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On some Points of the Internal Structure of *Squilla oratoria*

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With Plates I—II

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Contents

ANAL GLAND

Introduction

It has long been known that there exists in the stomatopod a kind of glandular caecum communicating with the digestive tract near the anus. Thus, as early as in 1883, CLAUS stated that in this group no antennal excretory gland is found, but "Ein stellvertretendes Organ findet sich als Anhang des Afterdarms und zwar an äussersten Ende desselben unmittelbar vor der Ausmündung neben der Afterspalte. Zu beiden Seiten der Afterspalte finden sich zwei Drüsensäckchen, deren Zellen stark in das Lumen vorspringen und ein Secret ausscheiden, welches sich als körniges Sediment niederschlägt" (p. 12). Apparently, this statement is based on his observation on the Alima larva. WOODLAND in 1913 remarks that "The rectal glands are found in both sexes underlying the ramification of the 'liver' in the telson. They are two in number, are large, with spacious lumina, and open in the adult as in the larva laterally at the posterior end of the rectum. In addition to these rectal glands there are present some small accessory tubules opening into the gut in the same region, which apparently bear some resemblance in structure to the urinary tubes of amphipods" (p. 425).

The minute structure and function of this organ, however, remains altogether unknown.

Material and Methods

The material of this study was obtained chiefly from adult individuals collected in Tokyo Bay as well as in Kasaoka Bay in the Inland Sea. Also some larval material which came from Tokyo Bay was used. To observe the organ in toto, the sclerite and hypodermis around the anus were removed; then the organ comes into view under the dissecting microscope as a set of four tiny sacs attached to the wall of the rectum very close to the anal split (*Text-fig. I, 1*).

For histological purposes, the organ was cut out with neighboring tissues and fixed with FLEMMING's strong solution, ZENKER's or BOUIN's mixtures or acetic sublimate solution, each of which gave fairly satisfactory results. Especially by FLEMMIMG's solution excellent figures were sometimes obtained; but ZENKER's and BOUIN's mixtures also gave nearly as good results. The macroscopical observations were made by the junior author alone, while all the histological examinations and descriptions were made by the senior author.

Macroscopical Observations

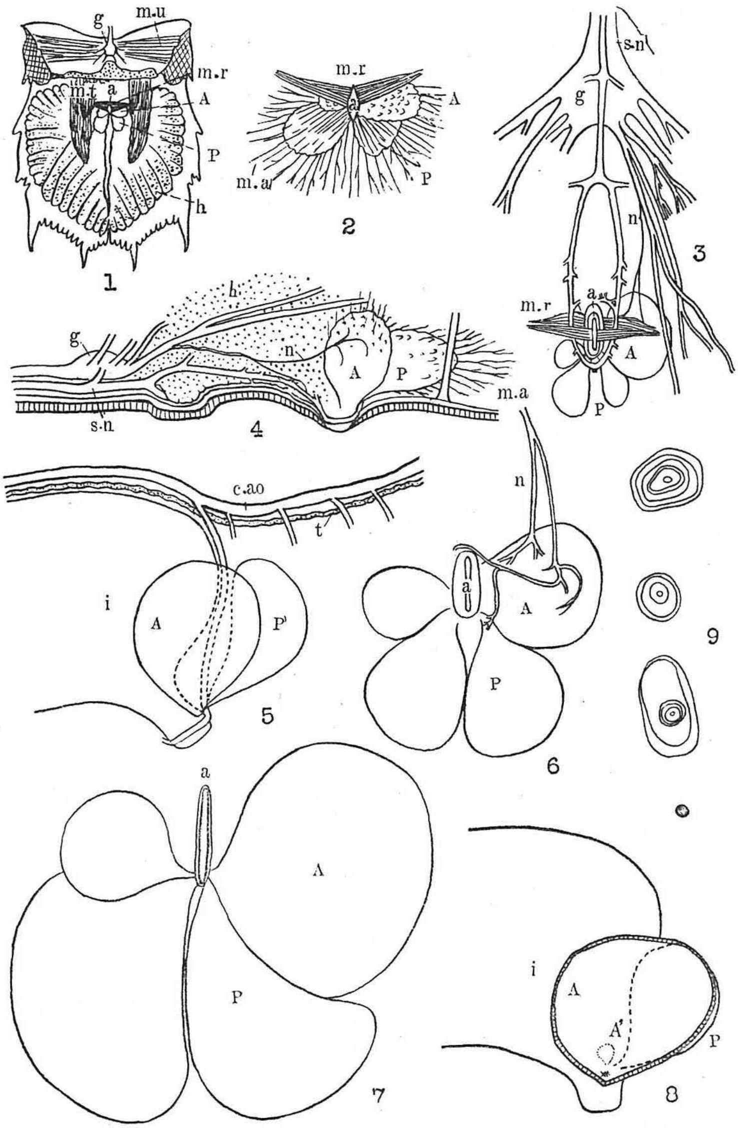
The organ consists of two pairs of small sacs lying very close to the anal split on its postero-dorsal side, between the flexor-muscles of the telson (*Text-fig. I, 1* & *2*). The anterior pair are partially hidden by the dilator muscles of the rectum. All are roughly pear-shaped and attached to the wall of the rectum on its postero-dorsal side each by a short stalk. They are wrapped with connective and muscle fibers and blood-capillaries which make the macroscopical observation rather hard. Especially in females in the breeding season the sacs are pressed under the enormous ovary and very hard to make out.

