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The facts contained in the preceding paper are interesting, as indicating the extent to which less powerful, though still sufficiently characteristic actions may be overlooked. Hitherto we have gone upon the supposition that the organic acids are entirely without action upon vegetable fibres, and constant use is made of them by the calico-printers in the production of their colours. My observations, however, sufficiently show that they cannot be used for this purpose without injury; and should serve as a warning to avoid their use, and to replace them as far as possible by neutral salts.

In conclusion, I may mention, as somewhat allied to the subject of this paper, that I have succeeded in making use of the difference of the action of weak animal acids on vegetable and animal fibres, as a means of detecting the admixture of cotton and flax with wool. The latter resists an acid which entirely destroys the former. This fact has acquired considerable practical importance from the extent to which mixed fabrics have been introduced of late years.

On a Hermaphrodite and Fissiparous Species of Tubicolar Annelid. By THOMAS A. HUXLEY, F.R.S., Lecturer on General Natural History in the Government School of Mines.

In the course of a series of dredging operations, in which I have lately been engaged, upon the shores of Caermarthen Bay, in the neighbourhood of Tenby, I took, upon one occasion and in one locality (in about six fathoms water, near Proud Giltar), the Annelid which is the subject of the present communication. It is questionable, however, whether the animal is so rare as I might have been led to suppose from this solitary instance of its occurrence within my own knowledge—for I had afterwards the opportunity of seeing masses of its calcareous habitation considerably larger than that which I took myself, in the celebrated collection of the late Mr Lyons of Tenby.

The *Vermidom* (as one might conveniently term the habitations of tubicolar* annelids in general) of this annelid is composed of very fine, more or less undulated, white, calcareous tubes, attached by one end to some solid body. Rising from this fixed base, they unite together side by side into irregular bundles, and these bundles anastomose like bundles of nerves in their plexuses—leaving irregular spaces here and there, and thus forming a kind of coarse solid network (fig. 1). Each tube has a circular section, but can hardly be called cylindrical, because it is thickened at intervals, so as to be obscurely annulated.

When placed in a vessel of clear sea-water, the annelids issue from the tubules of their vermidom, and each spreading out its eight branchial filaments and displaying its bright red cephalic extremity—the mass assumes a very beautiful and striking appearance—singularly resembling a tubuliparous polyzoarium (fig. 2).

If, however, a portion of the calcareous mass be broken down, and its delicate fabricators carefully extracted (fig. 3), their annelidan nature becomes immediately obvious; and in determining the exact place of this form among the tubicola, the expanded membrane which fringes the sides of the body, the peculiar branchial plumes, and the absence of any operculum, would point at once to the genus *Protula** as that to which this species belongs, were it not for two most remarkable peculiarities of its organization, which, so far as we know at present, are to be found in no *Protula;* and one of them in no other tubicolar annelid.

These peculiarities are, in the first place, that this species undergoes *fissiparous multiplication;* and, in the second, that it is *hermaphrodite*—the male and female reproductive elements being, unequivocally, developed in the same individual.

So far as I am aware, the process of fissiparous multiplication has hitherto been observed in only one family among the errant annelids, the *Syllidea* (of Grube); in only one family among the *Scoleidæ* (*Hirudinidæ* and *Lumbricidæ*), that of the *Naidea*,—and in only one genus among the tubicolar annelids, *Filograna*.

* On consulting the original description of *Filograna*—a genus to which the form of the Vermidom of this species would at first induce one to refer it, its affinities therewith appear evident; but whether there is any real difference between Filograna and Protula is a question for further consideration.

Hermaphrodism has hitherto been observed in no errant or tubicolar annelid.* Indeed the author to whom we are indebted for the most beautiful researches into annelid organization extant, M. de Quatrefages, thus concludes his elaborate memoir on the nervous system of the annelida :—

"We must then seek elsewhere (than in the nervous system) the characteristics on which to base the divisions which are necessitated by the great extent of this group, and the multiplicity of types which it embraces. Now, as an anatomical character, there is nothing more distinct and well marked than the union or separation of the sexes in the same individual. These differences of organization, besides, indicate profound physiological distinctions, which have long been justly appreciated by botanists. I am, therefore, more and more inclined to believe that the distinction of the annelids (Vers) into monœcious and diœcious ought to be adopted in science."†

In arriving at this conclusion, M. de Quatrefages was, of course, only furnishing additional evidence for the justice of that division of the annelids into the *Annèlides* proper, characterized by the separation of their sexes—and the *Scoléides*, characterized by their hermaphrodism—which was first established by M. Milne-Edwards, and which has been very generally received.

