XV MOLLUSCA, I: RATHOUISIIDAE.

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(Plates x–xiii).

Two species of this family were obtained by Mr. Kemp in the Abor foot-hills, both new to science. I have described them under the following names :—

Atopos (*Podangia*) *kempii* and *Prisma aborense.*

Atopos (Podangia) kempii, n. sp.

Two slugs, obtained at Kobo (400 ft.), belong to a new species which may be named *Atopos* (*Podangia*) *kempii*, and briefly defined as follows:—

Notum of light straw-colour, being dirty in its upper two-thirds, with an irregular network of dark blue lines (mostly passing diagonally in two directions), with dark elongated dots at the points of intersections. Surface of notum finely and uniformly granulated, with minute dark blue dots in the interspaces of the network in addition. Ommatophores and lower tentacles slaty-blue. Keel well-developed and prominent in the posterior three-fourths of the length of the body. Foot light yellow and extending beyond the inflexed posterior margin of the mantle, but not to its extreme posterior end. Length of notum 5·5 cm., breadth ·7, height ·9. Female genital aperture 1·0 cm. from the male genital aperture.

EXTERNAL CHARACTERS.

General.—The animal is elongated, limaciform. The body is flattened from side to side, having the shape of a narrow-based isosceles triangle in transverse section. The thickest part of the body lies at the junction of the anterior one-fourth and posterior three-fourths of its length. At that position the surface of the body presents a rounded prominence on each side, just below the keel. The prominence is more marked on the right side than on the left. The surface of the mantle (notum) is finely and uniformly granulated. The keel, in the middorsal line, is rounded and not very prominent in front of the thickest part of the body; it ends a little behind the anterior end of the mantle, which forms a hood over the head. Behind the anterior one-fourth of the length of the body, the keel forms a distinct vertical crest flattened from side to side, and extends to the posterior end of the mantle, gradually lessening in

height towards the posterior end. The margin of the mantle (perinotum) is thin, sharp and inflexed, but not wrinkled. The margin of the mantle-hood is entire. The mantle at the extreme posterior end of the body is inflexed, so that the posterior end of the foot projects below and a little behind the posterior margin of the mantle, which is thus placed in front and on the ventral aspect of the posterior end of the mantle.

The head is distinctly separate from the anterior end of the foot. The proboscis, which is protruded in the larger of the two specimens, is cylindrical, and ends in a blunt tip with the triradiate oral aperture in the centre. The ommatophores are short, stout and faintly annulated; they seem to be non-retractile. The lower tentacles are stout and short, being narrower at the base than at the tip. They are fused with the precephalic flap beneath except at the extreme anterior end for about ·1 cm. They are bounded externally by a deep sulcus, which extends from the base to the ventral aspect of their free anterior end. Each precephalic flap is a continuation forward of the head from the ventral aspect, and is united to that of the other side by a thin flattened band of integument above the mouth and beneath the ommatophores. The anterior and outer borders of the flap are convex, the inner one is nearly straight. The antero-external angle is acute but rounded, and the antero-internal angle is obtuse.

A small triangular process of integument is placed above the foot at its antero-lateral aspect, being continuous at its outer side with the lateral surface of the foot above the sole and in front of the attachment of the mantle to the side of the foot. The inner end of the process (corresponding to the apex of the triangle) is connected to the ventral surface of the precephalic flap at the outer side of its base by a thin band of integument. Below, the process is separated from the dorsal aspect of the anterior end of the foot by an oblique groove extending downwards and outwards from the inner side. These two triangular processes form the lateral boundary of the crescentic aperture of the pedal gland.

The foot is wide in front and tapering behind. It is widest at the junction of the anterior one-fourth and posterior three-fourths of its length, being a little constricted just in front of it. The anterior end is truncated and slightly concave. The posterior end is tapering but rounded, and extends a little downwards and backwards beyond the inflexed posterior margin of the mantle, but terminates in front of the extreme posterior end of the latter. The sole is lobulated in its anterior three-fourths, but smooth in the posterior one-fourth of the length.

Colouration.—The mantle is light straw-coloured, being dirty in its upper two-thirds. The surface of the mantle, in its upper two-thirds, is marked with an irregular network of dark blue lines, mostly arranged in two sets passing diagonally in opposite directions and crossing one another at obtuse angles (on the dorsal and ventral aspects). The points of intersection become thickened to form elongated dark blue dots varying from ·05 to ·1 cm. in

length. There are also minute dots of the same colour in the interspaces. The lower third of the mantle presents small elongated dots with a very faint trace of a network similar to that in the upper two-thirds. The striping is not symmetrical on both sides. The ommatophores and the tentacles are slaty-blue in colour. The precephalic flap is pale slaty-blue in colour. The foot is pale yellow.

