Note on the Early Development of *Tethya serica* Lebwohl, a Tetraxonian Sponge

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Tethya serica Lebwohl is a member of Tetraxonian sponges that lives on the sandy bottom of shallow waters near the Misaki Marine Biological Station; it has the shape of a pumpkin, hence the Japanese name Tonasukaimen for it. The early development of this sponge was first studied by Nagai in 1910, but his interesting results have unfortunately been passed almost unnoticed even among Japanese scientists. This was partly because the authors have overlooked, and did not cite his paper in their main textbooks or treatises except in Ishida's ('48).

To summarize his results briefly here; 1) This sponge belongs to that of dioecious type; 2) Its eggs and sperms being shed into the sea-water through the osculum, the fertilization takes place ectosomatic; an example of rare occurrence among sponges, perhaps the second case so far known, the first being that of *Cliona;* 3) The fact of the utmost interest found in the egg is that it has, radiating from its surface, numerous fine processes, each being rather stiff and not movable; again a rare, perhaps hitherto unknown, type of animal eggs; 4) When the egg is fertilized, some sticky substances are discharged from its surface and these substances expand and cover the tip of the processes, which then begin to bend down and become inconspicuous. The egg, which is now firmly stuck on the substratum by these substances, is then enveloped by a membrane transformed from them.

Nagai's observations, though of the greatest interest, leaving still much to be desired, further observation was undertaken to acquire more detailed knowledge about the development of this species. Here, the writer wishes to thank the staff of the Station and Mrs. Dan for the use of the laboratory fascilities, and Mr. Endo, without whose courtesy, photomicrographs presented in this paper would not have been prepared.

Methods of obtaining unfertilized or fertilized eggs

According to Nagai, breeding season of this species lasts from September to December. But, it seemingly begins much earlier in mid-summer.

When individuals of both sexes are kept in the same container, eggs that flow out of the osculum are soon fertilized by the sperms which similarly flow out of the male individuals. Eggs in the earliest stages of fertilization process can thus be obtained. Unfertilized eggs, however, can be obtained when these are caught while floating along the upward current coming out of the osculum, or by keeping female individuals in a separate container. These eggs can be fertilized by adding the water obtained by pipetting out from the gastral cavity of the male individuals.

Unfertilized egg

Eggs that flow out of the osculum are mostly spherical with a diameter of 0.17–0.18 mm, but oval ones are often observed. They are generally yellowish, but are sometimes more reddish, and are densely laden with yolk which shows faint hexagonal patterns. Around the egg, there is noted a clear vitelline membrane, and through this are radiated a number of fine processes, whose presence makes the egg resemble outwardly a form of Heliozoa (fig. 1 *a*). These processes are, however, rather stiff and not movable and their length is almost the same as