However, on a careful survey of the whole class of worms, many facts come to light which throw considerable doubt on the propriety of raising unisexuality or hermaphrodism into distinctive characters of large groups. We have hermaphrodite *Rotifera*, and unisexual *Rotifera*. The *Nemertidæ* and *Microstomum* are unisexual, the other *Turbellaria* hermaphrodite; there appears to be considerable doubt as to the universality of hermaphrodism in the *Trematoda* even; and *Echinorhynchus*, which cannot be placed very far from the *Tæniadæ* and *Distomata*, is well known to be unisexual, and

* See among other authorities, Frey and Leuckart, *op. cit. inf.*, p. 87, who examined Hermella, Vermilia, Fabricia, and Spirorbis, among the tubicolar annelids, with especial reference to this point.

† Types inférieurs de l'Embranchement des Annelés. Ann. des Sc. Nat. 1850.

there is therefore, perhaps, nothing so very anomalous in the discovery of a truly hermaphrodite tubicolar annelid. It is another question how far it need affect the classification to which I have alluded.

The fluctuation in the terminology of the classification of the annelids, in fact, has proceeded from the very common but always obstructive practice of giving notional instead of trivial names to incomplete groups of animals. Cuvier divided the annelids into errant, tubicolar, terricolar, &c., deriving his terminology from the habits of those with which naturalists were then acquainted; but, with the advance of knowledge, it was found that some of the *Errantia* inhabit tubes, while one main division of the "*Terricola*" consists of aquatic worms; and thus these notional terms, instead of aiding the memory as they were intended to do, served simply to originate and propagate erroneous conceptions. There can be no doubt that the divisions established by Cuvier are essentially natural, and had he devised some happily unintelligible Grecism, instead of the names which he actually adopted, they would have stood, their definitions altering with the progress of knowledge, until this day.

The divisions proposed by M. Milne-Edwards possess exactly the qualification which is here wanting. *Annélides* and *Scoléides* may mean anything, and, as names of groups, may very conveniently remain, even if it should be found necessary to remodel the whole definition which was primarily assigned to them. It appears to me, therefore, that if the statements which follow be confirmed, they will lead, not to an alteration or subdivision of the group of *Annelides*, but to a widening of its definition so as to include hermaphrodite forms; or perhaps it would be better to admit that owing to the imperfection of our knowledge, we have not yet a *definition* of either *Annélides* or *Scoléides* at all, but that we must arrange under the former head all those worms which resemble the errant and tubicolar sea worms more than anything else, while those which resemble the land and fresh water worms must fall under the latter category. If, from the great division of the *Annulosa*, we take away those animals which are characterized by the possession of one or more of the following characters—1. Articulated appendages. 2. Such appendages modified into jaws around the mouth. 3. A true heart in communication with the perivisceral cavity: that is, the Insecta, Myriapoda, Arachnida, and Crustacea—we have left a large division of the animal kingdom, to which the old term of *Vermes* might well be appropriated, had it not been already used in so many significations. For this division, whose members are united by a marked community of structure and development, and which includes the *Annelida* of Cuvier and a large section of his *Radiata*, viz., the *Entozoa*, the *Rotifera*, and the *Echinodermata*, I have elsewhere proposed the name of *Annuloida*, a term parallel to that very useful one of *Molluscoida* (*Molluscoides*), invented by Milne-Edwards for the *Polyzoa* and *Ascidians*.*

If it be remembered that it is only within the last few years that the structure and development of these *Annuloida*—which present extraordinary difficulties to the investigator—have been made the subjects of thorough and complete examination, it will not be a matter of surprise that, at present, the subordinate division of the group must be effected more by reference to types than by exact definition. Of course this is still more the case with the smaller sub-divisions; and until much more light has been thrown on these most interesting but most perplexing creatures, I think it would be well to understand the existing classes and orders to be purely conventional and artificial. For my own part, I doubt greatly whether any well-marked natural demarcation can, at present, be drawn between the *Annelida* (M. E.) and the *Scoleidæ*, or between these and the *Entozoa*; or, again, between the latter, the *Turbellaria*, and the *Rotifera*; or, once more, between the *Annelida* and the *Echinodermata*; though I have little doubt that the progress of inquiry will tend here, as elsewhere, to eliminate osculant forms, and to substitute definitions for types.