Measurements.—The measurements of the two specimens in cm. are as follows :—

		1	2
1.	Length along the middorsal line	7·1	5·3
2.	Length along the midventral line after straightening the animal	5·5	4·5
3.	Greatest height (ventral)	·9	·8
4.	Greatest breadth at the same part of the body	·7	·65
5.	Height of the keel at the junction of the posterior one-fourth and anterior three-fourths of the length	·125	
6.	Height of the keel at the junction of the anterior one-fourth and posterior three-fourths	·05	
7.	Length of ommatophores	·25	
8.	Breadth of ,,	·15	
9.	Length of lower tentacle	·15	
10.	Breadth of lower tentacle	·1	
11.	Distance of the male aperture from the anterior end of the foot	·2	
12.	Distance between the male and female genital apertures	1·0	
13.	Depth of the groove round the foot (to the margin of the mantle)	·2	

ANATOMY.

I Body-wall.

The body has the shape of an isosceles triangle in transverse section in the middle of its length. The triangle has a short base and the sides slightly concave in their upper one-fourth and markedly convex in their lower three-fourths Towards the posterior end, the sides become more convex than they are in the middle, the body assuming a broadly ovate shape in transverse section.

The body-wall is traversed by the following blood-sinuses, which pass longitudinally throughout the whole length of the body:—

(1) A sinus lying in the middle line beneath the keel, and in the middle of the thickness of the body-wall.

(2) A sinus, one on each side, lying above the groove between the foot and the mantle margin.

(3) A sinus, one on each side, in the middle of the thickness of the body-wall at the junction of the upper two-thirds and lower one-third of the body.

Minute structure.—The body-wall consists of a superficial epidermis and a deeper dermis (or cutis).

The surface of the body shows small arch-like prominences with more or less pointed notches between them. The epithelium consists of a single layer of columnar cells placed side by side. The free margin of the epithelial cells presents a thick refractile border. The cells are broad at the free end but tapering and pointed at the other. Those lining the notches are much longer and narrower than those lining the prominences. The epithelial cells lying in the immediate neighbourhood of the glandular cells become cubical in shape, or even flattened in a direction parallel to the surface. The protoplasm is coarsely granular in the outer two-thirds of the cells. The nuclei are oval or elongated, and are placed towards the inner ends of the cells.

Beneath the epidermis is a mass of connective tissue cells, which form a compact layer. Between these masses are found vertical strands of connective tissue fibres which pass inwards into the deeper layer of dermis. The cells are irregular in outline with spherical or oval nuclei.

The unicellular glands, lying in the outer portion of the dermis, vary much in shape and size. They can be divided into the two following groups:—

(i) Small glands, roundish or pyriform in shape, placed just beneath the epidermis; the neck and a portion of the body of the glands lie between the inner portions of the epithelial cells, which are, in some cases, flattened out to make room for the glandular cells. The necks of the glands open to the exterior between the adjacent epithelial cells, there being no distinct ducts. The protoplasm is finely granular and stained brownish yellow (pale) with haematoxylin and Van Giesen's stain. The nuclei are spherical and placed in the centre of the cells. The glands of this group are abundant in the side walls of the body, being very scanty in the keel and upper part of the body-wall.

(ii) Large pyriform glands, the largest ones of which extend to half the thickness of the body-wall from the outer surface. The glands are of 4 or 5 sizes, all being exactly similar in structure. A crescent-shaped portion of the glandular cells at the base is homogeneous and is stained deep yellow with Van Giesen's method, while the remaining portion is granular and takes a red stain when treated with the same reagent.

The dermis consists of a loose network of connective tissue fibres (mainly white) with connective tissue corpuscles dispersed between them. The connective tissue fibres form strands of various thickness, which extend inwards at right angles to the surface of the body from beneath the epidermal layer and between

the compact layer of connective tissue cells beneath the latter. As they pass downwards, the fibrous strands give off branches from the sides, which pass on to neighbouring strands. Just beneath the glandular portion of the dermis the strands break down to form an open network of connective tissue with numerous irregular spaces between them. In the interspaces of the network are placed numerous unstriped muscle fibres. Beneath the glandular layer the fibres are arranged diagonally and longitudinally, there being more fibres in the longitudinal direction. Towards the inner side the diagonal arrangement becomes more prominent than the longitudinal one. Lastly, on the inner side the fibres take a transverse (circular) course with a few longitudinal ones between them In the interspaces of the connective tissue network are seen numerous connective tissue corpuscles, some of which are very big, with large nuclei.

The blood sinus beneath the keel is elongately oval in transverse section, and consists of a thick layer of muscle fibres arranged transversely, lined by a single layer of flattened epithelium. The muscle fibres are separated by thin layers of connective tissue and a few connective tissue corpuscles. The other two pairs of blood-sinuses are broadly oval in transverse section and have a similar structure.

The inner surface of the mantle (hyponotum?), which forms the outer boundary of the groove round the foot, is lined by a single layer of cubical cells below and of flattened cells above. The nuclei are oval and are placed in a direction parallel to the surface. Beneath the epithelium is a thick layer of muscle fibres arranged longitudinally with little connective tissue between them. On the outer side, the structure corresponds to the dermal layer of the mantle wall with which it becomes continuous. Just beneath the muscular layer are seen numerous small pyriform unicellular glands, with long sinuous ducts opening into the circumpedal groove amongst the epidermal cells. The bodies of the glands take a deep blue stain with hæmatoxylin. The blue colour becomes least affected by subsequent treatment with Van Giesen's stain.

