7. Notes on the Assemblages of Benthonic Foraminifera from the Habitat of *Nautilus* in Fiji

by

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Introduction

The field study on the habitat of *Nautilus* off the east coast of Viti Levu Island, Fiji was carried out during the period from 19th August to 19th September, 1986.

The six bottom surface samples for the ecological study of benthonic foraminifera were collected from the four stations off Suva (SV-F1～SV-F4) and the two stations off Ovalau Island (OL-F1 and OL-F2). All samples were taken by the Phleger bottom sampler for the statistical analysis. Through the present study the relative rates of sedimentation based on the L/Tl values (ŌKI, 1986) were estimated and the mode of occurrence of genera of benthonic foraminifera relative to the water depth were clarified.

Materials and Method

The bottom samples used for this study were collected with a gravity core sampler at the four stations with 50 fathoms (92 m) difference in depth located on a longitudinal line off Suva, and at the two stations (403 m and 458 m in depth) off Ovalau Island (Fig. 1). Sounding was carried out by the echo-sounder and positioning was by the radar installed on R. V. Aphareus.

The topmost one centimeter sediment core sample, which is approximately 10 cc of wet sediments, was preserved in neutralized formaline (5 %) and stained with Rose Bengal for discriminating the live foraminifera.

In the laboratory, each sample was washed through a 200-mesh (0.074 mm opening) sieve and ovendried after removal of dye stuff (Rosa Bengal). Dry samples were split with a microsplitter to yield an aliquot containing more than 200 specimens and all specimens contained were picked from the aliquot. Aliquots

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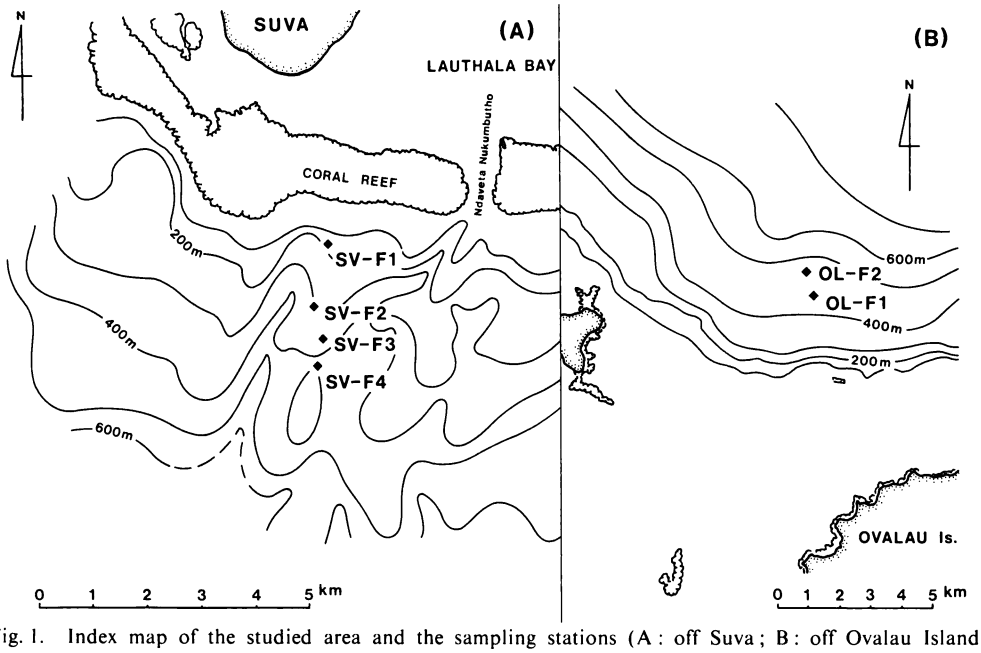

Fig. 1. Index map of the studied area and the sampling stations (A : off Suva ; B : off Ovalau Island).

containing less than 200 individuals of benthonic foraminifera were supplemented by additional splits. Specimens were spread on a tray, and all specimens of benthonic genera were identified and counted, and specimens of planktonic foraminifera within each aliquot were also counted.

Rate of Sedimentation

PHLEGER (1951) pointed out that the relative rate of sedimentation between the sampling stations can be inferred from the ratio of live specimens to the total assemblage of benthonic foraminifera contained in the surface sediments, which has been treated as L/T value by the subsequent authors (UCHIO, 1960 ; MATOBA, 1970). However, the L/T value must be smaller at the station where the dead tests of benthonic foraminifera derived from surrounding area by bottom current are accumulated, and this results in the under estimation of rate of sedimentation. To correct the defect, the writer proposed to use the ratio of live specimens to the total number of individuals only of the live species recognized at each station and designate it Tl instead of T (ŌKI, 1986). The L/Tl values of the sediments from the studied areas are shown in Table 1 and Fig. 4.