Both the pairs are rarely symmetrical in shape and size. This is especially the case with the anterior pair, of which the left sac is usually larger than the right, as shown in *Text-fig. I, 1—3* & *5—7*. In very large sacs of this pair, a very small supernumerary sac may exist at the base on its internal side (*8*). The largest sac measures 5 mm. in longest diameter. The stalks of all the four sacs lie very close together, so that in the side view the posterior sac is partly hidden by the posterior part of the anterior sac, and the posterior margins of the posterior sacs touch each other on the median line.

The innervation of the organ is from the last abdominal ganglion (*1, 3, 4, g*) which is situated in the sixth abdominal somite. Of the four pairs of nerves issuing from this ganglion, the last pair send out each on the internal side a thin fiber. This is divided into two branches which are subdivided and distributed on the ventral side of the sacs (*3, 4, 6, n*).

The blood supply comes from a pair of branches of the posterior aorta which pass down along the posterior wall of the rectum, encircling it near the anus, and united with branches from the subneural artery on the ventral side. Numerous branchlets issuing from these arteries are distributed around both the sacs (*3—5*).

The anterior sacs usually contain a concretion which is rather large in size, mostly being 1—2 mm. in diameter, spherical or somewhat irregular in shape, and light olivaceous or yellowish brown in color. It lies freely in the lumen of the sac so as to be moved easily by the motion of the animal. It is refringent, with beautiful concentric rings, and is dissolved readily by acids, producing gas foam, showing clearly that it is made up of a calcium compound (*9*). The posterior sacs never contain any concretion.



Text-figure I, 1. Sixth abdominal somite and telson with sternites removed, to show the position of anal sacs among the neighboring organs. Ventral view. ×3/4.

2. Ventral view of anal sacs with radiating muscle- and connective-tissue fibers. ×4.
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4. Lateral view of the same region. ×4.
5. Lateral view of the posterior end of intestine with anal sacs. ×5.
6. Ventral view of anal sacs showing innervation. ×5.
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Histological Observations

The Limit of Posterior Extension of Mesenteron

Before going into the histological descriptions of these sacs, mention must be made of the limit of posterior extension of the mesenteron in *Squilla*, because there are certain discrepancies of opinion on this point among previous investigators. WOODLAND (1913) remarks, "The mesenteron extends from the stomach to the region of the anus, where the cuticle of the proctodaeum becomes inturned for only a short distance" (p. 425). According to GIESBRECHT (1921), "Der mesodäale Teil des Darmes reicht bis ins Telson; er ist bis zum 4. Pleonsegment eng und dünnwandig, erweitert sich dann und schwillt im Sack an (mit dickerer, inner längsgerunzelter Wand), der mit ganz kurzem, ventrad absteigendem Proctodaeum nicht weit hinter dem ventralen Vorderende des Telsons mündet" (p. 99). BALSS' (1927) statement is somewhat different. "Der Hinterdarm, das Proctodaeum, beginnt im 6. Abdominalsegmente, erweitert sich blasenförmig und mündet im Telson ventral........." (p. 105).

My observations have revealed that WOODLAND and GIESBRECHT'S descriptions are correct. The mesenteron, as found by these authors, extends posteriorly into the telson down to the very close proximity to the anus. In the anterior part of the telson the cavity of the intestine is fairly wide and the wall is composed of secretory cells having nuclei at various heights. This portion of the intestine is continued backward into another portion which is rather pronouncedly different from the former in several respects. The internal cavity is very small; the wall is strikingly folded and encircled with a rather strong musculature. The component cells are tall and narrow, evidently non-secretory, the plasm appearing quite clear and the nuclei all situated near the basal end (*Text-fig. II, c*). All these features seem to show that the portion apparently performs the function of the colon. Next comes the rectum (*r*) which is quite straight and unfolded and has a very limited length of 1—2 mm. Here the cells are also elongated and narrow, but the plasm does not look so clear as in the folded

