THE LANCET.

MDCCCXXXIII—XXXIV.

IN TWO VOLUMES.

VOL. II.

EDITED BY

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SURGEON.

LONDON:

PRINTED FOR THE EDITOR,

BY MILLS, JOWETT, AND MILLS, BOLT-COURT, FLEET-STREET.

MDCCCXXXIV.

resemble the decayed leaves, or the light of the setting sun, or the sandy plains on which they lie in watch for their prey. I have found the spotted skin and the spotted fleece already obvious in the axis-deer dissected from the uterus. The metallic lustre, so rare in quadrupeds, is splendid in the chrysochloris. The hairs of quadrupeds are deciduous, like the plumage of birds; when their growth is completed and terminated, their bulb and their pulp are absorbed, their colour fades, they shrink and fall from the skin.

Such are the forms of the tegumentary organs appropriated to the different classes of animals, and such are the various systems of organs which are assigned to animals for their individual nutrition, and to establish their relations with surrounding nature.

LECTURE LV.

ON THE GENERATIVE SYSTEM IN THE RADIATED OR CYCLO-NEUROSE CLASSES.

THE organs of nutrition and of relation, which we have been hitherto considering, enable the individuals of species, for a limited time, to live, to grow, and to feel; but while myriads of individuals appear and disappear, like passing shadows in rapid succession, the species, or the typical forms of groups of animals, are still prolonged on the earth. The species, however, like the individuals which compose them, have also their limits of duration. The life of animals exhibits a continued series of changes, which occupy so short a period, that we can generally trace their entire order of succession, and perceive the whole chain of their metamorphoses. But the metamorphoses of species proceed so slowly with regard to us, that we can neither perceive their origin, their maturity, nor their decay, and we ascribe to them a kind of perpetuity on the earth. A slight inspection of the organic relicts deposited in the crust of the globe, shows that the forms of species, and the whole zoology of our planet, have been constantly changing, and that the organic kingdoms, like the surface they inhabit, have been gradually developed from a simpler state to their present condition. These slow changes are regulated by the laws which preserve individual forms, and check the transmission, by generation, of modifications suddenly induced. Although no animal can exactly produce its like, the progeny are so nearly such, that, for all the purposes of science, we regard their forms as identical with those of the parent, and out of an indefinite series of such generations, and of individuals as nearly resembling them, we frame our organic species, and ascribe them to nature. All forms of matter appear to have a capability and a tendency to become organized, as all organic forms tend to higher stages of development, and chemical analysis shows the highest as well as the lowest forms of organic beings to consist of a complicated aggregate of mineral gases and liquids and solids. These organized aggregates once formed from their elements, all possess alike the means of transmitting their forms by generation, which is effected by the separation of a portion of their substance, when their own development is completed. But although this function is the most universal in organized beings, and often requires a complicated system of organs for its performance, we observe the lowest tribes of animals to possess the means of continuing their race without a trace of distinct generative organs. In the polygastric animalcules we commonly observe the simplest mode of generation, where the parent body spontaneously divides, and each portion assumes the form of the entire animal. This *fissiparous* mode of generation gradually leads to the *gemmiparous*, which is common to most of the higher radiated classes, and in which distinct portions are developed from the body of the parent, which become detached, and assume the entire form. In most of the higher classes, from the radiata to the mammalia, the generation is *oviparous*, where the germs before their evolution are detached from the parent body, surrounded with membranes, and enclosed in a sac of nutritious matter provided for their development in the embryo state. In the *viviparous* mammalia the ovum is early hatched within the body, and the embryo advances to a higher stage of development, by again becoming organically connected with the parent, before it is finally detached to assume an independent existence. All these forms, however, are but different stages of the development of the embryo before its final separation from the parent, and they severally accord with the condition of the organization of the parent body, and with the situation it occupies in the scale of beings.

