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Two Cases of Hermaphroditism in the Sea Urchins, *Clypeaster japonicus* and *Hemicentrotus pulcherrimus*

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ABSTRACT Functional hermaphrodites in two species of sea urchin, *Clypeaster japonicus* and *Hemicentrotus pulcherrimus*, were found in Misaki, Japan. The eggs of these hermaphrodites were self-fertilized and development of embryos was practically normal. Microscopic observations of stained sections of the gonads revealed that in *C. japonicus*, four gonads were ovaries and the fifth was an ovotestis, and in *H. pulcherrimus*, four gonads were testes and one gonad was an ovotestis. (*Zool. Mag. 90: 394-397, 1981*)

Hermaphroditism is rare in sea urchins (Heilbrunn, 1929; Harvey, 1939, 1956). Boolootian and Moore (1956) summarized the hermaphroditism of echinoids as to genera and geographical distribution with a table of incidence. The statistics showed that most cases of hermaphroditism have come from three genera, namely *Arbacia*, *Paracentrotus* and *Strongylocentrotus*. The genera listed as having low incidences were *Dendraster*, *Echinocardium*, *Echinus*, *Psammechinus* and *Sphaerechinus*.

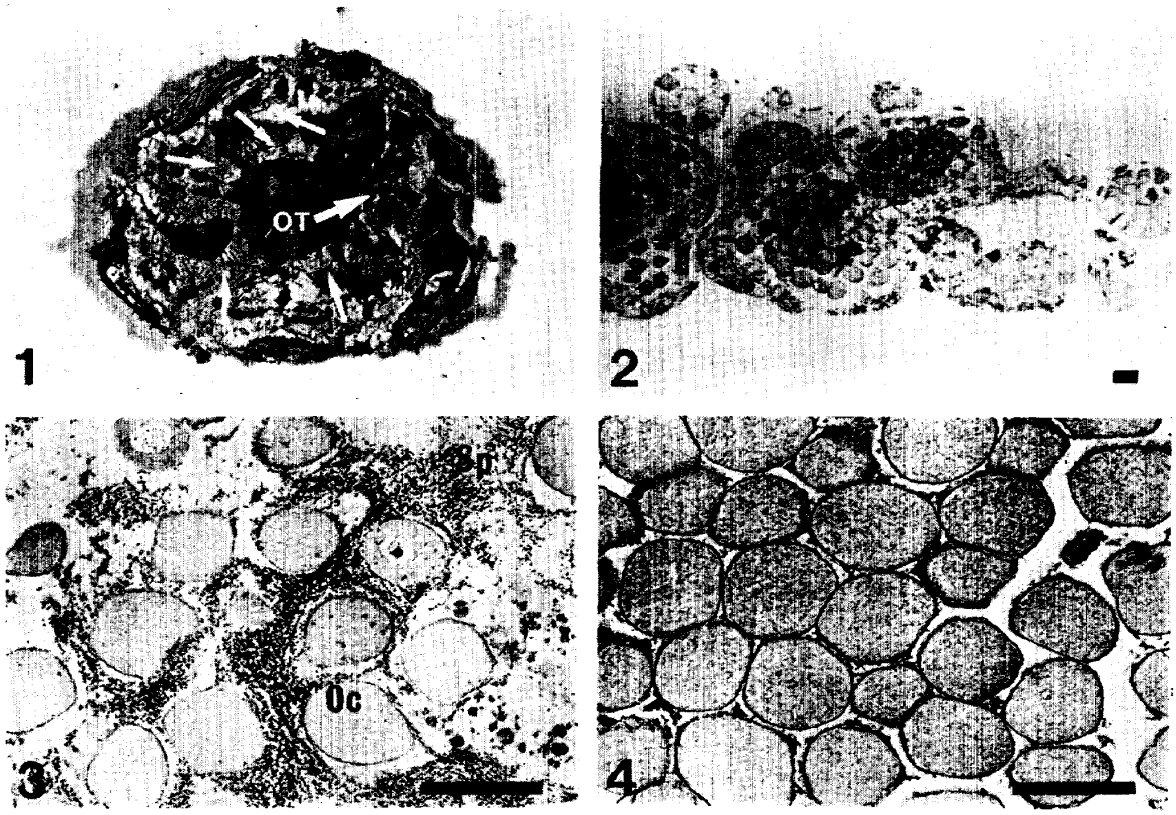
We report here on two cases of hermaphroditic sea urchins. They are *Clypeaster japonicus* and *Hemicentrotus pulcherrimus*. Both hermaphroditic sea urchins were found by chance among those collected at the Misaki Marine Biological Station (University of Tokyo, Misaki, Japan). Histological examination revealed that these two specimens were of opposite types. In *C. japonicus*, four gonads were ovaries and the fifth was an ovotestis, while in *H. pulcherrimus*, four gonads were testes and one was an ovotestis.

