the hinder part of the cardinal edge of the valves (fig. 3); it is deeply notched in the middle of the front edge over the separation of the valves, and more or less sinuous on the middle of the side edges over the convexity of the valves, as it is figured by Sowerby ('Genera,' f. 2 & 4) *; but it is often of a much larger size compared with the size of the valves, and more sinuated in front and on the sides than it is here represented. In most specimens of these fossils the dorsal valve is wanting, and there is only a slight fracture between the front of the hinge-margin of the valves, showing the remains of the cast of the shell by which it was attached (fig. 1), as it is represented in fig. 3 of Sowerby's 'Genera.'

[A Postscript to this paper will be found on page 162.—Ed.]

IX.—*On the Spermatology of a new species of* Nais. By H. J. Carter, Esq., H.C.S. Bombay.

[Concluded from page 33.]

Development of Spermatozoa in the Ovisac.

In the ovisac, *pari passu* with the ovum, the spermatozoa also frequently become developed; and this takes place in the following way: viz. a number of cells identical to all appearance with the floating-cells of the peritoneal cavity, that is, consisting of a cell-wall enclosing a number of refractive vesicles supported on an albuminous sphere or centre, fill that part of the ovisac which is not occupied by the group of ova. These, at a very early stage, when only a few are present (Pl. II. fig. 3 *h*), may be seen loose and under a spherical or diffluent form (*i*), or in agglomerated masses of twos, threes or more (*k*), or attached to the surface of the ovisac, and caudate (*l*), thus evincing the same plasticity of cell-wall that we have observed in the cell-wall of the floating-cells when adhering together or to the parietes of the peritoneal cavity, while most of the cells present, respectively, a few granules of that light brown matter in their interior, to which I have already alluded as a distinguishing mark of the sperm-cell throughout. (For more magnified views of these figures, see Pl. III. fig. 13 *a*—*f*).

After a time the vesicles enlarge, through nourishment probably derived from the "branchial" vessels, and surround, either entirely, or partially in groups, globular masses of fine granular matter, which vary in size from that of the sperm-cell upwards (figs. 14, 15), most of which contain more or less of the

* In the explanation of the plate, this figure is erroneously said to represent the form of the aperture of the shell.

characteristic brown matter. It has already been stated that the vesicles are disposed (according to their number) partially in a group or entirely around the albuminous centre of the floating-cell of the peritoneal cavity; and it is well to bear this in mind, for we shall see presently that when the spermatozoa which are produced from them are half-developed, they hang generally or partially in groups from the globular agglomerations, and that this grouping may be thus accounted for (figs. 17, 18, &c.). At this period (fig. 9) the vesicles are filled with a homogeneous refractive substance, which, upon contraction, after having been some time exposed to the action of the water, shows that it is composed of a granular endoplasm, supporting in one part of its periphery a nucleus,—in fact, that each vesicle is a complete cell (fig. 26 *a*, *b*); while the material of which the granular mass is composed at this time is so fine, that it has hardly passed beyond the homogeneity of the original albuminous mass (fig. 26).

The next stage in the development of the spermatozoa is that the vesicles become elongated and conical, and that the pointed extremity is applied to the granular mass, whose granular matter is also now becoming progressively coarser (figs. 10 & 16).

During the fourth stage, the conical point becomes lengthened into a pedicel, which thus presents the first appearance of the spermatozoon, and the material of the granular mass has become still coarser (figs. 11 & 17).

During the fifth stage (figs. 12 & 19), the spermatozoon grows out to its full length, and disunites itself from the granular mass (fig. 12 *e*), which, although keeping together in the ovisac while the spermatozoa are coiled round it, no longer coheres as before when forced out into the water, but, being effete, becomes lost or dispersed as soon as this takes place.