Minute structure of the foot.—The epithelium consists of a single layer of narrow elongated columnar cells with more or less fusiform nuclei. Between the epithelial cells are seen numerous ducts of unicellular glands (similar to those opening into the hyponotum) placed in the deeper layers of the wall of the foot. Beneath the epithelium is a thick compact layer of muscle fibres arranged longitudinally. Internal to this layer the muscle fibres are arranged in loose bundles which pass vertically upwards to end in the next layer. These fibres seem to be continued from the longitudinal muscle layers. The vertical muscle fibres give off branches from their sides, which pass to the neighbouring bundles. Amongst these vertical fibres are seen numerous narrow longitudinal bundles, which seem to be continuous with the lateral branches from the vertical ones. Above, the vertical fibres change their course and

form a network with connective tissue fibres similar to that in the mantle-wall.

II Pallial Complex.

The pallial complex is a more or less circular area underlying the mantle, the centre corresponding to a point a little behind the anterior one-fourth of the body-length. It extends equally on each side to the junction of the mantle with the base of the foot. The pulmonary chamber lies on the right side of the animal and occupies about one-third the area of the pallial complex. The roof of the pulmonary chamber is fused with the under surface of the mantle, and the floor is continuous with that of the pallial complex. The pulmonary aperture (?) is situated at the right antero-lateral corner in the same transverse line with the anterior end of the pericardium.

The pericardium lies in the right anterior quadrant of the pallial complex, forming a prominence on the surface of the body on the right side (mentioned in the description of the external characters). The pericardium is a broad oval sac having the heart obliquely placed inside it. The roof of the pericardium is fused with that of the pallium, while the floor is continuous with that of the latter also.

The heart is placed obliquely in the pericardium and extends from near the centre towards the right antero-lateral corner of the pulmonary area. The ventricle lies in front of the auricle. It is a thick-walled sac, wider than it is long. The origin of the aorta is directed anteriorly, and to the right. The pulmonary artery lies along the right border of the kidney in its posterior half.

The kidney occupies the left half of the pulmonary area. It forms a flattened hatchet-shaped body, with the two corners prolonged along the margin of the pulmonary area towards the right border of the same. It is adherent to the under surface of the mantle above and to the floor of the pulmonary area below, and lies over the salivary glands and the anterior end of the liver. The organ is thick in the centre and is thinned out at the margin. There is no distinct ureter; the kidney seems to open directly into the pulmonary chamber close to the pulmonary aperture. The tissue of the kidney has a spongy appearance; it consists of long wavy tubules held together by loose connective tissue.

The female genital aperture lies on the anterior aspect of the pulmonary area; the anus lies anteriorly to, and on the outer aspect of the female genital aperture.

III. Digestive System.

There is a large protrusible proboscis. In the larger of the two specimens obtained, the proboscis was everted to its full extent. It is a hollow, thin-walled cylindrical body, with the mouth of the animal forming a triradiate aperture in the centre of the blunt rounded tip. The base of the proboscis is attached to

the head just in front of the anterior end of the foot, and behind a narrow transverse band of integument unites the bases of the precephalic flaps beneath the ommatophores. The proboscis was retracted in the other specimen.

On making a longitudinal section of the everted proboscis and examining the half left in connection with the pharynx, I found that the pharynx, radular sac, oesophagus and two ducts of the salivary glands were placed in the cavity of the proboscis. The pharynx was continuous with the anterior end of the proboscis, but its wall was absolutely free and separate from that of the proboscis. The space between the pharynx and the wall of the proboscis is filled with a mass of fragile substance, undoubtedly coagulated blood. From the hinder end of the radular portion of the pharynx, strands of muscle-fibres could be traced behind to a narrow flattened band of muscular tissue attached to the dorsum of the foot behind.

In the other specimen, the proboscis was found to be folded twice, the distal third of the organ being placed inside the invaginated proximal two thirds. The distal third of the proboscis is thus not invaginated, like the proximal two-thirds, but is left as it is in the protruded proboscis. It will thus be seen that in the process of inversion of the proboscis tube, the proximal end is invaginated first. As the process extends from the base to the tip, the distal portion (*i.e.* the portion towards the tip) comprising about one-third the length is simply drawn in without any inversion. So that as the proximal portion of the proboscis becomes inverted, it gives rise to a cylindrical cavity which makes room for the distal portion of the same. It has already been noted that there is no connection in the way of muscular or fibrous strands between this distal portion of the proboscis and the pharynx inside it. It seems to be the final step in the retraction of the proboscis as, in the case of being otherwise, the tip would have been drawn too far behind into the cavity of the body to have any appreciable space for it.

Minute structure of the proboscis.—The wall of the proboscis consists of the following layers:—

(i) A single layer of flattened cells lining the outer surface of the proboscis. The nuclei are elongated and rod-shaped, and are placed parallel to the surface.

