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1. Environmental Background of the Habitat of *Nautilus* in the Southern Part of Tañon Strait, the Philippines

by

Shozo HAYASAKA,[1] Kimihiko ŌKI,[1] Akihiko SHINOMIYA[2] and Toshio SAISHO[2]

To obtain the basic data for understanding the environmental background of the habitat of *Nautilus*, two kinds of field operations were undertaken in 1981: (1) To get a better understanding of the general features of the southern part of Tañon Strait, oceanographic survey on the seawater characteristics and the sampling of plankton and bottom sediments were carried out at the nine stations arranged along transverse (Stations OB-5, F-1, F-2 and F-3) and longitudinal (Stations A-1, F-2, K-1, L-1, M-1 and N-1) lines (Fig. 1), along which the bottom topography was also surveyed by means of an echo-sounder, and (2) Much more detailed works were performed in the fishing ground off Bindoy village where the trapping *Nautilus* was also operated. In this chapter, the results of the field works mentioned above will be briefly summarized*).

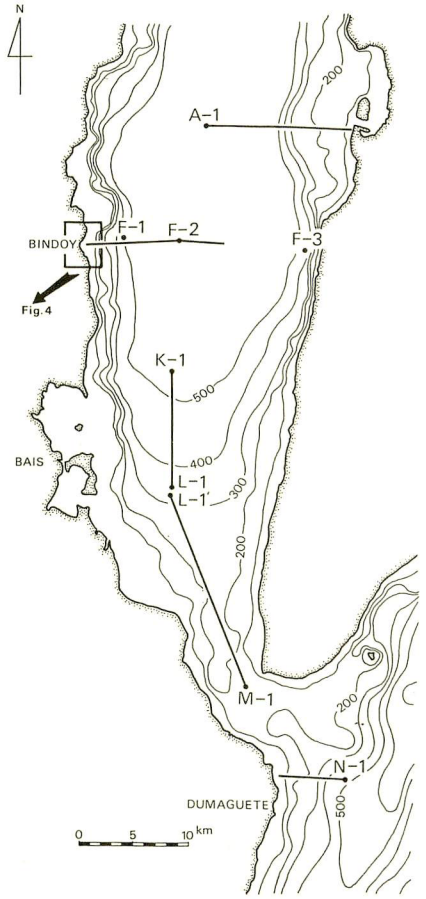

Fig. 1. Map of the southern part of Tañon Strait, showing the submarine topography, stations for oceanographic survey and lines of echo-sounding.

Tañon Strait

Tañon Strait, being rather narrow (27-15 km) and long (220 km from north to south) in outline, has the deepest point in its central part and depths greater than 500 m extend widely from north to south (Fig. 2).

1) Institute of Earth Sciences, Faculty of Science, Kagoshima University, Kagoshima 890, Japan.
2) Laboratory of Marine Biology, Faculty of Fisheries, Kagoshima University, Kagoshima 890, Japan.

*) For further details refer to the writers' first report (HAYASAKA *et al.*, 1982).