The part by which the spermatozoon adheres to the granular mass, though not distinguishable here from its linear form, is seen to be the head in *Nais albida* (figs. 32 & 33): hence it is the head which would appear to be developed first; and so Kölliker has stated, but not however in the way thus indicated, for he has observed that the whole of the spermatozoon becomes developed first in a cell within the vesicle (fig. 21 *a*), from which it gets into the cavity of the latter, and then forces its head out of one part to become attached to the granular mass*; but in all instances where the half-developed spermatozoa of this *Nais* have had the contents of the vesicle at their extremities contracted from long exposure to the water or from the addition of iodine, they have presented a granular aspect. This, however, may be, and probably is, owing to the extremely fluid state of

* Art. "Semen," Cyclop. of Anat. and Physiology, p. 486.

the matter composing the spermatozoon at this early period; for in *Nais albida* always, and even in *N. fusca* sometimes, the tails also project from the opposite side of the vesicle at the same time (figs. 25, 31, 32), thus proving that the whole body of the spermatozoon, at least in these cases, is formed at this early period. I have, however, not been able to see this or the daughter-cell in the sperm-vesicles of either of these *Naides*; nor have I, of course, been able to see that the spermatozoon is formed in the nucleus, as also stated by Kölliker*,—that is, I suppose, in the nucleus of the daughter-cell of the vesicle†,—probably from the smallness or unsuitableness of the materials I have had to deal with.

Among the contents of the ovisac from which the spermatozoa are thus developed, there are some granular masses which are surrounded by vesicles much larger than others (fig. 26), and these vesicles, although filled apparently with homogeneous refractive matter, like the rest, show, by the contraction of this into a globular form after they have been some time exposed to the action of water, that it also consists of a granular mass of endoplasm bearing in one part a nucleus (*a*, *b*). How such large vesicles are to bring themselves down to the size of those which only bear one spermatozoon each (fig. 16 *a*), I have not been able to understand; and never having observed more than one spermatozoon developed respectively from the vesicles attached to the granular masses, and these vesicles all small ones, I am at a loss to conceive what happens to the large vesicles, unless they become still larger, and then develope several cells in their interior, each of which bears a spermatozoon, as the presence of such cells now and then in the ovisac of *N. fusca* would seem to indicate (figs. 29, 30). That several spermatozoa may be developed from one vesicle is a common occurrence, and fig. 37 is an instance of it in *Ampullaria*; but whether this is another instance of each spermatozoon being developed from a separate cell, or the whole mass of cell-contents has split up into the bundle of spermatozoa thus represented, I am not called upon, or prepared even, here to discuss. Views respecting this will be found in the admirable article on "Semen," to which I have alluded. I must confine myself here to the common and only course of development in *Nais fusca* that I have been able to follow with certainty; and that is the one above described, wherein not only a gradual development of the spermatophorous vesicles can be traced from their first presence in the sperm-cell to the time when they become conical and present the first appearance of the spermatozoon, but the presence of the

* Art. "Semen," Cyclop. of Anat. and Physiology, p. 497.

† Is this a "nucleus," or the embryo of the spermatozoon?

brown matter unmistakeably marks the spermatophorous mass throughout, from the sperm-cell to the full development of the spermatozoa.

Let us now see what evidence we possess of connexion between the single small sperm-cell and the large globular masses supporting the vesicles, from which the spermatozoa are developed in the ovisac. In the first place, the only cells which are present in the ovisac, before the process leading to the development of the spermatozoa commences, are the ova *en groupe* and the sperm-cells, which at this time are identical with the floating-cells (fig. 9 *a*, *c*). It cannot be the ova, then, which develope the spermatozoa; hence we have only the sperm-cells left. Next we find several of the sperm-cells cohering together through the plasticity of their cell-walls, and forming agglomerations of different sizes; hence the *large* globular masses are accounted for (figs. 3 *k* and 13 *d*); while the presence of some cells or masses not exceeding the diameter of the single sperm-cell, yet bearing spermatozoa, shows that cells or masses, from the size of the sperm-cells up to that of the largest agglomerations, may bear spermatozoa (fig. 27). Lastly, having seen that the number of vesicles in the sperm-cells is very variable, and that these entirely surround the albuminous centre when numerous (13 *a*, *b*), or, when scarce, are situated on one part of it in a group (fig. 5 *d*), while they may be also partially or entirely absent, we have thus, in the early stage of the single sperm-cell, that which we have afterwards in the agglomerated mass, viz. the vesicles covering the mass entirely, or only attached to one part of it (figs. 17 & 18). Besides, it is very common to see the agglomerated masses themselves, at an early period, presenting groups of vesicles here and there upon them, indicative that the cells forming these parts of the masses respectively, alone bear vesicles (fig. 13 *d*). One point more deserves notice here, and one, too, which has not been well accounted for by the authors of the excellent article to which I have alluded, viz. the disappearance of the cell-wall or mother-cell in the globular masses. But this yields immediately to explanation when we know the cell-wall of the sperm-cells to be plastic, and therefore easy of disappearance in several ways; indeed, it is so evanescent, that in many of the cells of the reproductive band, as well as of the hepatic layer, where the *vesicles* have not undergone the least enlargement, the cell-wall is almost as often absent as present. However, one instance has occurred to me where the cell-wall seemed to have remained; and this was where the spermatozoa, which were more than two-thirds developed, had grown out from single sperm-cells—judging from their size (fig. 27). Here, then, it would appear that the mother-cell had become persistent from hardening, and that, as the vesicles under these circumstances could not be projected from the granular mass on the caudal ends of the spermatozoa as usual, the caudal ends had passed through both their vesicles respectively and the mother-cell. Fig. 28 also represents another instance where the mother-cell of an agglomerated mass appears to have remained. In some cases, too, even where the mother-cell is not persistent, and the vesicles, as usual, remain in contact with the granular mass, the tails of the spermatozoa are thrust through their opposite side (figs. 25 & 31–33), while not unfrequently both head and tail may be projecting while the vesicle is in the centre, as before mentioned (fig. 21 *b*). All this, however, is readily explained; for the vesicle in which the spermatozoon is developed is so flexible and plastic, that although the enclosed spermatozoon can throw it into all kinds of shapes, and half extrude itself, it is with the greatest difficulty only that it can throw it off altogether, while it is frequently so delicate in structure, and so diaphanous, that it is also very difficult to believe that it is not a part of the spermatozoon itself, whence the spermatozoon occasionally appears under a variety of shapes that are apt to mislead the observer in his determination of its true form.