(ii) A layer of transversely arranged muscle fibres separated from the epithelium by a thin layer of connective tissue.

(iii) A layer of longitudinally arranged muscle fibres which are grouped into bundles by transversely running fibres. The longitudinal bundles communicate with one another by smaller bundles. Interspersed through the muscle layer are unicellular glands, the contents of which take a deep blue stain with haematoxylin. Their ducts open into the outer surface of the proboscis.

(iv) On the inner side the wall contains numerous intercommunicating spaces containing blood.

The pharynx (buccal bulb or buccal mass) is a stout thick-walled tube lying in the anterior portion of the proboscis. The mouth opens into the anterior portion of the pharynx. There is no mandible. The radular portion of the pharynx (radular sac) is a thick conical body placed on a lower level than the pharynx proper. The tip of the radular portion is curved forwards, and gives attachment to retractor muscles which can be traced to a broad muscle band behind. The radula lies in the radular portion, forming a membranous expansion which spreads on the anterior end of a prominence in the cavity of the radular portion. The membranous expansion consists of radiating fibres held together by transverse fibres placed sparingly in an arch-like fashion. The teeth are arranged in **V**-shaped rows, the angle of the **V** being turned backwards. The teeth are lateral, there being no central or marginal; they are unicuspid and uniform in shape, but they increase in size from within outwards. The three outermost teeth are very small in size, while the fourth one is larger in proportion than the outer three. From the fifth onwards the teeth gradually increase in length, the longest one being 0·45 mm

The salivary glands form a much-lobulated mass lying in contact with the anterior end of the digestive gland on the ventral aspect and to the left. The posterior surface of the left gland presents a shallow concavity which fits into the convex surface of the liver. The two glands are apposed to one another to form a single mass, the left one being larger than the right. The small right salivary gland lies beneath the left one over the tip of the pedal gland, being connected to the latter by strands of connective tissue.

The two salivary ducts are much coiled and very fine. They run with the oesophagus through the aperture in the ganglionic mass to the right side beneath the radular sac till they reach the circular groove in front of the radular sac. Then they turn upwards along the right side of the groove nearly to the dorsal aspect, where they open into the base of the pharynx by the side of the oesophagus.

In connection with the anatomy of *Atopos* (*Podangia*) *sanguinolenta*, I described the salivary glands as an accessory digestive gland, as I could not trace the salivary ducts in those specimens. Now taking the minute structure into consideration, I find these two organs are identical, and the accessory digestive gland is nothing but the salivary glands forming a single mass.

Minute structure.—The gland consists of numerous lobules held together by very thin layers of connective tissue. Each lobule consists of a group of irregularly polyhedral cells closely applied to one another. The cells fall into two groups—(1) mucous and (2) serous, the latter preponderating over the former in number. The mucous cells contain coarse granules which are stained blue with haematoxylin; their nuclei are indistinguishable. The serous cells have clearer protoplasm with fine granules which take a brownish yellow stain with Van Giesen's stain. The nuclei

are oval or spherical, and are placed on one side of the cells. The cells open into very minute salivary ducts which are generally placed in the centre of the lobules. In each lobule a duct begins from the elongated neck of a cell or a group of cells (generally mucous in nature), and then runs for a short distance receiving in its course the secretion of other cells which open into it. The duct in this portion of its course is bounded by the cells themselves, there being no other wall of its own. Several ducts converge from the outer portions of the lobule towards the centre, where they unite to form a lobular duct. The outer portions of the primary ducts and the beginnings of the lobular ducts have their walls consisting of a single layer of elongated cells with fusiform or triangular nuclei. Then the cells lining their lumen become more or less columnar in shape. At the point of union of these ducts may be seen mucous cells opening directly into them by long narrow necks.

The oesophagus is a stout tube (a little narrower than the pharynx) which arises from the posterior end of the pharynx in the middorsal line. In the specimen with protruded proboscis, the oesophagus formed a straight tube, extending from behind the pharynx, through the aperture behind the cerebral ganglia, to the anterior end of the midgut gland on the ventral aspect. In the specimen with retracted proboscis, the oesophagus after its origin curves downwards to the left along the groove in front of the radular sac at the ventral aspect. It then passes a little forwards, and bending sharply backwards runs along the midventral line to end in the midgut gland. The oesophagus passes along the ventral surface of the midgut gland for a short distance and then enters into the substance of the gland and ends in the intestine. From the hinder end of the oesophagus at its junction with the intestine, it gives off a short tube which widens out and becomes continuous with the cavity of the midgut gland.

The digestive or midgut gland (liver) is a large elongated conical body, extending over the posterior three-fourths of the cavity of the body. Anteriorly it is truncated obliquely and forms a concave surface directed downwards, forwards and to the left. Posteriorly it is tapering, and is connected to the posterior end of the body by a strand of connective tissue. The surface of the gland is finely lobulated. The cavity of the gland is narrow, with numerous fine slit-like branches projecting into the substance of the wall of the gland. The cavity becomes still narrower and irregular towards the posterior end of the gland.

