

XXI.—*Fragmentary Notes on the Generative Organs of some Cartilaginous Fishes.*

By JOHN DAVY, M.D., F.R.S. Lond. and Edin., &c. (Plate XXII.)

(Read 7th January 1861.)

These notes have been made at different intervals of time, and in different places,—some, and the majority of them, in Malta, in 1832–33,—some at Constantinople in 1839–40, and a few at a still earlier period, viz. in 1816, when on a voyage to Ceylon.

Imperfect and brief as many of them are, I am induced to submit them to the Society, thinking they may be of some use as conveying the results of unbiassed observation, and that, as such, they may prove a small contribution to a difficult branch of ichthyology,—difficult, not indeed so much from the nature of the subject as from the comparatively few opportunities enjoyed by naturalists of obtaining specimens.

In accordance with the heading, I may premise that, in the details to be given, I shall do little more than transcribe the account of the particulars observed, and nearly in the words employed at the time of noting them down,—and this, though the terms may not always be of the most approved and correct kind.

The only general remarks I shall have to offer will be a few in conclusion.

1. *Of the Squulus Squatina.*—The notes I have on this fish were all made in Malta. The subjects of them were two females in a gravid state, and the generative organs detached of other eight, which were procured from the fishmarket of Valetta,—the Squatina being a fish there in some request amongst the lower classes as an article of diet. I shall give them nearly in the order in which they were made, submitting a brief notice of the organs in question, conveying the idea I have been able to form of their general structure.

In most respects they are very similar to the same organs in the torpedo.* Like them, they may be said to consist chiefly of three parts: the ovaries, situated high up above the liver; of oviducts, with a common infundibulum; and of two uterine cavities, expansions as it were of the oviducts. Each oviduct has two glandular bodies, one above the other, not unlike the one belonging to the oviduct of the torpedo, but somewhat larger, and its transverse striæ more strongly marked. The uterine cavities differ from those of the torpedo, in being smooth and entirely destitute of villi. During gestation they seem to be virtually closed, so that though a probe can be passed, both in the direction of the ovaries

* See *Physiol. and Anat. Res.*, vol. i. p. 55, for an account of these organs.

upwards, and in that of the cloaca downwards, yet they are capable of holding a fluid, of which a certain quantity has always been found present, associated with the contained ova and their embryos. These cavities, at least in the early period of gestation, have been found to communicate with the cloaca by two openings close to the papilla, in which is the common passage from two urinary bladders. Whether these openings do not become one at a more advanced period, I am doubtful. The figures in Plate XXII., from rude sketches with the pen made from nature, will help to give some idea of the several parts.*

The first specimen examined was procured on the 30th August. Each uterine cavity was found to contain two ova with an embryo attached to each by an umbilical cord, † in the midst of much transparent colourless fluid, without any traces of a common enveloping membrane. The ova were large; each weighed about $2\frac{1}{4}$ oz. They consisted entirely of yolk, and, like those of the torpedo, they had two membranes, one internal, very delicate and transparent, of little more consistence than that of the albumen ovi of the fowl, but thickening towards and in the cord, the other internal and vascular. The embryos were all small, and of about the same size. ‡ The branchial filaments were very short, and of a bright red colour; the eyes large and projecting; the mouth and gullet very large; the stomach very small; the intestine large and empty; the liver large.

On the 31st of the same month another specimen was procured. Three ova, with embryos, were found in one uterine cavity; two in the other. They were nearly in the same stage of development as the preceding. One egg with its embryo weighed $3\frac{1}{2}$ oz.; the embryo, 22 grs.; another embryo, 17 grs. The former measured $\frac{1}{7}$ th inch in length, $\frac{1}{5}$ inch in width. Some yolk was found in its intestine. The branchial filaments of both were about the same length as the preceding. The other eggs were not weighed; their membranes were so delicate that they broke in the attempt. The oviducts entire, including the uterine cavities and their contents, weighed $22\frac{1}{2}$ oz.; emptied of their contents their weight was $1\frac{3}{4}$ oz. and 29 grs. Now, supposing the weight of all the five eggs to be nearly the same, the weight of the fluid in both cavities would be about $4\frac{1}{4}$ oz. The cavities differed from the preceding, in being distinctly vascular.

On the 12th September, a female fish was examined that weighed 6 lbs. An embryo was found in each uterine cavity, and attached to one of the ovaries a

* Fig. 1. The oviducts expanding into a uterine cavity. Fig. 3. Kidney and urinary bladders.

† I use this term for the sake of convenience in its ordinary sense, and not being aware of any sufficient reason for discontinuing it, seeing that it performs the same part as the umbilical cord in the mammalia, connecting the embryo with its source of nourishment: moreover, a mark remains of it, denoted by a depression, after its removal by absorption, which may be called an umbilicus. This at least I have seen in the young torpedo.—See my "Researches Physiol. and Anat.," plate vii. fig. 1., in which it is shown.

‡ See Plate XXII., fig. 2

large egg. Its membranes had been broken; but from what remained, it might be inferred to be of its full, or nearly full size, and ready, or nearly so, to be detached, and to pass into the infundibulum. Many small ova were contained in the ovaries. Both embryos were very small, with short branchial filaments. Some small tortuous vessels, conveying fluid blood, were seen on the inner surface of the uterine cavities.