In the most dissimilar forms of polygastric animalcules, the fissiparous mode of generation is distinctly perceived, and it often takes place in species which are also capable of producing by the development and separation of gemmules. The division of the body most frequently takes place in a transverse direction, often in a longitudinal, and in some species we

observe the body to divide at one time transversely, and at another in a longitudinal direction. They divide only when they have attained their mature dimensions, and with greater quickness and frequency the more they are nourished. When the division is about to take place in a transverse direction, the whole body lengthens, a transparency is observed across the middle, as if by the preparatory division of the stomach and parts within; and at length an indentation or contraction is perceived at each end of the transverse transparent line. The contraction extending inwards around the middle of the body, the animal appears as if composed of two smaller individuals of the same form, united end to end. The point of attachment continues to diminish till the two distinctly formed though smaller animalcules become detached, and no distinction of form or size can be perceived between them. Before their final separation I have several times observed both kolpodæ and trichodæ moving rapidly to and fro through the most crowded part of the fluid, and among the loose particles of mucous or other matters lying at the bottom, as if they sought to aid their separation by impinging against the surrounding objects. This is the common mode of generation in the *trichoda*, *cyclidium*, *kolpoda*, *kerona*, *enchelys*, and all the simpler monadine forms of animalcules. Several of the *kolpodæ* and *trichodæ* however, are observed at times to expand transversely, and to divide in a longitudinal direction, by the same process which at other times they exhibit in a transverse direction. The division in a longitudinal direction proceeds generally from one extremity of the body to the other, sometimes from the posterior and sometimes from the anterior extremity, to the opposite end. The *vorticellæ* are observed to divide in this longitudinal direction, from before backwards; their bell-shaped body expands transversely, their doubly-ciliated circular free extremity divides into two, the division extends through the body to the peduncle, and the bell-shaped portions, when completed, escape from their base, leaving the peduncle to perish. This fissiparous generation, common in animalcules, was considered by Lamarck and others to be incompatible with the existence of internal organs, and was employed as an argument in favour of their internal homogeneous composition, and their nourishment by superficial absorption.

Many of the polygastrica are capable of a gemmiparous mode of generation, and the reproductive gemmules are sometimes developed internally, and sometimes on their outer surface. In the *volvox*, the gemmules are developed from the internal surface, and escape by an aperture from the parent sac, when they become free, and have attained the condition of structure necessary for their independent existence. We can often perceive generation within generation in these animals, by looking through their transparent parietes. The *vorticellæ*, *keronæ*, and other genera, are observed sometimes to produce small gemmules from the exterior surface of one end of their body, the anterior in the kerona, and the posterior in the vorticella, and these gemmules, gradually increasing in size, and acquiring the form of the parent, become detached from its body and assume an independent existence. Baker, Gleichen, Ehrenberg, and others, consider the polygastric animalcules as capable also of a true oviparous mode of generation, and you will observe in these figures of Ehrenberg the *kolpoda cucullus* represented as in the act of expelling from the anal orifice a mass of ova enveloped in a fine reticulate substance. Where individuals of known species are seen with dimensions smaller than those commonly produced by the fissiparous or the gemmiparous modes of generation, that distinguished naturalist considers them as having been developed or hatched from ova, as we see the young developed in rotifera and higher classes, and he regards the minutely granulated appearance of the interior parietes which we perceive in the *kolpoda*, *paramecium*, and other large animalcules, as produced by their reticulate ovaria distributed around that part of the body. Some of the larger animalcules have been kept isolated for five or six days without dividing or producing in any other way, and then have divided twice or thrice in one night. From the rapidity of the successive divisions of the body observed in the polygastrica, it is computed that one individual in seven consecutive days might produce a million by this mode of generation alone—a fertility surpassing that of all other known organized beings.

