

MERIDIONAL HYDROGRAPHIC SECTIONS AND PLANKTONIC FORAMINIFERAL ASSEMBLAGES IN THE WEST PACIFIC OCEAN IN 1995

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Introduction

Oceanographical surveys and studies of planktonic foraminiferal assemblages were carried out in Oct. 1995. The water temperature and salinity data were noted and planktonic Foraminifera were collected in the west Pacific on a voyage from Kagoshima to Palau. Oceanographic data were taken with CTD and XBT. Samples of planktonic Foraminifera were collected by vertical towing.

Observation Stations and Sampling Stations

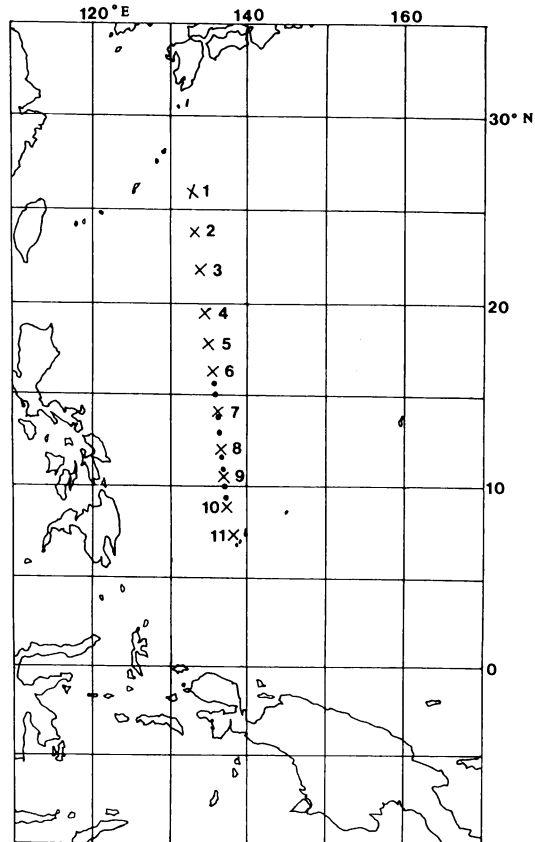


Fig. 1 Sampling stations in the West Pacific Ocean.
Map showing observation stations and sampling stations of planktonic Foraminifera.
Symbols; x: CTD observation and planktonic Foraminifera ; · : XBT observation

Planktonic foraminiferal sampling stations, and CTD and XBT observation stations are shown in figure 1. The XBT was launched at 8 stations from lat. 15°47.6' N, long.132°55.0' E, to lat.9°00.0' N, long. 134°00.0' E. The CTD was lowered at 11 stations from lat. 25°59.6' N, long. 131° 26.1' E, to lat. 7°50.8' N, long. 134°15.0' E. Samples of planktonic Foraminifera were taken at the same 11 stations with points of CTD. Table 1 shows the sampling positions, dates, hours, and temperature and salinity of the sea water. Figure 2 indicates the temperature-salinity diagram of sampling stations of planktonic Foraminifera at horizon in depth of 0-200 m. The T-S diagram of stations Nos. 10 and 11 are different from the others. Also the T-S diagram of No. 7 and 8 is divided from others. And No. 9 is different from the others. T-S diagram is divided into 4 types (Nos. 10 and 11, No. 9, Nos. 7 and 8 and others).

We consider that Nos. 10 and 11 correspond to the North Equatorial Current and No. 9 is equal to the North Equatorial Counter Current. No. 7 and 8 is perhaps the intermediate assemblage. No. 1 to 6 indicate the influence of the Kuroshio Counter Current. Figure 3 shows the vertical distribution of sea water temperature in the region between lat. 26° N, long. 131° E and lat. 5° N, long 134° E. The surface mixed layer of 28°C-29°C was about 70 m thick. There is a sharp thermocline of 15° C at 150-300 m of depths between lat. 50° N and lat. 100° N. The structure of thermocline consists of an upslope from the lat. 5° N to a peak of 7°30' N, and a descent from the peak to the North.

Table 1. CTD and XBT observation data ; Station Number, Date, Time of start of sampling, Position and Temperature of each depth. (T.: temperature, S.: salinity, D: depth)

