

## 9. Additional Record of Observation on *Nautilus pompilius* in the Aquarium of the Kamoike Marine Park, Kagoshima, Japan

by

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### Introduction

Living cephalopods are divided into two major groups: one comprises six living species of *Nautilus* and great many species of nautiloid and ammonoid fossils, and the other is the coleoid including squids, cuttlefishes, octopuses, argonauts and belemnoids (extinct). *Nautilus* has a complex brain, and among the invertebrates it has attracted special attention of paleontologists and biologists. However, very little is known of the life and behavior of *Nautilus* from the biological point of view, because it usually inhabits rather deep water around the islands in the Southwest Pacific Ocean.

The writers already recorded the laboratory observations on the *Nautilus* specimens carried out immediately after trapping in the Philippines and on the four specimens for about seven months from their arrival at Kagoshima City to the death of the last specimen in the aquarium of the Kamoike Marine Park (HAYASAKA *et al.*, 1982). Survival periods of the four individuals in the aquarium were 28 days for the shortest- and 222 days for the longest-lived ones.

In this paper, observation on the behavior of *Nautilus pompilius* in a glass aquarium will be briefly supplemented. The observation was carried out from September 1981 to March 1982 at the Kamoike Marine Park in Kagoshima, Japan.

### Materials and Method

Three specimens of *Nautilus pompilius* captured by trapping at the 120-130 m deep bottoms off Bindoy, Negros Oriental, the Philippines were shipped by air to Kagoshima after two days acclimatization in the aquarium of the laboratory at Silliman University, Dumaguete, the Philippines. The specimens were transferred directly from the Philippines to Kagoshima for further studies.

The tank used for rearing the nautili is made of acrylic resin, with a capacity of about one ton of water. It is 100 cm in diameter and 90 cm in height and at the

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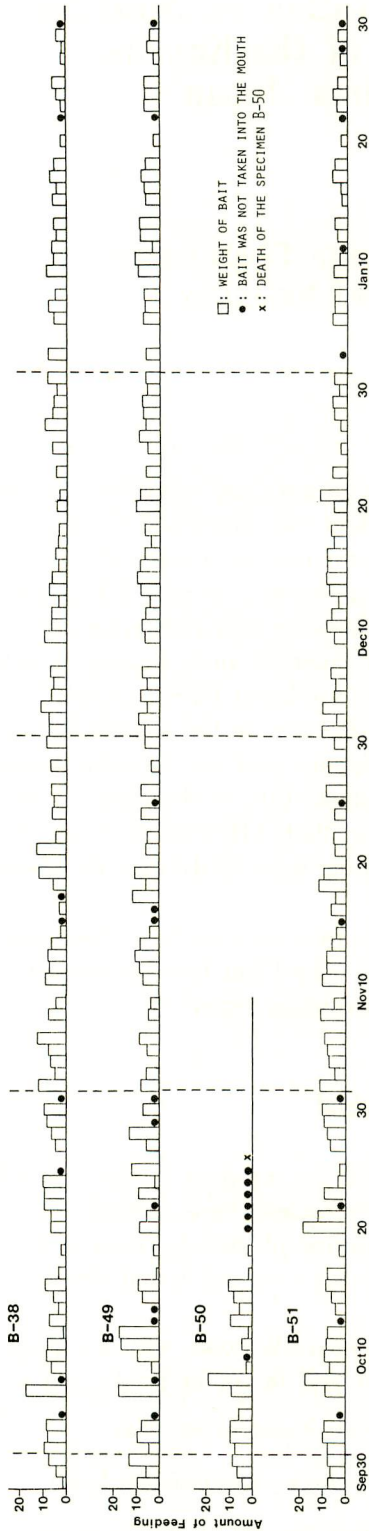


Fig. 1. Daily amount of feeding.

bottom covered with pebbles two blocks of dead coral skeletons were placed. The aquarium was set up about a meter above the floor. The illumination used in the day time was a 200 watt fluorescent light and a 20 watt red light was used in the night (from 6.30 p. m. to 8.30 a. m.). These illuminations were light enough to see the movement of the nautili with the naked eye. For rearing, fifty-fifty mixture of the aerated open sea water and the water circulating in a closed system, which were filtered by sand just after pumping up from the sea, were used. The water temperature was kept usually between 17°C-19°C during the period of rearing. The amount of ammonium in the water used was