The L/Tl value off Suva has a tendency to increase with water depth (10.3 →52.4)(Table 1 and Fig. 4). In this area, surface current moving toward the coast (outer margin of barrier reef) and offshore bottom current are recognized (Captain MAIWELAGI's personal information). On the sea bottom surrounding the shallow Station SV-F1 (183 m in depth), materials suspended in the water

can hardly be deposited owing to rather rapid bottom current and steep slope. The fine materials being moved to deeper bottom by the bottom current must be deposited and concentrated in the area surrounding the Stations SV-F3 (366 m in depth) and SV-F4 (458 m in depth) on rather gentle slope. High L/Tl value at the Station SV-F2 (275 m in depth) was explained as the result of deposition of coarse sediments[1] transported from the shallow area (HAYASAKA *et al.*, 1985).

Remarks on Foraminifera

1. General features of the foraminifera

The total number of benthonic and planktonic foraminifera at each station estimated based on the rate of sedimentation (L/Tl value), respective ratio of agglutinated, porcelaneous and hyaline benthonic foraminifera to the total benthonic foraminifera, and planktonic foraminifera to the total foraminifera are given in Table 1. Through the analysis mentioned above, the following several points were made clear.

1) Planktonic foraminifera contents in the sediments of the studied areas (ten bottom samples colleted in 1983; six bottom samples in 1986) are harmonized with water depth. As shown in Fig. 2, the data of all stations except for the Station SV-F2 are plotted on or near the parabolic line drawn in relation to water depth. The low content at the Station SV-F2 was explained as the result of deposition of derived sediments mentioned above.

Table 1. Composition of foraminifera in the bottom sediments obtained from the six stations off Suva (SV-F1~SV-F4) and off Ovalau Island (OL-F1 and OL-F2).

Station	off SUVA				off Ovalau	
	SV-F1	SV-F2	SV-F3	SV-F4	OV-F1	OV-F2
Depth (m)	183	275	366	458	403	458
Planktonic Population						
Number of individuals	1529	3171	11688	9256	22622	24910
actually counted	116	45	373	138	237	280
Pl/Pl+Be Ratio (%)	22.7	10.7	46.3	40.7	47.9	55.4
Benthonic Population						
Number of individuals	5194	13177	13568	13481	24627	20017
(actually counted) total	394	187	433	201	258	225
(actually counted) live	7	11	31	33	30	18
Agglutinated test (%)	6.3	7.0	4.8	10.9	3.1	6.2
Porcelaneous test (%)	12.4	11.8	11.5	17.4	16.7	16.4
Hyaline test (%)	81.2	80.7	83.6	71.6	80.2	77.3
Number of Genus	82	60	73	49	66	63
L/Tl value	10.3	36.7	35.7	52.4	43.5	36.2

Pl: planktonic foraminifera; Be: benthonic foraminifera

1) At the Station SV-F2, sand contents attain to 40.7 %.

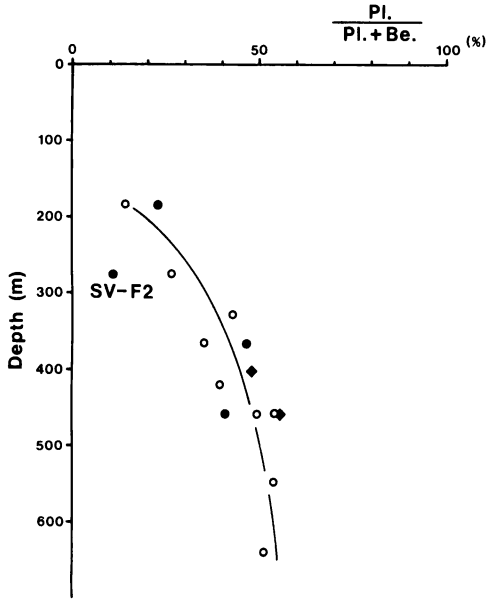

Fig. 2. The correlation between the frequency of planktonic foraminifera in the bottom sediments and the water depth off the east coast of Viti Levu, Fiji (●: off Suva in 1986; ○: off Suva in 1983; ◆: off Ovalau Island; Pl.: planktonic foraminifera; Be.: benthonic foraminifera).