Another point deserving of attention is the origin of the "brown matter," not only in the sperm-cells of the ovisac, but also in those of the so-called testes. This, as regards the former, seems easily determined; for if the sperm-cells of the ovisac be derived from the floating-cells of the peritoneal cavity, and the floating-cells subsequently become the hepatic cells, there is every reason to infer that the brown colouring matter is but the yellow colouring matter of the bile thus altered,—an inference which derives confirmation from the fact that the globular masses bearing spermatozoa in *Ampullaria* (figs. 35, 36) frequently bear at the same time one or two large bright bile-globules (*a*), together with the granules characteristic of the hepatic cell, some of which present the brown colour and character of the brown granules of the sperm-cell, and appear, as before stated, to be the abortive or effete remains of the bile-vesicles; so that here (figs. 35, 36) we have the granular mass with some of the vesicles half-developed into spermatozoa; others united together, forming bright amber-coloured bile-globules; and a third set in an abortive or effete state, presenting themselves under the form of granules, some of which have the colour and appearance of the brown granules of the sperm-cells. Thus we have not only evidence of the sperm-cells producing bile, like the hepatic cells, but also this fact corroborating the inference that both the sperm-cells and hepatic cells are derived from the floating-cells of the peritoneal cavity.

We have yet, however, to account for the presence of this colouring matter in the sperm-cells of the testes (fig. 6 *e*), which cells, as before stated, appear to be derived from the dermal cells of the reproductive band,—a point that should certainly not be considered as a natural consequence from their apparent identity with the floating-cells only; but it so happens that there is a maculated *Nais* which dwells in the salt- as well as the fresh-water pools here, and which latterly I have also found in the sediment of the jar of *Chara* before mentioned, where the dermal cells throughout bear amber-coloured globules (the *maculæ*), corresponding in appearance to bile, and answering to the common chemical tests for oily matter, that is to say, dissolving under the influence of æther or a solution of caustic potash respectively. Thus we have the dermal cells in this species, at all events, secreting an oily matter like bile, if not identical with it: and the cells of the reproductive band being but dermal cells apparently modified by hypertrophy, and thus brought into a state similar to the floating-cells of the peritoneal cavity, which appear both to secrete the bile and form the spermatozoa, as the occasion may demand, we have this sort of explanation (should these cells of the testes be hereafter proved to come from the reproductive band) to account for their presenting the characteristic brown matter of the sperm-cell of the ovisac.

Thus I have stated all that has occurred to me in the development of the spermatozoa in the ovisac of *Nais fusca,* worthy of mention; and although I have not been able to follow the developmental process of the spermatozoa in the so-called testes of this worm throughout, yet the *lacunæ* have been supplied from the progressive development of the sperm-cells in the testes of *N. albida,* which, proving to be the same as that of the ovisac of *N. fusca,* thus completes the process for us in the testes of both. Still, where the sperm-cells of the testes in these two species of *Nais* come from in the first instance, remains undiscovered.