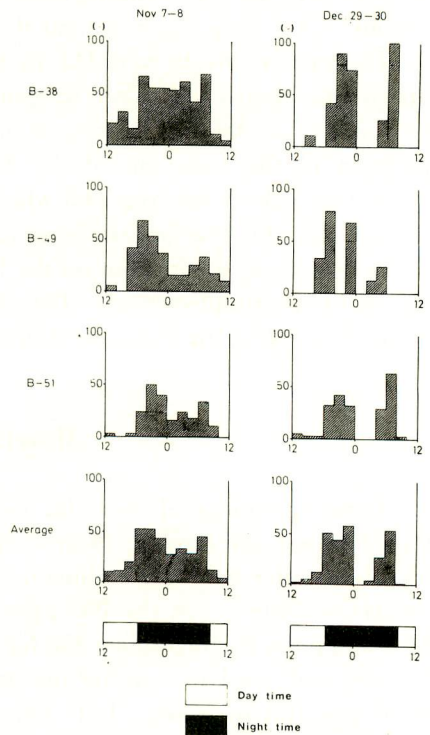


Fig. 2. Daily changes of swimming activity of the specimens of *Nautilus pompilius* observed on 29-30 Dec. and 7-8 Nov. 1981, shown as the percentage frequencies.

below 0.6 ppm and pH was 8.2-8.3. For feeding, approximately 5-10 g dead shrimps and fish were given to the animals everyday.

### Additional Record of Observation

#### A. The amount of feeding and the state of health of *Nautilus* (Fig. 1)

Feeding was tried once a day around 6 p.m. and the degree of appetite was judged through the observation whether the bait is taken into the mouth or not. At the beginning of rearing, each individual ate a slice of fish (common sardine) of about 10 g with good appetite. After that, they gradually reduce their appetite and after four months they came to take much longer time to eat only about 5 g shrimp. The shortest-lived individual did not show appetite at all for the last one week. Diminishing appetite towards the death is also observed in three other individuals. These facts suggest that the degree of appetite can be regarded as an index of health condition of *Nautilus*. In general, unhealthy condition indicated by diminishing appetite seems to happen almost simultaneously in four individuals.

#### B. Growth of the shell.

During four months rearing of the three specimens of *Nautilus*, indications of shell growth were searched for through the repeated measuring of the shells and weighing the animals. However no steady increase in shell size or weight of animal was recognized during four months from 27 September, 1981 to 21 January, 1982.

#### C. Behavior in the aquarium

In the dark, *Nautilus* showed active movements in the aquarium and the following three patterns of behavior were observed most frequently.

- 1) Swimming with a slight rocking movement along the glass wall of the aquarium at a certain fixed depth of water. The rocking movement with the fulcrum at a little above the center of the shell is caused by the discharging of water through funnel.
- 2) Repeated ascending and descending movements within various depth ranges between the surface and the bottom of water.
- 3) Irregular combinations of rocking, ascending and descending movements within narrow limits in any direction, vertical, horizontal and so on.

These types of movement are usually long-lasting and characterized by having uniform rhythms. The types of movement 1) and 2) were observed lasting for more than two hours and 3) lasting for more than eight hours without stopping.

Besides the behavior mentioned above, the following two types of movement were observed less frequently.

- 4) By a powerful discharge of water through funnel, the animal extending and widely opening tentacles makes a dash for and attaches to the glass wall of the aquarium.
- 5) Rocking with large amplitudes by frequent discharging of water through funnel exposing one third of the shell above the water surface. This behavior was observed quite frequently immediately after feeding.

It was observed that the nautili show the most active movement around sunset and sunrise (Fig. 2). During the period of time of rearing them, a 200 watt illumination used in the aquarium was switched on at 8:30 a.m. and switched off at 6:30 p.m. everyday.

It is still uncertain whether the apparent daily cycle of behavior mentioned above is resulted from the innate rhythms of the animals or from the change in brightness in the environment.

#### D. Interrelation between individuals

Although nautili usually act independently, they sometimes make a pair or a group adhering to each other regardless of sex of each individual at intervals of one or two days. Through the long-term observation, it was recognized that there seems to be some preference of individual to adhere.

