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To cite this article: Dr. Mitchill (1803) XLVI. Memoir on some peculiarities in the anatomy and physiology of the shark, particularly respecting the production of its young , Philosophical Magazine Series 1, 15:59, 264-268, DOI: [10.1080/14786440308676268](https://doi.org/10.1080/14786440308676268)

To link to this article: <http://dx.doi.org/10.1080/14786440308676268>



Published online: 18 May 2009.



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XLVI. *Memoir on some Peculiarities in the Anatomy and Physiology of the Shark, particularly respecting the Production of its Young.* By Dr. MITCHILL, of New York*.

ALTHOUGH the generation and multiplication of animals have so long exercised the attention of philosophers, the whole subject remains involved in intricacy and indistinctness. The maxim laid down by Harvey, and adopted by Linnæus, of *omne animal ex ovo*, that every animal proceeds from an egg, has, perhaps, been too generally received, since numerous facts, related by Mr. Bonnet, in his work entitled *Considérations sur les Corps Organisés*, evince the propagation of animals, in a great variety of cases, from germs. Notwithstanding the multiplicative powers of animals have been thus traced to eggs and germs, yet a popular distinction still prevails to a considerable extent, of classing animals that propagate their species by means of genital organs, into oviparous and viviparous.

The great discovery of Haller, that the membrane covering the yolk of an egg was really a continuation of the membrane covering the intestines of the chick, had not only given countenance to the idea of the pre-existence of the embryo, but has shown that animals, whether of the oviparous or viviparous kinds, really propagated their species in pretty much the same way.

Amidst the different modes in which the embryo and its membranes are organized in different animals, there seems to be one case which has not been hitherto described with the accuracy and minuteness which its singularity deserves: the genus of the squalus, which includes all the animals of the shark tribe, has some peculiarities which make these animals approach both to the oviparous and viviparous classes, without, however, belonging strictly to either.

It had been known a long time, that the young of the shark had something in their structure considerably different from any other creatures, and figures of them have been given by Edwards in his Natural History, and probably copied from thence into the Encyclopædia; but there has not been, as yet, any dissection of these animals in this period of their existence, nor any explanation of their physiology that I know of. It is the object of this short memoir to explain the structure and functions of the fœtus of a species of shark found frequently along the coast of New-York, in the waters of the Atlantic, during the summer months. About two years

* Communicated by the Author.

ago, as I was engaged in a fishing party in one of the bays on the south side of Long Island, a shark, between four and five feet in length, was taken in the seine, and secured in our boat, without receiving any material injury. Upon examination, this animal was found to be a female, whose uterus contained eleven young ones, of the size and figure represented in the plate.

Besides these young ones that had advanced thus far in their growth, there were contained a large number of ova within the body of this fish, in different degrees of evolution and size, some of them resembling the full grown eggs of the tortoise, and others similar to the smaller rudiments of eggs found in the ovaria of laying hens. On opening the uterus with a knife, the young fishes, as represented in the figure, were found each connected with an egg, dependent from that part of the belly which may be considered as the umbilicus, and appearing in the form of a very large hernia. This hernia, on examination, proved to be a true ovum, filled with yolky substance, evidently intended for its nourishment: and what was very remarkable, the young animal, though grown to a considerable size, and connected in this manner with its egg, had no connection whatever by means of an umbilical cord, a placenta, or by vessels of any kind, to the uterus of its dam; but it was so completely organized as to derive no sustenance to its body, nor to receive any renovation of its blood from its parent.

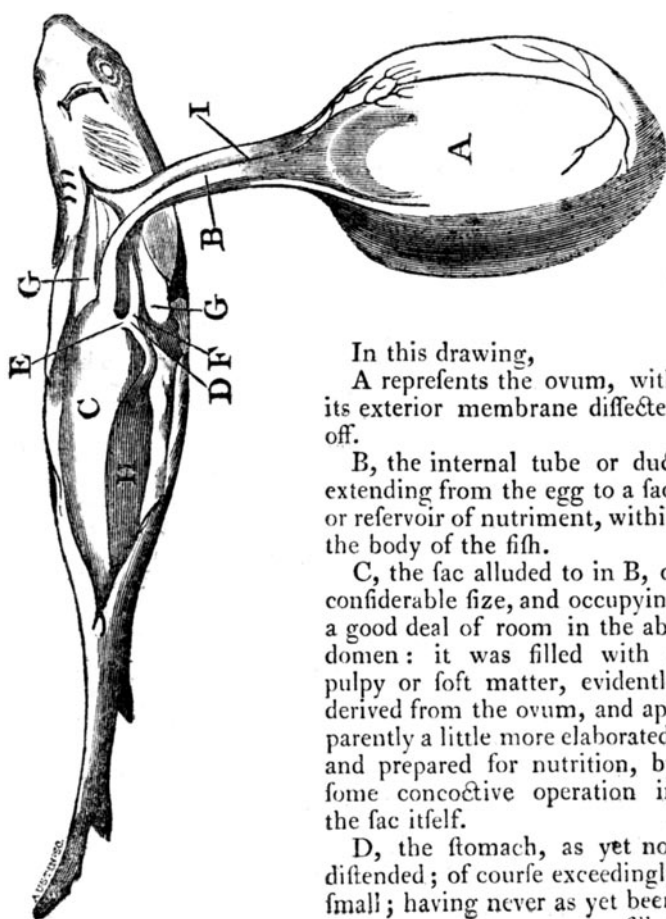
The membrane covering the egg contained most beautiful ramifications of blood-vessels. The arteries descending from the little fish could be seen sending off their branches over its whole exterior surface; and terminating in veins, to unite their trunks, and carry back their contents.

