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Environmental Background of the Habitat of *Nautilus belauensis* off the Southeast Coast of the Malakal Island, Palau

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Introduction

For eight days beginning on August 15, 1988, field studies to understand the environmental background of the habitat of *Nautilus belauensis* were carried out in Mutremdiu Bay, the Republic of Palau. Sea bottom profiles, distribution of bottom sediments and the vertical distribution patterns of sea water characters were obtained using small fishing boat of the Micronesian Mariculture Demonstration Center.

Submarine topography

Mutremdiu Bay, opening southward, is about 3.5 km long from north to south and about 3.5 km wide. Echo-sounding was carried out along six parallel lines in

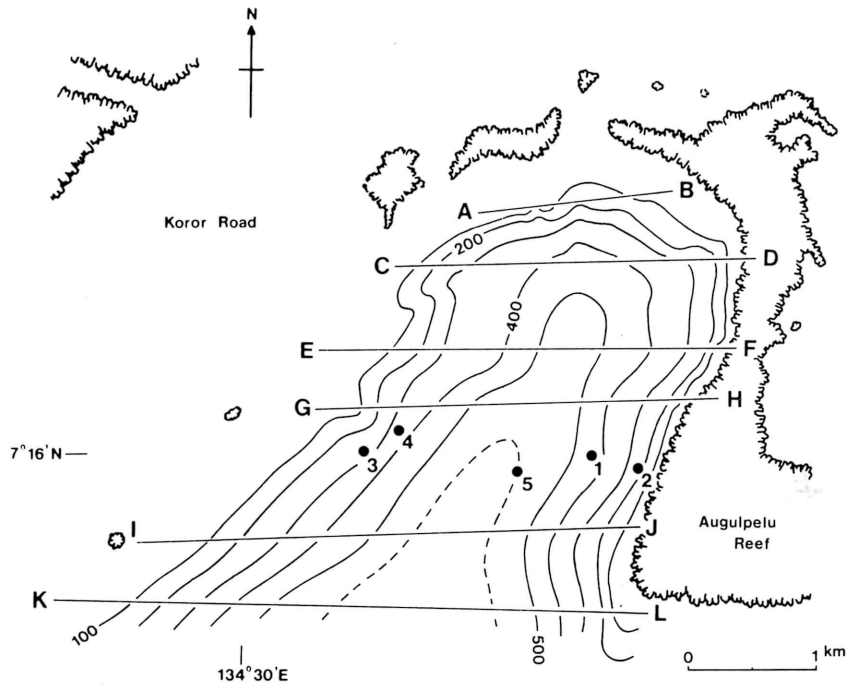

Fig. 1. Bathymetric contour map of Mutremdiu Bay, with the echo-sounding lines and the sampling stations of bottom sediments (1-5).