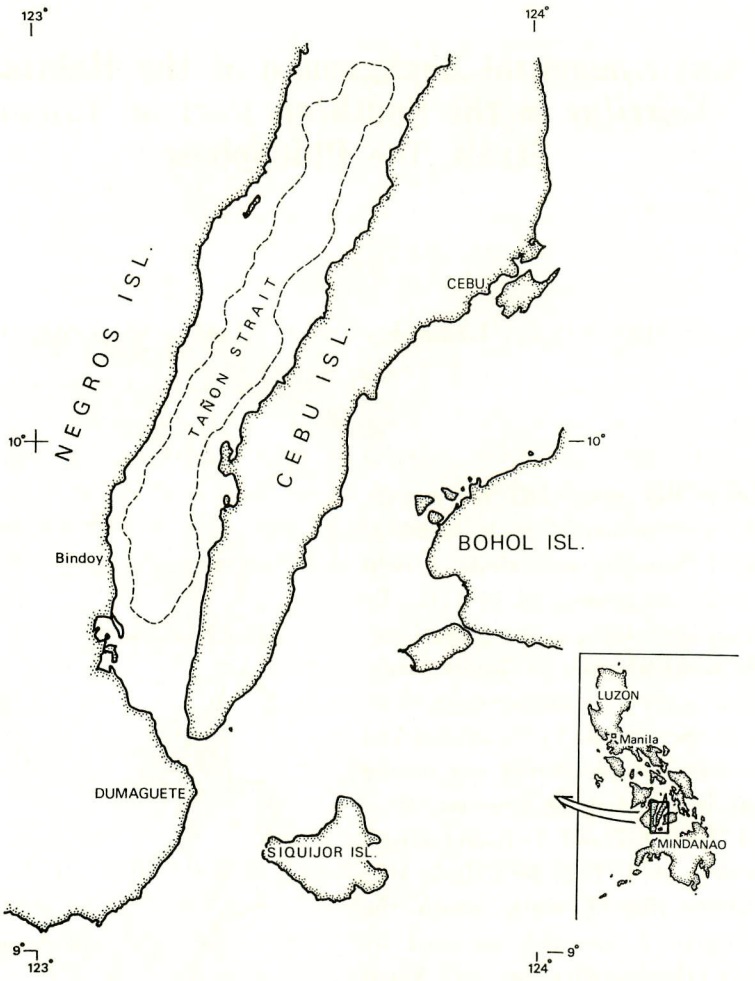

Fig. 2. Index map showing the studied area and the outline of the deepest basin (about 500 m in depth) in Tañon Strait.

The depth of the strait gradually shallows northwards and at the northern part of the strait there are many small islands such as Bayantan, Don and Guitan. Thus Tañon Strait is separated from the Visayan Sea by this shallow sea with many isles. On the other hand, the depth of the strait gradually gets shallower from the center southward to the outlet of the strait. The shallowest part is thought to be 125 m in depth off Liloan point of Cebu Island. Further south, outside the strait, the sea bed deepens again towards Bohol Strait.

Submarine Topography of the Area Studied

In the area studied (southern part of Tañon Strait), the deepest part (about 500 m in depth) occupies the northern half with steep slopes on both sides of it. The bottom

topography of the deep basin is almost flat and on both sides steep slopes climb up to the coast of islands or the outer margin of submarine terraces (Fig. 3 a). On the profiles of a submarine slope off Bindoy, peculiar features of step-like relief were observed (Fig. 4). This strongly suggests the occurrences of faulting between the island and basin and the tectonic origin of this strait such as a "Graben". It is particularly intersting that all the *Nautilus* specimens obtained are from such a steep slope of tectonic origin, because this seems to provide an ecological condition favourable for the habitat of *Nautilus* in terms of the geographical approximation of deep and shallow bottoms.

To the south, the depth gets gradually shallower to the outlet of the strait (Fig. 3b). Off the southern tip of Cebu Island there is a topographic rise of about 150 m in depth which bounds the southern end of the strait. Crossing over the rise the depth rapidly increases southwards between Negros and Bohol Islands where the seabed is more than 600 m deep. Therefore, the southern outlet of the strait represents an asymmetric saddle -like topography in the north-south profile of this area.