The singularity of all these appearances was considerably heightened by the capability of the little sharks, when cut out of the uterus, to live for a considerable time in the open air. The larger part of the brood had been left on the grass of the shore where the dam had been dissected; but the three which I reserved for examination lived, and exhibited, during the greater part of the time, brisk motion for almost two hours, although exposed to the temperature of a common atmosphere. During this time, while they lay before me on a plate, nothing of the kind appeared more beautiful or distinct than the branches of blood-vessels shooting through and running over the transparent membrane of the egg, the blood evidently appearing to acquire a brighter scarlet colour, whilst the fish was thus exposed to the air, than it had possessed during the immersion of the young animal in the fluid of the uterus. It seemed to have acquired more rapidly, and

to

to a greater quantity than before exclusion from its maternal membrane, the oxygen of the air to which it was exposed; the union of which with the blood evidently brightened its colour, and imparted to it at the same time so much of a stimulant quality as to have shortened the duration of its life by excessive excitement.

The internal structure of the fœtus of this shark may be seen in the plate. The dissection was made by my colleague Mr. Post, professor of anatomy in Columbia College; and the drawing was executed, immediately after, by Dr. Alexander Anderson, of New York, in the presence of the late Dr. Elihu H. Smith, Mr. William Dunlap, and Mr. Thorne.



In this drawing,

A represents the ovum, with its exterior membrane dissected off.

B, the internal tube or duct extending from the egg to a sac, or reservoir of nutriment, within the body of the fish.

C, the sac alluded to in B, of considerable size, and occupying a good deal of room in the abdomen: it was filled with a pulpy or soft matter, evidently derived from the ovum, and apparently a little more elaborated, and prepared for nutrition, by some concoctive operation in the sac itself.

D, the stomach, as yet not distended; of course exceedingly small; having never as yet been filled

filled with food derived from the mouth. In the plate will be seen a small passage or opening,

E, through which the alimentary matter in the sac, C, passes into the stomach, to be absorbed afterward by the lacteals of the intestines.

F, the œsophagus, of nearly the same size with the stomach.

GG, the two lobes of the liver.

H, the cloaca, or gut stretching towards the anus, and filled with the refuse matter of the alimentary mass.

I, the external membrane connecting the egg with the fish, cut through and turned back.

A species of shark, called *catulus major vulgaris*, is delineated by Edwards, but appears to be different from this. He has taken two views of the parent animal, and two more of the young. From the figures there given, it would seem that the same law of generation obtained as in this species. All the species probably breed in the same way.

There is a great variety in the multiplicative process of living beings. The female *rana pipa*, or Surinam frog, nourishes its young in certain cells or cavities in her back, and not in the womb. The *opossum* of this country supports her young appendant to the teats within the paunch or sac, called a false belly. The *kangaroo* of New Holland has somewhat of a similar structure and œconomy. More extensive and penetrating inquiries show the exceptions to the common mode of generation to be almost indefinitely curious and diversified. We see no end to the variety of ways in which the perpetuation of the species is carried on. Even Spallanzani (5 *Viaggi alle due Sicilie*, &c. p. 46), though he went to the lake of Orbitello on purpose to examine the anatomy of the large eels which live there, could discover in them no appearance of sex.

When I published my Inaugural Dissertation in 1786, *Circa novi Genituram Animalis*, I was decidedly in favour of the hypothesis of pre-existent germs, and of the production of animals by their gradual evolution. All my numerous experiments on generation appeared at that time to lead to such a conclusion, though I have since had a good deal of reason to doubt the soundness of the inference; and the experiment now to be related, though it throws light on some part of the process, leaves the main question almost as unsettled as ever. In 1789 I ordered a large sow to be killed, immediately after having had intercourse with a male. On examining the genital organs, the blood-vessels of the vagina, uterus, fallopian tubes, and fimbriæ, were more than usually distended,

distended, and the fimbriæ in particular were in a condition of high redness and inflammation. Their fibres were lengthened, and reached so far as, on one side, to embrace the whole ovarium, and contain it within their inclosure. But the most remarkable appearances were in the ovarium itself. The sow had borne pigs before. Some of the ova were of course exhausted of their powers, and exhibited the appearance common in such cases. The whole ovarium was tinged with blood, and appeared to have been under the operation of a powerful stimulus. The entire substance seemed to have been enlarged. The ova partook of this enlargement, and all of them had evidently shared in the excitement and suffusion. Some of them were but little swelled: some were so tumid as to be on the point of bursting: the membrane of others was ruptured, and the contents partly protruded; and, in several, the substance discharged from the broken ovum was fairly within the grasp of the fimbriæ. I imagined now I had before me proof sufficient to determine the derivation of the fœtus from the mother. I accordingly examined the portions of substance discharged from one ovum, and extracted from others, with all possible care. But instead of finding an embryo, or any thing like the rudiment of a young animal, the little masses I had obtained resembled coagulated blood more than any thing to which I can compare them, and appeared to have no more of organization or figure than is frequently seen in grumes or clots of that fluid.

XLVII. *On the Management and Improvement, by Tillage, of old Grass Lands on a direct Clay, such as is found in the Wilds of Surrey and Sussex*.*

THE substratum to this soil being impervious to water, the surface must consequently be continually saturated with moisture. Many landlords on such soils restrict their tenants, by covenants, not to till or plough up the old grass lands, under an apprehension of the soil being exhausted by tillage and cropping. In this unproductive state the land lets for from five shillings to seven shillings and sixpence an acre; and, being always full of stagnant water, the produce consists of poisonous weeds, water quitch, and a little four grass. Two acres will keep one head of lean cattle alive for:

* From Mr. Close's Paper in the Communications to the Board of Agriculture, vol. iii. part 1. We gave a former part of this paper in our last Number, p. 167.