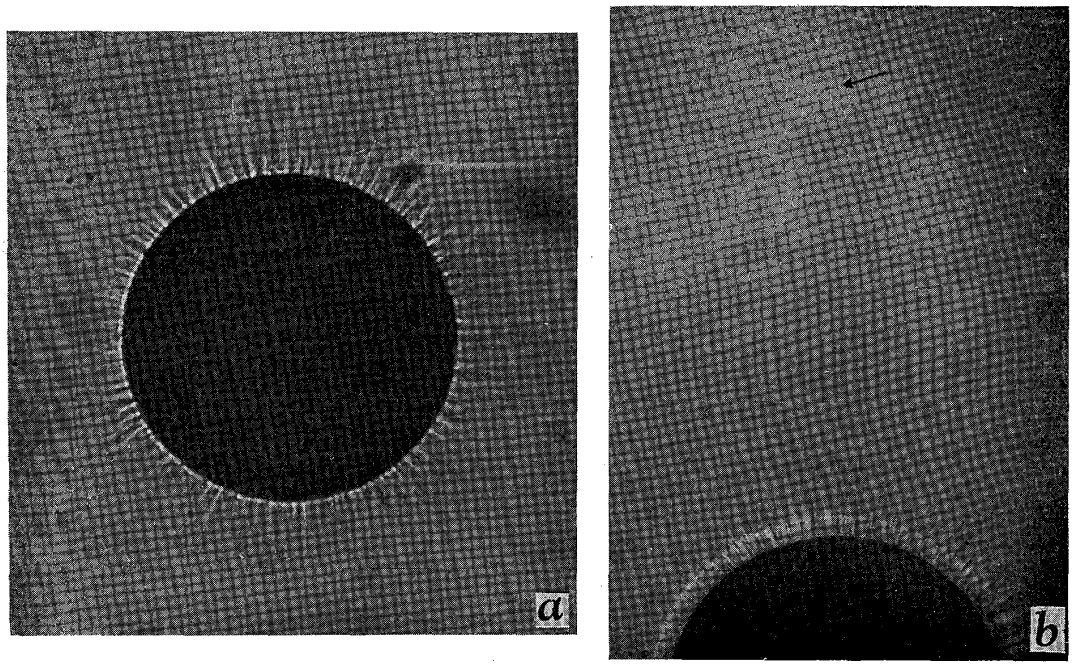

Fig. 1. *a*, Unfertilized egg; *b*, Egg-pocesses as observed with a phase constrast microscope. The arrow indicates the tip of the processes (×160)

that of the egg diameter when measured with an ordinary microscope (The processes in the figure by Nagai are too short). But, when observed with a phase contrast microscope, the tip of the processes is elongated extremely fine and is traceable until about twice the length of egg diameter (fig. 1 *b*). Whether each process is thus finely elongated or

only some processes or some processes at some limited regions have such characteristic form was not ascertained.

Fertilization

An actual process of fertilization was not so far observed, though several spermatozoa entangling between the roots of the egg-processes were quite often found. These eggs, when observed, soon elevate the membrane surrounding the egg at the site where a spermatozoon is supposed to have entered, and that process gradually extends around the egg within about one minute (fig. 2*a*; 2*b*). The elevated membrane is at first of irregular outline, but comes to be clearly defined and smoothly outlined while lifted. Usually, the membrane is lifted to the height of about one-tenth of the length of egg-processes when observed with an ordinary microscope.

While this is going on, two important features characterizing the early development of this species take place: these are 1) the adhesion of the egg to the substratum, and 2) the bending down of the processes upon the surface of the egg with the result of their withdrawal into the perivitelline space. The adhesion of the egg to the substratum starts when the membrane has still an irregular outline, and that adhesion gradually proceeds and comes to that degree that taking off the egg from the substratum, even by pipetting is difficult, and the egg itself then becomes usually flattened and takes an oval form as the result.

As to the egg-processes, almost simultaneously with the beginning of egg's adhesion, there occur a certain disturbance of their regularity and subsequent series of their bending process (fig. 2*c*~2*e*). Optically looking, bending takes place mostly in a spiral direction either right-handed or left-handed; but in some cases one side of the egg is of right-handed while the other of left-handed direction; and quite rarely spirality is not so conspicuous.

As this bending process proceeds, it finally comes to a stage when the egg-processes are completely withdrawn within the perivitelline space with the exception of the opposite two poles of the egg where there still remain a few processes projecting through the fertilization membrane (fig. 2*f*). These two portions, though they occupy rather wider areas at first, gradually become narrower calling forth a slight depression on the side of the egg surface and a slight elevation on the side of the fertilization membrane. Egg-processes thus projecting from these two portions are also finally withdrawn and the depression and the elevation of the egg surface and the membrane are smoothed out. The processes now completely enclosed within and filling up the perivitelline space make layers surrounding the surface of the egg, whose components, the individual egg-processes, are at first conspicuous but