On the 13th September another specimen was obtained. In each uterine cavity were two ova, with an embryo attached to each. One egg weighed $4\frac{1}{2}$ oz. and 40 grs.; the embryo 28 grs. An egg from the other cavity weighed 4 oz. 5 drs.; the embryo 26 grs.: the other egg $4\frac{1}{2}$ oz. 40 grs.; its embryo 30 grs. This embryo was $2\frac{1}{4}$ inches in length. Its branchiæ were beginning to be covered; its branchial filaments were red, and very short. No yolk-substance was found in its intestine.

On the 30th September, a specimen then procured contained an unusual number of ova, four in one cavity, three in the other. The eggs weighed, with their embryos attached, and the latter, after their separation, gave the following results:—

	Eggs and Embryo.				Embryo.	
	Oz.	Dr.			Dr.	Gr.
1. . . .	3	5	...	...	1	46
2. . . .	3	5	...	...	1	57
3. . . .	3	$6\frac{1}{2}$	...	...	1	46
4. . . .	3	$4\frac{1}{4}$	...	...	1	57
1. . . .	3	$6\frac{1}{4}$	...	...	1	50
2. . . .	3	$3\frac{1}{8}$	...	...	1	50
3. . . .	3	6	...	...	1	55

Four of the embryos were females, three were males. In most of them the branchiæ were no longer naked, and the branchial filaments had disappeared. Put into fresh water, some of them showed signs of life—a movement of their gills was perceived. The internal yolk-membrane was stronger than that of any of the preceding at an earlier stage, allowing the egg to be lifted without breaking, the thickness increasing towards the end. The internal membrane was beautifully vascular. There appeared to be two orders of vessels, their branches anastomosing, one conveying a brighter blood than the other; the vessels conveying the former smaller than those conveying the latter. The intestine of two embryos was examined; a little greenish matter, but no yolk, was found in it; yet, using the blowpipe, air passed pretty freely into it through the vitello-intestinal canal. The gills were similar to the preceding. The brain was distinctly formed; the kidneys were comparatively large; all the fins were distinct. The quantity of fluid in the uterine cavity was considerable.

In a specimen procured on the 2d November, an embryo was found in each uterine cavity. The ovum of one was broken; the other, which was entire,

weighed, with its embryo, 3 oz. $6\frac{1}{3}$ drs.; the weight of the embryo detached was 3 drs. and 11 grs. The gills were no longer naked, and they were without filaments; one embryo was opened. The substance of the egg was found passing into the intestine through a straight canal. The intestine was distended with a greenish matter, coloured by bile. The ovum presented a beautiful vascular appearance.

On the 9th of the same month another specimen was obtained. Two ova, with their embryos, were found in one uterine cavity, one only in the other. All the eggs were broken but one. It, with its embryo, weighed 3 oz. $3\frac{1}{3}$ drs.; the embryo alone weighed 1 dr. The branchial filaments were short, but distinct. The stomach was very small and empty. A little greenish matter was found in the intestine. A considerable quantity of fluid, as usual, was found in each uterine cavity, and of its ordinary appearance, clear and transparent, and colourless, and slightly saline to the taste; a portion of it evaporated yielded a considerable quantity of coagulated albumen; washed with alcohol, the solution obtained slowly evaporated, frothed at a temperature considerably below the boiling point, giving the idea of the presence of urea. When evaporated to a moderate degree of consistence, a drop of strong nitric acid was added, an immediate formation of white matter took place: this at the time I supposed to be nitrate of urea, as it dissolved on the addition of a little water, and as, when evaporated in its turn, a solid matter appeared in minute white scales, here and there giving off gas from decomposition: with these scales were intermixed a few minute prismatic crystals.

On the 8th February, the last specimen of which I have to make mention was obtained. This was a fish of about two feet in length. The oviducts, with the uterine cavities, formed a complete circle. The uterine cavities were thin, distended, and vascular, and were lined with much thick mucus or mucus-like matter. They contained each a single foetus. Each foetus was about six inches long, and appeared pretty perfect in form. The eggs were still large; one foetus was opened. A yolk-sac was found in the cavity of the abdomen, freely communicating with the outer yolk, and with the upper part of the intestine. The intestine was distended with the substance of the yolk, which in its lower portion was of an orange hue. One of the young fish was in part corroded, as if by the action of the fluid with which it was in contact: it showed no signs of putridity.

2. *Of the Squalus Galeus.*—The only notes of the generative organs of this species which I have were made in Malta, and are very brief. On the 25th January a female was procured from the market. Its uterine cavities were semi-transparent, and lined with a very vascular chorion. Each cavity contained three young fish; and each of these was included in a very delicate membrane, together with some gelatinous fluid. There was no appearance of an internal yolk; but to each

foetus was still attached the residue of the umbilical cord, still vascular; its floating extremity its thickest part. When the foetal fish were opened, an internal yolk-sac was seen in each, communicating with the upper portion of the intestine. The sac was distended with the substance of the egg, and a substance of the same kind was found in the intestine.