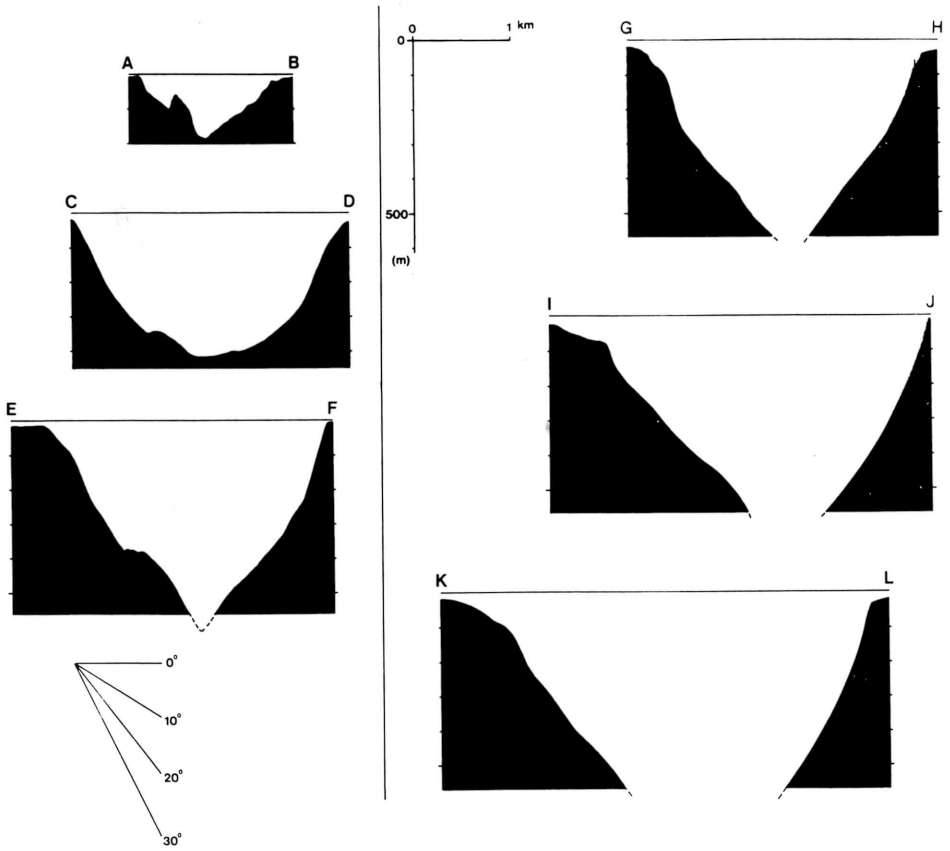

Fig. 2. Bathymetric cross sections of Mutremdiu Bay along the E-W lines shown in Fig. 1.

the E-W direction (Fig.1) on August 15, 16 and 23, 1988. Topographic data of bottoms deeper than 560 meters were inaccessible, because of the capacity limit (560m) of the portable echo-sounder (HONDA -HE 315) used on that occasion.

In the area studied, a straight submarine canyon having a V-shaped cross section extends from the bay-head to outside of the bay, and both sides of it show steep slopes (about 30° to 40°) climbing up to the edges of the barrier reefs (Fig. 2).

Bottom sediments

For the sampling of bottom sediments, a gravity core sampler (the phleger type) was used. Samplings of bottom sediments were tried at five stations of different depths (Fig.1), but all of them were unsuccessful. This may have been caused by the characteristics of the bottom sediments in the area, such as gravelly coarse-grained sand, or coarse-grained sandy gravel. In fact, the bottom sediments collected at the trapping sites by the small dredge connected with the traps were of gravelly coarse-grained sand.

Sea Water Characteristics

To obtain information on sea water characteristics at each station, oceanographic observation was carried out for four days from August 19 to 23, 1988, at the five stations in Mutremdiu Bay off Malakal Island (Fig. 3). At each station, water samples were collected by a bucket from the surface and by a Nansen bottle from depths of 10, 20, 30, 50, 75, 100, 150, 200, 300, 400, and 450 meters. Sea water temperature, conductivity, and dissolved oxygen (DO) were measured on each water sample on the boat. In addition, the transparency was measured with a secchi disk at each station. Salinity was calculated from the value of conductivity obtained.

Temperatures of water between the surface and 100m in depth were rather high, ranging from 30.50℃ to 25.00℃ at all stations (Table 1). On the contrary, toward the depth of 200m the temperature rapidly fell down to 13.09℃ (Stn. MU-H3) - 15.00℃ (Stn. MU-H1). From 250m in depth, the temperature declined gradually and reached about 8.5℃ at 450m in depth at all stations except for MU-H2. At station MU-H2, a water mass with a higher temperature (21.07℃) was observed at a depth of 300m. This phenomenon might have resulted from the lip