Minute structure.—The gland consists of numerous extremely elongated glandular cells, which are arranged side by side upon a thin layer of connective tissue which projects inwards from all sides towards the cavity of the gland. At the outer side this layer is continuous with the thin sheath of the gland. Each cell consists of granular protoplasm and contains an elongated nucleus towards its attached end. Amongst these cells are found goblet

cells, the pear-shaped bodies of which are placed upon the connective tissue layer.

The intestine begins from the hinder end of the oesophagus, and passing through the substance of the midgut gland for a short distance emerges from its anterior end towards the right side. It then curves forwards and outwards to the right and then passes backwards to end in the anus, which lies just in front of the female genital aperture.

Minute structure.—The intestine consists of the following coats from without inwards:—

(1) A thick transverse layer of muscle-fibres.
(2) Scattered and irregular longitudinal bundles of muscle-fibres, widely separated from one another by the transverse muscle-fibres and connective tissue.
(3) A layer of sub-mucous tissue thrown into a number of longitudinal folds, being very thick along the folds but quite thin at the intervals. The layer consists mainly of white fibres with a few yellow elastic fibres and connective tissue cells. In this layer are seen numerous unicellular glands, the ducts of which open into the cavity of the intestine.
(4) The mucous membrane consists of a single layer of columnar epithelium, with ducts of the unicellular glands between the cells.

IV Reproductive System.

The animal is hermaphrodite. The male genital organs are very compressed and are placed beneath the proboscis sheath to the right. The main portion of the female genital organ also forms a flat triangular mass lying on the right side of the anterior end of the midgut gland and applied to its side. The female portion lies behind the male portion, the retractor penis muscle of the latter only passing over the female portion to be attached to the body-wall behind it. I could not find any connection between the male and female genital organs. On examining the section of the female portion from the smaller specimen (as that of the larger specimen was accidentally lost), I could not find any spermatozoon in the acini. The question about the connection between the male and female portions still remains unsettled as I could not examine the mature specimen.

The main portion of the female genital organ consists of a glandular mass which lies on the right side of the liver. The glandular mass is placed a little obliquely, with the flattened surfaces applied to the liver on the inner side and to the inner surface of the body-wall on the outer. The anterior border is broad and irregular, while the posterior border is tapering and pointed. The ovarian portion of the organ is inseparable from the albumen gland, both of which are included in a single mass. It forms a translucent portion occupying about the anterior three-fourths of the

gland. Under the low power of the microscope the ovarian portion is seen to consist of thin-walled alveoli held together by connective tissue. The posterior portion of the mass (corresponding to about one-third the length) forms a dead white mass, which extends as a narrow strip for a little distance along the lower border of the gland and terminates in a round end towards the anterior portion. The duct of the gland begins from the lower border of the glandular mass and then runs backwards to the dead-white portion posteriorly; there it forms a close coil and then emerges from the posterior end of the mass. It then curves upwards and forwards along the upper border of the gland for a short distance, and at last bends downwards on the outer side of the mass to end in the oviduct. The albuminiparous portion forms a narrow strip in the upper border of the mass.

Minute structure.—The ovarian portion consists of thin-walled acini bound together by thin layers of connective tissue. Each acinus is lined by a single layer of flattened cells with disk-like nuclei. Inside this layer are numerous cells, more or less rounded in shape and lying attached to the cells of the wall. These cells are massed together in mullberry-like bunches projecting into the cavity of the acini. The cells have large spherical nuclei with a thin layer of protoplasm round them. The chromatin forms a close network with numerous dot-like nucleoli. Attached to the cellular lining are several ova in each acinus, in different stages of development. At first they are fusiform in shape, but become spherical when fully developed. The protoplasm is granular with a large spherical nucleus placed in the centre. The nucleolus is a refractile spherical body placed towards one side of the nucleus. The ovum is surrounded on the inner surface (*i.e.* towards the lumen of the acinus) by a single layer of flattened-cells continuous with that forming the wall. Each acinus gives rise to a duct which opens into the main oviduct. The acinar duct consists of a single layer of ciliated columnar epithelium with elongated nuclei, surrounded by a thin layer of muscular tissue. The main oviduct, which is coiled to form the dead-white mass, consists of a single layer of narrow, much-elongated cells with very long narrow nuclei. The cells are so closely arranged that even in a very thin section, the nuclei seem to be heaped together at right angles to the surface with very little protoplasm surrounding them. The inner surface of the cells is provided with distinct cilia which are as long as the cells themselves. The inner surfaces of the contiguous cells form a continuous refractile border in section. The individual coils of the oviduct are separated by a thick layer of connective tissue with numerous connective tissue corpuscles.

The albuminiparous portion of the gland consists of a scattered mass of small acini more or less rounded in shape, and separated from one another by thick layers of connective tissue. The epithelial lining of the acini consists of a single layer of elongated polyhedral cells with large oval or elongated nuclei. The protoplasm

is very granular. The cavities of the alveoli are mostly filled with secreted material. Amongst the acini are seen their ducts which consist of a layer of cubical epithelium with round or slightly oval nuclei.