From one of the ureters of the parent fish a fawn-coloured matter was pressed out, semi-fluid, not unlike lithate of ammonia. With equal parts of nitric acid and water it effervesced, and frothed when heated; but it became brown, not purple. There was not sufficient for further examination. It seemed to resemble the urine of the torpedo. May it not be a peculiar kind of animal matter?

3. *Of the Squalus Acanthias.*—The notes on this fish were made in part in Malta, and in part at Constantinople. The specimens examined were eight, one only of which was a male.

This male fish was procured from the fish-market of Galata. It was about two feet and a half long. Its anal appendages were of moderate size, composed of muscles and cartilages. Each organ communicated by a canal with an abdominal sac. These sacs, situated immediately under the common integuments, one on each side of the mesial line, were lined with a smooth, very vascular membrane, and contained a little opaque fluid, consisting, as seen under the microscope, of minute granules. The canal or duct of each terminated on the inner surface of its corresponding appendage. The appendages were without the glandular body met with in these organs of the rays, but each contained what I believe to be an auxiliary heart, such as I have described as occurring in the *Raia batis*.* The proper generative organs were well developed. The testes, situated high up under the liver, were of a large size, about $3\frac{1}{2}$ inches long by $\frac{3}{4}$ inch broad, rounded at their extremities, of a pale hue, and indistinctly mammillated, as if composed of no well-marked lobules. Each was bordered by a milk-like appendix, similar to that belonging to the testes of the *Raia clavata*, of which a figure is to be found in the work just quoted. This latter part was connected with the epididymis, or commencement of the vas deferens, by several straight tubes passing across, and included, in a delicate peritoneal fold. The epididymis superiorly, was small, the vas deferens there composing it being very slender and convoluted, but not collected in a mass as in the instance of *Raia clavata*. As it descended, still tortuous, till about $2\frac{1}{2}$ inches from its termination, it suddenly enlarged and became very capacious, continuing so till it terminated in the common receptacle of the spermatic and urinary fluid—*i. e.*, that receptacle in which the ureters end as well as the vasa deferentia. The capacity of each vas deferens, when expanded, was at least equal to that of the common receptacle; each contained about half a cubic inch of a creamy-yellowish fluid. The same

* See *Physiol. and Anat. Res.*, ii. p. 451.

kind of fluid was contained in the common receptacle, but of rather thicker consistence. This fluid, microscopically examined, was found to abound in spermatozoa. They were seen also in the fluid of the vas deferens, but not in the epididymis, testis, or in its milt-like appendix. The fluid obtained from these exhibited only granules similar to those found in the like parts in the *R. clavata*, suggestive of a growth, in transition, from granules into spermatozoa. The common receptacle or bladder terminated in a rudimentary penis, projecting about one-third of an inch into the cloaca, and about half an inch from the verge of the anus. The spermatozoa, of a spiral form, extremely fine at each extremity, were very long in proportion to their breadth—at least thirty-two times longer. Their length was about $\frac{3}{8}$ of an inch.*

The female generative organs of the Acanthias have a considerable resemblance to those of the torpedo, especially in the circumstance that the uterine cavity, when gravid (and it does not appear to exist except in this stage), has a distinctly villous structure.

All the female fish examined, with the exception of one, were procured in Malta.

The fish obtained at Constantinople was got from the market on the 17th February. It was shorter than the male fish already noticed, being about two feet long, but proportionally thicker. I expected to have found it gravid, but it was not; the generative organs were little developed. The ovaries, situated high up under the liver, were each about the size of a sixpence, and each only a few lines thick. They contained a small number of ova, the largest not bigger than a peppercorn. These, cut open, yielded a little glairy fluid, which, under the microscope, exhibited globules and granules. The oviducts were very small,—so much so as to be traced with difficulty. To each of them, near the ovary, a glandular body was attached, of about half an inch in length.

On the 3d March, in a female about a foot and a half long, an egg was found in each uterine cavity. It was of a long, oval form, within a delicate transparent membrane, containing a little clear fluid.† There was no appearance of foetal development. The uterine cavity was of a bright vermilion colour, and covered with villi. The ovaries were situated nearly as in the torpedo; each was a small cluster of ova attached to the peritoneum. The oviducts joined the infundibulum over the superior margin of the liver. In each, a little higher than the uterine cavity, was a glandular structure.‡

On the 10th March two uterine cavities, which had been found gravid on opening the fish in the market at Malta, were brought to me. In each were two embryos, with the ova to which they were attached. They were free—that is, without any including shell or membrane. The lining coat of the cavity was

* Pl. XXII., fig. 4.

† See fig. 5.

‡ Fig. 6.

strongly villous; the villi projected two or three lines; the surface, moreover, was beautifully vascular, and of a bright vermilion hue. The villi appeared to be formed of looped blood-vessels. The yolks belonging to the two embryos in each cavity were somewhat different, comparing the external and internal portion; in one instance the outer yolk bag was reduced very small,—the inner had become pretty large; in another the case was the reverse,—the outer was the largest. As might have been expected, there was a correspondence in the size of the young fish: the development of that to which the smaller internal yolk belonged was farthest advanced.