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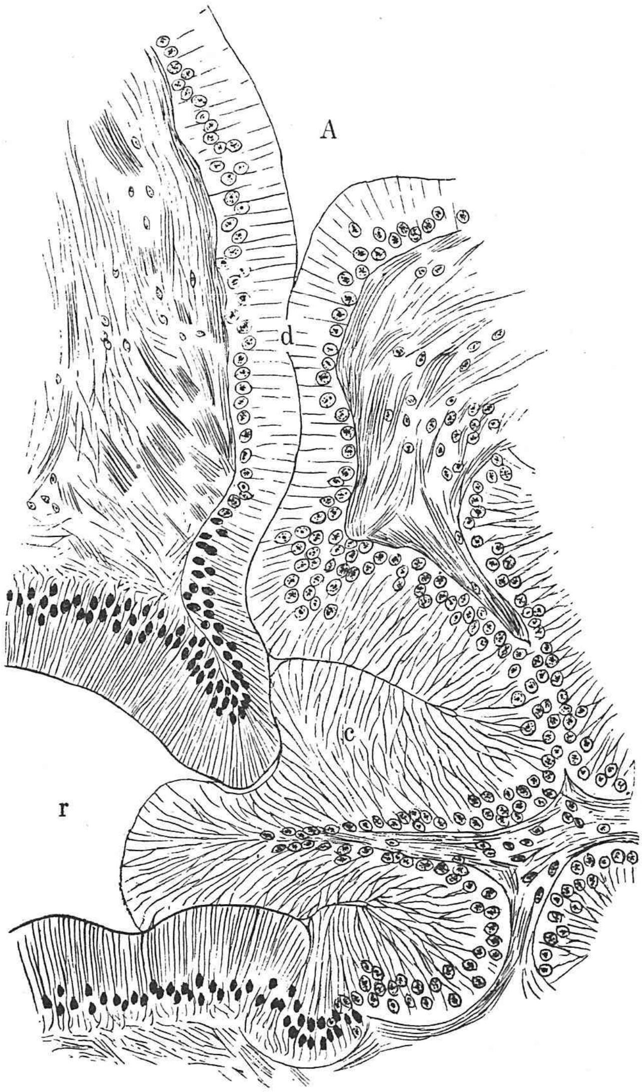
A. anterior anal sac, *A'.* accessory sac of the same, *a.* anus, *c. ao.* caudal aorta, *g.* last abdominal ganglion, *h.* hepatic gland, *i.* intestine with surrounding hepatic gland, *m. a.* muscle and connective-tissue fibers of anal sac, *m. r.* muscles of rectum, *m. t.* muscles of telson, *m. u.* muscles of uropod, *n.* nerve supplying anal gland, *P.* posterior anal sac, *s. n.* subneural artery, *t.* testis.



Text-figure II. Vertical section of the region between mesenteron and rectum, ×250.
A. anterior anal sac, *c.* colon, *d.* duct of anterior anal sac, *r.* rectum.

portion and stains fairly well with eosin. The contour of each cell appears very distinct so that strong striation is seen in the wall. The nuclei are more elongated than those in that portion and situated at about the middle of the length of the cells. The free border is covered with a chitin coat which is the direct continuation of the sclerite of of the ventral surface of the telson. The internal end of the wall of the rectum is reflected externally and the cells go over the cells in the folded portion rather abruptly.

It is beyond doubt, that the secretory part of the intestine found in the region of the telson belongs to the mesenteron, as also that the rectum is the proctodaeum. But the nature of the folded portion might not be so clear. However, careful examinations of the sections of the portion in question in the adult and larval specimens have revealed almost definitely that the cell-lining here is not ectodermal, but entodermal. Besides other facts, the absence of a chitin covering on the border and the rather abrupt change of the component cells from that portion to the rectum, in contrast to an insensible transition of the same from the former to the secretory portion, are the evidences for this view. No doubt embryological data will be found very helpful in deciding this question conclusively.

Histology of Anal Gland

Both pairs of the sacs have a rather spacious internal cavity which communicates with the posterior end of the mesenteron by a short stalk—the duct (*Text-fig. II, d*). The point of communication is in the folded portion of the mesenteron mentioned above. The ducts of the two pairs of sacs lie very close together, being only a few sections apart in transverse sections, while in horizontal sections both of them may appear in the same section (*Pl. I, fig. 1*).

The cells composing the wall of the sacs are all secretory in function and apparently only of one kind in the same sac; however, a very clear difference may be noted between the cells composing the anterior sac and those of the posterior sac, as will be described later on. The sacs are invested with a network of small haemocoelic lacunae which lie so close to the sac-wall that they are partially bound by the basement membrane on which the cells of the wall stand. Around the lacunae are numerous muscle-fibers, mostly circular in direction, and also some connective-tissue fibers.