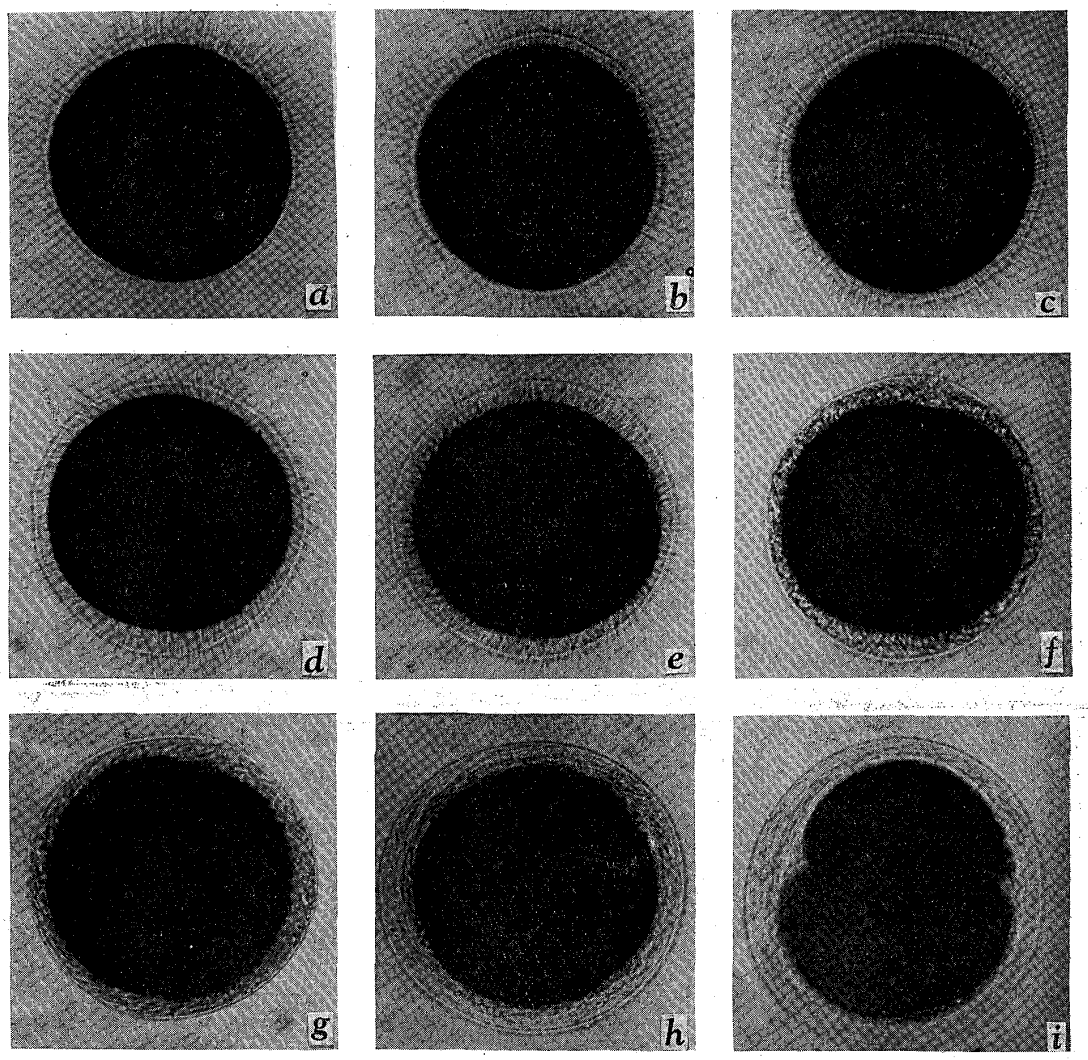

Fig. 2. A series of photographs from the fertilization to the beginning of the first cleavage. Time recorded from the beginning of elevation of the membrane. (×100) *a*, first stage of the membrane elevation (10″); *b*, 36″; *c*, a sign of disturbance of regularity in the arrangement of processes appeared (1′ 15″); *d*, processes are spirally twisted (2′ 20″); *e*, 3′ 35″; *f*, processes are still remainning at opposite two poles (8′ 25″); *g*, processes are now completely withdrawn into the peri-vitelline space (20′ 40″); *h*, processes are rather regularly arranged around the surface of the egg (1° 16′); *i*, 2 cell stage (3° 40′)

later become less distinct (fig. 2*g*; 2*h*). Explanation of this bending-mechanism is seemingly of rather complicated mater; but, so far as my observations go, at least a shifting of the fertilization membrane during formation seems to be responsible, for which conclusion, however, further observations and experiments are required.