Let us now, before going to the development of the embryo, compare with one another the changes which take place in the development of the ovum and sperm-cell, in order that we may see how far they correspond.

Ovum.	*Sperm-cell.*
Composition.	
Cell-wall.	Cell-wall.
Endoplasm (primordial film or cell).	Endoplasm (primordial film or cell).
Yelk (composed of fine granules).	Albuminous sphere (composed of crypto-granular refractive matter).

Ovum.	*Sperm-cell.*
	Composition.
Nucleus (or "germinal vesicle").	Nucleus.
Nuclei (or points in the endoplasm of the "germinal vesicle").	Vesicles (or cellules round the albuminous sphere).
Changes.	*1st stage.*
Cell-wall continues.	Cell-wall continues.
Endoplasm disappears.	Endoplasm disappears.
Yelk-granules become large and multiplied.	Albuminous sphere becomes perceptibly granular.
Nucleolus (or "germinal spot") perishes.	Nucleus perishes.
Nuclei, or points in the endoplasm of the "germinal vesicle," become surrounded by cells respectively.	Vesicles develope spermatozoa which attach themselves to the albuminous sphere.
	2nd stage.
Nucleus or "germinal vesicle" disappears (that is, bursts, and the "nuclei," now surrounded by cells, are dispersed in the yelk ?)*.	Spermatozoa fully formed and separated from the albuminous spheres or granular masses.
Yelk persistent.	Granular masses effete.
	3rd stage.
Ovum receives the spermatozoa.	Spermatozoa enter the ovum.
Yelk-granules are resolved into a crypto-granular mass.	
Yelk, having received its final envelopes and been laid, undergoes deduplicative subdivision.	

Thus we see that the differences between these processes are so great, that they cannot even be considered analogous. The new cells produced by the ovum and sperm-cell respectively, that is, the cells of the nucleus and the "vesicles," are the only products that we can compare with one another; and these are so far different, that one is produced in the germinal vesicle, and the other out of it, while the yelk of the ovum no doubt affords nourishment to the germinal vesicle, as does the granular mass

* I have also observed some of these cells (fig. 12 *h*) to be again charged with nuclei, indicative of their undergoing a further multiplication after having been dispersed in the yelk.

to the spermatozoa; but with the complete development of the latter, the functions of the granular mass cease, at the time that those of the yelk chiefly commence. There is so little analogy, then, between these two processes, that while they are *sui generis* as regards each other, that producing the spermatozoa is, I think, different from any other processes of cell-formation with which I am acquainted. Of course I allude here to the attachment of the spermatozoa to the albuminous sphere, and not to those instances where the whole of the cell-contents of the spermatic or mother-cell become divided up at once into a group of spermatophorous vesicles, each of which encloses from the beginning its share of nourishment, and thus has no occasion for re-attachment to an albuminous centre, as in some species of microscopic *Filariæ*. This is common enough among the Algæ.

Impregnation.

This I have not seen, and therefore there is a *hiatus* here which I cannot supply. Out of all the enlarged ova that have come under my observation, not one has presented that broken-down appearance of the granules of the yelk which follows impregnation; and although many have been bordering upon this stage, yet it has been impossible to witness impregnation by keeping the individual under the microscope, for the very pressure of the slip of glass which is necessary to bring the ovum into focus kills the worm. Hence we must pass over that part which intervenes between the development of the cells in the germinal vesicle and the expulsion of the egg, during which time the germinal vesicle disappears, impregnation takes place, the yelk-granules become dissolved or altered, and the ovum, after having received its final investments, is laid.

Development of the Embryo in Nais albida.

It has already been intimated that all the information which I have been able to obtain respecting the development of the embryo has been from the eggs of *Nais albida*, which were deposited in portions of a gelatinous Alga (*Glœocapsa*) that grows on the sides of old walls and gutters in the island of Bombay, during the rainy monsoon. By what means, in addition to the contractile power of the delicate oviduct, the eggs are expelled, I am ignorant; but having frequently observed species of this *Nais* with enlarged ova, in the midst of, and dragging themselves through, the gelatinous substance of the Alga mentioned, to which the eggs are thus agglutinated, it does not appear improbable that the resiliency of this substance may, to a certain degree, assist the *Nais* during delivery.