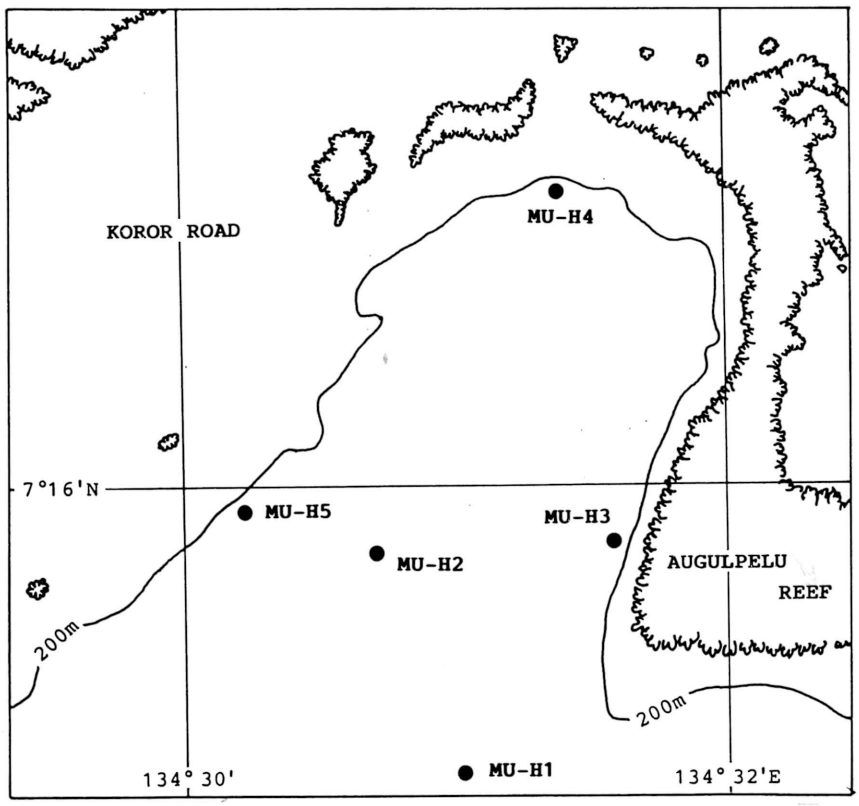

Fig. 3. The map showing the stations of oceanographic survey.

stream which flowed in this area from the surface. This suggests the constant existence of a clear thermocline between 100m and 200m in depth. The existence of a thermocline has also been reported by Saunders and Hastie (1989) who conducted a preliminary oceanographical survey in the autumn of 1987.

Salinities of the layers above the thermocline were nearly constant at around 33.0‰. Layers deeper than 150m, however, show rather low values of salinity, ranging from 29.12‰ to 31.52‰. Densities also changed at the thermocline from

Table 1. Oceanographic data from Mutremdiu Bay.

Stn. MU-H1
Date Aug. 19, 1988 Time 10 : 30-13 : 00
Ship Mesekiu Transparency 30.7m
Depth over 500m

Depth (m)	Temp. (℃)	Salinity (‰)	Density (σ_t)	DO (ppm)	Saturation Degree(%)
0	30.50	33.44	20.4	6.20	95.4
10	29.70	32.20	19.8	6.35	96.2
20	29.70	33.03	20.4	6.20	94.2
30	27.33	32.89	21.0	6.25	91.0
50	26.23	32.48	21.1	6.10	87.1
75	26.05	33.10	21.6	6.30	90.3
100	26.10	32.27	21.0	6.00	85.2
150	18.40	32.27	23.1	5.20	65.2
200	15.00	31.52	23.3	4.51	52.9
300	10.02	31.45	24.2	3.65	39.0
400	6.50	33.23	26.1	3.75	37.5
450	8.60	30.69	23.8	3.45	35.5

Stn. MU-H2
Date Aug. 22, 1988 Time 15 : 00-17 : 30
Ship Mesekiu Transparency 37.7m
Depth over 500m