* In writing this passage it escaped my memory that the very same division had been long ago proposed by Milne-Edwards himself:

"Je crois qu'il faudrait diviser cet embranchement (Les Articulés) en deux groupes principaux, l'un les articulés a pieds articulés, et l'autre les annèlides, les Helminthes, les Rotateurs, &c., serie à laquelle on pourrait donner le nom vulgaire des Vers." Sur la circulation dans les Annèlides. Ann. des Sc. Nat., 1838, p. 194.

Not only does it appear to me that, under these circumstances, it is inexpedient to create new sectional terms; but until a more extended and careful examination of the tubicolar annelides shall have been made with reference to these very points, I do not think it is worth while even to found a new genus for the form I am about to describe, as it possesses all the essential characters of *Protula*. Specifically, however, it appears to be distinct from all forms of *Protula* hitherto described, and I therefore propose to call it *Protula Dysteri*, after my friend Mr Dyster of Tenby, in whose society it was discovered, and from whom I hope some day to see good work in this branch of science.

I have already described the vermidom of this species, and I now therefore pass to the details of the organization of the animal itself. *Protula Dysteri* (fig. 3) possesses a very elongated body, which may be conveniently divided into a cephalic, a thoracic, an abdominal, and a caudal portion.

The cephalic portion (fig. 3, *e*) can hardly be said to constitute a distinct head, for the oral aperture, which is wide and funnel-shaped, is terminal. The dorsal margin of the oral aperture is formed by a prominent rounded lobe, beneath which are two richly-ciliated, short filaments, which adhere to the base of the branchial plumes, and might be regarded either as their lowest pinnules, or perhaps, more properly, as tentacles analogous to the operculigerous tentacles of the Serpulæ. On the ventral side the margin is deeply incised, so that a rounded fissure, bounded by two lips, lies beneath and leads into the oral cavity. From each side of the head springs a distinct branchial plume, whose peduncle immediately divides into four branches. These are beset with a double series of short filiform pinnules, the origins of each series alternating with those of the other. The termination of each branch is somewhat clavate, and when expanded the eight branches are usually gracefully incurved towards one another, the whole having not a little the aspect of a Comatula.*

The thoracic portion of the body (fig. 3, *e f*) is short, but wide and somewhat flattened. It is produced laterally into nine

* It is worthy of note, how very crinoid the branchial plumes would be if their skeleton were calcified instead of simply cartilaginous.

pairs of close-set, double pedal processes. The lower portion of each process forms a mere transverse ridge, beset with the peculiar hooks to be described by and by; the upper process, on the other hand, is conical, and is provided with elongated setæ. The most striking feature of the thorax, however, consists in the peculiar membranous expansion, (*b*) which, arising as a ridge upon each side of what might be termed the nuchal surface of the animal, and attached to the sides of the thorax, above the bases of the feet, runs down to terminate on the ventral surface, behind the last pair of thoracic appendages. From this origin it extends as a wide free membrane beyond the setæ, forming an elegant collar around the head, on whose ventral surface the expansions of each side unite, and form a wide reflexed lobe (fig. 4, *g*), while posteriorly they remain separate. To the thorax succeeds what may be called the abdomen, which is much longer than the other regions of the body; and is, besides, distinguished from them by the imperfect development of the feet, and the paucity of the setæ and hooks. In this, and in the caudal portion of the body, the relative position of the hooks and setæ is the reverse of what it is in the thorax, the former being superior, and the latter inferior. *

The caudal portion of the body is short, and wider than the abdomen. Its rings are close-set, with well-developed hooks and setæ, and it is terminated by two conical papillæ between which the anus is situated. There are not less than 50 rings in the whole body. Cilia could be detected in active motion on many parts of the external surface, on the bases of the feet, on the rudimental tentacles, and scattered in tufts over the whole surface of the thoracic expansions.

Having thus sketched its external character, I will now pass to the minuter features presented by the organization of the animal.

Branchial plumes.—The principal mass of these organs is formed by a clear, firm, supporting axis, so marked transversely as very closely to resemble the *chorda* of an *Amphioxus*. The lower end of this axis terminates by a somewhat pointed ex-

* According to Grube, this is the case in all the Serpulacea. See his most excellent work—“ Die Familien der Anneliden.” 1851.

