Outline of the Project

The motive of planning the present project was the aspiration for making a comparative study on *Nautilus pompilius* in nature between the Philippines and the Fiji Islands, situated at the opposite extremities of its distribution area (Fig. 1). Therefore, the items for field works were selected following the principle of the preceding project carried out in the Philippines

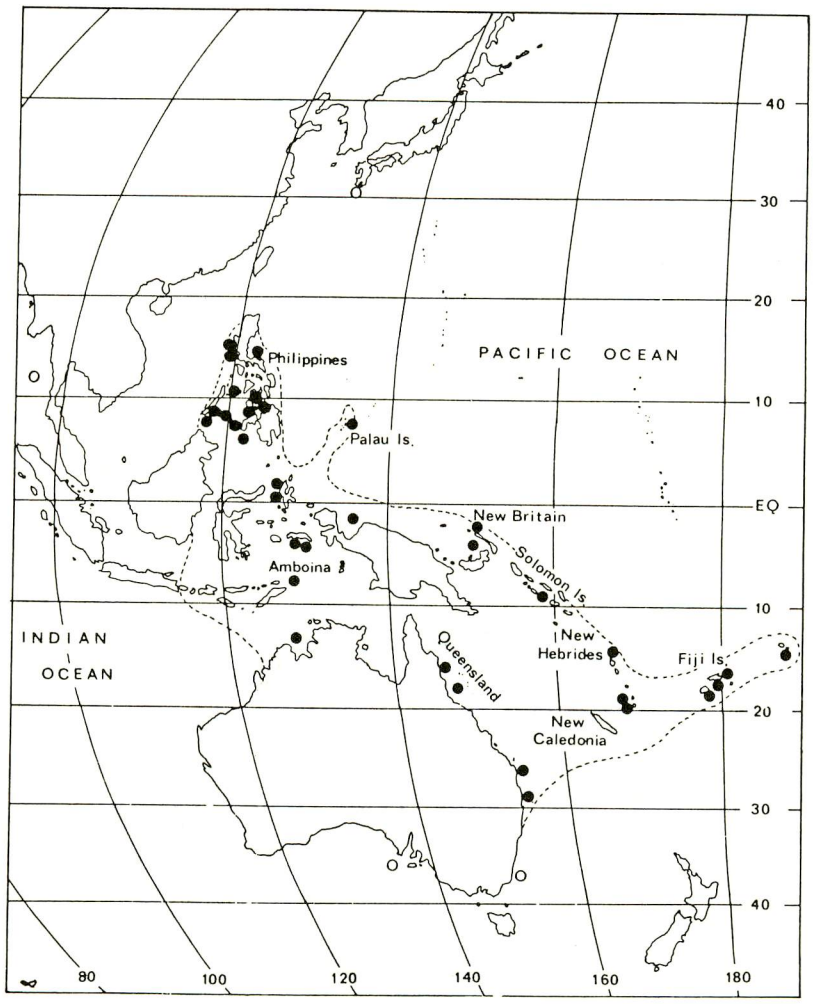


Fig. 1. Map showing the geographic distribution of *N. pompilius* or *N.* cf. *pompilius* in the Southwestern Pacific (adapted from HAMADA, 1977[1] and SAUNDERS, 1981[2]). Solid circles: distribution areas of large populations, open circles: rare occurrence probably resulted from inefective dispersal.

1) HAMADA, T., 1977: Distribution and some ecological barriers on the habitat condition of *Nautilus* and its application to the rearing of *N. macromphalus*. *Sci. Paps. Coll. Gen. Educ., Univ. Tokyo*, 27, 89-102.

2) SAUNDERS, W. B., 1981: The species of living *Nautilus* and their distribution. *The Veliger*, 24, 8-17.

(HAYASAKA *et al.*, 1982[1]; HAYASAKA *ed.*, 1983[2]) giving priority to understanding the environmental background of their natural habitat.

The two areas off Suva and off Pacific Harbour were fixed upon as the fields of studies in the present project. The reason is that these areas have been known to be densely populated by *Nautilus* through the many years investigation of deep sea fish by IMR*), and at the same time, commercial fishing has scarcely been practiced in the areas.