Depth (m)	Temp. (℃)	Salinity (‰)	Density (σ_t)	DO (ppm)	Saturation Degree(%)
0	29.90	33.23	20.5	6.15	94.5
10	29.88	32.62	20.0	6.20	94.9
20	29.80	33.30	20.5	6.30	96.9
30	29.74	33.30	20.6	6.16	94.8
50	29.81	32.75	20.1	6.20	95.1
75	28.51	33.10	20.8	6.30	94.0
100	26.25	32.89	21.4	6.30	90.0
150	17.80	31.18	22.4	5.20	63.6
200	13.10	30.83	23.2	4.35	48.9
300	21.07	31.52	21.9	3.30	43.0
400	8.93	30.49	23.6	3.30	34.2
450	8.45	29.12	22.6	3.37	34.2

Table 1. continued

Stn. MU-H3
Date Aug. 23, 1988 Time 9 : 50-11 : 16
Ship Mesekiu Transparency 31.7m
Depth 280m

Depth (m)	Temp. (℃)	Salinity (‰)	Density (σ_t)	DO (ppm)	Saturation Degree(%)
0	29.70	33.51	20.7	6.07	92.5
10	29.73	33.37	20.6	6.00	91.5
20	29.73	33.37	20.6	6.05	92.2
30	29.72	33.10	20.4	6.21	94.5
50	29.46	32.82	20.3	6.20	94.1
75	27.86	32.55	20.6	6.10	90.0
100	25.22	33.58	22.2	5.70	80.3
150	18.80	30.83	21.9	4.90	61.3
200	13.09	30.49	22.9	4.30	48.2
250	11.77	30.49	23.2	4.70	51.8

Stn. MU-H4
Date Aug. 23, 1988 Time 12 : 40-13 : 48
Ship Mesekiu Transparency 36.7m
Depth 170m

Depth (m)	Temp. (℃)	Salinity (‰)	Density (σ_t)	DO (ppm)	Saturation Degree(%)
0	30.16	33.85	20.8	6.10	93.8
10	29.74	31.93	19.5	6.00	90.8
20	29.74	32.62	20.1	5.93	89.7
30	29.73	32.68	20.1	6.01	91.1
50	29.39	32.89	20.4	5.80	87.7
75	28.31	32.55	20.5	6.11	90.8
100	26.08	33.16	21.6	6.00	85.6
150	19.24	31.18	22.1	5.00	62.7

Stn. MU-H5
Date Aug. 23, 1988 Time 14 : 10-15 : 20
Ship Mesekiu Transparency 34.2m
Depth 230m

Depth (m)	Temp. (℃)	Salinity (‰)	Density (σ_t)	DO (ppm)	Saturation Degree(%)
0	30.40	32.27	19.6	6.51	99.2
10	29.75	32.27	19.8	6.45	97.9
20	29.73	32.62	20.1	6.65	100.8
30	29.72	32.55	20.0	6.40	97.0
50	29.20	32.75	20.3	6.45	97.1
75	27.51	32.89	21.0	6.40	93.7
100	25.00	31.79	20.9	6.03	84.0
150	19.24	31.04	22.0	5.48	68.8
200	14.52	30.35	22.5	4.40	50.7

low value to high. The salinity values in this area seem to be generally lower than those observed in Fiji (Hayasaka *ed.* 1985).

Transparency ranges were from 30.7m to 37.7m at all the stations. It is generally said that the phyto-plankton is usually distributed down to a depth of five times that of transparency. This suggests that the lower limit of vertical distribution of phytoplankton may be 150-200m in depth in Mutremdiu Bay.

The DO values showed rather constant vertical distribution above the thermocline (mean value of DO between the surface and 100m in depth, 6.17 ppm). The saturation degrees were also constant at a high level (from 80.3% to 100%) in the same depth range. This might have resulted from the oxygen production of the phytoplankton. Low values of DO (from 3.30 ppm to 4.70 ppm) were observed in the layers under the thermocline at all stations. Saunders (1984) reported that *Nautilus belauensis* inhabits a depth range of 150m to 300m. Based on the results of the present survey, *Nautilus belauensis* is judged to inhabit sea water masses with low DO values.

Acknowledgments

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