a. Anterior Sacs

The anterior sacs are characterized by the presence of a concretion in their cavities (*fig. 2*) and also by the cells being vacuolated and cyanophilous. Some differences may be found in the nature of the cells composing the sac-wall between larger and smaller sacs of this pair. In smaller sacs the wall shows numerous foldings and the cells are rather tall and cylindrical and less vacuolated than in larger sacs (*fig. 4*). The nucleus is vesicular and situated usually near the middle or somewhat more close to the base. The plasm shows longitudinal striations and contains minute secretory spherules. At the distal end there is usually a secretory globule which is in various states of constriction and liberation. The content of the globule takes hardly any stain except when it encloses a cell-nucleus, which is sometimes the case. The cells which are not surmounted with the globule, have an even and truncated distal border where the characteristic longitudinal stripes are clearly observable. Evidently these cells represent the youngest stage of the secretory cells. When the secretory action arrives at a certain stage, a small globule is formed at the tip of the cell, which enlarges to a certain limited extent. The globule is then constricted off from the matrix and liberated in the cavity of the sac (*fig. 10*). Thus the terminal portion of the cell is lost; and when the same process is repeated, which is apparently the case, the part of the cell which contains the nucleus becomes constricted off (*fig. 4*). In the parts of the sac-wall where it is elevated into folds, the cells are particularly narrow and elongated, with the nuclei also elongated in the longitudinal direction. At the base of each fold occurs usually a haemocoelic cavity as a core of the fold, so to speak. (*fig. 7*).

In the larger sacs the folding of the wall occurs only in the part adjacent to the duct, the wall being much lower in the remaining part. The component cells may be nearly square with some longitudinal striations (*fig. 6*), or strongly swollen so as almost to become spheroidal and filled with a single large vacuole, while still others are very narrow and carry a large secretory globule at the distal end (*fig. 5*). Undoubtedly all these represent the different phases of one and the same secretory cell. Of the three phases mentioned above, the first is probably the youngest stage in which the secretory activity has not begun yet; the phase mentioned last is the next stage, which is in the height of activity, while the swollen cells probably belong to the senescent stage of the gland-cell. Evidently with the growth of the rectal sac, the component cells gradually undergo change both in shape and nature in the manner mentioned above.

In some preparations a breach is found in the wall of the sac, through which some waste matters are being thrown into the cavity (*fig. 6*). The matters are mostly senescent cells. But there is some room for suspecting that such is not a natural occurrence but simply an artefact.

As already stated, the anterior sac usually contains a concretion in its lumen (*fig. 2*). In some small sacs, as well as in some very large sacs, however, the concretion may be missing and the sac is empty except for the presence of small secretory spherules. In sections, as in view in toto, the concretion exhibits beautiful concentric rings. The ground substance is acidophilous and shows some detritus matter imbedded in it. Externally it is surrounded by a few layers of membraneous substance.

It is beyond doubt that the concretion is formed by the conglomeration of the substance contained in the secretory spherules, and that it is finally cast out by means of the duct into the rectal lumen and then to the exterior. Its absence in small as well as in very large sacs is evidently due to the fact that in the former it has not been formed yet, and in the latter it has been discharged already.

b. Posterior Sacs

In size and shape, and also in structure, the posterior sac shows little difference from the anterior sac. But the individual cells are decidedly more uniform in appearance, and the plasm is more compact and never vacuolated (*figs. 8, 9*). It is markedly acidophilous, in sharp contrast to the cyanophilous plasm of the cells composing the posterior sac. In some cases the cells are very tall with their terminal parts considerably drawn out into the cavity of the sac. Longitudinal striations occur in the basal region and also tiny fibrils in the middle region where the vesicular nucleus is found. Some granules which take basic dyes are distributed in the entire cell except the terminal region. The secretory substance is liberated as a vacuole constricted off from the tip of each cell. No concretion is found in the sac, as already mentioned.

Anal Gland in Larva

In the larva in the most advanced stage of development, the two pairs of sacs are already represented as evaginations from the intestinal wall in the same region as in the adult (*fig. 3*). The sharp difference in the component cells between the two pairs is already very apparent. The cells in the anterior sac (*A*) have a smooth border with nuclei situated nearly on the same level in the bottom region. The plasm is cyanophilous and slightly granular. But no concretion is found in the cavity. In the posterior sac (*P*), on the contrary, the cells have a distorted outline and peculiar amoeboid appearance; they are all much elongated and project into the cavity. The border is very uneven and the nuclei are situated at various heights. The plasm is acidophilous and compact. Usually the posterior sacs are larger than the anterior sacs, the former measuring up to 0.2 mm. in diameter and the latter 0.1 mm. or less.

General Remarks

Apparently all of the previous investigators of this organ have taken it for granted that it belongs to the proctodaeum. The observations mentioned above, however, seem to have disproved this view and supported the view of the mesenteric origin of the organ.

Next, as to the function of the organ, it is beyond doubt at least that both pairs are secretory. The difference in nature of the component cells, however, suggests that there is some difference in the substance secreted. The presence of a concretion in the anterior sac shows that a calcium compound, possibly of uric acid or something similar, is excreted from this organ and that this functions as an excretory organ. The posterior sac contains no concretion in its cavity, and it may be less certain that its function is of the same kind. But, since a more plausible interpretation is hardly possible, it seems likely that it is also an excretory organ discharging a substance somewhat different from that from the anterior sac. Probably these two pairs of glandular sacs carry out the excretion of the waste-products in the posterior region of the body, acting as auxiliaries to the maxillary gland which is the primary excretory organ of this animal.