The ovum of this worm (fig. 39) is elliptical and slightly bent upon itself. It averages about 1-55th part of an inch in length, and consists of a transparent, coriaceous shell (*a*), terminated by a thickened, irregular, papillary portion at each end, from the inner aspect of which a kind of chalaza (*b*) is continued on to the yelk-bag (*c*).

Each yelk-bag contains two yelks (*d, d*), which respectively undergo more or less irregular duplicative subdivision, of which the following is a summary: viz. during the first stage, or that of the larger fissuration, the mass becomes triglobular (39 *d*), after which only one of the divisions appears to undergo *minute* division, while the other two either remain passive or undergo what may be termed crypto-division, for their substance certainly passes into minute cells, in whatever way this may be effected (40, 41). As the fragmentation thus goes on, the trilobate mass becomes elongated, by the two unfissurating lobes uniting more intimately to form one part, while the fissurating one forms the other (42); and the two extremities of the embryo becoming approximated like the ends of a horse-shoe, it thus lies confined by a delicate membrane, in a somewhat compressed globular form, with a notch in one part of the margin (43).

The notch now extends inwards towards the abdominal limit, when the two halves of the worm thus become separated, and the part which underwent the *visible* fissuration appeared to me to be the head. The young *Naides* now burst through the delicate cell which appears to surround them respectively, and, becoming free in the cavity of the shell (44), travel round it for some time until they have gained sufficient strength to force an opening through one end of it, when they thus make their exit.

I had not many opportunities of watching the development of the embryo (which occupies about five days), because I only discovered the eggs of the *Nais* mentioned towards the end of "the rains," when the *Glœocapsa* was dying off, and these *Naides* also appeared to get weaker and perish with it; but out of about two dozen eggs, many of which I got within twenty-four hours after they had been deposited (for they were laid in my room), sufficient observations were obtained to enable me to give the above description and accompanying illustrations.

How the double yelk is produced, when only one ovum is developed at a time, I am unable to state; but, from one observation, I am inclined to think that the first line of fissuration determines this, viz. from the masses becoming permanently detached at this time, and the rest of the fissuration going on in them separately.

On one occasion I obtained an egg which appeared to belong to *N. fusca*, and contained three or four embryos; but unluckily the watch-glass containing it was upset, and thus the means of proving it to be so, by their further development, lost.

Abnormal Development of the Yelk.

If the yelk become abortive, fissuration does not appear to take place, but several sacs containing a fine granular matter are developed in the midst of its substance (fig. 45), while gradually this fine granular matter becomes transformed into globular cells, each of which contains a yellowish refractive oil-globule, if it be not a nucleus (*a, a*). As this is taking place, the sacs, which are now plastic and endowed with motor power, put forth respectively a tubular prolongation, which, on reaching the shell of the ovum, becomes suddenly diminished in calibre, and thus passes through it in an attenuated form (*a, a*); or the sac may assume nothing but a tubular form from the first, and, after penetrating the shell, expand into a globular or conical shape, ending in a narrow papillary eminence (*d*). Finally, the extremity of the tube, in both forms, yields to the pressure of the internal contents, which now rapidly issue, one after another (*b*), in the form of monociliated monads, about 1-5600th of an inch in diameter (46 *a*). These, after swimming about for a short time, become fixed, and the next day may be observed to have lost their cilium and to have put forth a short tube (*b*), after the manner of the parent sac; but whether this ends in another division of their contents into still smaller monads, or they thus perish, I am ignorant.

This development of the yelk, which does not occur if it become putrescent, is but another instance of what I have shown to take place in the protoplasm of the spores, &c., of Algæ*, when arrested in its progress to assume the likeness of the plant from which the spore has been produced; that is to say, that instead of doing this in either instance, the contents of the ovum and the spore respectively become transformed into monads, and finally into rhizopodous cells—that is, reduced to the lowest form of organic life with which we are acquainted.

I have stated that the sacs in the yelk "*put* forth tubular prolongations;" and this is done in the following way (if I may judge from similar sacs putting forth similar tubes under similar circumstances in the algal cell): viz. the endoplasm or protoplasm, whichever term is adopted, appears to be compelled to obey a law by which its surface becomes covered with a pellicle, and this pellicle again compelled by another law to harden soon after it has been formed; thus circumstanced, the endoplasm carries a pellicle with it, that corresponds in every way to its

* Annals, vol. i. 3 ser. p. 35, &c. pl. 3. figs. 13–15, and vols. xvii. & xix. 2 ser.

shape, wherever it goes, and whatever form it assumes; which pellicle, on hardening, takes on the form given to it by the protoplasm, and thus the tubular prolongation is produced; it is, in fact, only an instance of the way in which all organic forms are developed, viz. by the moulding power of the protoplasm, which in this case, however, has lost its specific nature.