Bottom Sediments

The bottom samples were collected at the following eleven stations : OB-1, OB-2, OB-3, OB-4, A-1, F-2, F-3, K-1, L-1, M-1 and N-1. Mechanical analysis of the bottom sediments brought about the following results (Fig. 5) : (1) Silt and clay fractions constitute more than 80 % of the samples obtained from depths over 400 m (Stations A-1, F-2, F-3, K-1 and N-1) ; (2) Silt/Clay ratios of the samples from the deepest part and the marginal slopes of the strait decrease southwards ; (3) The sample collected from a depth of 307 m on the slope (St. L-1) is characterized by poor sorting (So : 8.45) ; (4) Coral reef fragments of cobble and pebble sizes were collected from Station M-1 situated at the outlet of the strait ; (5) The proportions of clay in three samples are 3.5

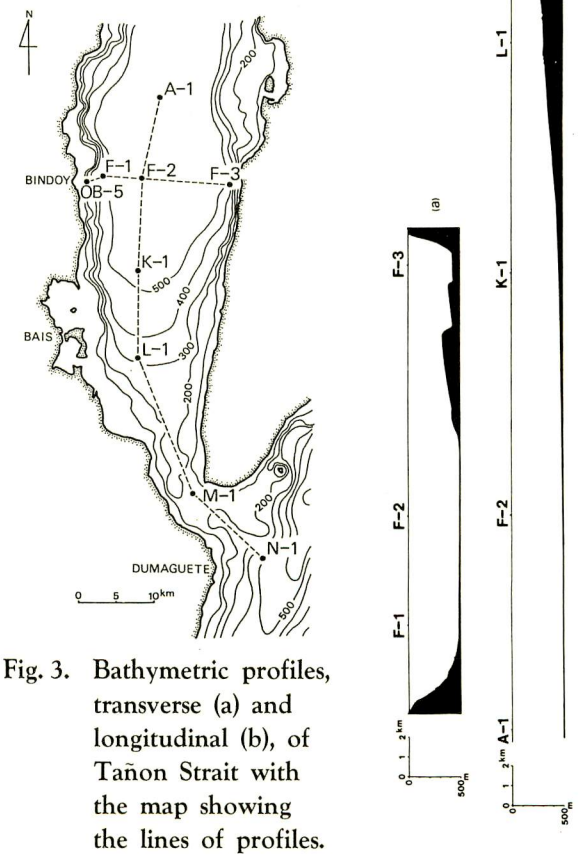

Fig. 3. Bathymetric profiles, transverse (a) and longitudinal (b), of Tañon Strait with the map showing the lines of profiles.