It may be mentioned that one of the uterine cavities, which made a very beautiful appearance from its vessels being distended with vermilion blood, was put into distilled vinegar; and that, when examined two days after, the vessels were found to contain air, as if extricated from the blood during its partial solution.

On the 1st April two small foetal fish, each about two inches in length, attached to their ova, were procured from the market. On extraction from the parent fish they had been put into water, according to instructions given to the Maltese fisherman, and which were observed in other instances. The branchial filaments were nearly an inch long, and were numerous. The head was large, the eyes very large; distinct marks of spines were apparent anterior to the dorsal fins.

On the 15th April a fish was obtained in which several eggs were found, nearly of their full size, attached to the ovaries. In one uterine cavity there was a single foetus; in the other, two. No membrane enveloped them; they seemed nearly fully formed, and were in immediate contact with the villous surface. This was very vascular,—its colour bright red. Two of the young fish were opened. The yolk of each egg was in part internal; but the inner yolk was small in comparison with the outer, and the sac containing it was even less in size than the intestine, which was distended with yolk substance. The stomach was empty. The communication between the gut and the inner yolk sac—the vitello-intestinal canal—was sufficiently large to allow of the free passage of an ordinary surgeon's probe. The contents of the intestine were of a brighter yellow than the yolk in either the inner or outer sac.

On the 1st October, in a small fish then examined, a single foetus, tolerably advanced, destitute of branchial filaments, was found in each uterine cavity. In one of the ovaries were minute ova about the size of a millet seed; attached to the other were some that were pretty large—about the size of a boy's playing marble: their enveloping membrane was highly vascular.

On the 22d of the same month a fish was obtained about two feet long. An ovum was found in each of its uterine cavities, contained in a delicate transparent capsule, which, towards its ends, had a light olive hue and a slight horny appear-

ance. It contained a considerable quantity of white, a pretty large yolk, and an embryo about $1\frac{1}{2}$ inch long. Large vessels passed from the yolk by the cord to the embryo. About one half of the yolk's proper membrane, at each side of the cord, at its margin, was beautifully vascular. The eyes of the embryo were large; the fins very small—only just appearing on the back, the pectoral more distinct. The branchial filaments were long, and of a bright red. Besides these filaments there were others similar, proceeding from the head, its back part, and also from each side of the abdomen, in a line extending from the pectoral fin.* Each filament—the branchial are specially mentioned—on careful examination with a lens, was found to contain four blood-vessels terminating in loops.

In a fish procured on the 15th May, of about the same size as the last, two eggs were found in each uterine cavity, with an embryo attached to each. The ova and embryos were contained in one common, very delicate, and transparent shell. Each embryo was in the same stage of development; each about three-quarters of an inch long. Viewed with a magnifying glass, its eyes were distinct and proportionally large; they were almost colourless, with hardly a trace of a pupil. The mouth was proportionally large, and apparently expanded wide. It gave the idea of the jaws being formed rather than the mouth itself. The branchial cartilages were distinct. Two or three short filaments were pendant from them on each side. Close to where the umbilical cord entered was a red spot—the heart. A vessel carrying red blood extended from it to the tail, and returned. The pectoral fins were small, the dorsal only just appearing, the tail gradually tapering. An attempt was made to lay open the cavity of the abdomen, but it failed, though using a very delicate and sharp scalpel, owing to the great tenderness of the parts,—it was torn rather than cut. The cartilaginous skeleton throughout seemed to be formed. The ovaries contained ova of different sizes; the largest were about the size of large cherries, the smallest about the size of a millet seed.

Another fish, also of about the same size as the two preceding, was obtained on the 13th June. Two eggs were found in each uterine cavity, with an embryo attached to each, in about the same stage of development as the last mentioned. Besides the branchial filaments, there were two filaments proceeding from the head, just behind the spiracula,—the water passages.

4. *Of the Squalus Carcharias.*—On a voyage to Ceylon, when within the tropics, an opportunity occurred of making a hasty examination of two gravid fish of this kind. In the uterine cavity of one, designated a small shark, taken in Lat. $8^{\circ} 23' N.$, four foetal fish were found, each about a foot long, with "a placenta" attached to each. From three the placenta was immediately removed,—cut or torn off. These fish died almost instantly. The one from which it

* See Plate XXII., fig. 7.

was not removed lived in the open air at least three hours after its extraction. Its stomach and intestines were both found empty; no yolk was detected internally. No mention is made of any including capsule, seeming to warrant the inference that no membrane of the kind remained, and that the young fish were in contact with the walls of the uterine cavity.

The other shark, which was called a large one, was taken in Lat. 2° 34' N. In its uterine cavities nine foetal fish were found, five in one cavity, four in the other. Each was contained in its own membrane, full of "liquor amnii," and each was connected with "a placenta" by a long "umbilical cord." All of them were about the same size—about two feet long. When extracted and thrown on deck, they were active and vigorous. Though without advanced teeth, two or three of them were seen to make an effort to bite a stick thrust against them.*

The so-called "liquor amnii" was very salt to the taste, was slightly viscid, not quite transparent, and of a light grey colour. A few white flocculi were suspended in it. When boiled, it did not coagulate or undergo any apparent change. Evaporated, it thickened, became brown, and ultimately black from charring, when it emitted much smoke and a strong ammoniacal odour.