Clypeaster japonicus Hermaphrodite

In June of 1978, several specimens of *C. japonicus* were collected from the water near the Misaki Marine Biological Station. When 0.6 M KCl was injected into the coelomic cavity, one of them exudated eggs from four gonopores, and both eggs and sperm from the fifth gonopore. This hermaphrodite was normal in external appearance and of average size (11.8 cm in long axis; 9.2 cm in short axis). The eggs of the hermaphrodite were perfectly fertile in sea water with its own sperm. Normal fertilization membranes were formed, first cleavage took place normally, and practically all the eggs developed to the pluteus stage.

After the eggs and sperm were exudated, the oral side of the shell was removed, and the whole body was fixed in Bouin's solution. The overall view is shown in Fig. 1. Even with the naked eye, the gonad (indicated as OT in Fig. 1) which had shed sperm appeared somewhat different from the other four gonads. Small pieces of tissue were excised from each gonad, embedded in paraffin, sectioned at 5 μm thickness, and stained with Delafield's hematoxylin and eosin.

The histology of the gonad which produced sperm revealed that this gonad was an ovotestis and contained both sperm and oocytes in the same tubule (Figs. 2 and 3). Most of the tubules in this gonad were of the same type. The other four gonads showed the normal histology of pure ovaries (Fig. 4).



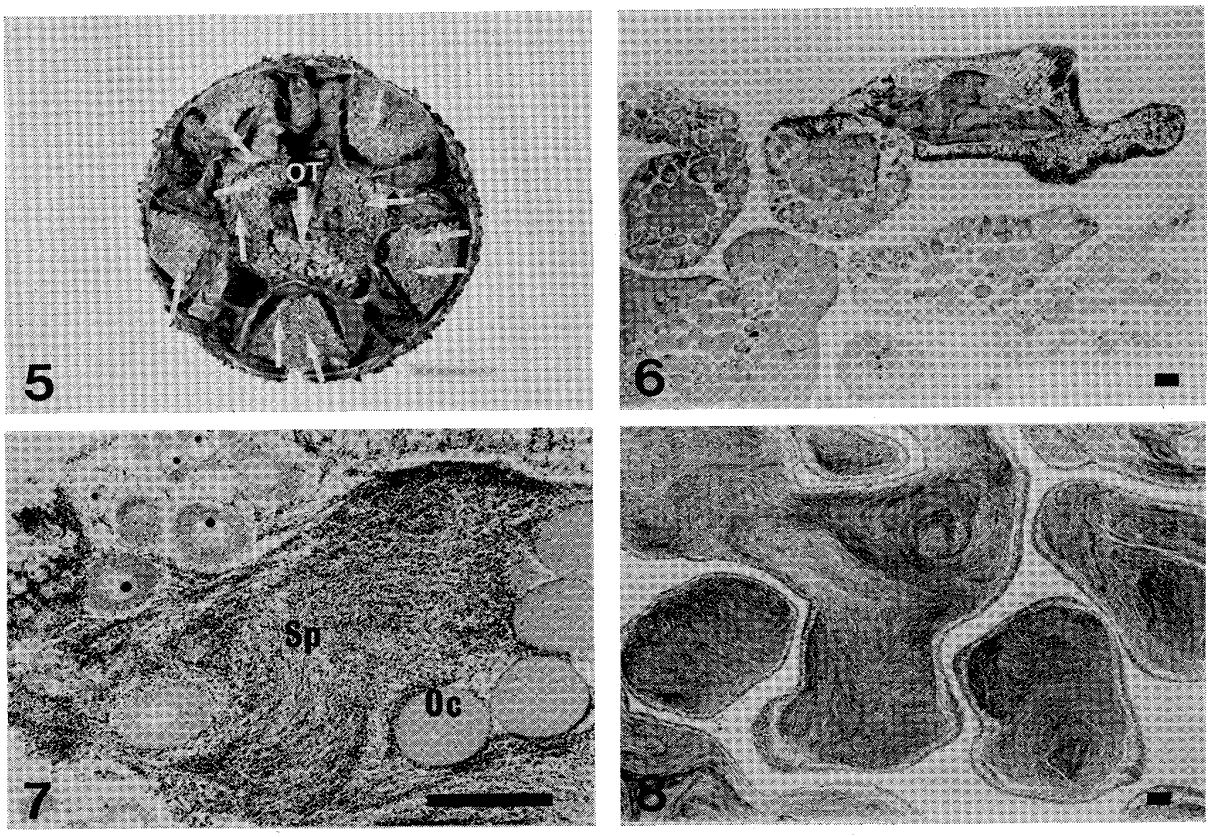
Figs. 1-4. *Clypeaster japonicus* Hermaphrodite.
Fig. 1. The gonads, portions of which were sectioned and examined (indicated by arrows).
Fig. 2. Ovotestis (OT in Fig. 1) containing both sperm and oocytes in the same tubule. Bottom bar : 100 μm.
Fig. 3. Higher magnification of the ovotestis shown in Fig. 2. Note the presence of both oocytes (Oc) and sperm (Sp). Bottom bar : 100 μm.
Fig. 4. Typical histology of a normal ovary found in the other four gonads. Bottom bar : 100 μm.