CTD	No. 1		No. 2		No. 3		No. 4		No. 5		No. 6	
Date	1995.10.10		1995.10.11		1995.10.11		1995.10.12		1995.10.12		1995.10.13	
Time	18 : 38		06 : 13		17 : 50		04 : 55		16 : 02		02 : 02	
Lat.	25-59.6N		23-59.7N		21-59.6N		19-59.7N		18-06.3N		16-12.9N	
Long.	131-26.1E		131-44.2E		132-02.1E		132-19.6E		132-35.8E		132-52.1E	
D(m)	T(°C)	S(‰)	T(°C)	S(‰)	T(°C)	S(‰)	T(°C)	S(‰)	T(°C)	S(‰)	T(°C)	S(‰)
0	28.49	34.31	28.53	34.60	29.41	34.86	29.35	34.37	29.67	34.27	29.39	34.36
10	28.52	34.55	28.48	34.63	29.37	34.86	29.30	34.45	29.66	34.48	29.39	34.56
20	28.52	34.61	28.48	34.64	29.38	34.86	29.30	34.47	29.54	34.59	29.39	34.60
30	28.50	34.63	28.48	34.64	29.37	34.86	29.30	34.47	29.56	43.67	29.39	34.63
50	27.69	34.70	28.14	34.67	29.37	34.86	29.39	34.65	29.51	34.72	29.39	34.64
75	23.89	34.80	25.60	34.70	25.94	34.88	26.12	34.86	26.84	34.86	26.20	34.93
100	21.91	34.85	23.01	34.81	23.63	34.95	23.29	34.94	25.24	34.96	23.77	34.96
150	19.87	34.91	20.11	34.86	21.08	34.95	19.84	34.93	22.75	35.04	20.65	34.97
200	18.58	34.87	18.42	34.84	19.47	34.93	17.89	34.82	19.84	34.91	18.29	34.86
250	18.05	34.84	17.57	34.80	17.80	34.83	16.64	34.74	18.06	34.85	16.66	34.73
300	17.24	34.77	16.40	34.71	16.72	34.74	15.17	34.60	16.21	34.68	14.89	34.58
400	15.19	34.61	13.67	34.49	13.99	34.50	12.22	34.37	12.08	34.36	11.14	34.35
500	12.60	34.41	11.22	34.32	11.24	34.32	8.83	34.17	9.13	34.22	8.51	34.34
600	10.08	34.27	8.55	34.19	8.17	34.15	6.64	34.15	6.83	34.18	7.11	34.38
700	7.39	34.16	6.71	34.17	6.01	34.14	5.67	34.25	5.62	34.29	5.93	34.39
800	5.70	34.18	5.26	34.24	4.99	34.26	4.86	34.33	5.02	34.40	5.13	34.44
900	4.80	34.25	4.34	34.34	4.41	34.34	4.33	34.40	4.40	34.46	4.51	34.48
1000	4.08	34.32	3.78	34.39	3.89	34.40	3.93	34.47	3.94	34.50	4.11	34.52
1100	3.69	34.38	3.25	34.44	3.60	34.47	3.60	34.50	3.56	34.52	3.73	34.53

Table 1. (Continued)

CTD	No. 7		No. 8		No. 9		No.10		No.11	
Date	1995.10.13		1995.10.13		1995.10.14		1995.10.15		1995.10.152	
Time	12 : 02		22 : 04		08 : 03		20 : 01		14 : 01	
Lat.	14-21.5N		12-29.6N		10-41.2N		9-07.5N		7-50.8N	
Long	133-07.2E		133-22.8E		133-37.8E		133-50.4E		134-15.0E	
D. (m)	T. (°C)	S (‰)	T. (°C)	S (‰)	T. (°C)	S (‰)	T. (°C)	S (‰)	T. (°C)	S (‰)
0	29.84	33.85	29.62	33.98	29.56	33.61	29.67	33.35	29.66	33.27
10	29.67	33.87	29.63	33.98	29.56	33.61	29.37	33.48	29.37	33.41
20	29.50	33.86	29.63	34.00	29.56	33.63	29.38	33.51	29.33	33.48
30	29.49	33.86	29.57	34.00	29.56	33.63	29.38	33.51	29.32	33.52
50	29.48	33.86	29.55	34.00	29.52	33.86	29.31	34.04	29.32	33.56
75	29.46	33.98	27.98	34.47	28.41	34.31	26.96	34.39	25.28	34.55
100	27.99	34.50	26.20	34.81	25.64	34.76	20.23	34.73	20.18	34.69
150	24.98	35.00	22.85	35.02	19.68	34.79	14.88	34.55	13.97	34.51
200	20.65	34.96	18.14	34.70	15.07	34.57	11.98	34.48	10.82	34.51
250	16.57	34.73	13.72	34.52	11.44	34.44	9.97	34.48	9.90	34.52
300	13.65	34.46	11.56	34.47	9.39	34.33	9.21	34.51	9.16	34.53
400	9.80	34.37	8.39	34.40	7.94	34.45	7.97	34.53	8.23	34.54
500	7.97	34.42	7.13	34.43	7.32	34.52	7.31	34.52	7.57	34.54
600	6.84	34.44	6.33	34.45	6.69	34.52	6.80	34.52	6.88	34.52
700	6.17	34.46	5.93	34.49	6.09	34.51	6.25	34.52	6.25	34.52
800	5.40	34.46	5.44	34.51	5.75	34.52	5.60	34.52	5.67	34.53
900	4.90	34.50	5.01	34.52	5.35	34.53	5.13	34.54	5.14	34.54
1000	4.45	34.53	4.57	34.54	4.94	34.54	4.71	34.55	4.67	34.55
1100	4.08	34.55	4.16	34.55	4.56	34.55	4.26	34.56	4.09	34.57