In the stomach and intestines of the parent fish, four different kinds of parasitical worms were observed,—two in the former, two in the latter.

5. *Of the Squalus Centrina.*—In the month of March, when at Constantinople, I procured two fish of this kind, which had been taken in the Sea of Marmora, and, it is worthy of remark, by the same cast of the net: they were male and female.

The male fish was about 2½ feet long, and rather slender. The testes † were pretty large, each nearly of the form of a date, its surface vascular, smooth, and equal. Its substance was soft; when cut it yielded some opaque fluid, which, under the microscope, was seen to abound in globules. The milt-like part superiorly was thin and small; cut into, it yielded a milky fluid, in which, under the microscope, numerous globules were seen, and one spermatozoon. The epididymis, itself small, was connected with the milt-like part by four or five delicate tubuli; these, divided under water, yielded a little milky fluid, also abounding in globules similar to those of the milt-like part. A milky fluid was also obtained from the epididymis, from its superior portion. This was rich in spermatozoa; it contained, besides, a few globular particles. The vas deferens and the vesicle in which it terminated yielded a cream-like fluid, rich also in spermatozoa. The vesicle in which, probably, the ureters also terminated (it was not ascertained by

* Other instances of a like kind might be mentioned, showing how provident Nature is in giving instincts and organs to young animals, suitable to their protection when in their feeblest state, and their lives, in consequence, most in danger. The foetus of the torpedo, even before birth, I have found capable of giving a shock. In the foetus of the viper (*Coluber berus*) I have found the poisonfangs developed. The young alligator I have seen, as soon as it left the egg—and that prematurely, from the egg being broken—make to the adjoining water, and, if stopt, attempt to bite the arresting object.

† See Plate XXII., fig. 8.

dissection), communicated with the cloaca through a papilla, the rudimentary penis. The spermatozoa were all similar. Many of them were collected in a cluster. They were all motionless in fresh water and in brine; but in salt water—that of the Bosphorus*—many of them were active. They were found to vary in length from about $\frac{1}{10}$ to $\frac{1}{5}$ of an inch. The diameter of the rounded extremity was about $\frac{1}{30}$ of an inch.† The anal appendages were large, and proportionally thick. Each communicated with a subcutaneous sac similar to that of *S. acanthias*. The cavity of each was about an inch long, and follicular. The appendages, in their general structure, were “similar to those of the rays and squali.”

In my “Researches Physiological and Anatomical,” when treating of the male organs of cartilaginous fishes, I ventured to offer the conjecture—an old opinion—that the anal appendages, the characteristic of the male fish, are designed for the purpose of intromission in the performance of the generative act, and I then quoted a passage from Aristotle to the same effect: “Sunt qui se vidisse confirmant non nulla in cartilagineis aversa modo canum terrestrium cohærere.” In examining these two fishes, I found what appeared to me to be circumstances favourable to the above supposition. In the instance of the male, the generative organs, as described, were clearly in the condition required at the breeding season. Those of the female were found to be so also. The female, about one-third larger than the male exclusive of the anal appendages, was similar to it in form and appearance. The cloaca, the common opening,—that in which the intestine and uterine cavities terminated,—was sufficiently large to admit the appendages; and it is worthy of remark, that the part was slightly lacerated at its superior commissure; also, that the mouths of the uterine cavities were protruding, and were very red and vascular. Within the cloaca, between the two uterine openings, above the opening into the intestine, was a clitoris, if I may so call a vascular conical projection, of about one-eighth of an inch in length, through which was a passage from the urinary bladder. The bladder was of a globular form, and pretty large; two ureters terminated in it, at its upper end. The ovaries contained ova of different sizes, the largest about the size of a boy's playing marble. They were enveloped in a delicate vascular membrane. Their contents were of a soft consistence, like the yolk of the egg of the common fowl, and of a light cream colour. Above the liver was situated the infundibulum of the oviducts. These ducts were thin and plicated. About two inches above the uterine cavities, on each side, was a glandular body, forming a part of the oviduct. The uterine cavities were long, wide, and capacious. Their superior opening was small, their inferior large. Their inner surface was red, and covered with villi—these about a quarter of an inch long; they were well displayed by immersion of the part in water. Both the oviducts were empty,

* This water is less salt than that of the sea—the Mediterranean and ocean—nearly the same as that of the Euxine. I have found it of sp. gr. 1012, that of the Euxine being 1011.

† See Plate XXII., fig. 9.

as were also the uterine cavities. A little fluid lubricating the latter was scraped off and subjected to the microscope; some blood corpuscles were seen in it, and minute globules, and also two spermatozoa, respecting which it is said in my notes, "I think there can be no mistake, their form being so peculiar."

6. *Of the Riva Aquila*.—Of this fish I have notes of two specimens only, both procured in Malta, and both females.

