the *third glandular mass;* and, last of all, on the floor of the groove are elongated cells with very long cilia. The glandular cells are of peculiar form—broad at the base, and tapering towards the apex.

The walls of the groove contain very numerous blood-spaces.

Histology of Gonads.

The gonads are covered by a continuation of the epithelium lining the peribranchial cavity. Beneath this wall, and lying right round the gonad, is a distinct blood-space. The gonads are ovotestes; the tubules from each testis open into the vas deferens. The latter runs from the anterior to the posterior end of the body in close connection with and anterior to the oviduct, and at the place where the ducts open into the atrial cavity turns anteriorly for a little way, the two terminations thus forming a fork. In specimens taken in the winter, when the surface of the gonad is of a uniform green, it is found the testis occupies only the lower central portion of the gonad, and a transverse section taken above the centre of the gonad shows merely the riper ova aggregated to one side, and the unripe ova filling the remainder of the cavity.

Later on, at the time when the white specks appear on the green surface, a transverse section of the free surface shows the tubules of the testes scattered here and there, with the unripe ova in between. As we pass downwards we still have the unripe ova among the tubules of the testis, but at some distance down we come upon the ripe ova lying towards the posterior end of the gonad, with the tubules of the testis around them on the three sides.

Consecutive sections, taken at the stage when the green colour of the gonad is aggregated round the base, show that in the upper part of the gonad the tubules completely fill the cavity, the unripe ova being absent, and that at the proximal end the ripe ova are collected. These in the earlier stages have a peculiar, somewhat hexagonal, shape, and exhibit distinct vitelline membrane and germinal vesicle, with clear membrane and germinal spot. When fully ripe the ova are enclosed each in a capsule of low cubical cells.

While speaking of the muscular tunic I referred to a tissue which occupied the proximal end of the anterior prolongation of the body. This, in the specimens collected in winter, presents a greenish colour, resembling that of the gonads; this colour in spirit, like the green of the gonads, changes to pink. The tissue appears to be in connection with the anterior gonads of both sides, especially that of the left, by the body-wall. A section of the anterior prolongation shows that it is full of blood-vessels, the tissue lying at the proximal end. When examined microscopically it is seen that the tissue is made up of small roundish bodies having exactly the structure, size, &c., of unripe ova.

Histology of the Problematical Organs on the Intestine.

These structures are covered with the layer of cœlomic epithelium covering the latter, so that they appear as outpushings of the wall of the intestine into the peribranchial cavity. They are formed of connective tissue full of blood-spaces, their structure, in fact, being simply that of the intestinal wall. Through the blocks themselves, and in the wall of the intestine below, wind very numerous tubules. These branch free, and end in terminal dilatations or ampullæ. Both tubules and ampullæ are lined with a single layer of low cubical cells. They appear to correspond to those described in Ascidia, Perophora, &c., as ramifying over the stomach and part of the intestine, the difference being that the organ in *Boltenia pachydermatina* extends almost to the posterior end of the body.

The histological structure of the brain I have not been able to make out at all satisfactorily. The nerve-cells are small, and the nerve-fibres lie beneath. The neural gland I could not discover at all, unless it corresponded to certain tubules among the brain-tissue. These were small clear-walled tubules, in connection with which appeared to be secondary vessels with small ampullæ. In the walls of some of these vessels were what appeared to be concretions, on which acetic acid (1 per cent.) had a slight effect. The cavities of the dorsal tubercle are lined by a layer of columnar epithelium provided with very long cilia. Under the epithelium is a layer of connective tissue continuous with that of the mantle.

In concluding this paper I might take the opportunity of drawing attention to the close resemblance *Boltenia pachydermatina* bears to *Culeolus* in certain important points of structure. In some of these points, as far as I can gather, it differs from other genera of *Boltenia*, and about other points I am uncertain. The description of *Culeolus* is taken from

Herdman's "Report on Tunicata, 'Challenger' Expedition," vol. vi. First of all, as to the position of the heart, Herdman speaks of *Culeolus* as being singular among the Cynthiidæ in having the heart on the right side of the body, in close relation to the endostyle: as we have seen, in *Boltenia pachydermatina* it occupies this position. Secondly, in the branchial sac *Boltenia pachydermatina* alone of the *Boltenieæ* possesses six folds on each side, the others having more: in *Culeolus* six appears to be the normal number.

Again, *Culeolus* and *Boltenia pachydermatina* agree pretty closely in the structure and position of the gonads, also in the fact that the ripe ova are enclosed in capsules of cells. In both *Boltenia pachydermatina* and *Culeolus* we find sixteen tentacles, placed larger and smaller alternating, and besides these a number of smaller tentacles without definite arrangement.