In *Nebalia* there occurs a blind sac of the mid-intestine in nearly the same region. This shows, however, a rather great difference in structure from the anal gland of *Squilla,* so that it is rather difficult to homologize it with this organ.

Of the previous authors, CLAUS, as mentioned above, has mentioned the presence of two gland-sacs, the cells of which are prolonged strongly into the lumen and produce a granular secretion. Evidently he observed the posterior sacs only. WOODLAND also, has noticed two glands which open into the rectum, and in addition that "there are present some small accessory tubules opening into the gut in the same region". These "tubules" apparently refer to the posterior sacs whose wall may be wrinkled, and which look not unlike some tubules (*Pl. II, fig. 1*) in sections.

HEART AND ARTERIAL SYSTEM

Introduction

The circulatory system of the stomatopod is only imperfectly known, since the accounts given in papers by older authors such as AUDOUIN, M.-EDWARDS and DUVERNOY are all very meagre and inaccurate, while the descriptions of CLAUS and GIESBRECHT are confined to statements on the system in the larval form. Such circumstances apparently justify the publication of a brief note prepared by the senior author some years ago concerning the heart and arterial system of the adult *Squilla oratoria*. The observations were made on fresh material obtained in Tokyo Bay with the only aid of the ordinary injection method.

Before going into detail, it may be mentioned that the heart and arterial system of the adult stomatopod differ in no important way from those of the larva as described by CLAUS and GIESBRECHT, save only in certain minor points, mainly in the circulation of the carapace.

As is already known from the works of previous authors, the circulatory system of this crustacean is highly characterized by the persistence of primitive features, such as the elongated tubular heart, the metamerically-arranged ostia and lateral arteries.

Heart

The heart (*Pl. II, fig. 1 H*) extends from the maxillary region of the cephalo-thorax to the fifth abdominal somite. Anteriorly it begins very close to the posterior wall of the stomach, where it is expanded dorsally and laterally into an onion-shaped sac. A pair of transverse ostia are found on the dorsal wall near the posterior end of this portion. The rest of the heart, by far the greater portion of it, is a tube, with a caliber of from ca. 1.5 mm. in the anterior region to ca. 3 mm. in the posterior, and perforated with 12 pairs of ostia (*os*) on the dorsa surface. All of the ostia are elongated in the oblique direction right-forward to left-backward, in concordance with the main direction of the muscle-fibers of the heart. The only exceptions form the first and last pairs, which are symmetrically set, the former convergent with each other and the latter transverse to the length of the heart, in accordance with the local direction of the muscle-fibers.

Of all the twelve pairs of ostia, five occur in the thoracic, and the rest in the abdominal region. They are missing in the first three thoracic somites, while the remaining five thoracic somites have them each nearly in the middle of its length. In the first five abdominal somites occur a pair of ostia very close to the anterior border. The fifth somite is exceptional in having two additional pairs of ostia, one in the middle and the other somewhat nearer the posterior border. The former are undoubtedly those of the sixth somite which have been shifted forward. As to the last pair it is likely that they belong to the seventh somite which of course remains united with the telson and in an undifferentiated state.

Arteries in Cephalic Region

From the anterior end of the heart is given off the cephalic aorta (*c. ao*), which passes straight along the median line on the dorsal wall of the stomach to the base of the rostrum. It sends out a few small branches to the muscle of the antenna in its course. It is then furcated into two lateral branches, each of which is directly subdivided into an internal and an external ramus. The internal ramus joins with its mate on the other side and forms the ophthalmic artery (*oph*) which follows the course of the cephalic aorta until it is bifurcated and enters the paired eye. The ophthalmic artery gives off a ventral branch, nearly as thick as itself at its base, the cerebral artery (*cer*), which ramifies on the ventral side of the cerebral ganglion. The external ramus (the common antennal artery, *c. an*) is again bifurcated into an antennular and an antennal artery. The former passes along the external margin of the antennular somite into the antennule, while the latter enters the antenna, after sending off branchlets to the adductor muscle of the same; it is then divided into two branches going into the flagellum and the foliaceous appendage.

The anterior expanded portion of the heart further gives rise to an artery from each of its anterio-lateral corners (arteria lateralis cephalica, *l. c*), which ramifies in the lateral and ventral regions of the head and supplies blood to the epistome and all the mouth-appendages including the labrum, mandible, paragnath, maxillula and maxilla. The mode of ramification is as shown in the figs. 1 & 2.

As compared with the arterial system of the cephalic region of the larva, as described by previous authors, the system in the adult shows the following differences: In the larva the ophthalmic artery is the direct continuation of the cephalic aorta, while in the adult the latter undergoes the furcation and reunion mentioned above, which is evidently due to the development of the ligament in this region connecting the rostrum and the carapace in the adult. Further, in the larva a branch of the common antennal artery of one side goes to the antero-median spine, and a few branches of the antennal artery to the other regions of the carapace. These all have much atrophied, the former having disappeared completely and the latter being represented by very small branchlets supplying the muscles of the antenna. The branch of the art. lat. cephal. which is given off to the postero-median spine of the larval carapace is also missing in the adult circulation.

