On the Development of a Brood-Caring Actinian[1)]

By

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(With 2 Text-figures)

In 1949 Nyholm reporting on the development and dispersal of *Halcampa duodecimcirrata* divided the dispersal-modes of actinians larvae into the following four types: A. *Sagartia* type, eggs develop outside the female animal; B. *Urticina* type, eggs develop inside the female animal, pelagic planula stage shorter than in A; C. *Peachia* type, medusophilous, good dispersal; D. *Halcampa* type, eggs develop on the bottom into a planula-like larva entirely without cilia, there being no pelagic stage, thence slight dispersal. The actinian here reported is somewhat in agreement with *Halcampa* (D type) deficient in pelagic stage, but different from the latter in regard to the brood-caring habit.

The actinian was recorded by Uchida (1934) as *Epiactis prolifera* from the Northern coasts of Japan. At that time he described briefly the anatomy of the young actinians which were generally found attached to the column of mother actinians in the vicinity of the Akkeshi Marine Biological Station from January to August, but especially in spring. The number of them attaching to a single mother actinian is very variable but their stages in a mother are nearly similar. From the fact that the youngest embryos adhering to the mother are furnished with the two germinal layers, it was surmised that the eggs fertilized in the mother's coelenteron were thrown out in sea-water from it by the contractive movement of the column as in *Actinia equina*, and were immediately attached to the wall by means of mucus secreted from the surface of the ectodermal protuberances. It was generally observed that the lower part more than half the surface of the embryo was firmly coated with the ectoderm of the mother, which was very undulated and featured in having large cells containing many granulae well stained by haematoxylin. These large cells seem to be mucus cells.

In spite of the publication of works on the development of the brood-caring echinoderms, such as sea-stars, sea-urchins and sea-cucumbers, there has been published no paper concerning the development of the brood-caring actinians. Therefore, we undertook to reveal the life history of the Japanese actinian several years ago. As the young actinians adhering to the mother are found from

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December to August every year, the breeding season of thea ctinian seems to last fairly long. Since the actinians carrying young ones are most frequently found in winter and rather rare in summer, it can be postulated that the breeding season possibly takes place late in autumn. The fact was confirmed by the junior author who observed the spawning of several individuals of the species reared in the aquarium during the end of October to the beginning of December.

In the spawning it was often observed that a single actinian first emitted the sperm and several hours afterwards discharged eggs. From the observation