tremity, which lies in immediate proximity to the œsophagus (fig. 4), and receives the insertion of the lateral longitudinal muscles of the body. Superiorly, as has already been said, the axis divides into four branches, one of which enters the stem of each branchia and forms its skeleton and support, sending lateral processes into each of the pinnules. These, however, are much more delicate, and are composed of oblong particles set end to end; somewhat like the axis of the tail of an Ascidian larva. All this branchial skeleton, as one might term it, is invested by a continuation of the general parietes of the body, which adheres closely to the outer side of the stem and pinnules, but leaves a space on their inner side. In this space lies the so-called "blood"-vessel, with its green contents. It does not fill the space, but lies loosely in it; the interval between it and the walls of the filament being, I suppose, in continuity with the perivisceral cavity.*

The whole of the internal surface of the branchiæ is provided with long, close-set, vibratile cilia, while nothing of the sort is visible externally. The end of the stem has a very peculiar structure. It is somewhat enlarged by the development within its walls of a number of elongated granular masses of about $\frac{1}{1000}$ inch in length, entirely made up of very minute, strongly refracting granules, which, when pressed out, become rapidly diffused and dissolved in the surrounding water. These bodies were not confined to the ends of the branchial stems, but similar aggregations existed at the ends of many of the pinnules, and were also very regularly developed in little elevations seated upon the sides of the stem in front of the base of each pinnule.†

Alimentary Canal.—The œsophagus leads into a pyriform, more or less marked, dilatation or crop, provided with thicker

* The skeleton of the branchiæ of the Serpulacea has been well and carefully described by De Quatrefages in his valuable memoir "Sur la circulation des Annelides," Annales des Sciences Naturelles, 1850; and that of Sabella unispira by Grube, so long ago as 1838. See his memoirs "Zur Anat. und Physiologie der Kiemenwurmer." 1838.

† Are the peculiar rounded whitish granular patches which occupy a similar position on the arms of Comatula of a corresponding nature, or are these really testes? I have never been able to find developed spermatozoa in them, nor anywhere else in Comatula.

walls than the remainder of the alimentary canal (fig. 5). The crop communicates by a constricted portion with a wide stomach, whose walls are strongly tinged by deep brown granules. This passes into a narrow intestine, which widens in the caudal region into a sort of rectum, opening externally, between the terminal papillæ, by a richly-ciliated anus.

In every segment the intestine was united to the parietes by delicate transverse membranous dissepiments, forming partitions across the perivisceral cavity, and thus dividing it into a series of chambers, which, so far as I could observe, did not communicate with one another, though it would be unsafe absolutely to affirm this.

"*Vascular*" *System.*—The so-called "blood"-vessels* of the Annelida were represented, in the present case, by lateral contractile vessels which ran upon each side of the intestine, and gave off transverse branches on to the dissepiments, from which twigs proceeded dorsally and ventrally.

The dimensions of these lateral vessels varied considerably; sometimes they were comparatively narrow, but in other instances so wide as to appear to form a complete sheath around the intestine. They contained a deep green, clear fluid, totally without corpuscles or solid elements of any kind, while they themselves, when empty, were usually quite colourless; but I would draw attention to the curious fact, which I have also observed in other annelids, that in the anterior part of their course they occasionally present bright green, granular particles, imbedded in, and adhering to, their outer surface.

The opacity of the anterior end of the animal, resulting from the quantity of deep red pigment, prevented any very

* At the last meeting of the British Association (September 1854), I ventured to propound the theory that what are commonly called the blood-vessels of the Annelida are not "blood"-vessels at all; that is, that these vessels, and the fluid which they contain, are not the homologues of the blood-vessels and blood of Vertebrata, Mollusca, and Articulata, the latter being represented in annelids by the perivisceral cavity and its contained fluid, whose anatomical and physiological importance have been so excellently and exhaustively developed by De Quatrefages. See his researches on the Annelids, and more particularly his memoir "Sur la cavité generale du corps des Invertebrès." It is to be hoped that M. de Quatrefages understands that instructed Englishmen do not countenance the unwarrantable attempts that have been made to depreciate his merits in this country.

certain observation of the manner in which these vessels terminate there. I am inclined to think, however, that they open into a circular vessel, from which the branchial vessels arise.

It was no less difficult, in an adult specimen, to determine whether a ventral vessel existed or not; but in a young form, I saw such a vessel communicating with the inferior transverse branches, and distinctly contracting. It was superficial to the ciliated canal immediately to be described.