2) The number of individuals of the planktonic foraminifera is less than 3000 at the Stations SV-F1 and SV-F2 (both shallower than 300 m) and around 10000 at the Stations SV-F3 and SV-F4 (both deeper than 350 m) off Suva.
At the two stations (deeper than 400 m) off Ovalau Island, the number of individuals of the planktonic foraminifera is more than 20000.

3) The number of individuals of the total benthonic foraminifera is about 5000 at the shallowest Station SV-F1 (183 m in depth) and around 10000 at the three stations (SV-F2～F4) deeper than 275 m off Suva. At the two stations (OL-F1 and F2) off Ovalau Island, the number of individuals of the total benthonic foraminifera is more than 20000.

4) The number of genera in the sediments off Suva has a tendency to decrease (82→49) with water depth. At the two stations off Ovalau Ialand, the number of genera is around 65.

5) The composition of benthonic foraminifera contained in the sediments off Suva (ten bottom samples collected in 1983; four bottom samples in 1986) and off Ovalau Island (two bottom samples in 1986), Fiji, are given in Table 1 and Fig. 3. The assemblages of benthonic foraminifera off Suva are divided into two groups by the radio of the agglutinated foraminifera. One group (SV-1,

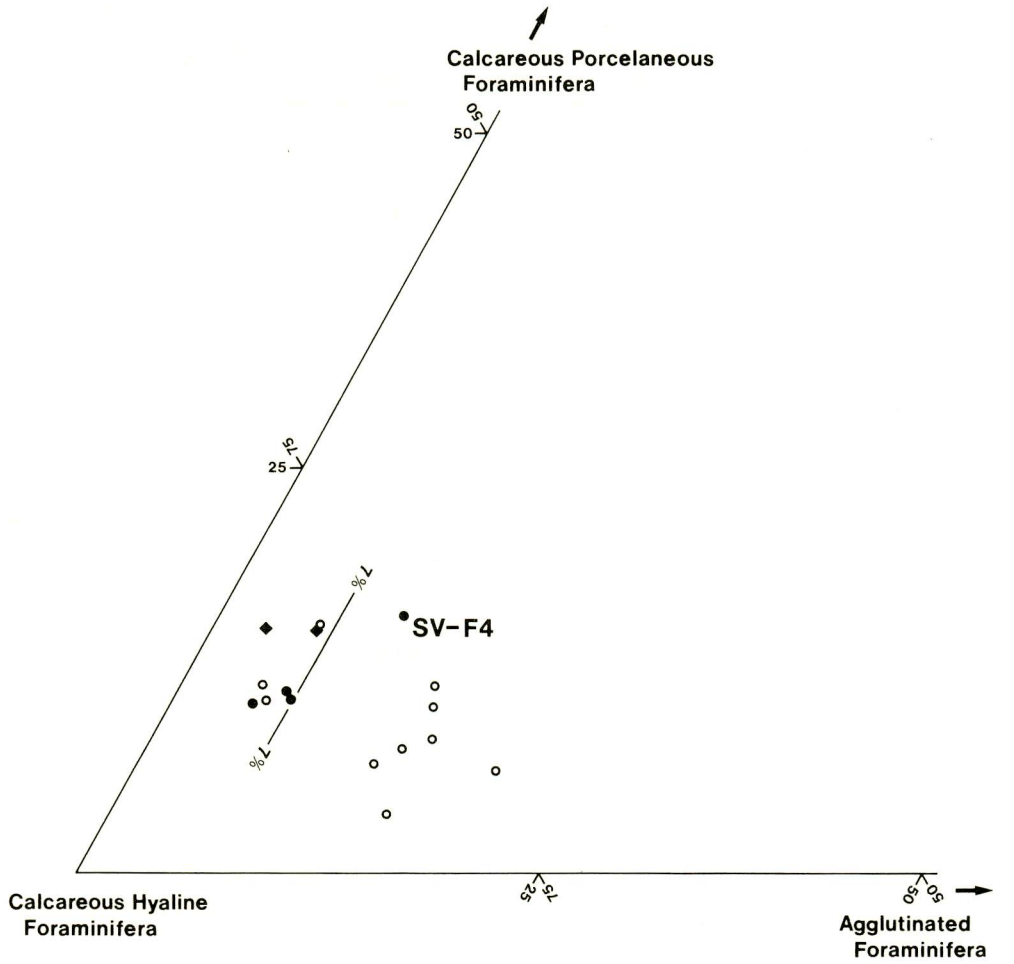

Fig. 3. Triangular diagram of the ratio of the three kinds of benthonic foraminioferal tests (●: off Suva in 1986; ○: off Suva in 1983; ◆: off Ovalau Island).