XBT	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8
Date	1995.10.13	1995.10.13	1995.10.13	1995.10.13	1995.10.14	1995.10.14	1995.10.14	1995.10.15
Time	05 : 09	08 : 56	14 : 42	19 : 27	01 : 33	06 : 24	12 : 30	07 : 42
Lat.	15-47.6N	15-00.0N	14-00.0N	13-00.0N	12-00.0N	11-00.0N	10-00.0N	9-00.0N
Long.	132-55.0E	133-01.7E	133-10.5E	133-18.3E	133-21.6E	133-35.2E	133-43.7E	134-00.0E
Long.	132-55.0E	133-01.7E	133-10.5E	133-18.3E	133-21.6E	133-35.2E	133-43.7E	134-00.0E
	T. (°C)	T. (°C)	T. (°C)	T. (°C)	T. (°C)	T. (°C)	T. (°C)	T. (°C)
0	29.00	29.07	29.47	29.27	29.27	29.34	29.14	28.78
10	29.00	29.07	29.24	29.37	29.27	29.39	29.14	28.78
20	29.00	29.05	29.24	29.29	29.32	29.39	29.14	28.90
30	29.10	29.00	29.22	29.32	29.32	29.42	29.14	28.97
50	29.07	29.02	29.27	29.24	29.42	29.44	29.37	28.90
75	27.01	28.08	28.39	28.25	28.42	28.06	28.27	24.90
100	25.22	26.68	27.37	27.15	26.86	25.49	24.60	21.40
150	21.81	23.16	23.79	22.94	21.45	20.20	16.57	12.89
200	18.04	18.98	19.86	16.86	15.44	14.44	12.59	10.28
250	15.59	15.93	15.34	13.24	11.23	11.36	10.04	9.34
300	13.03	12.99	12.24	11.07	9.59	9.49	9.08	8.73
400	9.71	9.34	8.92	8.26	7.95	7.36	7.93	7.91
500	7.87	7.59	7.40	7.19	6.65	7.00	7.24	7.36
600	6.31	6.56	6.45	6.34	5.95	6.31	6.65	6.61
700	5.34	5.68	5.71	5.71	5.48	5.83	5.97	5.93
800	4.78	5.07	5.10	5.22	5.02	5.36	5.47	5.29

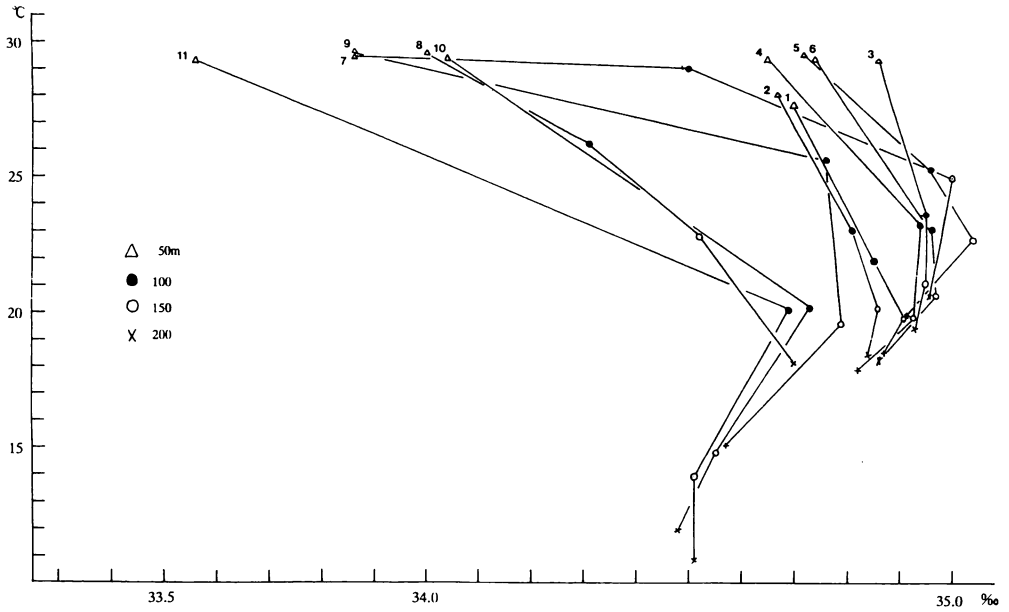


Fig. 2 Temperature-salinity diagram of sampling stations of planktonic Foraminifera (Station Number: 1 - 11)

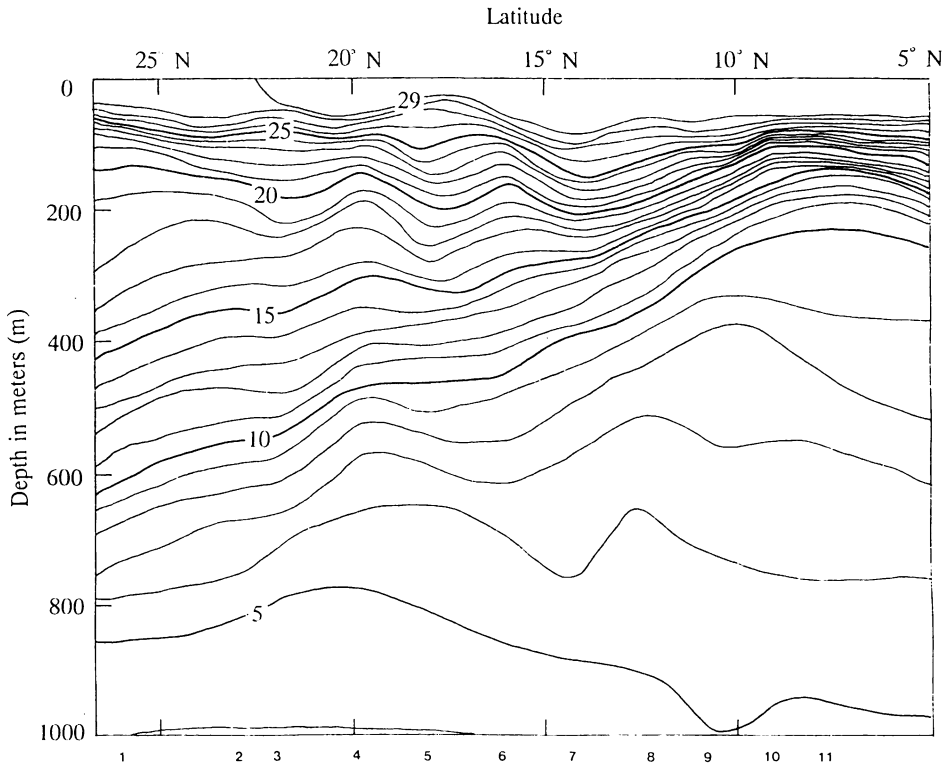


Fig. 3 Vertical distribution of water temperature (°C) between 26° N and 5° N (Number 1-11 Planktonic sampling station)