The chief works which I consulted in writing this paper were,—

Herdman's "Report on the Tunicata collected during the Voyage of the 'Challenger'" ("Report on the Scientific Results of the Exploring Voyage of H.M.S. 'Challenger:' Zoology," vol. vi.).

Hancock "On the Anatomy and Physiology of the Tunicata" (Linnæan Society's *Journal of Zoology*, vol. ix., p. 309).

Papers by Julin and van Beneden in the "Archives de Biologie," tome ii., fascicules 1, 2; tome vi., fascicule 2.

Bronn's "Klassen und Ordnungen des Thierreichs," iii., 1 (Malacozoa).

KEY TO PLATES XXXI.–XXXIV.

a. Anus.
at. Atrial aperture.
at. n. Nerves arising from the atrial end of the ganglion.
br. Branchial (oral) aperture.
br. f. Longitudinal folds in branchial sac.
br. n. Nerves arising from the branchial end of the ganglion.
d.b.v. Vessel running along the dorsal free edge of the branchial sac.
d.g. Digestive gland.
d.t. Dorsal tubercle.
d.v. Vessel arising from the dorsal end of the heart.
en. Endostyle.
f, f. Folds in test.
g, g. Hermaphrodite genital masses.
g.d.l. Left genital duct.
g.d.r. Right genital duct.
h. Heart.
i. Intestine.
i.s. Structures on intestine.
m.b. Muscular bands in mantle.
n.g. Nerve-ganglion.
œ. Œsophagus.
œ.a. Œsophageal aperture.
r.t.v. Vessel to test from right side.
st. Stomach.
st'. Stalk.
t. Test.
t.p. Processes on test, spinous, round, or oblong.
t'. Typhlosole in intestine.
tn. Tentacles.
v.v. Vessel from ventral end of heart.

DESCRIPTION OF PLATES XXXI.–XXXIV.

Plate XXXI.

Fig. 1. Full-grown specimen, stalk cut off.
Fig. 2. Specimen nearly full-grown, having spinous and oblong processes on the test.
Figs. 3 and 4. Young specimens. Fig. 4 is very young, the spines beginning to develope.
Fig. 5. Specimen having a bivalve imbedded in the test.
Fig. 6. The right half of the test is cut away. Notice the muscular bands of the body and the interlacements between them. Notice also the blood-vessel to the test on the right (cut).

Plate XXXII.

Diagrammatic view, with the test and body-wall of the left side removed.

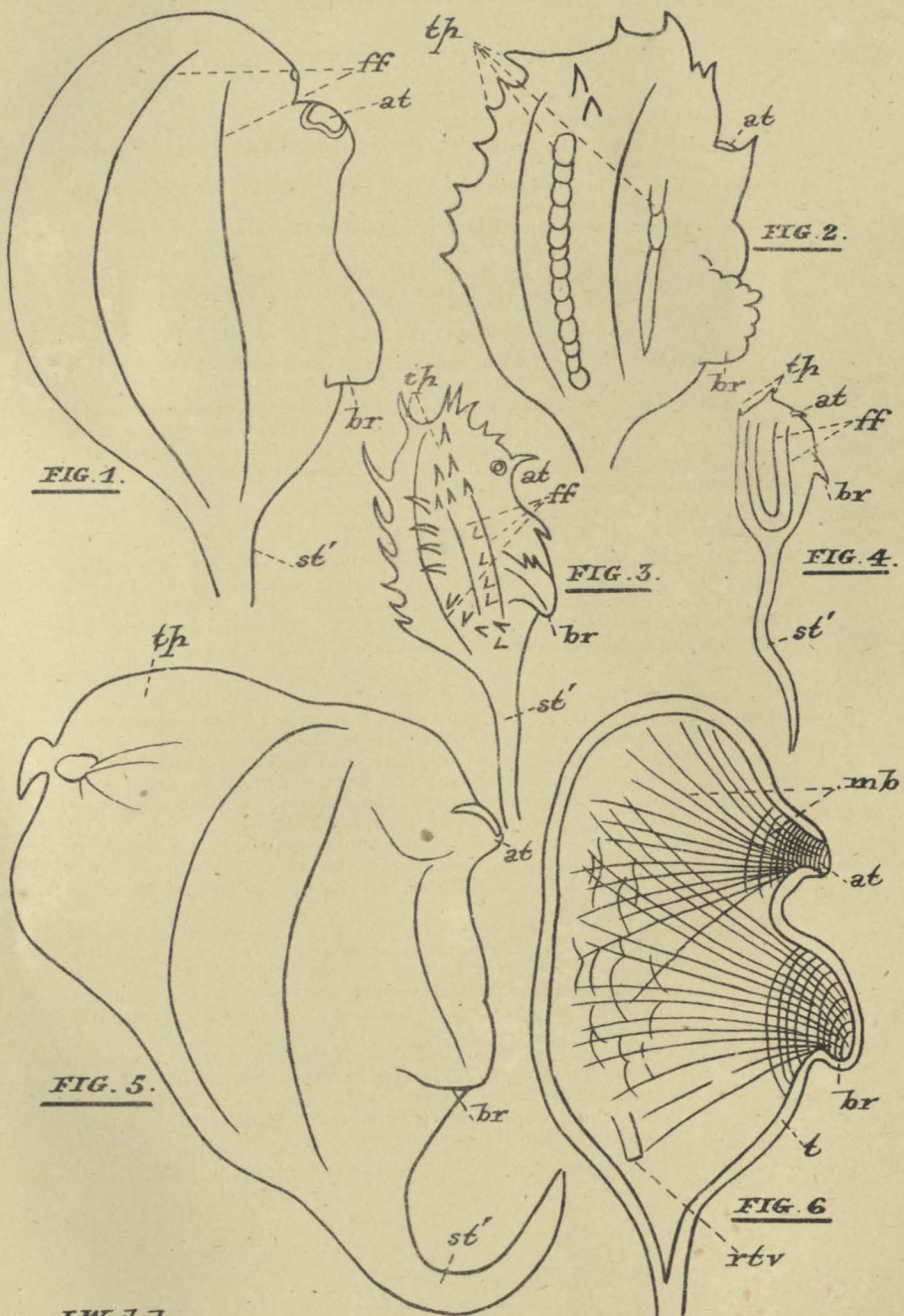
The cut body-wall is represented by the double line between endostyle and test, &c. The branchial sac is shown with part of its left wall cut away to show the ring of tentacles and dorsal tubercle. The folds of the right side are represented as seen. A bristle is passed from the interior of the body out through the branchial aperture.