SV-4, SV-10, SV-F1, SV-F2 and SV-F3) is characterized by the frequencies of them less than 7.0 %. Another group (SV-3, SV-5, SV-7, SV-8, SV-9, SV-11, SV-12 and SV-F4) is characterized by the frequencies of them more than 10.9 %. The former is recognized in the sediments from the bottom shallower than 366 m and the latter deeper than 420 m except for the Station SV-7 (366 m in depth). The assemblages of benthonic foraminifera off Ovalau Island are included in the former group in spite of the water depth more than 400 m.

2. Vertical distribution of genera of the benthonic foraminifera

The relative occurrence of genera of benthonic foraminifera were given in Table 2 and Fig. 4. Based on the classification of Foraminiferida by LOEBLICH and TAPPAN (1964) and NOMURA (1983 a, b), the 145 genera of benthonic

Table 2. Occurrence of the total and live benthonic foraminifera off Suva and off Ovalau Island.

Station	off SUVA				off Ovalau	
	SV-F1	SV-F2	SV-F3	SV-F4	OV-F1	OV-F2
Fauna \ Depth (m)	183	275	366	458	403	458
AGGLUTINATED TEST						
Psammosphaera	2	1				
Saccammina			1(1)			
Lagenammina	3			3(1)		1
Technitella		1(1)				
Tolipammina		1(1)				
Nodosinum					1(1)	
Reophax	2	3(2)		7(6)	1	2(1)
Miliammina ?	1					
Haplophragmoides		2(2)				
Cribrostomoides	2(2)		3(3)	3(3)		
Recurvoides	1					
Spiroplectammina	1	1				
Textularia	7	3				2
Siphotextularia	2				1	1
Trochammina	1		5(3)	3(2)	2(1)	4(1)
Ammosphaeroidina			1(1)			
Cystammina						1(1)
Barbourinella	1	1				
Gaudryina	2		4(4)			
Heterostomella		1(1)				
Tritaxia			2		2	2
Eggerella				1		
PORCELANEOUS CALCAREOUS TEST						
Cyclogyra	6			4		
Agathammina ?				1		
Cornuspiramia		1			1	
Ophthalmidium					2	
Cornuloculina		1		1		1
Wiesnerella	1		2		3	1
Spiroloculina	1	1	1	2		
Planispirinoides	5	1				
Vertebralina			1			2
Quinqueloculina	23	8	20(1)	18	8	10
Massilina			1			
Palaeomiliolina ?	5	2			4	
Pateoris					2	
Siphonaperta		1	2			
Triloculina	1		3	3	2	2
Miliolinella	1	1	8	2	6(2)	7
Scutuloris	3			1	1	
Miliola	2					
Hauerina	1	1	2			
Sorites		1				1
HYALINE CALCAREOUS TEST						
Nodosaria		2	1			
Amphicoryna	2					
Dentalina	1	1				
Lagena	1	1				
Lenticulina	4	1		1	3	2

Table 2. Continued.

Station	off SUVA				off Ovalau	
	SV-F1	SV-F2	SV-F3	SV-F4	OV-F1	OV-F2
Fauna \ Depth (m)	183	275	366	458	403	458
Palmula					1	
Pseudonodosaria		1				
Saracenaria			1			
Bolivinella	2	2	1		7	
Guttulina					1	
Sigmomorphina	1					
Seabrookia	9(1)		4	16(2)		2
Oolina			1			
Fissurina	2		7	2	5	2
Turrilina	1	1		1		
Buliminella			1			5
Buliminoides						1
Tosaia ?						1
Sphaeroidina	2	1	9		1	1
Bolivina	16	10(1)	21	13(3)	27(8)	15(2)
Loxostomoides			2		1	
Rectobolivina					2	1
Bulimina		4	22	6(2)	2	3(2)
Globobulimina			2			
Stainforthia				1(1)		
Reussella	3	3	4		7	
Trimosina			1		1	
Uvigerina	14	4	3		8(1)	1
Hopkinsina		1	5			
H. ?	1	2				
Pseudouvigerina ?					1	
Sagrina						3
Siphogenerina	1		1			
Siphouvigerina			6	4	2(2)	4
Trifarina	4	2(1)	5	2	6(2)	3
Uvigerinella	5					
Discorbis	14	3	24	5	5	4
Discorbinella	2		6	1	1	3(1)
Eoeponidella				1		
E. ?			1			
Epistominella	1	2	2(1)	4	2	4
Eilohedra		1	7(2)	2	2	1(1)
Gavelinopsis	9	1	1	3		1
Laticarinina ?	1	3	1			
Neoconorbina	3		1		1	4
Patellinella	1		2			
Pijpersia		1				
Planodiscorbis			4			
Rosalina	9	4	4	8	9	6
Tretomphalus	9	3	13	6	3(1)	2
Cancris	2					
Valvulineria	1		6(3)	9(4)	2	
Glabratella	9	3	7		5(1)	2
Angulodiscorbis	2		2	1		
Siphonina	2					
Asterigerinoides				1		
Spirillina	8	2		5	1	2
Conicospirillina			1			
Planispirillina	1					1