Table 2. List of planktonic Foraminifera
Number means total specimen number (Adult and young specimen number, Infant specimen number)

Depth (m)	No. 1(18-38-20-00)			No. 2(6-07-7-40)			No. 3(17-49-19-00)		
	0-50	50-100	100-150	0-50	50-100	100-150	0-50	50-100	100-150
Candaina nitida D'ORNIBNY									
Globigerina rubescens HOFKER	9(. 9)			6(. 6)	2(. 2)	3(1. 2)	2(. 2)	10(5. 5)	9(3. 6)
Globigerinella aequilateralis (BRADY)		1(. 1)				2(. 2)			
G. calida (PARKER)	2(1. 1)			10(5. 5)	1(. 1)		14(6. 8)	13(9. 4)	14(7. 7)
Globigerina glutinata (EGGER)	2(. 2)			12(5. 7)	1(. 1)	3(. 3)	32(15.17)	21(10.11)	14(3.11)
Globigerinoides conglobatus (BRADY)							4(4.)		
G. obliquus BOLLJ				1(1.)			10(7. 3)	4(2. 2)	6(5. 1)
G. ruber (D'ORBIGNY)	3(1. 2)			3(. 3)			50(11.39)	31(27. 4)	8(4. 4)
G. sacculifer (BRADY)	8(1. 7)	1(1.)		11(8. 3)	2(. 2)	3(. 3)	204(162.42)	63(57. 6)	62(43.19)
G. tenellus PARKER	3(. 3)			5(. 5)		1(. 1)			3(. 3)
Globoquadrina conglomerata (SCHWAGER)									
Globoquadrina hirsuta (D'ORBIGNY)									
G. menardii (PARKER, JONES & BRADY)									
G. tumida (BRADY)				1(. 1)					1(. 1)
Neogloboquadrina duterrei (D'ORBIGNY)									
Orbulina universa (D'ORBIGNY)									
Pulleniatina obliquiloculata (PARKER & JONES)									
Haastigerina pelagica (D'ORBIGNY)									
Miscellaneous	20(. 20)	1(1.)	8(. 8)	22(. 22)	3(2. 1)	2(1. 1)		253(. 253)	135(. 135)
Total	47(3. 47)	3(3.)	12(1. 11)	71(19. 52)	14(6. 8)	13(5. 8)	22(6. 16)	569(205. 364)	283(116. 167)

Depth (m)	No. 4(4:54-6-40)			No. 5(16:01-17-50)			No. 6(2:00-3:05)		
	0-50	50-100	100-150	0-50	50-100	100-150	0-50	50-100	100-150
Candaina nitida D'ORNIBNY									
Globigerina rubescens HOFKER	9(2. 7)	2(. 2)		10(5. 5)	17(11. 6)	4(3. 1)	1(1.)		
Globigerinella aequilateralis (BRADY)			2(1. 1)		17(10. 7)	2(. 2)			
G. calida (PARKER)	7(4. 3)	6(2. 4)	10(4. 6)	3(3.)			1(1.)	2(. 2)	4(3. 1)
Globigerina glutinata (EGGER)	107(11. 96)	48(. 48)	32(16. 16)	54(10. 44)	62(18. 44)	30(7. 23)	6(3. 3)		
Globigerinoides conglobatus (BRADY)							8(. 8)		4(. 4)
G. obliquus BOLLJ	10(9. 1)	10(10.)		2(2.)	14(4. 10)	4(3. 1)			2(. 2)
G. ruber (D'ORBIGNY)	24(12. 12)	18(2. 16)	2(1. 1)	9(5. 4)	9(4. 5)	7(3. 4)			3(. 3)
G. sacculifer (BRADY)	69(52. 17)	52(46. 6)	26(13. 13)	88(70. 18)	97(75. 22)	30(22. 8)	30(22. 8)	8(7. 1)	8(7. 1)
G. tenellus PARKER									
Globoquadrina conglomerata (SCHWAGER)									
Globoquadrina hirsuta (D'ORBIGNY)									
G. menardii (PARKER, JONES & BRADY)	2(. 2)								
G. tumida (BRADY)									
Neogloboquadrina duterrei (D'ORBIGNY)									
Orbulina universa (D'ORBIGNY)									
Pulleniatina obliquiloculata (PARKER & JONES)									
Haastigerina pelagica (D'ORBIGNY)									
Miscellaneous	146(13. 133)	25(. 25)	25(1. 24)	570(. 570)	255(. 255)	70(. 70)	16(. 16)		8(. 8)
Total	374(103. 271)	163(61. 102)	111(50. 61)	102(55. 47)	475(126. 349)	151(41. 110)	99(26. 73)	12(7. 5)	42(9. 33)

Table 2. (Continued)