Segmentation

The first cleavege takes place about 2 and a half hours after fertilization at a room temperature of 26° and about 4 hours at 19° (fig. 2*i*). Eggs segment totally and adequally, but there are many variations in

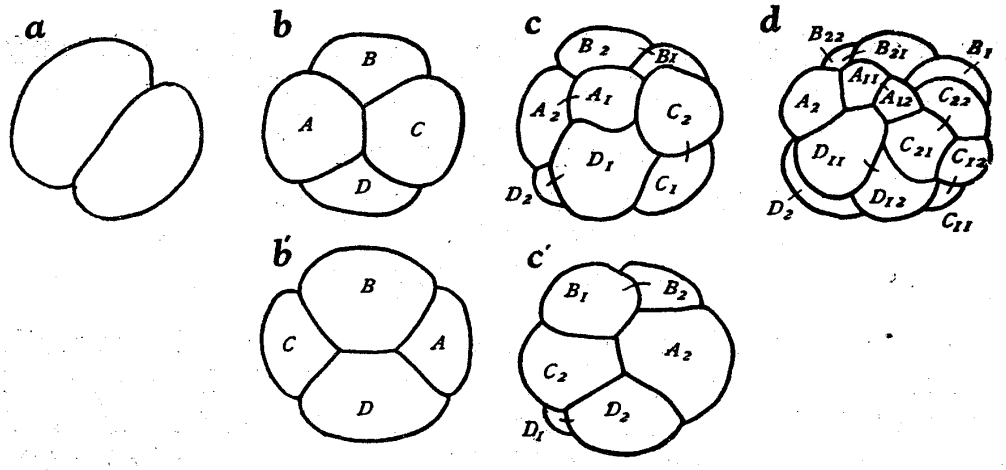

Fig. 3. An example of successive stages of cleavage patterns. *a*, 2 cell stage; *b*, 4 cell stage; *b'*, underside view of *b*; *c*, 8 cell stage; *c'*, underside view of *c*; *d*, 16 (?) cell stage

cleavage patterns, and even the first cleavage is often omitted. These variations probably depend largely upon the degree to which the egg adheres to the substratum. Therefore, a single example is presented as an illustration (fig. 3).

Summary

1. The early development of *Tethya serica* Lebwohl was described.

2. This species belongs to the dioecious type and the fertilization takes place ectosomatic.

3. Eggs, usually spherical in shape, have a diameter of 0.17–0.18 mm. They are densely laden with yolk and are covered by a clear vitelline membrane, through which are radiated a number of fine processes, rather stiff and not movable. Their length is measured with an ordinary microscope as the same as that of the egg-diameter, but their tip can be traced until about twice the length of the egg-diameter when observed with a phase contrast microscope.

4. When fertilized, the fertilization membrane is elevated and the egg comes to adhere to the substratum. Almost simultaneously with this, each process gradually begins to bend over the surface of the egg and is finally enclosed within the perivitelline space, making layers around the egg.

5. Eggs segment totally and adequally. But there are many variations in cleavage patterns, which probably owes to the degree to which the egg comes to adhere to the substratum.

Literature

Ishida, J. 1948. Hatching in Animals. (in Japanese) Tokyo: Kawade Publ. Co.

Nagai, M. 1910. On the fertilization of the egg and its cleavage in *Tethya serica*. (in Japanese) Dobutsugaku Zasshi **22**: 76-85