Table 2. Continued.

Station	off SUVA				off Ovalau	
	SV-F1	SV-F2	SV-F3	SV-F4	OV-F1	OV-F2
Fauna \ Depth (m)	183	275	366	458	403	458
Sejunctella				1		1
Patellina	1	2	1		1	1
Ammonia					2	
Asterorotalia		1			1	
Calcarina	2	1				
Siderolites			2			
Elphidium	5(1)		3	1	3	1
Cribroelphidium	1					
Protelphidium	1			1	1	
Nummulites	3	3				1
Heterostegina	1					
Eponides ?		1				
Cibicorbis					2	
Amphistegina	11	26	7		1	
Hyalinea ?	5	1	1			1
Cibicides	3	4	4		4	
Rectocibicides		1				
Cymbaloporetta	5	1	6		14	3
Fursenkoina						1
Sigmavirgulina	3				1	1
Islandiella	8		2	5	2	3
Cassidulinoides	2		2(1)	1	1(1)	1
Globocassidulina	25(1)	17(2)	41(5)	7(3)	21(5)	29(3)
Cassidulina	4		5	1	1	5
Lernella	1		1		2	
Paracassidulina	39(1)	3	22(2)	7(3)	4(2)	9
Burseolina			3	5		2(1)
Ehrenbergina			4			6
Chilostomella			2			
Allomorphina						1
Nonion					1	
Astrononion	13	3	22	3	5(1)	1
Florilus						1
Nonionella	1(1)	2	1	1	1	
Pullenia	2					
Oridorsalis		1			1	
Gyroidinoides	4	5	12(1)	3(1)	7(2)	11(4)
Anomalina	8	2	5	2	8	5
Cibicidoides	19	11	7(1)		2	2
Gavellinella			2			
Melonis	2					
Ceratolamarckina			2	2		1
Lamarckina	1		1			1
Hoeglundina	2	1			1	2
Alliatinella			5	2	1	
Geminospira					1	
Miscellaneous						
agglutinated test	0	0	5(2)	5	1	1
porcelaneous test	0	4	10	3	14	13
hyaline test	5	6	20	10(2)	12	10

( ): number of individuals of live test

foraminifera were recognized in the studied areas. Through the classification, the following several points were made clear.

Bolivina (frequencies: 4.1-10.5 %), *Globocassidulina* (3.5-12.9 %), *Quinqueloculina* (3.1-9.0 %), *Paracassidulina* (1.6-9.9 %) and *Discorbis* (1.6-5.5 %) showing rather high frequencies among the 145 genera occur in the bottom sediments of all the stations (SV-F1～F4 and OL-F1～F2). As the other genera showing low