Plate XXXIII.

Diagrammatic view of the body from the right side, the body-wall of the right side and the right half of the test being removed. The cut body-wall is represented by a double line, as in Plate XXXII., and the branchial sac is shown cut open as before. A bristle is passed out through the branchial aperture, as in Plate XXXII.

Plate XXXIV.

Fig. 1. The body-wall of the right side is removed. Note, as in figs. 2 and 3, the black line drawn across the body-wall in the neighbourhood of the anus. This represents the point to which the lining invagination of the test is carried from the atrial aperture. The terminal end of the intestine is shown projecting from beneath the branchial sac, to its left.
Fig. 2. The right wall of the branchial sac is cut away. A bristle is passed out through the branchial aperture.
Fig. 3. The branchial sac is removed, also the right half of the ring of tentacles.
Fig. 4. The body is opened along its ventral aspect, the sides thrown back, and the branchial sac removed. In this sketch the muscles of the right half of the body only are shown. The liver is cut away, the stalks being represented on the stomach. The lining invagination of the test in the atrial aperture has been removed.
Fig. 5. Transverse vertical section of the body near the atrial aperture. This sketch shows the relations of the atrium. The atrial invagination is shown shaded dark. The cut is made at the point where the intestine turns at right-angles to its former course, to end in the anus.