The first was procured on the 12th April. In each of its oviducts was a large membranous shell, which, independent of its horns, was about five inches long. One of them, opened, was found to contain a yolk about the size of the yolk of a hen's egg; a considerable quantity of glairy white enveloped it. The shell externally was nearly black—rough, tough, and very strong: internally it was lined with a delicate white glistening membrane. Above that part of the oviduct in which the egg was contained was a large globular body surrounding the duct, in appearance, as to structure, more like a testis than any other that at the instant I could call to mind. The lower end of the oviduct terminated in the cloaca; it was so contracted, that the little finger was introduced with difficulty. There was no appearance of development in the ova.

The second fish was obtained on the 22d September. Though quite fresh, its ovaries and oviducts were for most part reduced to a pulp, as if by a process like that which sometimes destroys the stomach, and has been referred to the action of the gastric juice. In this instance, however, the stomach was quite sound, without any traces of softening. It was of moderate size, full of *broken* food, suggesting the idea that this fish masticates its food, for which its strong, laminated molar teeth are so well adapted.

7. *Of the Squalus Canicula*.—Of this species I have notes of four, one of them a male. All were procured in Malta.

I shall first make mention of the male. It was obtained on the 11th September. Its anal appendages are merely stated to be similar in structure to those of the torpedo, the lateral anal fins uniting behind them and partly covering them. The testes were very distinct, and situated high up in the abdominal cavity; the spermatic tubes large and tortuous, terminating in vesiculæ seminales, and these in a single papilla situated in the cloaca, close to the anus. When the vesiculæ were pressed, a thick, creamy fluid was discharged, flowing from the papilla.

Of the other fishes, females, the first was obtained on the 22d April. A large cluster of eggs was situated over the spine: these of various sizes—the largest about the size of large cherries; their membrane was vascular, including a yolk. The upper part of each oviduct was also very vascular. The infundibulum was small. In the oviduct there were no ova and no enlargement. Each was provided with a glandular structure. Below the gland, where it is presumed the egg would rest and acquire its shell, the oviduct was very small and pale—not thicker than a crow quill—its sides in contact.

On the 15th of May another fish was obtained, of about a foot long. An egg was found in each of its oviducts, enclosed in a firm, hard shell,—so hard as not to be easily cut. The ovum was of a brownish hue, and was surrounded by a glairy white. No traces of development could be detected in it.

On the 28th of August two ova, each in its shell, were got from the market, said to have been extracted from the left oviduct of a catfish. Each shell was about two inches long, and about half an inch wide, tough, and yet transparent, pointed at its extremities, from both of which a strong fibre proceeded. The fibres, drawn straight—that from one end measured about a foot in length, that from the other about half a foot. The largest was in part divided into several delicate filaments.* The contained ovum, seen through the transparent shell, was situated midway. In one shell that was opened, a yellow yolk was found in a small quantity of colourless, transparent, and “very viscid white.” This “white” did not mix readily with water, and was not coagulated by nitric acid.

On the 5th September two fish were obtained, both of them gravid. The condition of the generative organs of each was similar. In each oviduct an egg was found, surrounded by white, in a semi-transparent shell. One was immersed in boiling water. The yolk became hard after having been boiled about two minutes; the white did not coagulate, nor undergo any apparent change,—it remained transparent and viscid. On each side, above that part of the oviduct holding the egg, and about an equal distance from the infundibulum, was a glandular body surrounding the tube. The infundibulum was large, and very vascular. The ovaries, joined together, lay in the direction of the spine, about half-way between the oviducts, and about the same distance from the infundibulum. In them was a cluster of ova of different sizes, connected by a loose cellular tissue. The smallest of the cluster were about the size of mustard seed, hard, and opaque; the largest were nearly the size of the mature yolk, but spherical in form. Between the largest and the smallest there were many of intermediate grades. The largest were situated lowest, and consequently most distant from the infundibulum.†

8. *Of the Scyllium Melanostomum.*—Of this fish I have notes of two, both procured at Constantinople,—a male and a female,—and both in the same month, February.

The male was about two feet long, and slender. Its testes were proportionally large,—one on each side of the spine, not distinctly divided throughout.‡ They were of a light fawn colour and soft consistence, more resembling the testes of the osseous fishes than those of the majority of the cartilaginous kind. They tapered towards the cloaca, where it may be supposed their ducts terminated. The whole seemed homogeneous. Under the microscope, their soft substance seemed

* See Plate XXII., fig. 10. † See Plate XXII., fig. 11. ‡ See Plate XXII., fig. 12.

to be composed of globules, nearly transparent, of from about $\frac{1}{1000}$ to $\frac{1}{2000}$ of an inch in diameter. Different parts of the organ were examined, without any difference of result; no capillary spermatozoa could be detected, and the globules, except when moving in currents, were motionless. The anal appendages were small. They were not specially examined as to their structure.

The female was also about two feet long, but thicker in proportion to its length than the male. At the time it was obtained, it was not quite dead.* The ovaries were large and long, extending nearly the whole length of the abdomen. Their upper portion abounded in ova, from the size of a grape seed to that of a mustard seed, and smaller. The larger were not perfectly transparent; they contained a turbid fluid, which, under the microscope, exhibited globules of about $\frac{1}{1000}$ of an inch in diameter, and smaller. The confining membrane was thick and strong. The lower portion—more than one-half of the whole—had a milt-like appearance. Under the microscope it exhibited globular nucleated particles, of about $\frac{1}{2000}$ of an inch in diameter. The oviducts were large,—their infundibulum above the liver. To each oviduct a glandular body was annexed, just below which was a little enlargement of the tube; and towards the termination of each duct in the cloaca there was also an enlargement of it.