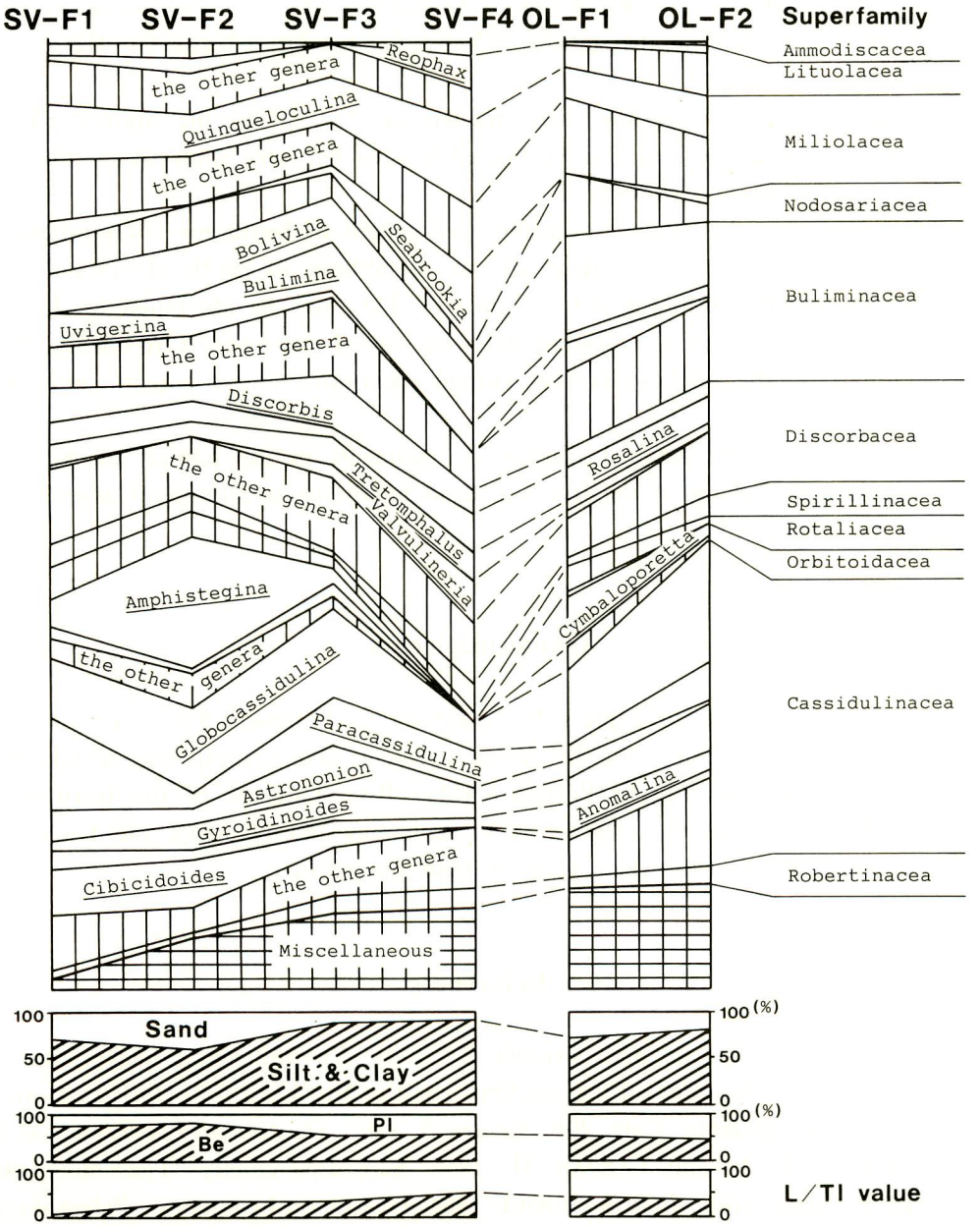

Fig. 4. Relative abundances of genera in the studied area (SV: off Suva; OL: off Ovalau Island; Pl: planktonic foraminifera; Be: benthonic foraminifera).

frequencies, *Gyroidinoides* (1-4.9 %), *Anomalina* (1-3.1 %), *Rosalina* (0.9-4 %) *Tretomphalus* (0.9-3 %) and *Astrononion* (0.4-5.1 %) were known to occur at all the stations. A live *Tretomphalus* having a float chamber occurs at the Station OL-F1 (403 m in depth). *Bulimina* occurs at the five stations except for the shallowest Station SV-F1 and shows the frequencies ranging from 0.8 to 5.1 %.

Cibicidoides shows the high frequencies (4.8-5.9 %) at the stations (SV-F1 and SV-F2) shallower than 275 m.

On the other hand, *Trochammina, Miliolinella* and *Siphouvigerina* occur with rather high frequencies at the stations (SV-F3, SV-F4, OL-F1 and OL-F2) deeper than 366 m.

Amphistegina showing the high frequencies (13.9 %) at the Station SV-F2 seems to have been derived from the shallow area by some underwater processes such as the submarine sliding.

Judging from the relative occurrence of genera of benthonic foraminifera in the studied areas, a clear difference of the assemblages of benthonic foraminifera in relation to the depth was not recognized. This may be attributed to the fact that dead tests of benthonic foraminifera were moved downward through the steep slope (5-9°) by the offshore bottom current mentioned above and/or submarine sliding.

To scrutinize the detailed features of sediments in the habitat of *Nautilus,* the population analyses of the live and dead benthonic foraminiferal assemblages should be performed.

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