Filaria in Nais albida (fig. 50).

Among the figures illustrative of this paper will be observed one of a *Filaria*, which I frequently found singly and in variable plurality in the peritoneal cavity of *Nais albida*, which worm, I have already stated, was met with accidentally in a species of *Glœocapsa* that abounds with microscopic *Filariæ* during the rainy season. This Alga having been collected for this purpose, I shall defer further mention of this fact than that which will be found in the explanation of the figures, until I come to describe these *Filariæ* generally, which I propose to do on a future occasion.

Bombay, 24th April, 1858.

EXPLANATION OF PLATES II., III. & IV.

N.B.—Wherever the species from which the figure has been taken is not mentioned, it must be assumed to be *Nais fusca*.

For the purpose of conveying some idea of the relative size of many of the objects, they have been drawn upon a scale of 1-12th to 1-5600th of an inch, and their measurements given in 5600ths, with the same view.

Plate II.

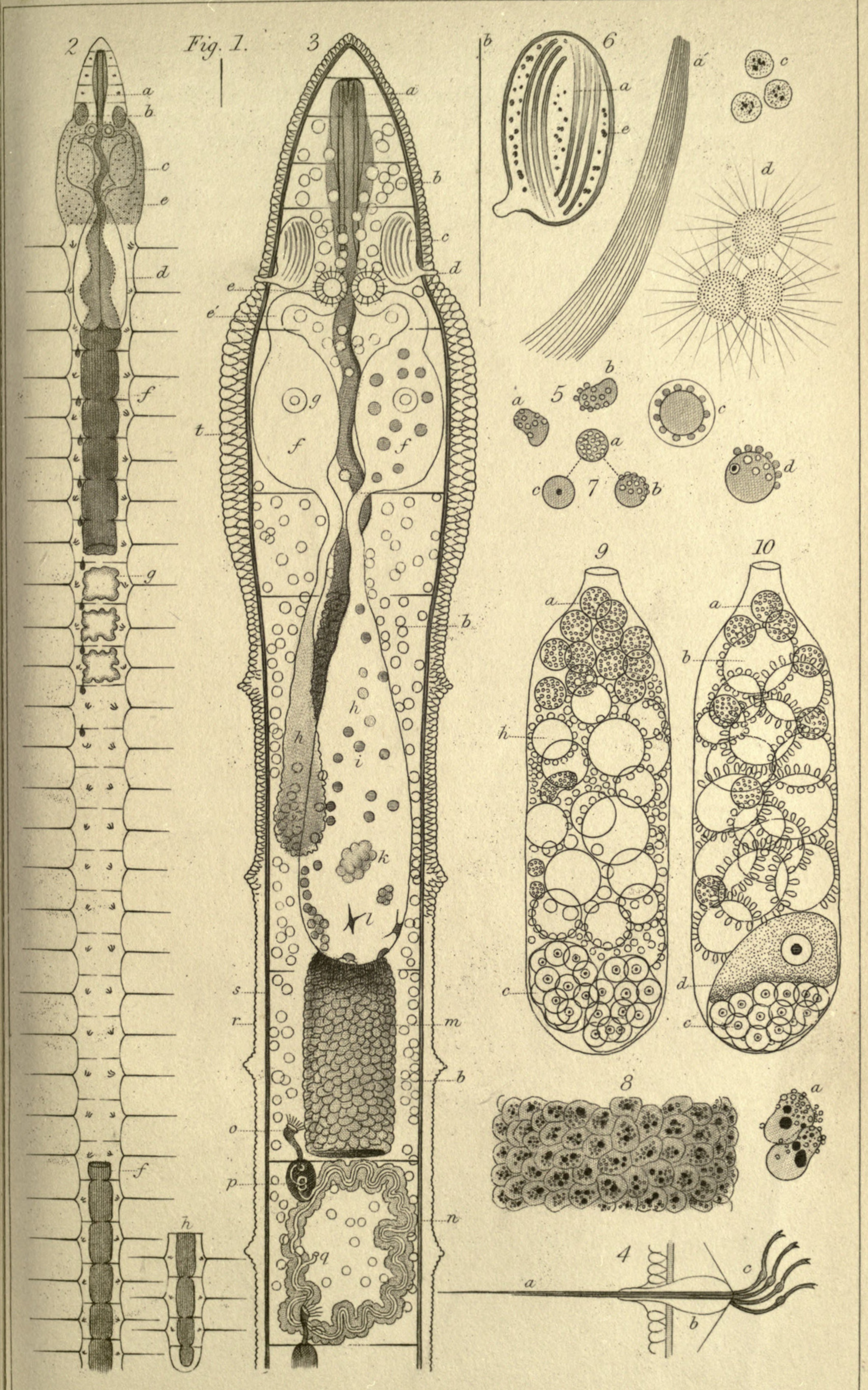
Fig. 1. *Nais fusca*; natural size.