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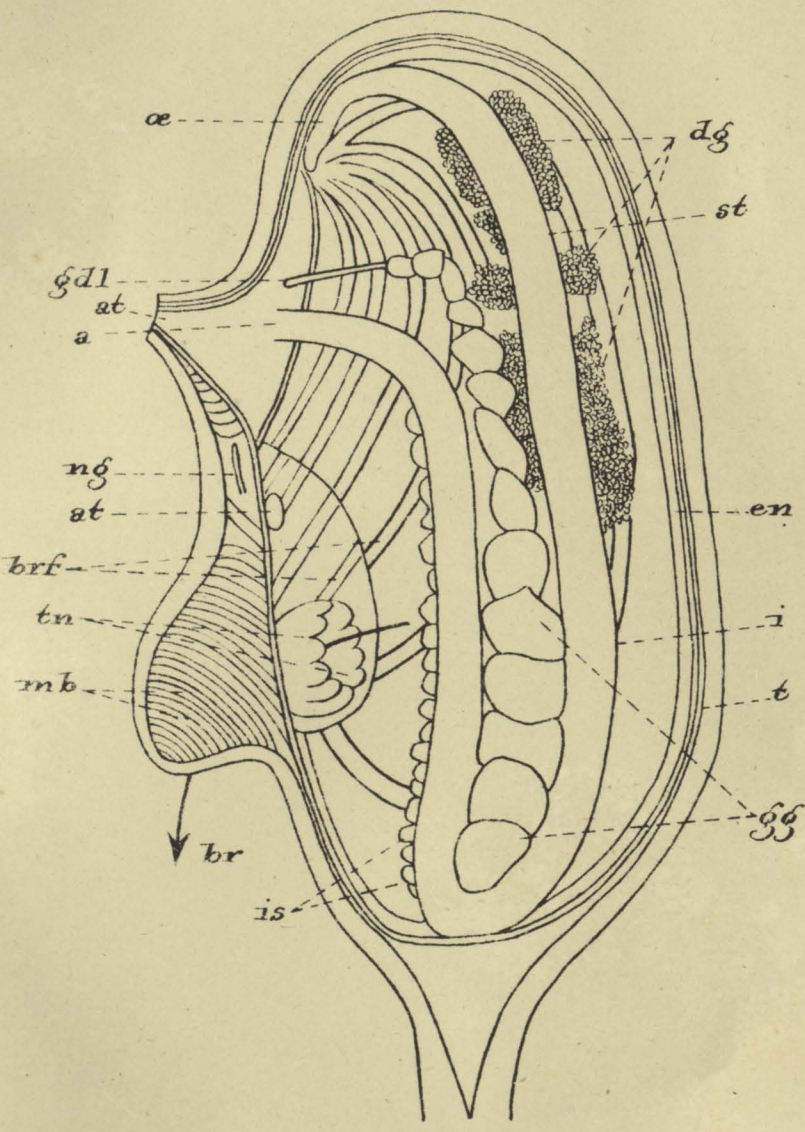
BOLTENIA PACHYDERMATINA.



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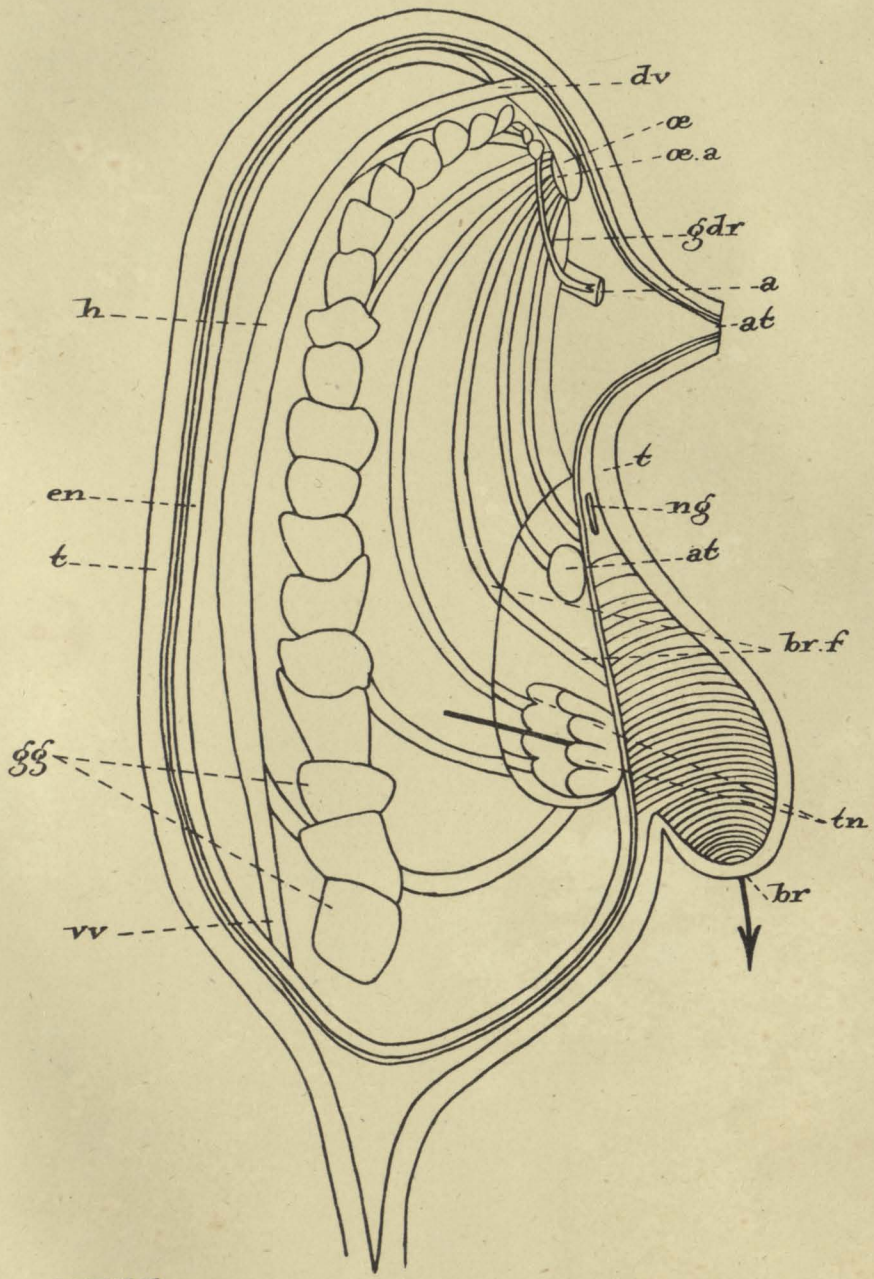
BOLTENIA PACHYDERMATINA.