#### E. Sexual behavior and spawning.

In copulation behavior, the male holds the female with the elongated tentacles for more than five minutes on each occasion (Pl. 8, fig. 1). Two eggs were laid on December 8, 1981 and one on January 5, 1982, both in the night. In both cases, the eggs were spawned deep inside a cavity of coral block. However, larvae did not hatch out of the egg capsules (Pl. 8, fig. 2).

### Concluding Remarks

In the present article, only brief remarks were given on the behavior of *Nautilus* in captivity. For the further studies on the life and behavior of *Nautilus*, such as spawning, hatching, early development, growth, communication behavior between the animals and sensibilities for taste, touch and smell and so on, it is indispensable to realize much longer rearing of the animals in aquarium as well as much more detailed ecological studies on their habitats. We are hoping for the progressing of our study along these lines in future.

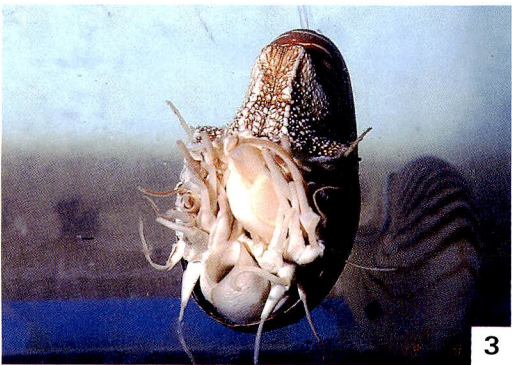
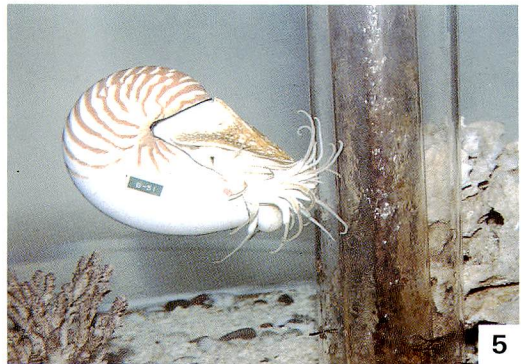
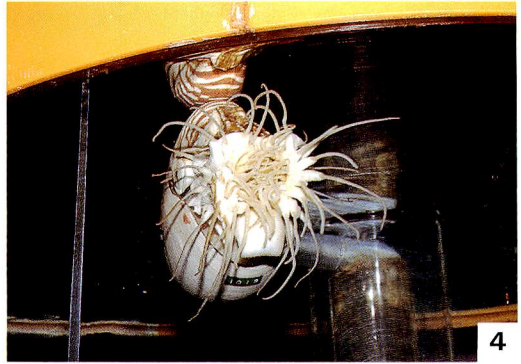
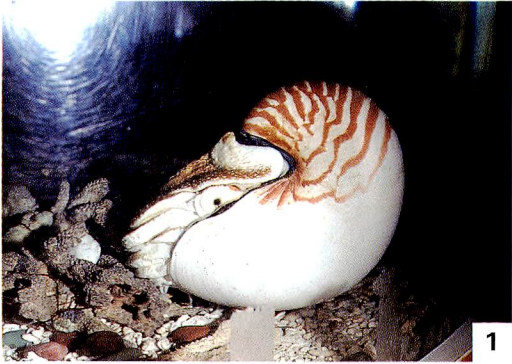
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Plates 7-8

### Explanation of Plate 7

- Fig. 1. *Nautilus pompilius* resting on coral block.
- Fig. 2. Natural pose gently swimming backward with slight rocking of the shell.
- Fig. 3. *Nautilus* being active on the surface of water in the aquarium.
- Fig. 4. Adhering onto the inner surface of glass wall of the aquarium.
- Fig. 5. *Nautilus* just before loosing its hold on drain pipe.
- Fig. 6. *Nautilus* beginning to swim to ascend by discharging water through funnel pointing downward.



### Explanation of Plate 8

- Fig. 1. Copulating behavior; a male holds a female with elongated tentacles.  
Fig. 2. The egg spawned inside the cavity of a coral block.