Arteries in Thoracico-abdominal Region

Altogether fourteen pairs of arteries are given off from the lateral sides of the heart. These are arranged essentially metamerically, so that they may well be named segmental arteries. Of these, seven (*sg. 1—7*) belong to the thoracic and the rest (*sg. 8—14*) to the abdominal region. They all start very close to the ostia with the exception of only the first two pairs, for which there exist no ostia. The first segmental artery (*sg. 1*) is furcated into an anterior and a posterior branch which enter the first and second maxilliped respectively. The second segmental artery (*sg. 2*) goes into the third maxilliped and its branch supplies the second maxilliped, while the third proceeds directly into the fourth maxilliped without dividing. The fourth (*sg. 4*) curves ventrad and enters the fifth maxilliped. This artery is connected on both sides with the subneural artery to be mentioned below, by a rather strong communicating ramus. The fifth to seventh segmental arteries (*sg. 5—7*) show nearly the same ramification: each is divided near its base into an anterior branch which ramifies among the muscles and the hepatic gland of the corresponding somite and a posterior branch which advances into the pereiopod.

The eighth segmental artery (*sg. 8*) sends branches to the posterior part of the eighth thoracic somite and also to the anterior part of the first abdominal somite, but takes no part in supplying the leg.

The succeeding four segmental arteries have nearly identical ramification. Each is furcated into a dorsal ramus dividing among the muscles and the hepatic gland of the preceding somite, and a ventral ramus going directly ventrad and entering the pleopod of that somite. Thus in this region a rather curious situation obtains, namely, that the blood supply of each somite is secured by the segmental arteries of the succeeding somite.

The thirteenth segmental artery (*sg. 13*) shows much the same configuration, except that the branch of the dorsal ramus which runs along the border between the fifth and the sixth abdominal somite communicates with the fourteenth segmental artery.

The fourteenth segmental arteries (*sg. 14*), the last pair, are given off from the posterior extremity of the heart, behind the last (thirteenth) ostia. They run backward for a short distance, keeping close contact with the caudal aorta, and after sending out a larger branch on the internal side to the hepatic gland, part with that aorta, but still go backward to the posterior border of the sixth somite, where each turns abruptly outward, and proceeds into the uropod, sending out a number of branchlets to the hepatic gland in its course. It is then furcated into an internal and an external ramus, which are both again bifurcated. Of the four secondary branches thus produced, the innermost one enters the endopodite of the uropod, the next two the internal and external prolongation of the basal segment of the same, while the outermost one proceeds into the exopodite. The outer primary ramus of this segmental artery communicates with the branch of the thirteenth segmental artery mentioned already, at a point slightly distal to the point of the primary furcation.

The caudal aorta (*ca. ao*) passes straight on the median line of the telson to nearly the posterior end; it sends off numerous side-branches on either side to the muscles and the hepatic gland present in the telson.

Subneural Artery

The subneural artery (*Fig. 3, s. n.*) is a straight artery which passes on the median line of the body on the ventral side of the nerve chain. It stretches between the anterior end of the large cephalo-thoracic ganglionic mass and the posterior end of the last abdominal ganglion, and sends out many branchlets to the ganglia lying between these two extremities, thus serving primarily to nourish the central nervous system. There exist also several lateral branches of this artery which connect it with segmental arteries (rami communicantes, *rc*). The first of these rami (*rc. 1*) exists just behind the anterior extremity and on one side only. stretching between the artery and the first segmental artery. The second (*rc. 2*), which has already been mentioned, is paired, fairly strong, and connects the subneural artery with the fourth segmental artery. The third to the sixth (*rc. 3—6*) are very dilicate arteries and occur in the first to the fourth abdominal somite, stretching between the artery and the ventral rami of the ninth to the twelfth segmental arteries. They are usually unpaired and exist either on the right or the left side only, but may be symmetrical in some cases (this is subject much to individual variation).

The last two communicating rami, the seventh and eighth (*rc. 7—8*), are both fairly strong and occur always on both sides, the former communicating with the thirteenth, and the latter with the fourteenth segmental artery. The last pair are given off from the posterior extremity of the subneural artery.

Judging from the comparison of the above-mentioned facts with accounts given by previous authors, the arterial system of the thoracico-abdominal region undergoes no important change during metamorphosis.

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EXPLANATION OF PTATES I & II.

Plate I.

Anal gland

Abbreviations

A.	anterior sac.	*m. t.*	muscles of telson.
a.	anus.	*r.*	rectum.
b.	blood-lacuna.	*P.*	posterior sac.
c.	concretion.		

Fig. 1. A horizontal section of rectal region close to anus, showing the anterior and posterior anal sac on one side with their stalks. ×50.