The oviduct after emerging from the main mass of the female portion passes downwards to end in the vagina.

The vagina is a short tube which passes outwards to end in the genital aperture.

The receptaculum seminis is a pyriform body opening into the vagina by a very short neck just before the vagina ends in the genital aperture.

The male genital organs consist of the following parts :—

A fine thread-like tube which opens into the penial sheath at its dorsal end near the attachment of the retractor penis muscle. It is coiled several times round the distal end of the penial sheath. It passes forwards along the outer side of the penial sheath to its base, and then turns backwards along the inner border to the base of the right Simrothian gland to nearly half the length of the coecal tube from its attached end.

The penial sheath consists of a tubular structure which opens in connection with the right Simrothian gland at the base of the right lower tentacle on its outer side.

The penis is a short cylindrical body, connected to the penial sheath at its distal end.

The rectractor penis muscle is a long narrow strand, extending from the posterior end of the penial sheath to the body-wall on the right side a little behind the female genital aperture. The muscle passes over the female genital organs to its destination.

The right Simrothian gland is a long tubular body which can be divided into two portions—(1) a long and fine tubular portion which is closely coiled to form a more or less irregular mass, and (2) a thick tubular portion produced at its distal end into a tubular coecum on the inner side. A few muscular strands are seen to arise from the surface of the coecum and pass to be inserted into the dorsum of the muscular foot. There is no left Simrothian gland.

Minute structure.—The distal portion of the Simrothian gland is so closely coiled that the adjacent portions of the loop become more or less fused with one another by their outer coats, and it is impossible to uncoil them without tearing through the outer coats. The wall of the tube consists of the following layers from without inwards :—

(1) A layer of elongated cells, the protoplasm of which is highly granular. The granules are stained with haematoxylin. The nature of these cells is obscure. The layer is ensheathed by a membrane consisting of a layer of flattened connective tissue cells attached end to end

(2) A layer of muscle fibres arranged circularly.

(3) A single layer of short columnar cells with elongated rod-shaped nuclei.

The first and second layers may in some cases be fused in adjacent portions of the tube.

V Nervous System.

The nervous system is of euthyneurous type. Like the other species of the same genus, the ganglia are concentrated to form a rectangular mass, with a hole behind the closely apposed cerebral ganglia for the oesophagus and two salivary ducts. The cerebral ganglia are placed on a higher level than the others. The two viscero-pleural and two pedal ganglia form a flattened squarish mass, being only indistinctly separated from one another by a shallow cruciform groove. The buccal ganglia are placed at their usual position at the junction of the proboscis and the radular sac on the ventro-lateral aspect. The stomato-gastric connectives are very long in correspondence with the protrusible nature of the proboscis.

VI. Pedal Gland.

The pedal gland is an elongated tubular body 1·7 cm. in length, and is situated beneath the ganglionic mass on the dorsal surface of the foot. It extends about one-fourth the length of the body from the anterior end of the foot. The organ is slightly flattened dorso-ventrally towards the base, but cylindrical in the posterior two-thirds The gland opens externally, in the middle line, in the shallow groove between the head and anterior end of the foot.

Minute structure.—The lumen of the gland is circular in transverse section in the distal two-thirds of its length, but more or less elongated and flattened in its anterior one-third. The lumen is lined by a single layer of broadly columnar epithelial cells in the lower third of its circumference, while at the sides they become gradually cubical which again become flattened out at the upper third. Outside the epithelium lies a layer of connective tissue continuous above with what forms a sheath round the whole gland. In the anterior flattened portion of the gland, the lower half of the lumen is lined by a single layer of columnar epithelium, while the upper half is lined by a single layer of flattened cells. Between the epithelial cells are seen the openings of the ducts of numerous unicellular glands, which form the whole mass of the gland.

The unicellular glands are more or less club-shaped, with wide ducts opening into the lumen of the tube. The granular contents are stained blue with haematoxylin.

VII. Muscular System

On the dorsal surface of the foot towards the anterior end is a muscular cushion with strands passing in all directions and becoming continuous with the musculature of the foot. This cushion

does not seem to be connected to any other muscle strands passing to other portions of the body-wall. It seems to be the remains of the well-developed columellar muscle of typical pulmonates.

Prisma aborense, n. sp.

A single specimen of the present species was obtained under stones at Rotung, 1300 ft.

The animal seems to belong to a new species. The presence of precephalic flaps is a remarkable point to note.

Notum finely granulated, with small tubercles in addition. Notum of sepia colour with black dots and lines, the latter forming an open meshwork not symmetrical on both sides. Foot sole light lamp-black, with the rims and circumpedal groove (including the inner surface of the free mantle margin) yellowish white. Body prismatic in transverse section with a faint rounded keel in the middorsal line. Mantle forming a hood over the head; mantle-margin thick and directed inwards. A thick precephalic flap beneath each lower tentacle and fused with it. Tentacles and flaps slaty-black. Length of notum 2·7 cm., breadth ·15, height ·7, breadth of foot sole ·3, ♀ aperture ·35 from ♂ aperture.