Of a dorsal vessel I could find no trace. The final ramuscules of the superior transverse branches of the lateral trunks were found, whenever they could be distinctly observed, to terminate *cæcally*. There could be no question whatever, that these cæcal ends were the natural terminations of the ramuscules, as the animal under observation had been subjected to no violence, and was viewed by transmitted light. I am the more particular in insisting upon this point, as one might very readily be led, in dissecting annelids, to suppose that cæcal terminations of the vessels are much more frequent than they really are. Their vessels, in fact, possess, in a very high degree, that tendency to contract when torn, which is so well known in the arteries of the higher animals. And if under the simple microscope the vessels of an Eunice or Nereid be deliberately pulled asunder, it is most curious to observe how very little of the contained fluid pours out, and how smooth and round the torn ends immediately become. In our *Protula*, however, the mode of examination was such as to preclude all chance of error from this source; and I have besides fully confirmed the fact of this mode of termination,* in the singular and beautiful genus *Chlorœma*, which has the advantage of great transparency. In this animal it is easy to observe that, though many of the ultimate branches of the vessels anastomose, and thus give rise to a network, yet that there are also many branches of no inconsiderable dimensions, which terminate in cæcal extremities. Such vessels may be frequently observed coming off from the transverse trunk and hanging freely into the peri-

* This cæcal termination of the vessels appears to reach its greatest development in the Scoleid genera, Euaxes and Lumbriculus, in which a vessel arises in each segment from the dorsal trunk, and shortly divides into many cæcal ramuscules. See Siebold. Vegleichende Anatomie, p. 212.

visceral cavity, attached only by a few delicate threads of connective tissue, to the parietes. It is most curious to watch the regular contractions of these pendent vessels, their momentary emptying, and their subsequent distention and erection by the returning wave of fluid. And in considering the nature of this remarkable system of vessels, it is most important to note that we have here, at any rate, no circulation, but a mere backward and forward undulation.*

Ciliated Canal.—A clear, longitudinal, very narrow ($\frac{1}{1400}$ to $\frac{1}{3300}$ inch) canal (fig. 6, *a*) may be observed extending along the ventral surface of the intestine in the middle line, from the anus, where it appeared to me to open, as far as the brown dilated stomach, when it either stopped or became so obscured as to be no further traceable. The canal had well-marked walls with a double contour, which sometimes appeared curiously broken; and contained, set along its dorsal wall, one to four longitudinal series of cilia (fig. 9). These were placed at regular intervals, and worked together, as if they were pulled by a common string. In young specimens there was only one cilium in each row, but in the older ones I saw as many as four in each transverse line. Has this enigmatical canal anything to do with the 'typhlosole' of the earthworm?

On the dorsal surface of the head a longitudinal canal, which sometimes appears to be ciliated, was visible at *b* (fig. 3); posteriorly it divided into two branches which dilated into granular cæca, arranged in a kind of festoon in the first segment of the thorax.

The coloration of this part of the body prevented me from determining whether this canal opened externally or into the œsophagus, and also whether it was in any way connected with the ventral ciliated canal,—both of them points of much interest.

However this may be, these sacs are clearly homologous with the curious sacs which have been described in *Chlorœma*, and perhaps with the sacs opening externally, which are found in the anterior segment of *Pectinaria*.

* The general contractility of the vessels of the annelids has already been pointed out by De Quatrefages. Siebold doubts the existence of a regular circulation in the majority of the *Annelida*. *Op. cit.*, p. 210.

I may mention here that ciliated organs, possibly homologous with these, and with the lateral convoluted canals of the *Lumbricidæ* and *Hirudinidæ* are by no means uncommon among the *Annelida Errantia*, and may be observed in *Phyllodoce;* it requires care however to discover them.

Nervous system.—On this head the result of my examinations was exceedingly unsatisfactory, as I could assure myself of the existence of only two oval ganglia, one on each side of the œsophagus, each of which presented a dark pigment mass (eyespot ?) on its anterior extremity.

Reproductive elements.—Protula Dysteri can hardly be said to possess special reproductive organs, the reproductive elements, viz., ova and spermatozoa, being developed as it were accidentally from the walls of the perivisceral cavity, by the fluid contained in which (whose nature and importance M. de Quatrefages has so well pointed out) they are bathed, and supplied with nutritive materials. It appeared to me that the spermatozoa or ova took their origin in granular thickenings of that portion of the face of the dissepiments which is traversed by the transverse vessel, becoming detached thence, and floating freely in the perivisceral fluid, as they attained their full development. *

The youngest spermatozoa were minute spherules, of not more than $\frac{1}{5000}$ of an inch in diameter, aggregated together into irregular masses (fig. 11). In a more advanced state a very fine short and delicate filament could be observed springing from one side of this body. By degrees the spherule became elliptical, and narrowing *pari passu* with the elongation and thickening of the filament, the ultimate result was a spermatozoon, such as that represented in fig. 11, with a subcylindrical slightly pointed head of $\frac{1}{3500}$ of an inch in diameter, and a very long actively-undulating tail.