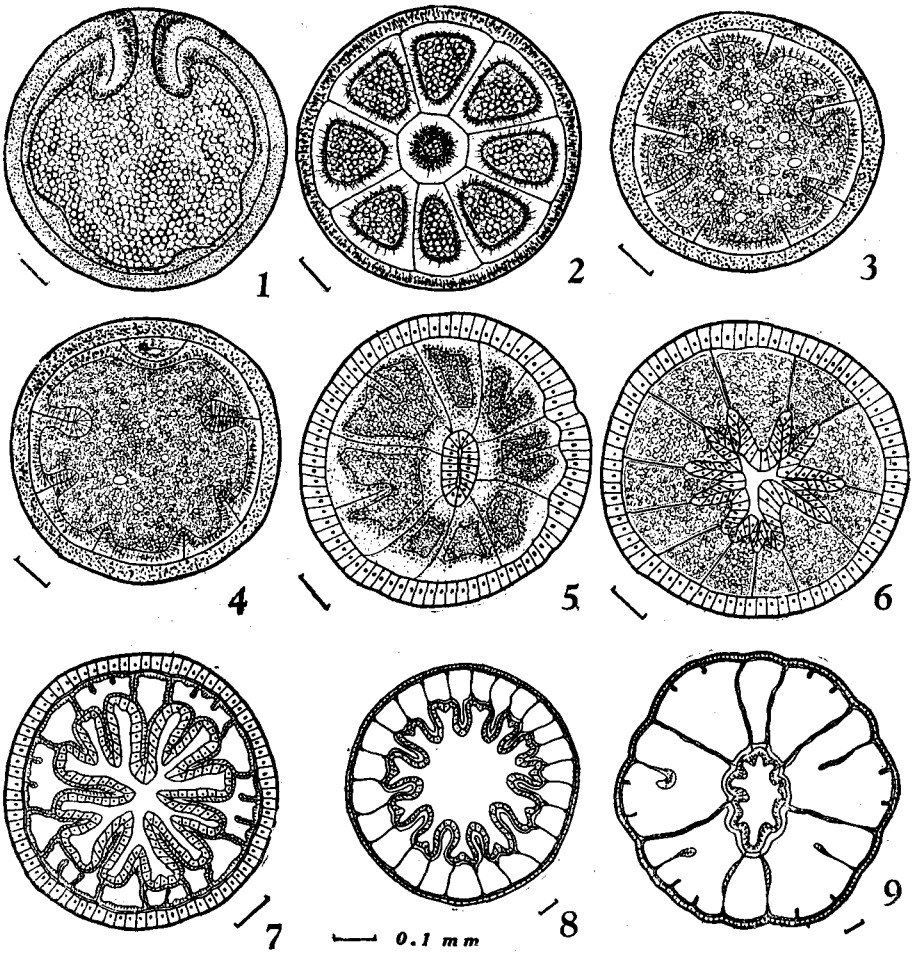

Fig. 1. Embryos and young actinians adhering to the column of the mother : 1. embryos ; 2. the same magnified ; 3. young actinians, showing in 4 the close contact of the pedal disc to the columnar mucus tissue of the mother.

it has been revealed that the species is hermaphrodite. In sections it was detected that older series of mesenteries bear testes and younger series of them carry ovaries. The directive mesenteries have always testes alone and young imperfect mesenteries are provided with ovaries. Therefore, the intermediate imperfect mesenteries show often hermaphrodite. The testes are found to develop in the lower part of the mesenteries, while the ovaries are observed to locate in the upper part of them. This actinian is possibly an example of protogyny. In spawning the sperm is at first emitted from the stomodaeum together with milky white mucus by the rhythmical contractive motion of the columnar muscles. The sperm is nematosperm, composed of a head, a middle piece and a tail, the tail being 4.5 μ long and the remnant 2.5μ long. The sperm was observed to remain alive for 5 days in the water of 7.5°C. Several hours afterwards the ova are discharged in groups from the mouth, also together with a milky white mucus by the same contractive motion. These eggs are brownish red and rather large in size among actinians, approximately 1 mm in diameter. They have been already fertilized in the gastric cavity of the mother. The eggs ejected attach themselves to the mother-actinian by transparent mucus which makes very easy to adhere the eggs to the wall of glass vat. All the eggs thus discharged do not attach to the column of the mother and some eggs are thrown near the base of the mother actinian. The embryos attached to the mother's column are nearly wrapped with the mother's ectoderm which is here composed of high columnar mucus cells containing minute granulae (Fig. 1, 1 & 2). After the two germinal layers have been clearly differentiated in the embryos, the basal disc consisted of columnar mucus cells, becomes into close contact with the mother's column (Fig. 1, 3 & 4).

So far as the writers are aware, the youngest embryos attached to the mother actinian are in the gastrula-stage and quite deficient in cilia. The young actinian has neither free-swimming nor crawling stages at all. The spawning season seems to last fairly long, because among the actinians collected in November and December some had the column thickly covered with embryos, some bearing small number of them and some having none of them at all. In the stomach cavity of the actinians bearing youngs there could be seen many eggs unfertilized. These eggs will possibly fertilized after some interval. The fertilized eggs newly emitted from the mouth of the mother are already in gastrula-stage as stated above. They are covered with a rather thick layer of transparent mucus as in *Halcampa duodecimcirrata*. It was often observed that many spermatozoa are aggregated on the layer and some penetrate it to the fertilization membrane. Beneath the mucus layer are found the fertilization membrane and perivitellarine space. As in most of actinians the egg is provided with a good deal of deutoplasm. Though the invagination takes place as usual in other species of actinians, the process could not be clearly observed on account of the deutoplasm. In sagittal sections of the embryo one can see a narrow blastopore and large mass of deutoplasm in the central part (Fig. 2, 1). In horizontal sections there can be seen 8 radial pockets and a

narrow stomodaeum in upper portion (Fig. 2, 2) and mesenteries in the lower part (Fig. 2, 3). Intermediate spaces between the mesenteries are packed with deutoplasm.