	No.7(12:00-13:10)			No.8(22:00-23:00)			No.9(8:00-9:05)							
	0-50	50-100	100-150	0-50	50-100	100-150	0-50	50-100	100-150					
<i>Candaina nitida</i> D'ORNIBNY														
<i>Globigerina rubescens</i> HOFKER	12(,12)	1(,1)					1(,1)	1(,1)						
<i>Globigerinella aequalateralis</i> (BRADY)			1(1,)			1(,1)	2(,2)	1(,1)	1(,1)					
<i>G. calida</i> (PARKER)	4(,4)		1(,1)			3(1,2)	2(,2)	1(,1)						
<i>Globigerinita glutinata</i> (EGGER)	34(,34)	2(,2)	1(,1)			7(1,6)	6(,6)	5(,5)	5(,5)					
<i>Globigerinoides conglobatus</i> (BRADY)														
<i>G. obliquus</i> BOLLII								1(,1)						
<i>G. ruber</i> (D'ORBIGNY)		1(,1)	1(,1)			1(,1)	1(,1)	1(,1)						
<i>G. saeculifer</i> (BRADY)		1(,1)	1(1,)			5(5,)	3(1,2)	4(,4)	4(4,)					
<i>G. tenellus</i> PARKER	2(,2)													
<i>Globoquadrina conglomera</i> (SCHWAGER)														
<i>Globorotalia hirsuta</i> (D'ORBIGNY)														
<i>G. menardii</i> (PARKER, JONES & BRADY)				2(2,)										
<i>G. tumida</i> (BRADY)														
<i>Neogloboquadrina duterrei</i> (D'ORBIGNY)														
<i>Orbulina universa</i> (D'ORBIGNY)														
<i>Pulleniatina obliquiloculata</i> (PARKER & JONES)														
<i>Hasigerina pelagica</i> (D'ORBIGNY)														
Miscellaneous	67(,67)	2(,2)					8(,8)	3(,3)	15(,15)	44(,44)	16(,16)	8(,8)	16(,16)	
Total	119(,119)	7(,7)	4(1,3)	8(8,)			17(2,15)	18(3,15)	25(,25)	24(,24)	62(,62)	24(4,20)	10(,10)	22(,22)

	No.10(20:00-21:05)			No.11(14:00-15:05)					
	0-50	50-100	100-150	0-50	50-100	100-150			
<i>Candaina nitida</i> D'ORNIBNY									
<i>Globigerina rubescens</i> HOFKER	11(,11)								
<i>Globigerinella aequalateralis</i> (BRADY)		1(,1)							
<i>G. calida</i> (PARKER)	1(,1)								
<i>Globigerinita glutinata</i> (EGGER)	11(,11)								
<i>Globigerinoides conglobatus</i> (BRADY)	3(3,)								
<i>G. obliquus</i> BOLLII									
<i>G. ruber</i> (D'ORBIGNY)	10(2,8)								
<i>G. saeculifer</i> (BRADY)	5(5,)	2(2,)							
<i>G. tenellus</i> PARKER									
<i>Globoquadrina conglomera</i> (SCHWAGER)									
<i>Globorotalia hirsuta</i> (D'ORBIGNY)									
<i>G. menardii</i> (PARKER, JONES & BRADY)	1(,1)	1(1,)							
<i>G. tumida</i> (BRADY)	1(,1)	2(1,1)							
<i>Neogloboquadrina duterrei</i> (D'ORBIGNY)									
<i>Orbulina universa</i> (D'ORBIGNY)		2(1,1)							
<i>Pulleniatina obliquiloculata</i> (PARKER & JONES)									
<i>Hasigerina pelagica</i> (D'ORBIGNY)									
Miscellaneous	55(,55)	3(,3)	3(,3)	10(,10)	513(,513)	50(,50)	57(,57)	40(,40)	76(9,67)
Total	98(10,88)	12(6,6)	10(4,6)	23(2,21)	697(107,590)	89(15,74)	74(8,66)	76(9,67)	

Sampling Methods of Planktonic Foraminiferal Assemblage

At each station, we collected 4 samples by vertical towing from the sea water between 200-150 m, 150-100 m, 100-50 m, and 50-0 m in depth. Table 2 shows data on planktonic Foraminifera. When the towing wire of the plankton net slanted, the towing wire was lengthened to reach a depth of 50 m. Table 3 shows the towing distance in each 50 m horizon. The 4 samples of each station are the vertical sample and also the quantitative samples. We can get to know the volume of planktonic Foraminifera per unit mass.

Table 3. Sampling data of planktonic Foraminifera

No	Date	Time	Lat	Long	50 ~ 0	100 ~ 50	150 ~ 100	200 ~ 150
1	1995/10/10	18:38~20:00	25 59.6 N	131 26.1 E	62m	61m	58m	66m
2	1995/10/11	06:07~07:40	23 59.7 N	131 44.2 E	68m	57m	62m	65m
3	1995/10/11	17:49~19:00	21 59.6 N	132 02.1 E	58m	58m	59m	59m
4	1995/10/12	04:54~06:40	19 59.7 N	132 19.6 E	57m	61m	62m	62m
5	1995/10/12	16:01~17:50	18 06.4 N	132 35.8 E	58m	61m	68m	67m
6	1995/10/13	02:00~03:05	16 12.9 N	132 52.1 E	51m	53m	53m	53m
7	1995/10/13	12:00~13:10	14 21.5 N	133 07.2 E	51m	52m	52m	53m
8	1995/10/13	22:00~23:00	12 29.6 N	133 22.8 E	51m	50m	51m	53m
9	1995/10/14	08:00~09:05	10 41.2 N	133 37.8 E	51m	50m	51m	51m
10	1995/10/14	20:00~21:05	09 07.5 N	133 50.4 E	53m	56m	60m	59m
11	1995/10/15	14:00~15:05	07 50.8 N	134 15.0 E	57m	60m	56m	58m

Planktonic Foraminiferal Assemblage

BÉ (1977) explains synthetically Recent planktonic Foraminifera. HEMLEBEN et al. (1989) refer to the vertical distribution and daily migration. For the purpose of making clear the ecology, distribution and daily vertical migration, we carried out the planktonic Foraminifera. Meridional hydrographic sections and planktonic foraminiferal assemblages in the West Pacific Ocean were carried out by HATTA, A. and S. HAYASAKA (1987), HATTA, A. et al. (1990), HATTA, A. et al. (1992).