Fig. 2. A horizontal section of an anterior anal sac containing a large concretion. ×30.

Fig. 3. A nearly horizontal section of rectal region close to anus of a larva of the most advanced stage of development, showing two pairs of anal sacs and rectum. ×300.

Fig. 4. A part of the wall of a small anterior sac. ×400.

Fig. 5. A part of the wall of a large anterior sac. ×400.

Fig. 6. A part of the wall of another large anterior sac, showing a breach in the wall. ×400.

Fig. 7. A folded part of the wall of an anterior sac. ×400.

Fig. 8. A part of the wall of a posterior sac. ×400.

Fig. 9. Typical cells composing the wall of posterior sac. ×1000.

Fig. 10. Three stages in the formation of excretory spherule from the cells of anterior sac. ×1000.

Plate II.

Heart and arterial system

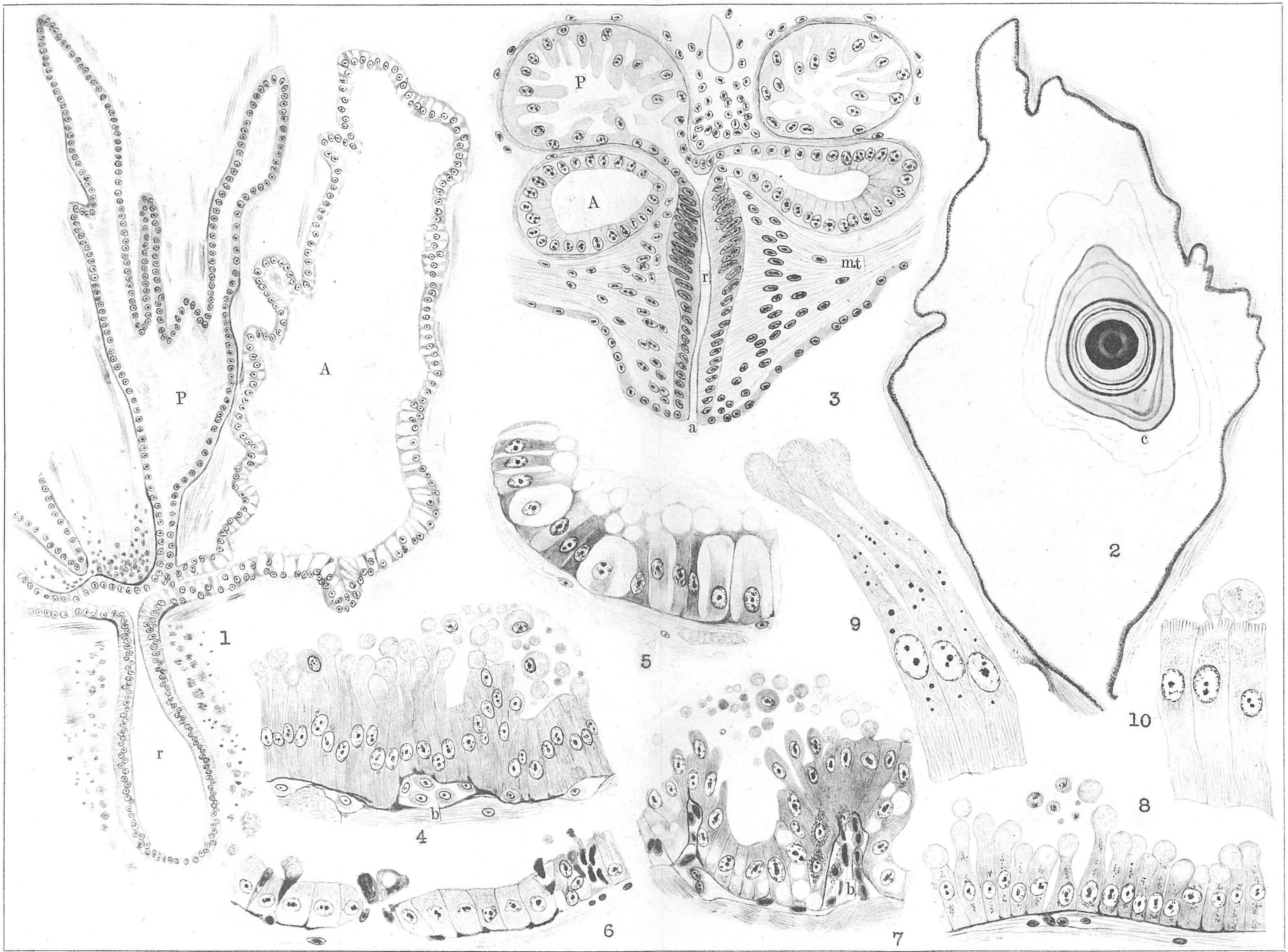
Abbreviations

al.	antennular artery.	*mx.*	maxilla.
an.	antennal artery.	*mxl.*	maxillula.
c. an.	common antennal artery.	*mxp.* 1—5.	first—fifth maxilliped.
c. ao.	cephalic aorta.	*oph.*	ophthalmic artery.
ca. ao.	caudal aorta.	*os.* 1—13.	first—thirteenth pair of ostia
cer.	cerebral artery.	*pl.* 1—5.	artery supplying first-fifth pleopod.
en.	endopodite of uropod.	*r. c.* 1—8.	first—eighth ramus communicantus.
ex.	exopodite of uropod.	*s. g.* 1—14.	first—fourteenth segmental artery.
H.	heart.		
l. c.	arteria lateralis cephalica.		
md.	mandible.		