Fig. 2. Ditto, proportionally magnified, showing—*a*, œsophagus; *b*, testes; *c*, oviducts, or so-called "uteri;" *d*, ovisacs; *e*, reproductive band; *f, f*, intestine; *g*, segmental organ; *h*, continuation of worm. (The central part of this figure is not filled-in, to save trouble.)

Fig. 3. Ditto, anterior part, still more magnified, showing—*a*, œsophagus; *b, b, b*, floating-cells in the peritoneal cavity; *c*, testes; *d*, orifices of spermatic ducts; *e*, ciliated openings of *e'*, the so-called "fallopian tubes;" *f*, oviducts, or so-called "uteri;" *g*, vaginal openings of ditto; *h, h*, ovisacs; *i*, floating-cells in cavity of ditto (see the same also, fig. 12 *a, e*, more magnified); *k*, ditto, agglomerated (afterwards forming granular masses); *l*, ditto, caudate (for a more magnified view, see fig. 13 *a, f, d, e*); *m*, intestine, covered with hepatic cells; *n*, segmental organ; *o*, ciliated or internal opening of ditto; *p*, elliptical portion of ditto; *q*, external opening of ditto; *r*, external or cellular sheath; *s*, internal or structureless sheath; *t*, reproductive band.

Fig. 4. Magnified view of cirrus and setæ: *a*, setæ; *b*, bulb of ditto; *c*, cirrus.

Fig. 5. Cells of reproductive band, diffluent in form, about 2-5600ths of an inch in diameter when spherical (drawn on a scale of 1-12th to



H.I.C. del. J. Basire sc.

1-5600th of an inch): *a*, with cell-wall; *b*, without cell-wall; *c*, imaginary section of spherical form, more magnified, to show the relative position of cell-wall, vesicles, and albuminous sphere; *d*, spherical form of ditto without cell-wall, showing the vesicles still adhering to the albuminous sphere, also the nucleus.

Fig. 6. Testes, so-called, magnified, containing bundles of spermatozoa (*a*) and granules (*e*): *a'*, bundle more magnified; *b*, single spermatozoon; *c*, sperm-cells from testes containing the characteristic brown matter (on same scale as fig. 5); *d*, globular masses of granules bearing spermatozoa from ditto, of which the component parts are proportionally magnified, each mass about 3-5600ths of an inch in diameter (on same scale as fig. 5); *e*, loose granules.

Fig. 7. Floating-cells, magnified (on same scale as fig. 5): *a*, with cell-wall; *b*, without cell-wall; *c*, after the bursting of the vesicles, showing nucleus (fig. 5 *c*, *d*, are also equally characteristic of the composition of this cell).

Fig. 8. Portion of intestine magnified, to show the layer of hepatic cells (the larger dark spots represent the bile-globules): *a*, two hepatic cells still more magnified.

Fig. 9. Ovisac with spermatozoa and groups of ova in first stage of development: *a*, sperm-cells (identical in appearance with floating-cells), about 2-5600ths of an inch in diameter; *h*, granular masses surrounded respectively by spermatophorous vesicles (see a more magnified view of one of these masses, isolated, fig. 14); *c*, two groups of ova, each about 10-5600ths of an inch in diameter, of which the ova are about 2-5600ths of an inch in diameter each.