9. *Of the Raia Oxyrhynchus.*—Of this fish I have notes of two specimens, both examined at Malta, and both females. In one, opened on the 2d April, an egg was found in each oviduct, below its gland. The shell inclosing it was not perfectly formed; its lower moiety, which was perfect, was of a greenish brown, tough and strong; its upper portion was greyish, tender, and very easily broken.† Much thick, tenacious, mucus-like matter enveloped it. There was no appearance of an embryo.

The other fish was obtained about the same time. The precise date is not given. In this instance, also, an egg was found in each oviduct. Each egg was contained in a horny shell, the horns of which were short, as if not fully formed. A tough glutinous matter, of the colour of the shell, was found covering it, seemingly the material of which it was formed. The oviducts were red; their glandular structure large. The ovaries contained many ova; and there were several eggs loosely attached to the ovaries. They were of a spherical form,—the largest about the size of the yolk of a pigeon's egg.

In conclusion, recurring to the preceding notes, it is worthy of remark, that whilst there is a certain resemblance to be seen in the generative organs of the several species, there are also well-marked differences—differences which, it may be inferred, have relation to foetal development. Under this head, do not the observations justify at least three divisions? 1st, The viviparous fish, of which the Squatina is an example, an instance, like that of the torpedo, of the ovum

* See Plate XXII., fig. 12.

† See Plate XXII., fig. 13.

passing into the uterine cavity, and there undergoing its full development, unclosed in any shell or membrane. *2dly*, The ovo-viviparous fish, such as the *S. acanthias*, *S. galeus*, and probably *S. carcharias*, the ova of which, enveloped in a glairy white and contained in a delicate membrane, undergo their development in the same cavity. *3dly*, The oviparous fish, such as the *S. canicula*, *R. aquila*, the ova of which, provided with a horny shell the matter of which is secreted by one or more glands, are expelled from the oviducts before their development begins, and are hatched in the sea.

As regards the first division, are not the ova fully formed in the ovaries, and undergo no further increase of size after entering the oviducts? Also, as regards the foetus, is not its growth in the uterine cavity not solely due to matter derived from the yolk, but in part to matter absorbed from the cavity itself? I am induced to suppose that this is the fact, from the analogy of the foetal torpedo, which, at its full time of birth, I have found to be very much heavier than the egg;* and also from the circumstance that the uterine cavity, as I have seen both in the instance of the Torpedo and of the Squatina, has become much thinner as the period of gestation advanced and approached its maturity, comparing it with the average of the organ earlier.

As regards the second, is not the common including membrane or capsule of the ovum and embryo found in the uterine cavity as a temporary provisional membrane? and is it not absorbed, in part or in whole, before the young fish quit the uterine cavity? Some of the appearances described under the head of *S. acanthias* and *S. carcharias* seem difficult of explanation except on this idea. The absorption of the membrane, whilst it may conduce to the exit of the young, may aid also their growth.

Further, are not what I have called "placentæ"—the cotyledons of MULLER—residual masses of vitelline vessels,—residuary after the absorption of the yolk,—the view long ago entertained by a distinguished naturalist?† and, though different from true placenta, yet do they not exercise a similar function, supposing, as I believe was the case, that in the instance of the young of the Carcharias there was an active circulation in the mass, owing to which the foetus that had not the vascular mass detached from it lived so long?

As regards the third, are not the ova of these fish all hatched in the sea, their development altogether taking place after being laid? That they are, I have been led to believe, not so much from my own limited observations of a negative kind, never having, in the examination of the eggs whilst in the oviducts, seen any

* See *Physiol. and Anat. Res.*, vol. i. p. 65.

† See *Hist. Nat. des Poissons*, par MM. Cuvier et Valenciennes. The remains of the vitellus is described by the former (inferring that the first volume was written by Cuvier) as adhering to the uterus almost as firmly as a placenta. This I have never witnessed; nor have I ever witnessed, till at an advanced period, the interior lobe of the vitellus, which is described by him as always existing in the foetus,—“comme un appendice de l'intestin.”—See *loc. cit.*

traces of embryonic growth, as from the experience of the Maltese fishermen, who, in opening hundreds of the species, I have been assured, have never found a young fish included.

The branchial filaments of the embryo of the cartilaginous fish have commonly been considered as concerned solely in aërating the blood of the young fish. Have they not another use also?—are they not concerned, in a formative way, in promoting the growth of the part to which they belong? The circumstances that they are absorbed about the time that the gills become covered,—*i. e.*, cease to be naked,—and that they are not always restricted to the branchia, seem to favour an affirmative answer.