The field operation for the present project was performed for 36 days from 26 August to 30 September, 1983 in close co-operation with the staff of the Institute of Marine Resources, the University of the South Pacific. All of the off-shore works were efficiently supported by the crew of "Nautilus" and "Aphareus", and the facilities basically necessary for field and laboratory works were supplied under the direction of Prof. Uday RAJ, the director of the Institute.

Field Works:

The field studies for the project carried out in the two areas (Fig. 2), off Suva (A) and off Pacific Harbour (B), are summarized below.

(1) Oceanographic observation

Echo-sounding for topographic survey along the eight lines in the area A as shown in Fig.

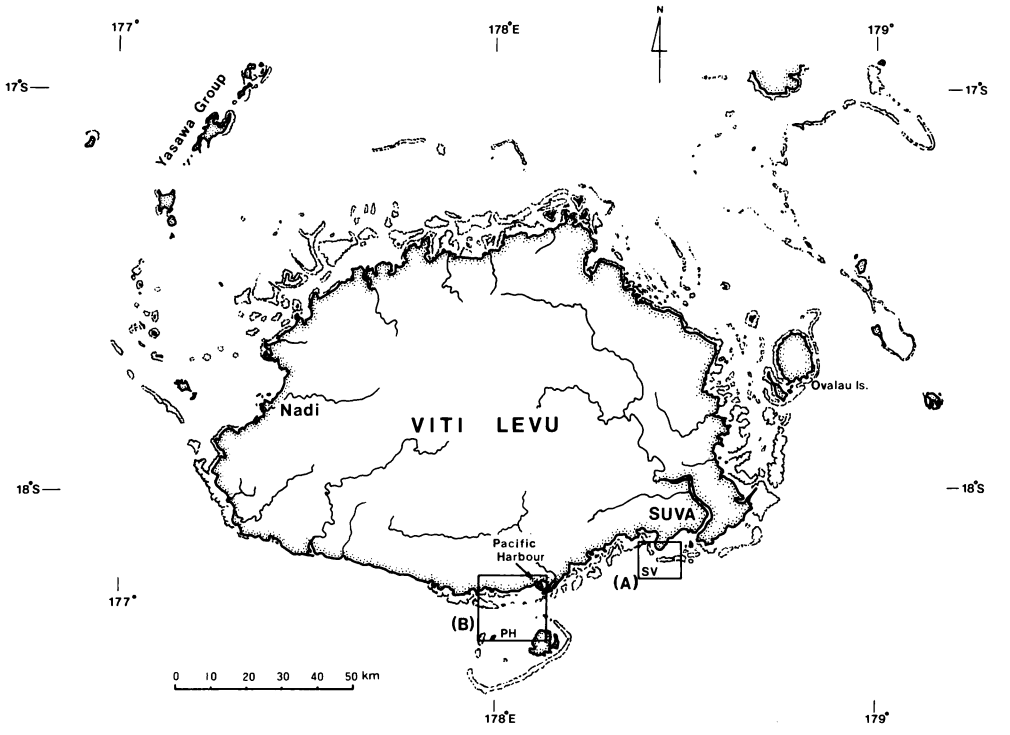


Fig. 2. Index map of the studied area.

1) *op. cit.*

2) *op. cit.*

*) Abbreviation for the Institute of Marine Resources, the University of the South Pacific.