Fig. 1. Dorsal view of entire body showing heart and arterial system. ×1.

Fig. 2. Dorso-lateral view of the head and anterior thoracic region, showing arteries. ×1.

Fig. 3. Ventral view of the thoracic and abdominal region, showing subneural artery and other arteries communicating with it. ×1.



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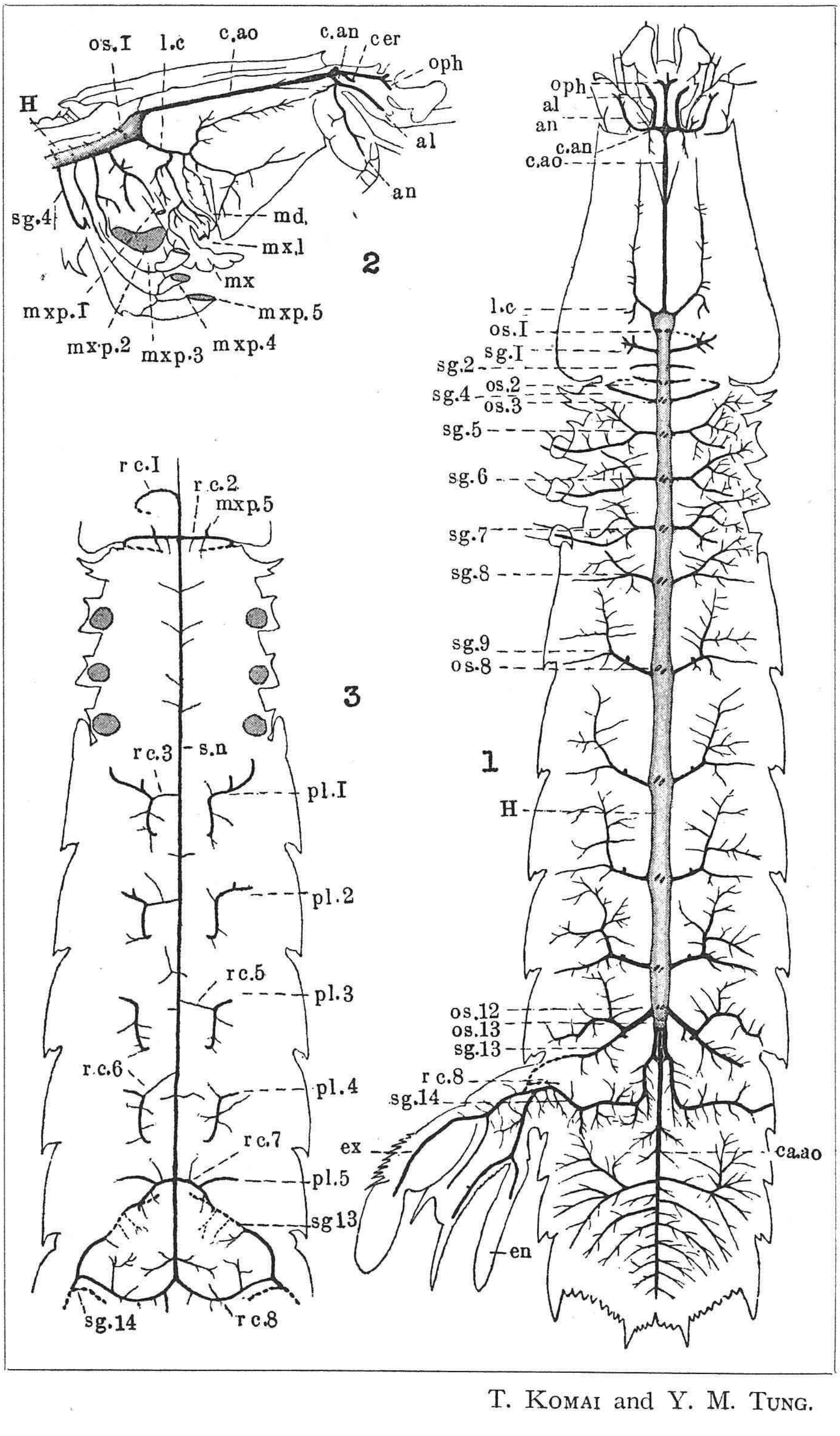

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