The poriferous animals present an internal gemmiparous mode of generation in all the species in which this function has been examined. The gemmules are developed in the deeper parts of the parenchymatous or soft cellular substance of the body, between the parietes of the internal canals. In the species of our own coasts, the gemmules make their appearance in the earlier part of the winter, when the cellular or gelatinous matter is also most abundant throughout the whole animal. These reproductive bodies at first appear as minute opaque yellow points irregularly distributed in groups at a dis-

tance from the porous and absorbent surface of the body. As their development proceeds, they increase in number, they become larger, more opaque, more consistent, of a livelier yellow colour, and from being minute round points, they assume a more regular ovate form. In about two months after they are first perceptible, the greater part of the gemmules have completed their ovate form; they are detached from their connexion with the cellular tissue of the parent animal, and they are quite perceptible to the naked eye, being about the fifth of a line in length, and the tenth of a line in breadth. These ovate portions of the gelatinous substance of the parent are ciliated over their whole surface, excepting over their posterior tapering extremity, and when we examine them, before their maturity, in sections of the animal, we observe them attached, by this tapering unciliated portion, to the internal parietes of the deeper canals, while their ciliated portion is free. Those little reproductive bodies, at first of a round form, more pellucid, and almost gelatinous in their texture, assume gradually this consistence and ovate shape as they advance to maturity, and they are seen to communicate with the interior of the canals that ramify through the body. They are seen protruding from the gelatinous parietes of those internal canals into their interior cavity, and upon directing the microscope to their wider rounded surface, which is free, that exterior surface of the still undetached gemmules is seen to be covered over with cilia that are in constant rapid vibration. Thus these gemmules assist in their own separation and final expulsion from the parent, as in zoophytes. The rapid action of those cilia tends to pull them from the surface, to lengthen their form, to aerate and develop their structure, and to disengage themselves altogether; the streams that are constantly rushing in through the pores, and out from the vents, carry away from the interior and from the surface of the parent, the reproductive gemmules destined to continue the race. The soft gelatinous moving gemmules of the porifera, when newly detached from the body, are found, in the common halina panicea of our coasts, to contain already siliceous spicula developed within their interior. They continue, after their expulsion, to move to and fro in the water by the rapid vibrations of their cilia for a limited time, when they at length fix themselves in the position best suited for their future development, and which is peculiar to each species; some, with prominent papillæ, growing best upon a perpendicular or an inclined surface, some, without papillæ, upon the under surface of oblique or overhanging rocks; and some, with delicate branches, hanging from the lower surface of an inclined plane. The whole surface of the body in those reproductive gemmules is not, as in those of zoophytes, covered over with vibratile cilia; it is covered with cilia over all the anterior part to about one-third from the tapering posterior extremity; and in watching them beginning to fix on watch glasses, under the microscope, we find that a part of the unciliated surface first touches and fixes on the watch-glass, when the whole of the gemmule spreads itself out on the glass, and grows in the form of a flat motionless film. When it is thus fixed by its tapering extremity, and beginning to spread out, the cilia are still observed continuing for a short time to vibrate, and they now clear away by their rapid action the particles of loose or floating dust at the bottom of the glass, on the surface upon which they have to spread and to grow. When they have spread out into a flat extended transparent film, we can see the gradual appearance of newly-formed spicula, both in the central cellular tissue of the body, and in the more transparent homogeneous margin of the growing animal. Those spicula appear suddenly in their places, at once fully formed, and are not at first seen as small fibres that increase by the gradual addition of matter around their circumference —those minute crystalline spicula that form the skeletons of most of the poriferous animals. Those crystalline bodies have a definite arrangement in the developing body, which is not perceptible at first, when they are few and isolated; but when the pores make their appearance, and the fecal orifices become visible on the surface, all manifest a perfect harmony of arrangement; all that at first appeared to be thrown zig-zag in confusion through the gelatinous growing membrane, at length manifest great symmetry and method in their distribution, with relation to the pores, canals, and orifices. The gemmules, while free and swimming by the spontaneous movements of their cilia, appear to be sensitive to light, as they are observed to accumulate and fix chiefly on the dark or shaded parts of the vessels in which they are placed, and they are probably guided by the influence of light to the most proper situation for the different species to adhere to and to grow. They present no external aperture nor internal cavities while they are in this free condition of infusoria, their motions are equal, smooth, and gliding through the water, and they appear to be conscious of each other's presence, when they approach

near to each other in swimming, as they are sometimes observed in such circumstances to arrest their course and to swim for a short time round each other. They appear, by their constant gliding motions, to seek for a suitable place for their future development; but we cannot detect, nor even conceive, those mysterious laws by which their movements are so wisely regulated.