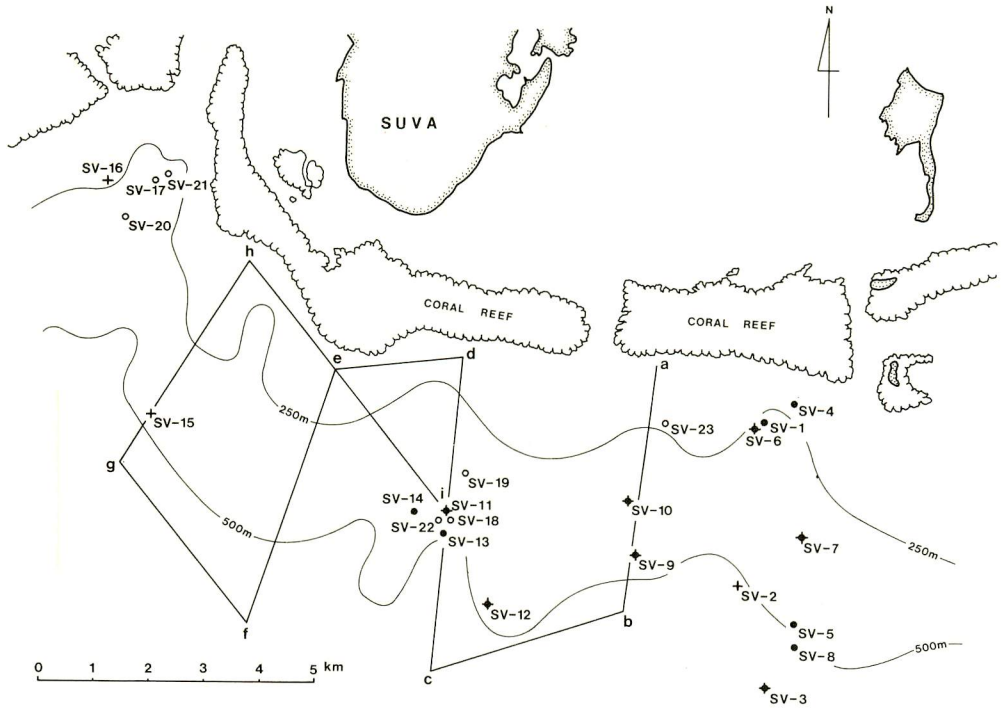


Fig. 3. Map showing the locations for trapping *Nautilus* (●), oceanographic survey (+) and underwater TV and still camera works (○); and the lines of echo sounding off Suva (A in Fig. 2).

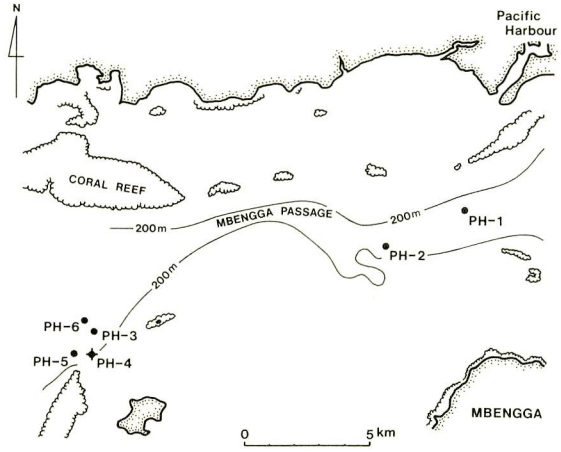


Fig. 4. Map showing the locations for trapping *Nautilus* (●) and oceanographic survey (+) off Pacific Harbour (B in Fig. 2).

3 and collecting water samples at 10 stations in the area A and at 1 in B (Figs. 3 and 4) for measurements of temperature, salinity, pH and DO were carried out. Sampling of bottom sediments was practiced with small cylinders attached to the cages for trapping *Nautilus*.

(2) Trapping of *Nautilus* and its associated fauna

At 13 and 6 stations in the areas A (Fig. 3) and B (Fig. 4) respectively, trapping works were carried out in making use of the three kinds of traps designed by the IMR with the two kinds of frozen fish as bait inside of each trap. The details of trapping experiments are described in the later section.

(3) Release of the captured *Nautilus* after tagging

Among the 163 specimens of captured *Nautilus*, 69 were tagged with specimen number and released for the long-term observation of growth and behavior of *Nautilus*.

(4) TV and still camera works

To get real images of habitat and evidences for the behaviors of *Nautilus* in natural environment, photographing by means of the underwater TV and still camera was performed at 7 stations in the area A (Fig. 3).

(5) Describing the number, sex, size and weight of the captured *Nautilus*

All the specimens of captured *Nautilus* were described in detail immediately after trapping to provide the basic data for the subsequent laboratory works.

(6) Describing the fauna associated with *Nautilus*

Numbers and kinds of organisms captured by trapping together with *Nautilus* were described after heaving up the traps as the data concerning the food habit and some other problems of living *Nautilus*.