EXTERNAL CHARACTERS.

The animal is elongated, limaciform and is prismatic in transverse section. The height of the body is greatest in the middle third of its length. The body tapers slightly to a rounded end anteriorly, and gradually to a bluntly-pointed end behind, the margin of the mantle (perinotum) being inflexed at the latter end.

The mantle is rounded with a keel in the middorsal line. The keel is prominent and ridge-like in the anterior-third of the body, but is broad and rounded in the posterior two-thirds. The foremost part of the mantle is bent at a right angle to the part behind and forms the hood covering the head. The hindermost part of the mantle is bent downwards and forwards just behind the posterior extremity of the foot, the outer surface being thus directed downwards and backwards. The anterior border of the mantle presents a wide rounded notch in the middle line. The mantle-border (perinotum) is thick and slightly inflexed; it forms a convex surface about ·08 cm. wide, which narrows down to disappear at the posterior end. The surface of the mantle is granulated.

The head is separated from the body by a distinct transverse groove. The ommatophores are short, stout and cylindrical, they are transversely wrinkled, and seem to be non-invaginable. The precephalic flaps are placed on the lateral aspects of the head, and form the lateral boundary of a trapezoid-space leading into the mouth. The two flaps are united to each other by a thin narrow flap of integument extending across the middle line beneath the ommatophores, and forming the dorsal wall of the trapezoid spaces mentioned above. The outer (dorsal) surface of each precephalic

flap is fused with the lower tentacle at the inner side, being slightly grooved on the inner aspect for the reception of the ommatophore. The infero-external surface is directed downwards and outwards, and lies on a thin flattened process of integument placed over the lateral aspect of the anterior surface of the foot. The infero-internal surface is directed downwards and inwards and is continuous behind with the lining of the cavity leading to the mouth. The anterior border is thick. The outer border is also thick. The inner border gives attachment, at its back, to an integument which forms the dorsal wall of the cavity mentioned above. The inferior border is continued at its base to a transverse ridge of integument, which forms the inferior boundary of the cavity leading into the mouth.

The lower tentacle is fused with the precephalic flap except at the rounded tip.

A thin flap of integument extends transversely below the cavity leading into the mouth, forming its ventral wall. On either side it is attached to the inferior border of the precephalic flap at its base. From the attachment of this membrane to the precephalic flap, arises a thin integument which at once ends in a triangular process on its upper aspect. The triangular process is attached behind to a thin band extending, from the outer aspect of the head at its posterior end, downwards to the side of the foot at its anterior end. This post-cephalic band is bounded behind by a groove which is a continuation of what forms the boundary between the head and the body. This band forms the dorsal wall of a slit-like cavity into which the pedal gland opens.

The mantle is attached to the dorsal surface of the body about ·2 cm. behind the head. The line of attachment then passes forwards and downwards to come within ·5 mm. of the groove behind the head, at the level of the lower border of the precephalic flap; then it runs parallel to the groove behind the band (just described) and ends in the groove between the foot and the margin of the mantle.

The foot is widest at a point ·3 cm. from the anterior margin and tapers very gradually to a point at the posterior end. The foot projects beyond the mantle border for about ·12 cm. at its posterior end. The anterior end of the foot forms a concave surface, the lateral borders of which are sloping from above downwards and backwards for about ·2 cm. from the anterior margin. The sole is finely wrinkled in a transverse direction, the margin of the sole forming a thick rim.

Measurements (in cm.)

Length along the middorsal line of the mantle	4·0
Length along the midventral line	2·7
Greatest height (at the junction of the anterior one-third and posterior two-thirds)	·7
Greatest breadth	·75

Depth of the circumpedal groove	·2
Length of the foot	2·6
Width of the foot sole	·3
Distance of the male aperture from the anterior end of the foot	·15
Distance of the female aperture from the anterior end of the foot	·5
Length of the head	·25
Length of ommatophore	·1
Thickness ,,	·05
Length of the precephalic flap	·055
Length of the protruded proboscis	·45
Width of the keel	·05
Width of the mantle border	·08

Colouration.—The surface of the mantle (notum) is sepia, marked with numerous black lines which pass in various directions forming a very irregular open meshwork; the wide and irregular meshes are occupied by blotches of the same colour. The ommatophores, the lower tentacles and the dorsal aspect of the precephalic flap (excepting a narrow strip along the anterior border) are slaty-blue, the sole is of the colour of light Indian ink with the rim yellowish white.

ANATOMY.

I. Pallial Complex.

The pulmonary area is broadly reniform in shape, the greatest breadth lying in a transverse direction. It lies behind the line of attachment of the mantle to the body behind the head. The area extends both to the right and left side of the body beneath the mantle, being continued to the junction of the mantle to the base of the foot on the right side, but ending about 1·5 mm. above on the left. The roof of the pulmonary area is fused with the mantle, as well as with the dorsal wall of the pericardium. The floor lies on the anterior end of the liver, the salivary gland and the radular portion of the pharynx. There is no pulmonary chamber.