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BOLTENIA PACHYDERMATINA.

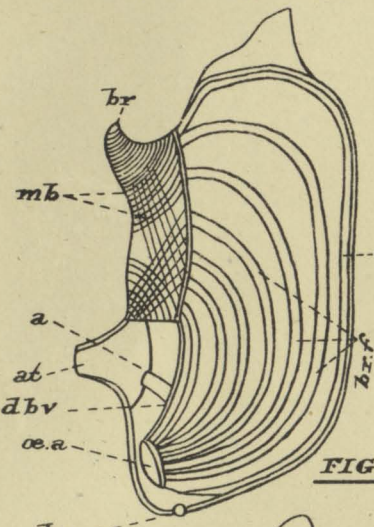

FIG. 1.

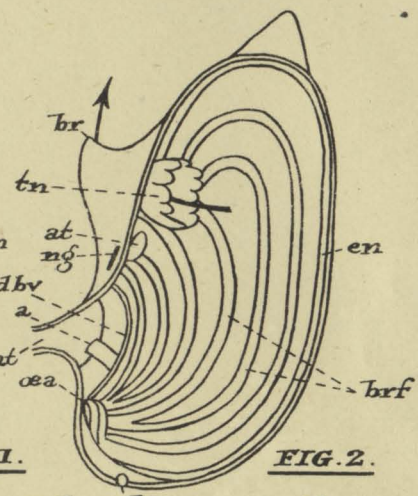

FIG. 2.

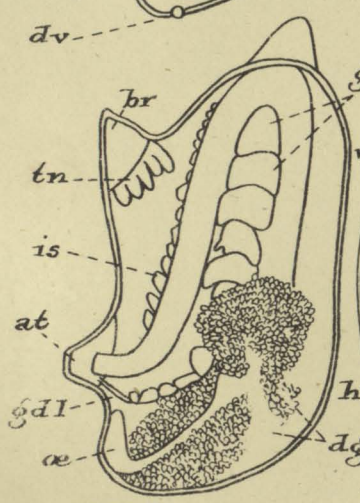

FIG. 3.

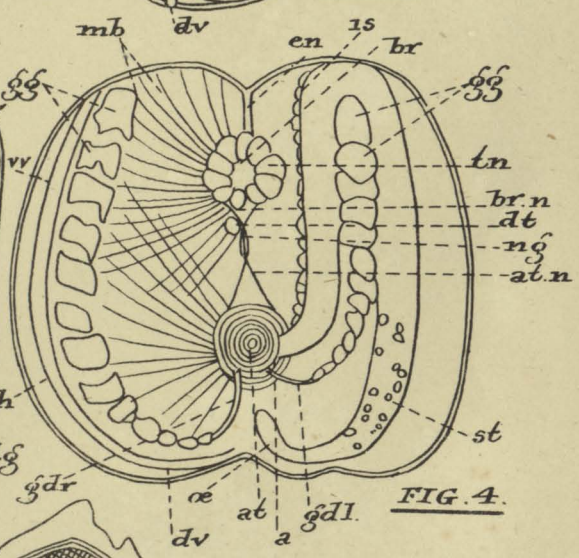

FIG. 4.

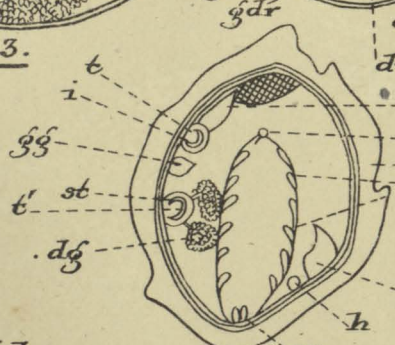

FIG. 5

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BOLTENIA PACHYDERMATINA.