(7) Rearing *Nautilus* and observing their behavior in the laboratory aquarium

Throughout the period of time of field works, 24 specimens of captured *Nautilus* were kept alive in the temperature-controlled aquariums at IMR for observation of their versatile behaviors.

Laboratory Works:

In 1984, all the members of our group have been engaged in the laboratory works along the following lines. (A few scientists outside of the group joined us to take share in the laboratory works particularly on some groups of animals.)

(1) Description of the physiographic condition of the habitat of *Nautilus* in the studied area.

(2) Analyses of the biotic factors of the environmental condition of the habitat of *Nautilus*, namely, of plankton, foraminifera, smaller macro-benthos, crustacean and fish populations.

(3) Scrutiny into the ecological interrelation between *Nautilus* and its associated fauna.

(4) Morphological and physiological analyses of *Nautilus* with special reference to its growth and development.

(5) Observation of the behaviors of *Nautilus* in captivity.

(6) Analysis and description of the behaviors of *Nautilus* in its natural habitat and the features of sea bottom environment based on the pictures taken by the underwater TV and the still camera.

The results of studies in field and in laboratory comprise a few matter of interest from the biological and paleontological points of view.

The natural habitat of *Nautilus* in Fiji is restricted to rather deep bottom on steep submarine

topography developed outside the barrier reef. This is one of the most important physiographic features of the habitat of *Nautilus* in terms of the geographic approximation of deep and shallow bottoms. It is particularly interesting that the feature of the habitat of *Nautilus* mentioned above is commonly recognized in Fiji and in the Philippines (HAYASAKA *et al.*, 1982) in spite of clear difference in genetic process of sea bottom topography between the two areas. This seems to support that *Nautilus* has a stage of life history to inhabit rather shallow part of bottom topography.

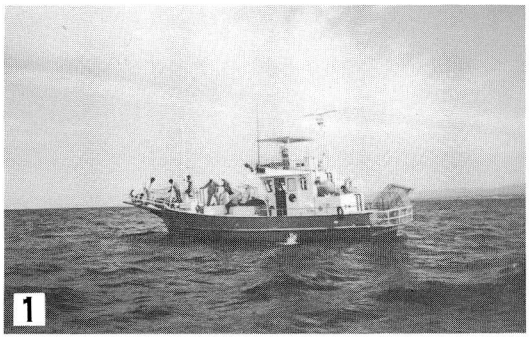
Close relationship in mode of occurrence between *Nautilus* and shrimps expected through trapping operation was confirmed by the pictures of underwater camera (*see* frontispiece). Among the fauna associated with *Nautilus*, twelve species of shrimps were discriminated. It was ascertained statistically that the species having the closest relationship with *Nautilus* was *Heterocarpus sibogae*. This seems to suggest a type of food habit of *Nautilus* in the present area. This is to be scrutinized in detail in relation to the results of esophagus and stomach contents analyses, of which preliminary report is given in this volume.

Through the detailed studies on the growth of *Nautilus* approached on the two different basis, namely the statistical analyisis of morphogenesis of *Nautilus* shells (hard part) and the histological and histochemical analyses of gonad (soft part) of *Nautilus*, it was made clear that the change in shell morphology with its growth has a close interrelation with the growth patterns of gonad. The investigation along this type of problem is particularly important for the paleobiological studies on fossils and should be further progressed in future.

(Shozo HAYASAKA)