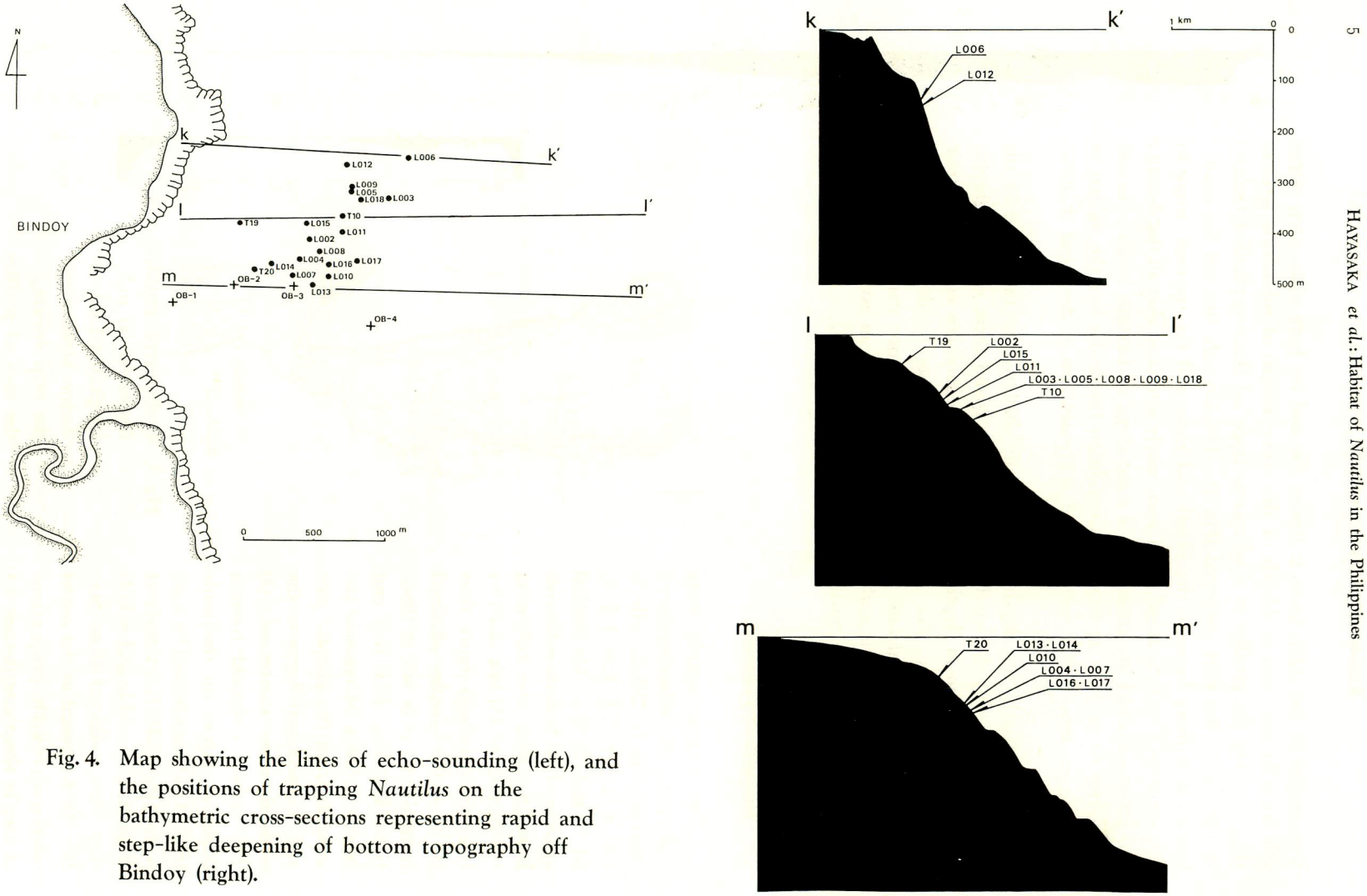

Fig. 4. Map showing the lines of echo-sounding (left), and the positions of trapping *Nautilus* on the bathymetric cross-sections representing rapid and step-like deepening of bottom topography off Bindoy (right).