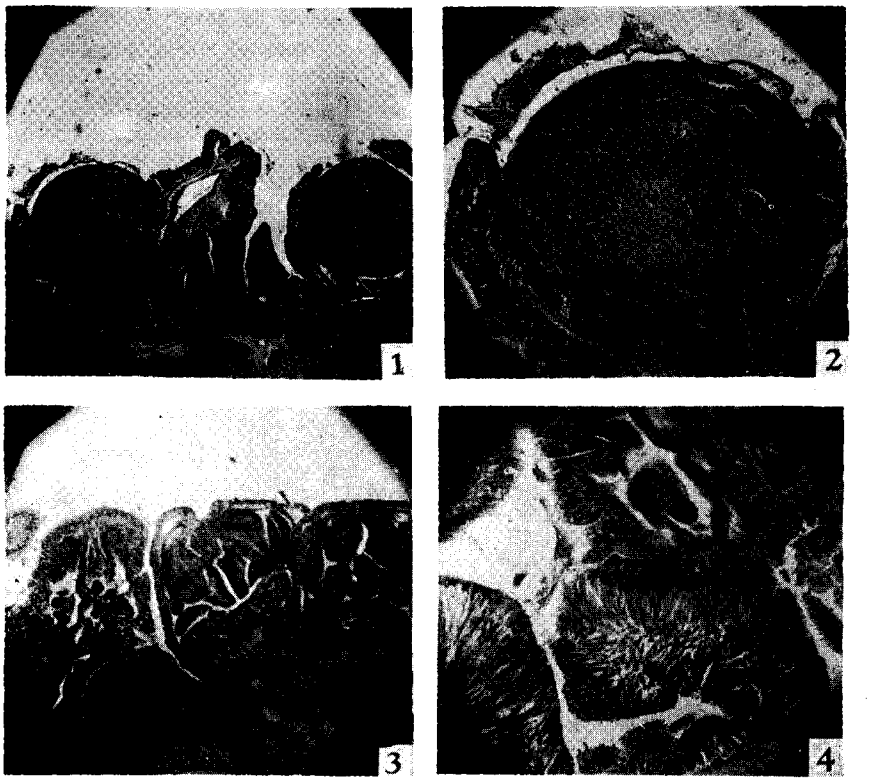

Fig. 2. Development of the embryo ; 1. Sagittal section of an embryo, two germinal layers already formed, with the blastopore and thick deutoplasm ; 2. Horizontal section through upper part of the same, showing the formation of mesenteries and radial pockets ; 3. Horizontal section through the middle level, showing the symmetrical formation of mesenteries and thick deutoplasm ; 4. The same through lower part ; 5. Horizontal section through upper part of an embryo further developed, showing the increase of imperfect mesenteries ; 6. The same of an embryo more developed ; 7. The same of an embryo still further developed, deutoplasm already absorbed ; 8. Horizontal section of upper part of an embryo of 24 tentacles ; 9. The same of lower part of an embryo with 24 tentacles.

Along with the appearance of the tentacles around the mouth the stomodaeum becomes wide and gradually folded. The deutoplasm occupied the

intermediate spaces between the mesenteries becomes gradually absorbed. The young actinians found on the column of the mother develop *in situ* to have 12 tentacles and 6 pairs of mesenteries (Fig. 2. 6) and then come to have 24 tentacles and 12 mesentery pairs, of which 8 mesenteries are perfect and 16 are imperfect (Fig. 2, 7–9). In this stage they leave possibly the column of the mother for independent life, because there can be found fair number of free-living young actinians with 24 tentacles on rocks around the habitat of the species. As to the development of the mesenteries the actinian pass through the *Edwardsia*-stage and then *Halcampula*-stage.

Specific remarks : In 1934 Uchida identified the Japanese species with *Epiactis prolifera* which is distributed in northern parts of North America. In the paper he pointed out the synonymy of the actinian with *E. ritterii* = *Cnidopus ritteri*. from Pacific Grove, California and *Bunodes japonica* from Hakodaté, Hokkaido. Carlgren (1947) agrees with Uchida as to the identification of the present actinian with *Bunodes japonica* and the last summer, when the latter visited him, talked that the Japanese species is possibly identical with *C. ritteri*, but seems to be different from *E. prolifera*. So far as the senior writer has observed the preserved specimens of *E. prolifera* in Carlgren's collection, they seem to be very similar to the Japanese specimens. The problem will be solved in further study.

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