44 samples of planktonic Foraminifera have been examined. The list of planktonic Foraminifera from 11 stations is shown in table 2.

The following species were contained ; *Candeina nitida* D'ORBIGNY, *Globigerina rubescens* HOFKER, *Globigerinella aequilateralis* (BRADY), *G. calida* (PARKER), *Globigerinita glutinata* (EGGER), *Globigerinoides conglobatus* (BRADY), *G. obliquus* BOLLI, *G. ruber* (D'ORBIGNY), *G. sacculifer* (BRADY), *G. tenellus* PARKER, *Globoquadrina conglomerata* (SCHWAGER), *Globorotaria hirsuta* (D'ORBIGNY), *G. menardi* (PARKER, JONES & BRADY), *G. tumida* (BRADY), *Neogloboquadrina dutertrei* (D'ORBIGNY), *Orbulina universa* (D'ORBIGNY), *Pulleniatina obliquiloculata* (PARKER & JONES). The significance of distribution and daily migration of planktonic Foraminifera will be discussed at some other time.

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Explanation of Plate 1

Fig. 1 : *Globorotalia menardii* (PARKER, JONES & BRADY), No. 11, 50-0 m, x 24

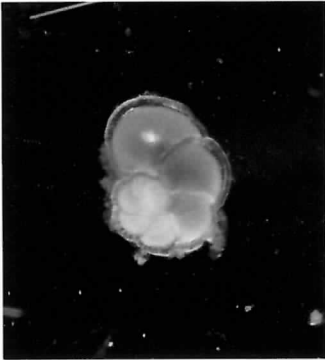
Fig. 2 : *Globorotalia scitula* (BRADY), No. 10, 200-150 m, x 48

Fig. 3 : Upper; *Globigerinoides sacculifer* (BRADY), Under; *Globigerinella calida* (Parker), No. 10, 100-50 m, x 48

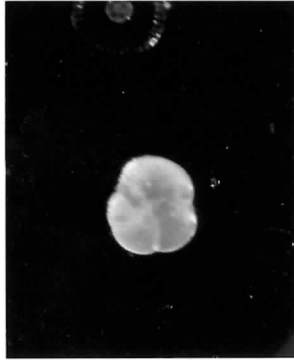
Fig. 4 : *Candeina nitida* D'ORBIGNY, No. 11, 50-0 m, x 48

Fig. 5 : *Globigerinella calida* (PARKER), No. 6, 150-100 m, x 48

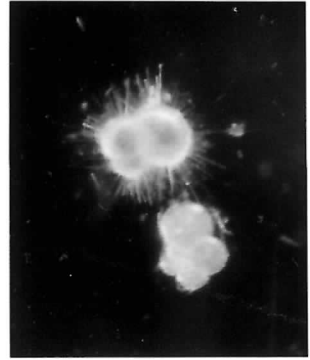
Fig. 6 : Assemblage of Plankton; *Globorotalia*, *Globigerinoides*, *Orbulina universa*, etc., No. 11, 50-0 m, x 12



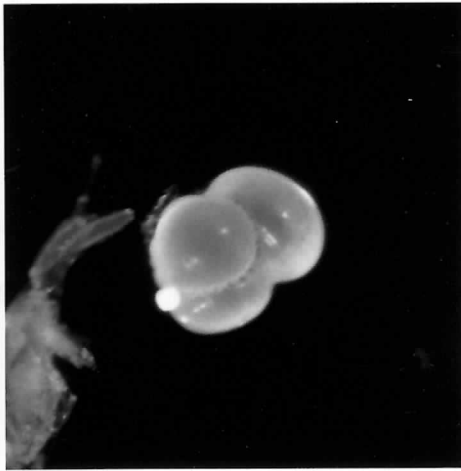
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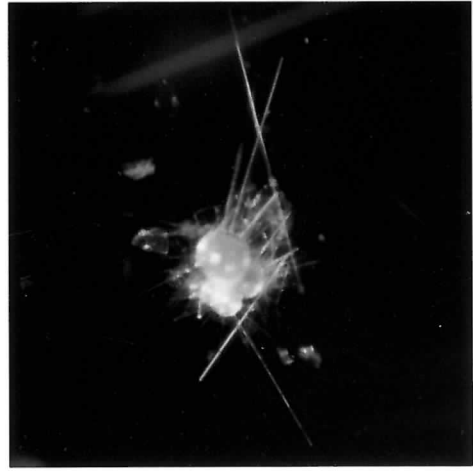
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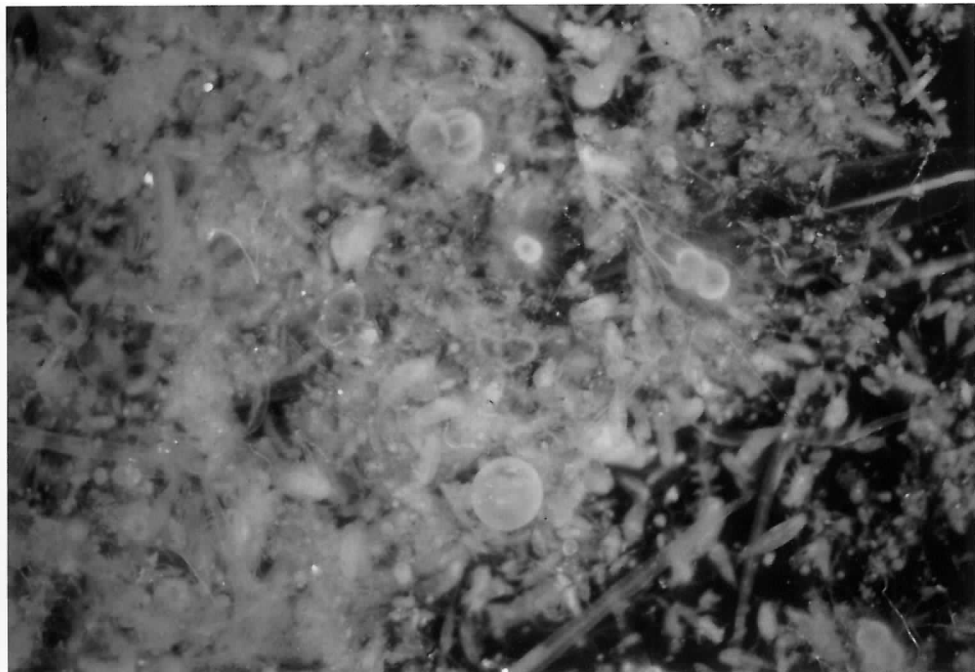
3