The zoophytes, like the porifera, are gemmiparous animals, but they present a great variety of distinct forms of this mode of generation. They present no distinction of sex, they are all productive, all female, like the other radiated classes, and like all the so-named hermaphrodite invertebrata. Some develop the gemmules externally, in others they are produced within the body of the parent; but whether the reproductive bodies are developed on the surface or in the interior, they are still sac-less portions, or naked embryos, detached from the parent, in a condition capable of gradually assuming its form, or after they have already acquired it. The simplest external form of gemmiparous generation is presented to us in the common fresh-water polype or *hydra*, which abounds in our stagnant ponds, and in similar situations in most parts of the globe. That isolated polypus, or simple digestive sac, with a variable number of prehensile arms extended from around the orifice, shoots out little buds from the middle of its exterior surface. Those minute fleshy buds extend, and at length form the same kind of hollow sac, and from around its margin small arms begin to bud out; and so a distinct new being, like the parent body, is developed, and remains for a limited time in connexion with the surface. Sometimes this bud is detached in the undeveloped condition of a round globule in the *hydra*. The animal is also capable of dividing its body transversely into two beings, like the fissiparous polygastrica. The newly-developed generation of external buds will sometimes be observed to develop a second generation from their surface, before they themselves are detached, as we see developed within the body of the volvox among the animalcules. I have observed the little *hydra* tear itself from the parent body while in a glass of fresh water. The parent animal attached to the side was moving towards the lighted side of the vessel—their accustomed movement—one of the young already developed, and still attached to the surface of the parent, fixed its little mouth to the surface of the glass, the parent body continuing on its march, by fixing alternately its caudal and its oral disk, like a leech creeping on the same surface; the young and the parent pulled in different directions, and thus the two were torn asunder; the little one continued its motions, and was now compelled to provide for itself. We observe thus, frequently, several generations of those little hydræ all united together, and forming a ramified fleshy aggregate of simple hydræ, like ramified vorticellæ. This simple mode of external gemmiparous generation is found to take place in the hydra, whether you turn it outside in, or leave it with its surfaces in their ordinary position. If you turn it outside in, when the animal is thus inverted, the digestive becomes the generative surface, and what was before the generative surface now becomes the digestive. These remarkable properties show the extreme simplicity of the whole organization, where all portions of those animals possess the same properties, and are capable of exhibiting the same vital phenomena. You can almost mince to atoms this simple digestive sac, composing the hydra, without destroying its vital properties, and its remarkable powers of reproduction. In the actinia the gemmules are developed within the body, and I have often dissected them out, completely formed, from the body of the small *actinia rufa*. They were almost colourless and transparent, and had four or five tentacula already developed.

A more complex form of gemmiparous generation is seen in those ramified horny tubular zoophytes, where the fleshy substance of the animal is contained in the interior of the horny texture, as in *sertulariæ*, *plumulariæ*, campanulariæ. At certain determinate points of the body, different but constant in each species, we observe, gradually protruded and developed in a soft condition, small and variously formed gemmiferous *vesicles*. In campanularia the gemmules are developed in capsules within the usual vesicles. Those vesicles sometimes come out from the axillæ or points of junction of the branches, and sometimes they are developed in the course of the branches, along with the cells of the polypi. They are at first soft, transparent, thin, and short sacs, with their horny exterior not yet consolidated; and a softer internal membrane, lining the whole, is filled with a thin colourless gelatinous substance which communicates with the fleshy part of the body. In the interior, at the bottom of this gemmiferous vesicle, the soft transparent cellular tissue soon assumes a more condensed appearance, and something is seen to be developing from that part of the vesicle next to the general fleshy portion of the animal from which it is always developed.