The pericardium lies in the anterior one-third of the pulmonary area. It extends a little more to the right than to the left.

The heart lies a little obliquely, the ventricle being placed a little in front of the auricle and to the left. The auricle is placed just beneath the middorsal line of the body.

The kidney occupies the rest of the pulmonary area. It is a spongy mass bounded both on the inner and outer aspect by a thin membrane forming the floor and roof of the pulmonary area.

II. Digestive System.

The proboscis was protruded in the specimen and the pharynx was placed inside the proboscis sheath. Fine strands of connective tissue were seen extending from the inner side of the proboscis

sheath to the anterior portion (about one-sixth the length) of the pharynx.

The pharynx is a stout tubular structure, a little flattened from above downwards. When the proboscis is protruded, the whole of the pharynx with a portion of the radular sac is drawn into the cavity of the proboscis, the hinder two-thirds of the radular sac being left in the cavity of the head.

The radular portion of the pharynx is stouter and more flattened than the pharynx proper; it is placed at an angle with the pharynx and is itself curved so that the posterior end is bent downwards.

The radula is a narrow band which is placed on an elongated cushion from the ventral wall of the sac. The anterior end of the band is curved downwards and backwards round the blunt anterior end of the cushion. The teeth are unicuspid and are arranged in **V**-shaped rows. Each presents a crescentic notch toward the distal end.

The oesophagus begins from the middorsal line of the pharynx a little in front of its middle (including the radular portion). It runs backwards for a short distance, and then curves downwards to come to the ventral aspect. It passes through the aperture in the ganglionic mass and then passes along the ventral aspect of the liver, and opens into its cavity at a little distance behind the anterior end.

The salivary glands form a single inseparable mass lying in front of the liver. The mass is triangular in shape, and is placed on the distal portion of the pedal gland. The salivary ducts, two in number, arise from the ventral surface of the glandular mass, the left one arising a little in front of the right. They pass through the aperture in the ganglionic mass, and open into the pharynx on the ventro-lateral aspect in the same vertical line with the beginning of the oesophagus.

The liver is a stout conical sac with thick walls. The anterior end is broad and is bevelled at the ventral aspect. The posterior end is tapering and ends in a blunt point. The surface is uniformly lobulated, with small depressed areas bounded by raised white lines. The cavity of the liver is spacious and presents an irregular lining of ridges and papillae. The cavity of the organ was filled with a granular mass, which on microscopic examination was seen to consist of the remains (the cellulose lining) of various sorts of unicellular and branching filamentous algae.

The intestine begins from the ventral aspect of the liver on its left side. It passes forwards and to the right to end in the anus placed close to the ureter.

III. Reproductive System.

The animal being of very small size, it was impossible to trace the connection between the male and female portions.

Male genital organs.—The penis when contracted forms a small conical prominence inside the lumen of the long tubular penial sheath at its distal end. The flagellum lies along the side of the penial sheath, extending from the base of the penis to the proximal end of the sheath. The penial sheath is a tubular structure fused with the Simrothian gland about half its length from the proximal end, and having a common lumen for the two. The right Simrothian gland is a tubular structure fused with the penial sheath for a short distance from its proximal end. The tube consists of a narrow and loosely coiled distal portion, and a thicker proximal portion provided with a rounded projection into its cavity at the beginning.

Female genital organ.—The female genital organ forms a small flattened body applied to the inner surface of the pulmonary area and opening into the external aperture by a short duct. There is no distinct albuminiparous portion of the gland.

IV. Nervous System.

The ganglia form a squarish mass with the aperture for the oesophagus and two salivary ducts. The cerebral ganglia are closely united to each other and are placed on a higher level than the others. The pedal and viscero-pleural form a compact mass behind the cerebral. The pedal cords, one from each ganglion, pass backwards to the posterior end.

The two buccal ganglia lie in the angle between the radular portion of the pharynx and the oesophagus, a little behind the beginning of the latter. They form a pair of oval bodies closely applied to one another like a pair of beads. There are three nerves from each ganglion, one of which is connected to a nerve from the cerebral ganglion.

V Pedal Gland.

It is a stout tube more or less flattened on the dorso-ventral line. It is bent on itself a little in front of its middle so that the posterior portion is directed to the left of the animal. The latter portion of the tube lies in contact with the ventral aspect of the salivary glandular mass, with which it is connected by means of connective tissue.

LITERATURE.

In addition to the literature mentioned in my last paper "On the Anatomy of *Atopos* (*Podangia*) *sanguinolenta* (Stol. MS.), the following papers were also consulted:—

1. E. Ghosh, "On the Anatomy of *Atopos* (*Podangia*) *sanguinolénta* (Stol., MS.)." Records of the Indian Museum, Vol. vii, Part ii, No. 17, 1912.

2. Collinge, W. E., "*Atopos* list and distribution, spp; *A. onwense*, sp. n. Java." Journ. Conch., 12, p. 199, 1908.
3. Simroth, H., "Uber das Vaginuliden genus *Atopos* n.g." Zeit. f. Wiss. Zool., 1891, Bd. iii, pp. 593—616.