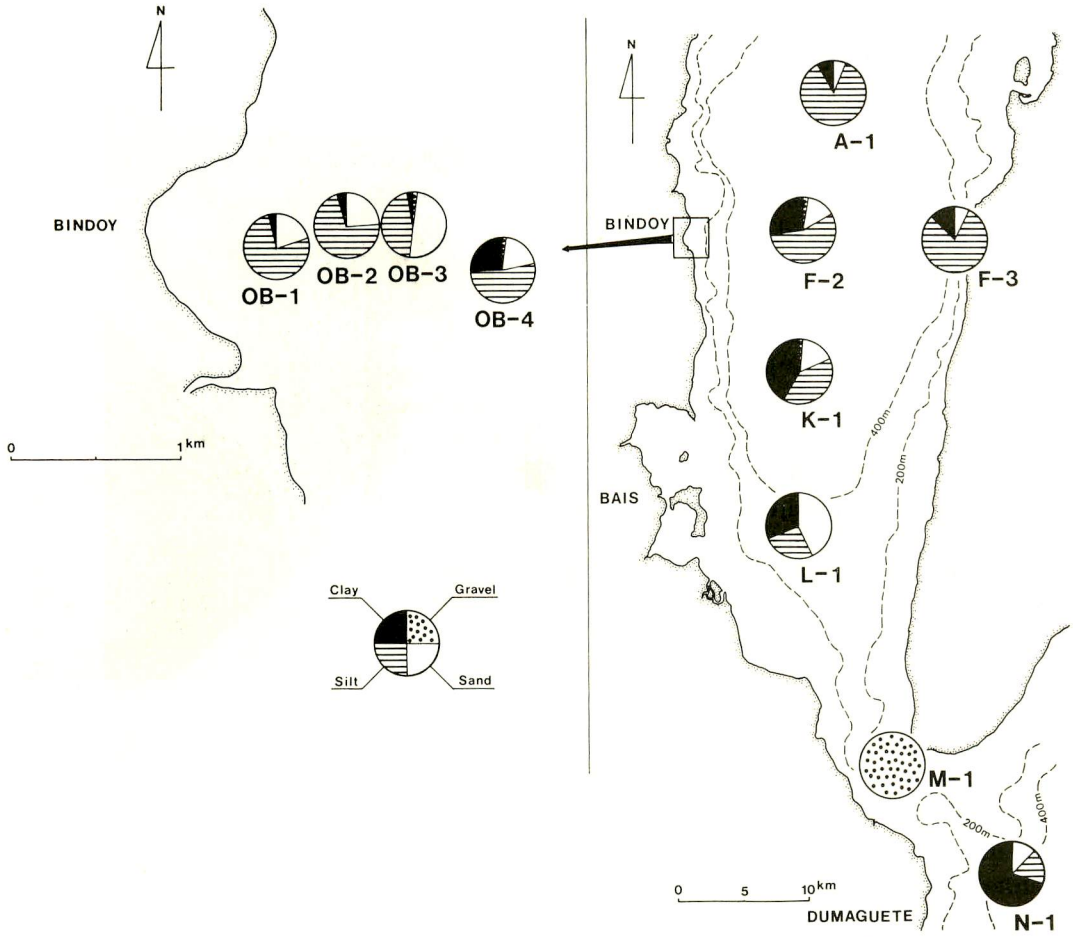

Fig. 5. Map showing the grain size ratios of bottom sediments at each station in the southern part of Tañon Strait (right) and off Bindoy (left).

% to 4.4% (Stations OB-1, OB-2 and OB-3 off Bindoy) and the sand content regularly increases from 20.1% to 49.8% as the depth increases.

Carbonates dissolved from the five samples with a solution of hydrochloric acid are as follows. Dissolved carbonate values in the samples collected from the deepest part (Stations A-1 and F-3) are 30% and 47%. These high values seem to reflect the abundance of planktonic foraminiferal tests and shell fragments in the bottom sediments in addition to the constant supply of carbonate-rich sediment chiefly from the small but numerous rivers in Negros and Cebu islands where the limestone formations of various ages are widely distributed.

Water Masses

Concerning the sea water characteristics, water temperature, specific gravity, pH, dissolved oxygen (DO), salinity, chemical oxygen demand (COD) and oxygen isotope of water sample were measured on the boat or in the laboratory on each water sample

collected from the depths of 10, 20, 30, 50, 75, 100, 150, 200, 300 and 400 meters at the nine stations.

In the vertical distribution pattern of dissolved oxygen, it was generally recognized that DO decreases with depth and its maximum value was usually observed at the depths between the surface and 30 m, which may indicate the existence of a maximum layer of phytoplankton producing plenty of oxygen around this layer.

From the temperature profiles, transverse (Fig. 6a) and longitudinal (Fig. 6b), several characteristic features of the water masses occupying the area studied in early September were clearly recognized. Rapid change in water temperature (thermocline) occurs constantly at the depth between 100 and 150 m of each station. Sea water temperature gradually lowers from the surface (about 30° C) to 100 m (about 25° C), and immediately below the thermocline it is about 20°C. The water mass above the thermocline showing a beautiful stratification throughout the area within Tañon Strait crosses over the topographic rise at the outlet of the strait. This implies a remarkable stability of water at least in this season. On the contrary, the water mass below the thermocline, lower in temperature and heavier than the shallower water, represents a striking contrast of vertical temperature distribution between the areas inside and outside the strait. Within the strait, the temperature of water deeper than 200 m seems to be rather constant and bottom water temperature