This organized portion at the bottom of

the vesicle extends upwards, carrying with it a narrow portion, like a chord, into the middle of the interior of the vesicle, and then the little gelatinous gemmules appear to be connected with the base of the vesicle by fleshy chords, called by Mr. ELLIS umbilical chords. This connexion they keep up with the fleshy substance occupying the interior of all the ramifications until they are fully developed, until they have acquired their entire form, and have their minute vibratile cilia developed upon their surface; then the connexion is absorbed and lost, the fleshy substance composing the umbilical chords disappears, the gemmules, arrived at maturity, now move freely, by their vibratile cilia, in the interior of the vesicles, and the vesicle itself undergoes a change by which it is prepared for their escape. We observe that by the rapid and spontaneous action of the little vibratile cilia disposed around the surface of the reproductive gemmules, that they are prepared, by their own locomotive powers, to escape from the vesicle without the aid of any peristaltic or other motion from that capsule, which such a dense horny texture could not produce. The birth of these gemmules is their own act, and not the act of the parent; it is a beautiful provision in the inert bodies of zoophytes, which could not assist in the expulsion of the gemmules.

You observe that the capsule which contains the gemmules is closed at the free extremity by a transparent covering or operculum, which at length drops off, as in the oviferous capsules of gasteropods, and the passage is left freely open to the ingress of the water when the gemmules are matured; they feel the new stimulus of the external element, they are excited to more lively actions, their texture is condensed, they become perfected for their future motions, they escape from the vesicle, and swim about freely in the water by the rapid motions of their cilia, for a time; then they fix and develop, like the gemmules which have escaped from the orifices of porifera. The oviferous vesicle thus deprived of all its original contents, sometimes develops a polypus, but generally it is absorbed at its base, its connexion with the parent zoophyte is dissolved, it falls off, and leaves not a trace behind. So that those vesicles, like the seeds of plants, are deciduous parts, which here make their appearance at stated seasons of the year, generally in the spring on our coasts, and their forms are so different in the different species, that they afford useful zoological characters for their determination.

The *gemmules* are minute, round, soft, and highly organized ciliated gelatinous bodies in these tubular keratophytes. They move slowly to and fro, like animalcules, with, apparently, the design of sentient beings. They are here highly irritable; if they touch a particle of sand, or a fibre of any substance in their way, their bodies suddenly contract into a pyriform, or ovoidal, or some other shape. I speak now of the irritability of the swimming gemmules of the tubular polypifera; that phenomenon has not been witnessed in the ciliated gemmules of any poriferous animal. Those ciliated free gemmules thus swimming about with their highly-irritable bodies, changing frequently their form, contracting it in various directions as they glide along, continue their vibrations for a short time, until by some unknown means they are made conscious that they are touching a surface suited for their attachment; they are in the best position for fixing, and then they fix their bodies; they spread out in form of a flat and thin layer of cellular tissue, which has usually transparent thin margins, and the more opaque portion of the cellular tissue is seen in the interior of the spreading body. This continues to spread out as a thin film of irregular form over the surface of the watch-glass in which it is allowed to grow, and in those horny tubular species of zoophytes which are permanently fixed by a spreading ramified root, as these sertulariæ and *plumulariæ*, we observe that certain arrangements are taking place, of the particles in the interior of this thin gelatinous film that is spreading over the surface of the glass. Certain parts of the growing gemmule are soon perceived to have greater opacity than others, and those opaque parts, towards the centre of this spreading gelatinous substance, assuming a radiating form, the whole of the reproductive gemmule extends out at those parts of the margin where those radii appear to shoot out, and, consequently, the transparent homogeneous part which always bounds the exterior surface of the more opaque, continues outwards over the extending radii. In course of time we perceive distinctly that those more opaque and granular parts constitute the cellular internal living fleshy substance of the rays, and that the rays themselves are covered with a transparent, homogeneous, soft substance, that becomes condensed into the horny external tubular sheath. Watching carefully the development of the central fleshy part, and looking at it in an oblique direction, we can see that there is a slight central elevation where all the rays meet, that there is something like the stem of the zoophyte beginning to shoot up from the centre of these radi-

ating roots, and by holding it in an oblique direction, we can see that that stem is shooting higher and higher from the centre of those first-formed rays which constitute the roots, and that thus the roots, or parts of attachment in place of the polypi, are the first-formed parts which these spontaneously-moving free reproductive gemmules produce, after they have fixed and begun to develop; then the stem, then the branches, last of all the cells, and, in the bottom part of these cells, the polypi, are at length developed. So that the polypus, which Mr. Ellis imagined to be the first-formed part of these zoophytes, appears to be the last.