Hemicentrotus pulcherrimus Hermaphrodite

This specimen was collected in March of 1979 also from the sea near the Marine Biological Station. The external appearance was normal, with a size of 4.2 cm in diameter. This hermaphrodite exudated sperm from four gonopores, and both eggs and sperm from the fifth gonopore. Sperm agglutination was caused by its own egg sea water. The self-fertilized eggs developed normally to the two-arms-pluteus stage without any food. After this stage, they were fed on diatoms until 50 days after fertilization, and developed to the eight-arms-pluteus stage.

The stained sections were made in the same way as *C. japonicus*. Figure 5 presents the overall view, and portions of gonads (arrows) were excised and examined microscopically. The portion indicated as OT in Fig. 5 looked somewhat different from other places. As expected, examination of the sections revealed the ovotestis in this portion of the gonad. It contained two types of tubules. Some of the tubules were filled with oocytes at various stages of maturation, and the other tubules were filled with both sperm and oocytes, showing a typical example of an ovotestis (Figs. 6 and 7). The other four gonads, however, were purely testes, having their tubules all densely packed with mature sperm (Fig. 8).

Ruggieri (1969) reported the *in corpore* fertilization and development in *Arbacia punctulata*. In the present study, however, no



Figs. 5–8. *Hemicentrotus pulcherrimus* Hermaphrodite.
Fig. 5. The gonads, portions of which were sectioned and examined (indicated by arrows). Bottom bar: 1 cm.
Fig. 6. Section of ovotestis found at OT in Fig. 5. Most of the tubules contain oocytes at various stages of maturation. One tubule at the upper right is filled with sperm and oocytes. Bottom bar: 100 μm.
Fig. 7. Higher magnification of the ovotestis shown in Fig. 6. Note the presence of both oocytes (Oc) and sperm (Sp). Bottom bar: 100 μm.
Fig. 8. Typical histology of a normal testis found in the other four gonads. All the tubules were densely packed with mature sperm. Bottom bar: 100 μm.

histological sections which exhibited such *in corpore* fertilization were observable. All reports on hermaphroditic Japanese sea urchins were individuals belonging to *Strongylocentrotus* and *Hemicentrotus*. In *H. pulcherrimus*, one gonad was an ovary and the others were ovotestes (Okada and Shimoizumi, 1952). In *S. intermedius*, each gonad contained female and male fractions, being mainly the female type (Tajima and Tomita, 1980).

Development of the secondary sex characters in these hermaphroditic sea urchins is also a matter of much interest. Unfortunately, in the present report, we did not attempt to examine the local differences in secondary sex characters such as the color of tube feet, shape of genital papillae and size of genital pores, which were reported in normal sea urchins (Harvey, 1956; Tahara, Okada and Kobayashi, 1960).

We hope that the present report may serve to stimulate an interest in the phenomena of hermaphroditism in sea urchins.

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