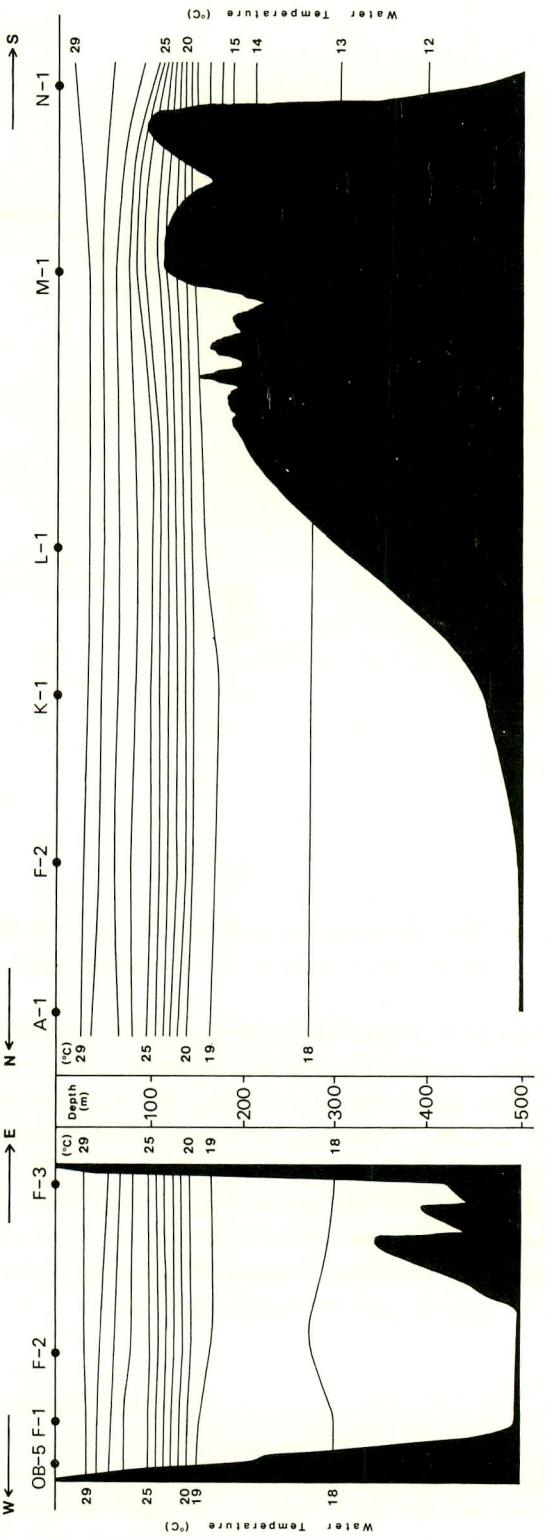

Fig. 6. Distribution of water temperature in the transverse (a) and the longitudinal (b) profiles of the southern part of Tañon Strait. Lines of profiles are shown in Fig. 3.

is thought to be about 17°C, while outside the strait (St. N-1) rapid lowering of temperature below the thermocline is observed; 14.6°C at a depth of 200 m, 13.02°C at 300 m and 12.60°C at 400 m (Fig. 6).

Judging from information hitherto collected, the lower limit of the optimum temperature-range for *Nautilus* is around 15°C. Therefore, the water mass below the thermocline in Tañon Strait seems to be suitable for *Nautilus* to inhabit as far as the water temperatures are concerned, while outside the strait their habitat must be restricted to the rather narrow depth range right below the thermocline.

Not only from the outline of Tañon Strait representing a long deep basin separated from the sea outside by shallow areas but also from the poor mixing of water outside and inside the strait assumed from the striking contrast of temperature between them, it can be presumed that Tañon Strait is characterized by a more or less closed environmental condition from the oceanographic point of view.

Reference

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