We observe nearly the same phenomena in watching the development of the gemmules in very different kinds of zoophytes. In the *flustræ*, which are cellular flexible membrano-calcareous zoophytes, the gemmules are developed in the interior of the same cells in which the polypi are lodged, and the polypi give place to them as they develop. The polypi themselves being thus forced to become deciduous, the gemmules occupy their place, develop, and escape, when mature, from the apertures of the cells, by the rapid movement of their cilia, showing that those polypi, which are here periodically deciduous, are not so essential to the existence or development of those animals as it was at one time conceived they were. Watching the reproductive gemmules of the flustræ, we see their vibratile cilia, their spontaneous motions, their fixing at length, and spreading like a gelatinous film, as in the other zoophytes. In the interior of the fixed and growing gemmule, we observe the white opaque calcareous particles, assuming gradually a form which presents the exact shape or outlines of a cell for a future polypus. From this single first-formed cell, we perceive, in the spreading gelatinous film which embraces its small opaque rays, extending from the outer margin, forwards and backwards, that those shooting calcareous rays in the spreading gemmule are parts of the adjoining cells of the *flustra*. At the bottom of the first-formed cell, an organization of a different kind is now commencing. The thin transparent cellular tissue is about to produce a rudimentary polypus. That polypus is still contained in a distinct small closed sac, with a transparent fluid around it at the bottom of the first cell. As yet there is no aperture in the membranous sac, nor in the enveloping cell. The first-formed cell could not, therefore, in these flustræ, and closely-allied zoophytes, be considered as developed or growing by the aid of a polypus, which is itself yet only in an embryo condition, enveloped in a membranous shut sac, and has no egress from its cell to seek for food, even if it were organized to a condition fit to seize it. This first polypus of the flustra gradually assumes all its parts; it becomes larger; its tentacula, and its anterior and posterior fibres of attachment to its cell, are developed. The little thin transparent membranous sac which encloses it extends upwards, and is found to line the whole internal parietes of the cell. An aperture is at length formed at the upper part of the cell, and then the polypus is sufficiently organized to extend itself from the aperture, and exert its little arms in creating currents for respiration and for food, by the rapid vibration of the cilia disposed along their sides. So that you observe here again, in a very different form of zoophyte, that the most inert parts are those which are the first result of the development of the gemmule, and not the polypus, which is the last part to be developed.

In some, and indeed in most of the higher forms of corticiferous and solid calcareous zoophytes, the gemmules pass through the bodies of their large and complicated polypi. We observe the same in this *lobularia digitata*, where we find eight clusters of small white round bodies making their appearance at the base of each of the polypi in the autumn. Those little round bodies, or gemmules, become gradually more white and opaque as they enlarge. At length they assume an orange colour, then they become redder, and, when fully grown, have a deep and bright-red colour. They successively detach themselves from the little white groups with which they were originally connected by filaments or umbilical chords. They escape thus into the body of the polypus, below its stomach. At the back part of the polypus, behind this open stomach, they are seen to be perfectly free, and to move and change their relative positions by the rapid vibrations of extremely minute cilia that cover their outer deep red surface. When the polypus is fully expanded, so as to enjoy the tranquil sea, there is a free passage of water through the stomach, from the mouth to the posterior extremity of the polypus, by the rapid vibration of the oral cilia, those of the tentacula not being vibratile. The sea water has free ingress through the stomach to the gemmules; the gemmules feel its influence, and advance; and as they approach the open posterior part of the stomach, they appear stimulated with new energy; they seek to enjoy that new stimulus; the aperture of the stomach behind seizes them; their cilia and all their motions are now for a time at an end. They are

conveyed through this open sac of the stomach, and, as we see also in actiniæ, escape by the mouth. Then their cilia commence again, and they move to and fro until they obtain a place to fix and develop, as in other species.