As to the use of the anal appendages of the male cartilaginous fishes, respecting which there has been so much difference of opinion amongst naturalists,—some, as RONDELET, WILLOUGHBY, RAY, ARTEDI, MACRI, DE BLAINVILLE, following ARISTOTLE in the opinion that they are penes, organs of intromission; others, as BLOCH, HOME, CUVIER, and most recent writers, maintaining that they are merely holders, “claspers,” and in the generative act employed solely to embrace and retain the female,—I have been led to prefer the older view mainly from the consideration of the structure of the parts, seemingly so ill adapted for the use last referred to, especially keeping in mind the glands with which they are furnished. Which of the two hypotheses is the correct one, can only be determined by further and careful observation. The fact I have mentioned under the head of *S. centrina* must be admitted, I think, to favour most the old opinion. Theoretical arguments might be used in support of the same; but these, at best, cannot compel conviction.*

LESKEETH HOW, AMBLESIDE,
Sept. 22, 1860.

* MACRI, in *Atti della Reale Accademia Scienze* (of Naples), vol. i, uses a very ingenious argument of the kind above alluded to: “In natura osservi una legge costante ed invariabile, stabilita dall’onnipotente, che quando gli animali maschi son corredati d’una sola verga, le lor femmine hanno eziando una sola vulva ed un sol utero. E all’opposto, dove le medesime son provvedute di due vulve, o d’una bifurca, e die due uteri, o d’un uteri bifido, posseggno i maschi o una verga bifida o un doppio membro generatore” (p. 83).

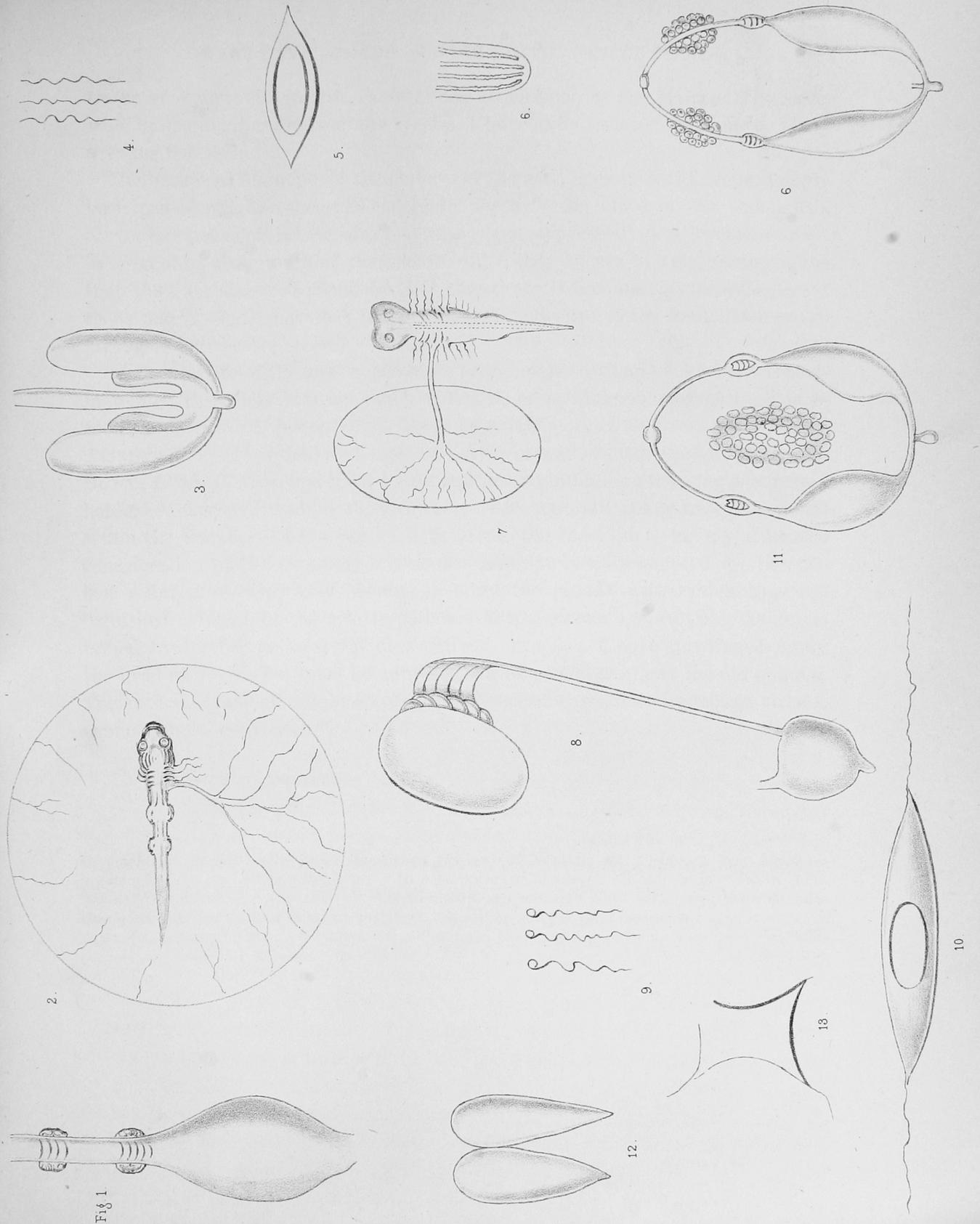


Fig 1