Fig. 10. Ovisac with ditto ditto in second stage of development: *a*, spermatic cells unaltered, or with a little brown matter in their interior, as before. (From the constant ingress of floating-cells, even to the end of the development of the spermatozoa, there are always some of these in their primary stages present at the mouth of the sac, and therefore some are frequently found here in all stages of development; but with each impregnation, the ovisac appears to be cleared of everything except the remaining ova.) *b*, granular masses surrounded by the spermatophorous vesicles, now become conical (see fig. 16); *c*, single group of ova; *d*, single ovum with germinal vesicle, more advanced in development than the rest.

PLATE III.

Fig. 11. Ovisac with group of ova and spermatozoa in third stage of development: *a*, spermatic cells unaltered; *b*, granular masses surrounded by vesicles now pedicelled (see fig. 17); *c*, group of ova; *d*, ovum more advanced; *e*, another, less advanced; *f*, more magnified view of germinal vesicle, showing nuclei or points in endoplasm.

Fig. 12. Ovisac with spermatozoa fully developed: *a*, sperm-cells unaltered; *b*, spermatozoa developed and separate from the granular masses (see fig. 19); *c*, group of ova; *d*, ovum just previous to the disappearance of the germinal vesicle; *e*, effete granular masses; *f*, germinal vesicle more magnified, showing the nuclear points surrounded by cells, and the nucleus or germinal spot perishing or in progress of dissolution.

Fig. 13. Sperm-cells from the ovisac (on same scale as fig. 5): *a*, spherical form; *b*, diffluent form; *c*, undergoing fissiparation in the mother-cell (the only instances of this kind that I have observed have been in the ovisac, never in the peritoneal cavity); *d*, agglomerated, presenting the "brown matter" (represented by the dark shades) and isolated groups of vesicles in different parts; *e*, caudate form, also containing a little of the "brown matter;" *f*, single spherical sperm-cell presenting the "brown matter" in its interior.

Fig. 14. Granular mass with vesicles, in the first stage of development, 4-5600ths of an inch in diameter (on same scale as fig. 5). This is the smallest "granular mass" that I have met with, though probably not the smallest that exists, as there must be some not larger than the albuminous sphere of the floating-cell (see fig. 27).

Fig. 15. Ditto, ditto, 15-5600ths of an inch in diameter (on the same scale).

These two figures show the relative difference in size of the granular masses which compose the sperm portion of the contents of the ovisac.

Fig. 16. Granular mass (11-5600ths of an inch in diameter) with vesicles in second stage of development, *i. e.* when the latter become conical, and the matter of the granular mass coarser: *a*, vesicles.

Fig. 17. Granular mass (10-5600ths of an inch in diameter) with vesicles in the third stage of development; granular matter still coarser.

Fig. 18. Granular mass (5-5600ths of an inch in diameter) with spermatozoa still further developed, and attached in two groups.

Fig. 19. Granular mass with spermatozoa fully developed and separate, though still retaining the vesicles at their ends (and probably over their whole bodies, for it is so delicate that the spermatozoa can hardly ever be said to be out of the vesicle until no appearance of it is left).

Fig. 20. Granular mass contracted after long exposure to water, showing that sometimes there is a thin pellicular cell left in contact with the developed spermatozoa, though it probably amounts to nothing more than a surface-condensation, and not a real cell.

Fig. 21. Five figures showing the progressive formation of the spermatozoon, from the daughter-cell in the vesicle (according to Kölliker) to the common form under which the spermatozoon presents itself both in the testes and ovisac: *a*, vesicle with daughter-cell, according to Kölliker; *b*, spermatozoon with both extremities extruded from the vesicle, which is kept distended in the centre by the elasticity of its coils.

Fig. 22. Granular mass (8-5600ths of an inch in diameter) with spermatozoa attached in four groups.

Fig. 23. Granular mass with spermatozoa attached in one group.

Fig. 24. Granular mass with spermatozoa attached all over the mass, but, by a current of water, all drawn in one direction, showing how they may become "bundled" under these circumstances.

Fig. 25. Granular mass covered with vesicles, through some of which the caudal ends of the spermatozoa are projecting.

Fig. 26. Granular mass (7-5600ths of an inch in diameter) covered with vesicles of the largest size, viz. 2·5-5600ths of an inch in diameter; on the same scale as fig. 5. A few only of the vesicles are figured here, for the purpose of showing that the material of the granular mass is always extremely fine when surrounded by the larger vesicles. *a*, vesicle more magnified; *b*, after long exposure to water, showing that when its refractive contents become contracted, they assume a granular form, accompanied by a nucleus.

Fig. 47. *Nais albida*, natural size.