Nearly the same structure and phenomena were observed by CAVOLINI, in the madrepores, in the *caryophyllia*, and this appears to be common to most of the larger solid calcareous zoophytes; but CAVOLINI considered their gemmules as escaping by marginal openings between the tentacula of the polypi. In the *pennatula* and *virgularia* we observe gemmules which pass through the same phases of development in acquiring consistence, opacity, magnitude, colour, sphericity, freedom from attachment to the parent, and a ciliated surface to carry them through the bodies of the polypi, and, for a limited time, through the waters of the sea.

The lively-coloured internal bodies, of various hues, which we observe in the summer and autumn, shining through the transparent central parts of the acalepha, while they glide smoothly through the still seas, are closely allied in all their known properties and phenomena to the reproductive gemmules of zoophytes, and not to the ova of higher classes. They are minute round portions of the gelatinous substance of the parent which has no trace of sex, or means of impregnating ova; they present bright colours when mature, like the gemmules of inferior classes, being sometimes yellow, or orange-coloured, or purple, or bright red; and they have been long known to possess spontaneous motion when separated from the body in the *cyanæa aurita*, as mentioned by ROSENTHAL. I have observed the same spontaneous motions in those of the common rhyzostomes of our coasts; and in the bright-red spherical gemmules discharged from a minute *equorea* of the Thames, I could perceive not only the slow gliding spontaneous motions, but through the microscope I could also detect a finely ciliated zone in rapid action around their circumference. The two clusters of gemmules have the same bright-red colour, extending along the sides of the intestine in this *beroe pileus*, which contrast beautifully with the blue transparent texture of the animal. Those ovate gemmules are suspended in ramified groups from beneath the air-vesicle of the *physalia*, as we see them developed around the free margin of the mantle in several *medusæ*. Magnified views of these ovate gemmules of the *physalia* you observe in these recent plates of OLFERS, representing the various organs of that interesting animal. According to CHIAJE they form a single granular group in the *cestum*, placed at the end of the mesentery, and in the *velella* they pass out by little white tubes between the tentacula. In the four lively coloured reddish-brown gemmiferous clustres developed from the partitions between the respiratory and the digestive cavities of the *rhizostoma Cuvieri*, EYSENHARDT observed that the minute component fusiform bodies, which he regarded as obviously connected with generation, possessed distinct spontaneous motion, both before and after they had severally detached themselves from their peduncles. He considered these small generative bodies as capsules filled with a fine grenular or cellular matter, and has figured them as such. When CAVOLINI first observed the spontaneous movements of the gemmules of zoophytes after they had escaped from their open vesicles he considered them, and described them, and figured them as capsules singularly animated, and filled with minute generative globules, which escaped by the bursting of the capsules; but he soon afterwards corrected his mistake on finding that these supposed gemmiferous capsules, endowed with spontaneous motion, are the gemmules themselves.

In the echinoderma we find a more obvious and a more complex structure of the generative system, but still presenting no distinction of sex, all produce alike. In the asterias we observe in each of the radiating divisions of the body, whatever be their number, two ramified, glandular and highly vascular sacs, attached to the upper surface of the skin, that produce, at the commencement of the winter season, little round bodies that are discharged by small orifices around the mouth or entrance to the stomach. In the *echinus* we perceive also glandular sacs, five in number, and filled with small round bodies. These sacs are situate in the upper portion of the cavity of the shell, and open each by a short separate duct, which penetrates the outer angle of the large genital calcareous plates disposed around the anus. These ovaries were observed even by ARISTOTLE to be very early developed in the *echinus*, and they were used as food in his time as in ours. The large group of long convoluted and ramified tubular cæca seen in the anterior portion of the body of the *holothuriæ*, is their so-named ovary, which greatly enlarges, as in the other echinoderma, at the season of reproduction; and all its divisions are then found filled with a reddish viscid matter, which envelops all the minute developing germs. At other seasons this ramified generative organ is found to contain a thin white fluid, and its duct opens by a small