Explanation of Plate 1

Fig. 1. R. V. Aphareus.
Fig. 2. R. V. Nautilus.
Fig. 3. Oceanographic observation (Salino-meter).
Fig. 4. Fixing underwater TV and still camera to a frame.
Fig. 5. Hanging down underwater still camera fixed to a frame.
Fig. 6. Small dredge for sampling of bottom sediments.
Fig. 7. Three aquariums for rearing *Nautilus* set up on three steps.
Fig. 8. Dissecting *Nautilus* to take out gonad.
Fig. 9. Preparing for transportation of *Nautilus* to Japan.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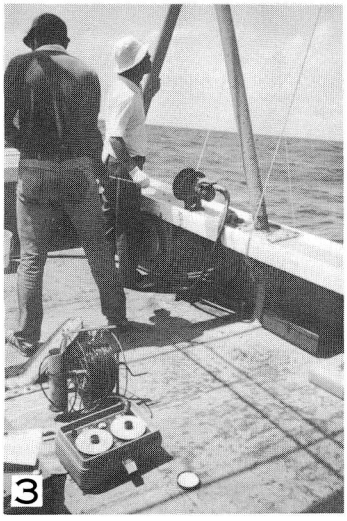
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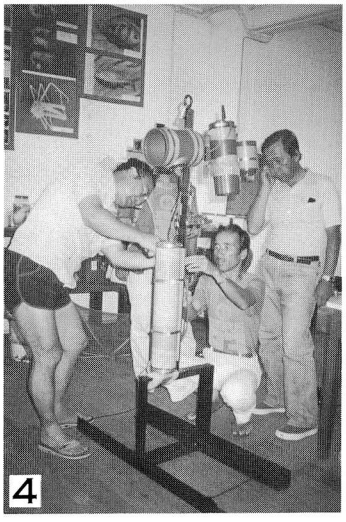
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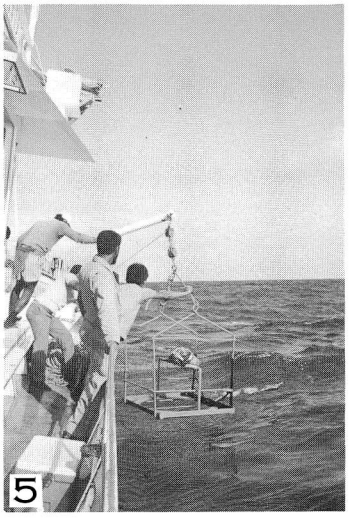
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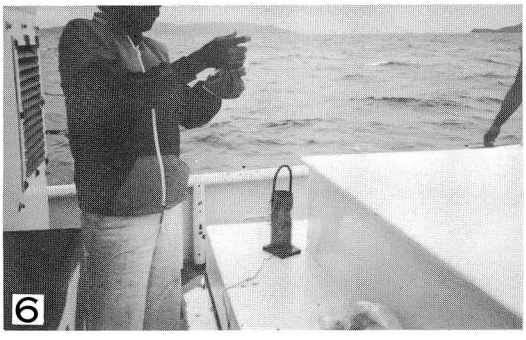
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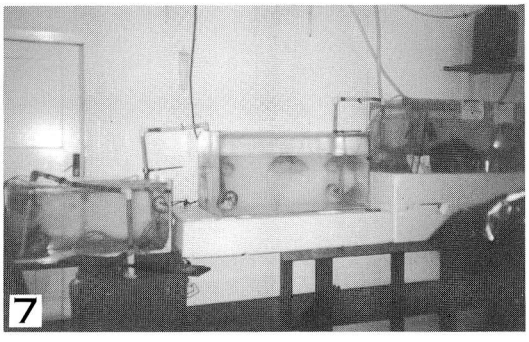
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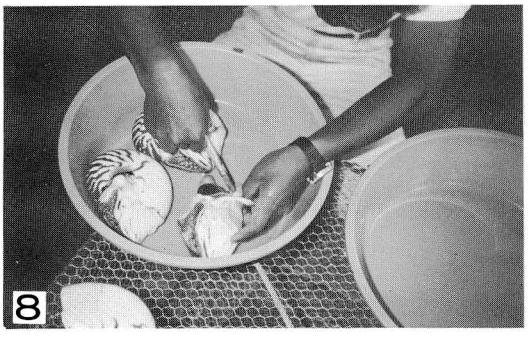
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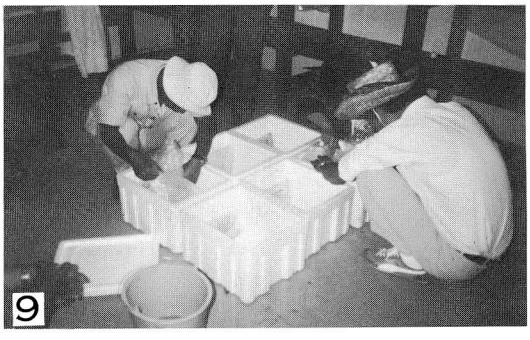
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