The ova are, at first, very small, not more than $\frac{1}{4000}$ of an inch in diameter, and possess a relatively very large, clear space, representing the germinal vesicles, containing a minute

* Frey and Leuckart (Zool. Untersuchungen, p. 88) assert that the generative elements of the annelids are developed from a free blastema, and not from the septa only, as Krohn asserts to be the case in Alciope, and as I should, from what is stated above, be disposed to believe.

germinal spot. By degrees they increase in size to $\frac{1}{600}$ inch, with a germinal vesicle of $\frac{1}{1000}$, and a spot of $\frac{1}{3500}$, and a few granules become visible in their yelk. From this size they gradually increase to the $\frac{1}{150}$ inch in diameter, acquiring a well-marked vitellary membrane, and a dark orange-red, very coarsely granular yelk. The germinal vesicle and spot may still be rendered visible by pressure, the former having about $\frac{1}{600}$ of an inch in diameter.

When those segments of the body in which the genitalia are situated were subjected to moderate pressure, the spermatozoa made their exit at the bases of the pedal tubercles of the male segments, while the ova, just giving rise to bulgings in a corresponding position, eventually passed out in the same manner. I could not satisfactorily decide, however, whether the apertures by which the generative products passed out were natural or artificial.*

Setæ and Uncini of the Pedal Tubercles.—The general form of the pedal tubercles has already been described; it remains only, therefore, to note more particularly the form of their appendages, whether *Setæ or Uncini.* The *Setæ* (figs. 7, 8) are slender spines, about $\frac{1}{80}$ of an inch in length, consisting of a haft and a blade; the former is about six times the length of the latter, and is rounded, flattening gradually as it passes into the blade, with which it is completely continuous, though at an obtuse angle.† The blade tapers gradually to its point, and is smooth on one edge, but minutely denticulated upon the other, while delicate striæ are continued from the serrations upon the flat face of the blade.

Such is the structure of those stronger setæ which are directed forwards on each side of the head-lobe. Those of the

* It should be added that the genital products occupy about fourteen successive segments of the abdomen, of which the two anterior are seminiferous; the rest, ovigerous. See fig. 3.

† I am not aware of any annelid in which the setæ are really articulated. The statements of Audouin and Milne-Edwards rest, I believe, upon errors of observation, very intelligible, if one considers what microscopes were twenty years ago. How such strange perversions of fact as the figures of annelid setæ appended to Dr Williams's Report on the British Annelida, published in the Transactions of the British Association for 1851—can have arisen, it is not so easy to comprehend.

posterior segments have a similar general structure, but are more delicate.

The *uncini* (figs. 7, 8) are very small, not more than $\frac{1}{1000}$ inch in length; and it is not easy to make out their exact structure. Each, however, appears to be composed of a short implanted stem, and a blade set upon the end of this, at somewhat less than a right angle, like the claw of a hammer. The edges of this blade are minutely denticulated.

Fissiparous multiplication.—It was only a minority of the *Protulæ* which presented the aspect hitherto described; for the larger number were undergoing multiplication or prolification, by a process which can only be described as a combined fission and gemmation. The prolification takes place so as to separate all the segments of the parent behind the sixteenth, as a new zöoid; but it is not a mere process of fission, for the seventeenth segment, *i. e.*, the first of the new zöoid, undergoes a very considerable enlargement, and eventually becomes divided into the nine segments of the head and thorax, of the bud. These segments do not appear all at once, but gradually, one behind the other. The intestinal canal of the stock and of the bud are at first perfectly continuous, but the peri-intestinal cavity of the bud is completely filled with a mass of red granules. These would seem in some way to subserve the nutrition of the young animal; for in some free zöoids, apparently fully formed, all but the development of genitalia, the caudal segments were full of these orange granules, while no trace of them was to be found anteriorly.*

It is very interesting to note the manner in which the branchial plumes are developed, as it closely corresponds with what Milne-Edwards describes in *Terebella*. Each plume appears at first as a quadrate palmate process of the dorsal side of the first segment; and the divisions representing the stems of the future branchiæ are at first mere processes,—perfectly simple tubes, which do not even present annulations.