4



5



6

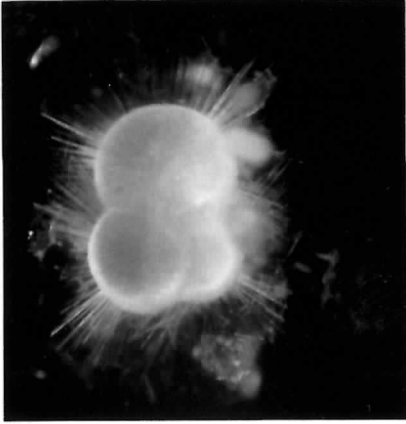
Explanation of Plate 2

Fig. 1 : *Globigerinoides sacculifer* (BRADY), No. 10, 100-50 m, x 48

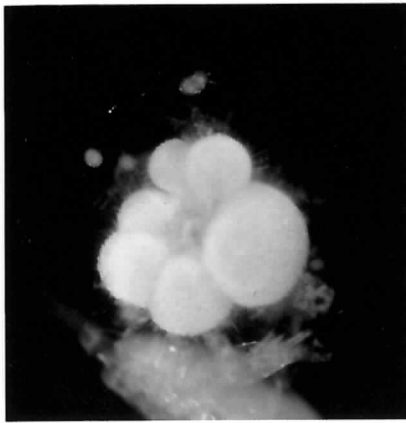
Fig. 2 : *Globigerinella aequilateralis* (BRADY), No. 6, 150-100 m, x 36

Fig. 3 : *Globigerinoides ruber* (D'ORBIGNY), No. 11, 50-0 m, x 36

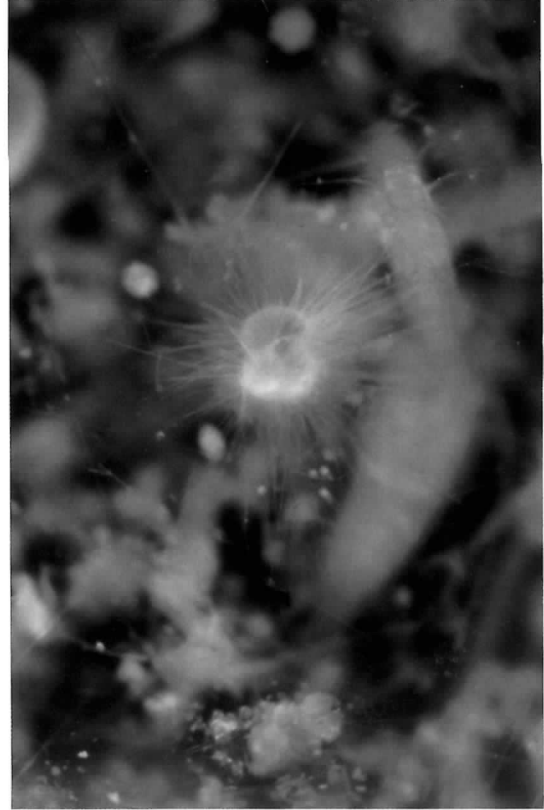
Fig. 4 : *Globigerinoides ruber* (D'ORBIGNY) and assemblage of plankton; No. 11, 50-0 m, x 24