round orifice, protected by a transverse fold, on the surface of the skin, at a short distance behind the mouth. Several small glandular cæca communicate with this oviduct before it opens on the surface, which have generally been considered as impregnating or male organs. In the beginning of winter the little brown-coloured lengthened germs are found, a line long, in the viscid matter of the ovary, which has now enlarged to many times its ordinary size.

Thus we observe, that throughout the radiated classes, all the individuals are organized alike to perpetuate their race, and they are not only all productive, all female, but their fertility surpasses that of all the higher orders of animals, so that they are not less remarkable for their generative than for their digestive powers. In the fissiparous animalcules the whole body may be considered as generative, and the life of the individuals appears thus to have no end. The generative portion of the body is scarcely more limited or more defined in the class of poriferous animals, where the gemmules pour out in thousands from the interior of a single individual, which survives for several seasons. In the zoophytes, the parts of the body appropriated to reproduction are almost as numerous, though now more determinate in their position, and in the higher forms of acalepha and echinoderma, where the generative portion of the body becomes more and more limited and defined, a distinct organ is at length developed, to which alone the whole function of generation is appropriated, and which becomes more and more complicated in its structure, and divided in its function, as we ascend through the higher grades of the animal kingdom.

LECTURE LVI.

ON THE GENERATIVE SYSTEM IN THE ARTICULATED CLASSES.

Next in fertility to the radiated tribes of animals we find the classes of articulata, where the generative organs are more circumscribed and defined, and where sexual distinctions and the oviparous form of generation are gradually established. The fissiparous animalcules cast off their successive generations, heedless of their future existence; and the higher gemmiparous classes of radiata produce periodically their crops of reproductive gemmules, like the seeds of plants, and trust their safety and development to nature: but now complicated instincts, connected with generation, begin to manifest themselves, and to provide for the progeny beyond the period of its attachment to the parent. The sexual distinctions, and the high development of the generative system, are not less remarkable in the articulated classes, than the predominance of their animal over their organic functions; but from the mystery in which the whole function of generation is involved, it is easier to perceive the increasing complexness of the organs, than to assign uses to the various parts, and it is perhaps from this circumstance that we can discover less evidence of unity of plan in the composition and forms of their generative apparatus, than in almost any other part of their economy.

In the lowest articulated classes, we still find many animals without organs of impregnation or excitement, and which, like all the radiated tribes beneath them, are self-productive, and without a trace of sexual difference. The cystic entozoa, as the cysticercus, the cœnurus, and the echinococcus, appear to have an internal gemmiparous mode of generation, like the volvox among the animalcules. They present no organs appropriated to this function, but minute gemmules are observed to develop from their interior parietes, which, after assuming the perfect form, become detached, and are found floating loose in the contained fluid of the parent sac. The long articulated flat tænioid worms possess in each segment an ovary, which is sometimes long and with radiating ramifications, and sometimes of a simple round form. This ovary occupies the central portion of each joint of the body, and terminates in the lateral pore by a distinct oviduct. There is also a small glandular sac in each segment, which communicates with the extremity of the oviduct, and which some have imagined to be an impregnating organ. The termination of the oviduct is prolonged outwards as a stiliform tube, and forms the supposed penis; but as all the segments are alike generative, they probably possess only organs belonging to the female sex, as all other supposed hermaphrodites. The generative organs of the distoma hepaticum, like each segment of the tænia, possesses a ramified and complicated ovary and a lengthened oviduct, with which a long and tortuous secreting tube, regarded as a testicle, is found to communicate. The ovary here occupies the circumference of the body, and the supposed testicle the central part: they open together at the lower and anterior part of the body, immediately behind the mouth. The ova, viewed through the microscope, appear as thin sacs, filled with regular spherical and