Several modes of prolification are already known to exist among the annelids. The one long since described by O. F. Müller, as one of the methods of multiplication of *Nais*, and

* Sars gives an account of the prolification of Filograna implexa, similar in all essential points. See his Fauna littoralis, &c., pp. 88-9.

more lately by Quatrefages as occurring in *Syllis prolifera* is very nearly simple fission, the animal dividing near its middle, and the under half, before separation, only putting forth, as buds, those appendages which are characteristic of the head.

Secondly, Milne-Edwards has described in *Myriadina* a prolification by a sort of continuous budding between the anal and the penultimate segment. A new ring is produced behind the penultimate segment, and this enlarging gives rise to a new ring posteriorly, and so on until the bud attains its full length.

It would seem possible that the second mode of prolification in *Nais,* described by O. F. Müller, is in reality the same as this, though he describes the new growth as entirely resulting from the excessive development of the anal segment.

Thirdly, M. Schulze, an excellent observer, has described a third very singular mode of prolification in *Nais,* whence the long chains of zooids occasionally observed arise. For when, by the fissive process the *Nais* is divided into an anterior and posterior zooid, the last segment of the former greatly enlarges, becomes divided into segments, and the anterior of these becoming a head, a new zooid is formed between the previously existing ones; this process is repeated in what was the penultimate, but is now the ultimate segment of the anterior zooid; and, again, in the anti-penultimate, so that at least a long string of zooids is formed, each of which, except the last, is produced from a single segment.

Fourthly, According to Frey and Leuckart, whose observations have been confirmed by Krohn (Wieg. Archiv., 1852), *Autolytus prolifer* multiplies in a somewhat similar way, but instead of each new interposed zooid being formed at the expense of a fresh segment of the anterior zooid—it is produced by the metamorphosis of a bud, or rather of a mass of blastema the equivalent of a bud, developed from the under extremity of the last segment of the anterior zooid.

Supposing further observation to confirm the distinctness of all these modes of prolification, they might be classified according to the amount of the already formed parental organism which enters into the produced zooid.

1. All the segments of the latter were segments of the former, the new products being merely cephalic organs.

2. None of the segments of the produced zooid belonged to the parent zooid, but the former is a metamorphosis of a whole segment of the latter.

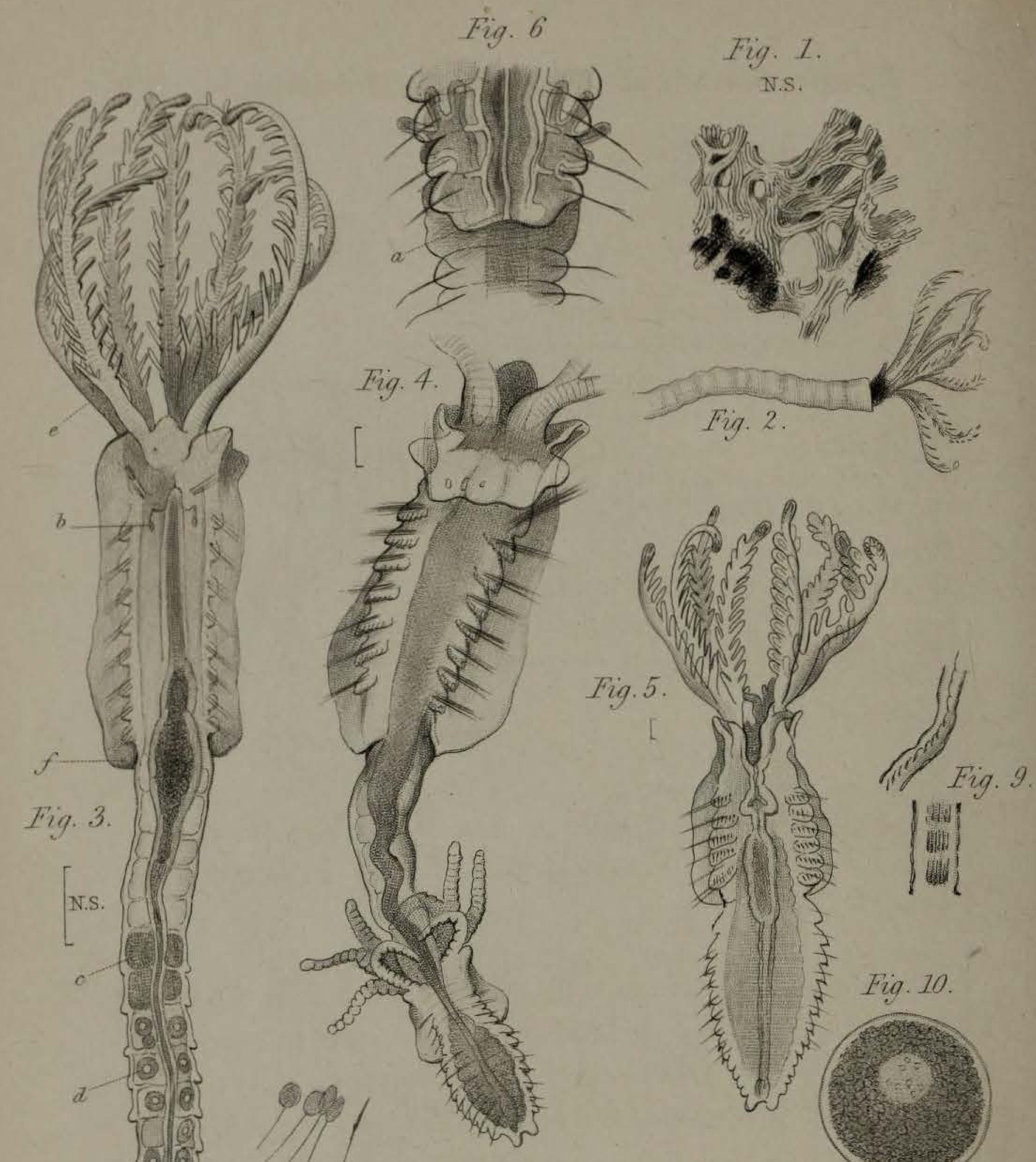
3. None of the segments of the produced zooid belonged to the parent zooid, and the former contains hardly any of the primitive substance of the latter, being developed by germination from its last segment.