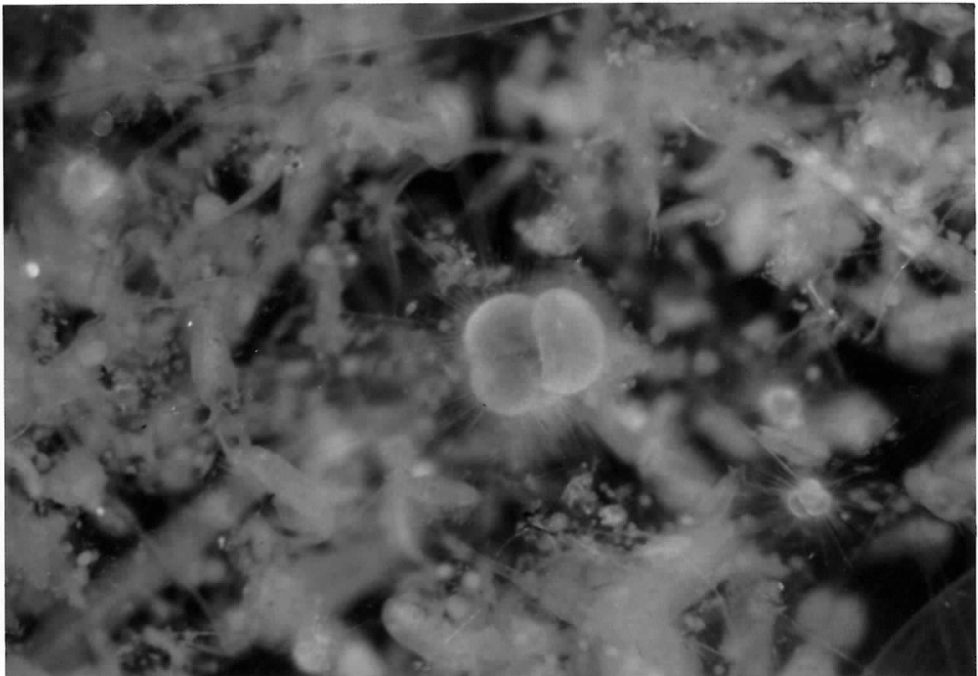
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2



3



4

Explanation of Plate 3

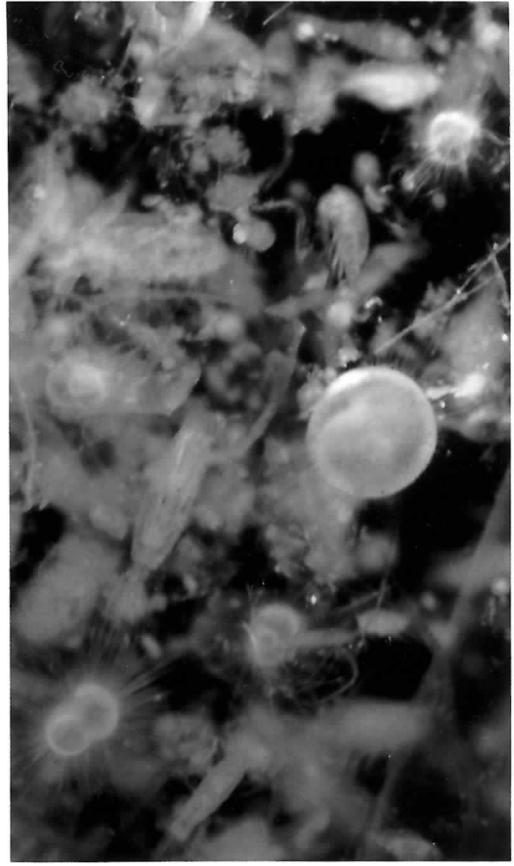
Fig. 1 : *Orbulina universa* D'ORBIGNY, No. 10, 100-50 m, x 48

Fig. 2 : *Orbulina universa* D'ORBIGNY and other planktonic foraminifera, No. 11, 50-0 m, x 28

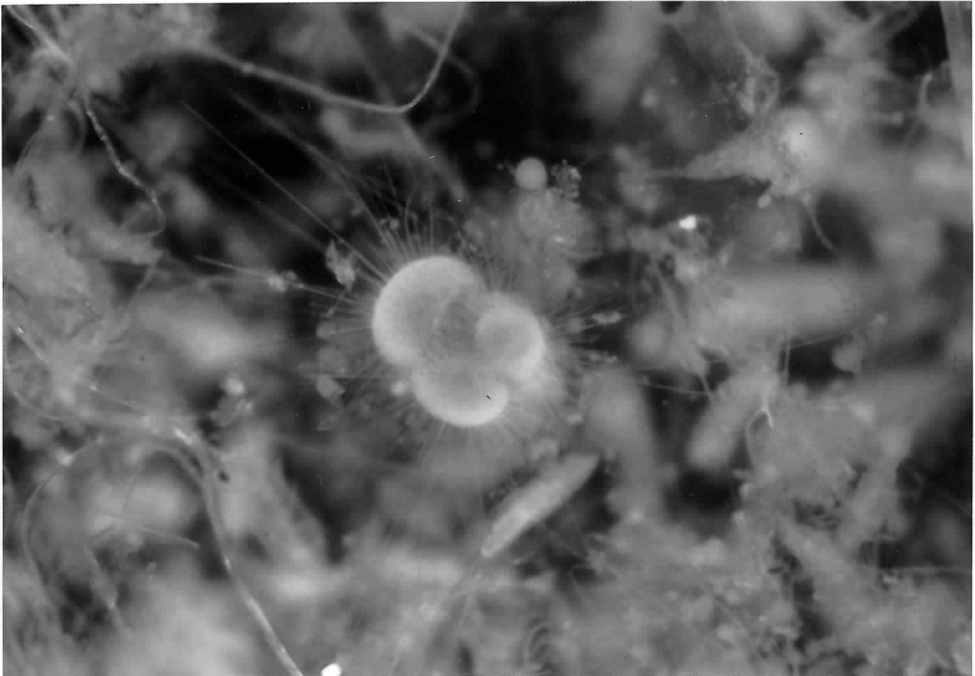
Fig. 3 : *Globoquadrina conglomerata* (SCHWAGER), No. 11, 50-0 m, x 36



1



2



3