It is clear that the prolification of *Protula Dysteri* will come under none of these categories; but is a combination of the first and second methods. The abdomen of the produced zooid is a mere fissive product of the parent, but its thorax is the result of the metamorphosis of a single segment of the parent into many segments.

Quatrefages endeavoured to show that the relation of the produced zooids of *Syllis* to the anterior zooid was that of an "alternation of generation," the former alone developing sexual products. Krohn has however proved that no such relation exists in this case; but on the other hand he brings forward good evidence to demonstrate that the posterior zooids of *Autolytus prolifer* really *are* generative zooids, and alone develop the reproductive elements. The male zooids in this case are widely different from the gemmiparous zooid; so different, in fact, that they were regarded by O. F. Müller as belonging to a distinct species.

I sought carefully for evidence of any such "alternation" in *Protula Dysteri*, but the result was to convince myself that nothing of the kind exists.

The generative products may indeed almost always be detected, though the ova are very small and indistinct, in the anterior zooid of any still unseparated pair; and it is therefore clear that the gemmiparous zooid is not asexual, the invariable rule where that separation of the individual into asexual and sexual zooids, which constitutes the so-called "alternation of generations," really exists.



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Description of Figures, Pl. I.

Fig. 1. Vermidom of *Protula Dysteri*.
2. Single calcareous tube with the worm protruded and expanded.
3. An adult *Protula* extracted from its case, *c*. branchia, *c*. testes, *d*. ova,—(dorsal view).
4. A *Protula* undergoing prolification (central view).
5. The produced zooid just set free.
6. Junction of parent and derivative zooids (ventral view), *a*. ciliated canal.
7. Pedal tubercle.
8. *Setæ and Uncini.*
9. Ciliated canal, greatly magnified.
10. Ova—young and completely developed.
11. Spermatozoa—young and completely developed.

On the Artificial Preparation of Sea Water for the Aquarium. By GEORGE WILSON, M.D., F.R.S.E., Lecturer on Chemistry.*

In an interesting communication contained in the "Annals of Natural History, for July 1854 (p. 65), Mr Gosse has recorded the results of an important experiment on the possibility of artificially preparing sea water for Marine Vivaria. Guiding himself by Schweitzer's analysis of the water off Brighton, and excluding the less abundant ingredients, he employed chloride of sodium, sulphate of magnesia, chloride of magnesium, and chloride of potassium,† which were dissolved in a suitable quantity of water. In April last various species of marine plants and animals were introduced into this imitation sea water, and as during a period of six weeks they "throve and flourished from day to day, manifesting the highest health and vigour," Mr Gosse draws the very natural conclusion,

* Read to the Chemical Section of the British Association, September 1854.

† The following are Mr Gosse's exact directions:—Common table salt, 3½ ounces; Epsom salts, ¼ ounce; chloride of magnesium, 200 grains troy; chloride of potassium, 40 grains troy. To these salts a little less than four quarts of water were added.