

# New Data on the Daily Migration of Planktic Foraminifera near the Island of Amami-Ooshima

Akio HATTA\*, Kiyoshi SHIMADA\*, Masataka HIGASHI\*\*,  
Akimasa HABANO\*\*, and Takafumi AZUMA\*\*

(Received October 15, 1998)

## abstract

The daily migration of planktic foraminifera was investigated off the island of Amami-Ooshima, in the Nansei Islands, in the West Pacific Ocean. In order to clarify the daily migration of planktic foraminifera, samples were collected at the same location by positioning ship at the same latitude and longitude with the GPS (Global Positioning System). Planktic foraminifera were collected by vertical towing at depths of 0 to 200m, which were divided into 4 zones.

## Introduction

The distribution of planktic foraminifera in the West Pacific Ocean was investigated by HATTA et al. (1990, 1992, 1996). The main purpose of these studies was to survey the ecology and environment of living planktic foraminifera. As the studies clarify the distribution, a new question arose. The question is the daily vertical migration of planktic foraminifera appears to be the reverse of that of other small planktic animal, which exist in the deep zone in the daytime and in the shallow zone in the nighttime.

In order to clarify the question, the daily migration of planktic foraminifera was investigated off the island of Amami-Ooshima in the Nansei Islands in the West Pacific Ocean.

## Previous works

BÉ (1977) studied the planktic foraminifera from the ecological and zoogeographical point of view. He observed that the highest concentration is generally found below the surface, approximately at depths of 10m to 50m, and some species live in the sunlit

---

\* Faculty of Education, Kagoshima University, Kagoshima, Japan

\*\* Faculty of Fisheries, Kagoshima University, Kagoshima, Japan

waters for the maintenance of their symbiotic zooxanthellae, and the olive-green or brownish color of the protoplasm in epipelagic individuals is indicative of either freshly ingested phytoplankton or the presence of symbionts, and no other species except *Hastigerinella digitata* are known to spend their entire life cycle below a depth of 1000m. He stated that many species spend their earlier stages in the epipelagic zone and eventually seek deeper habitats. With regard to daily vertical migration, he explained that many nekton and plankton groups migrate upward at dusk, presumably to feed in the relatively rich surface waters, and usually descend to deeper levels before daybreak. This widely observed phenomenon of daily vertical migration has prompted a number of investigators to determine whether a similar relationship exists for planktic foraminifera.

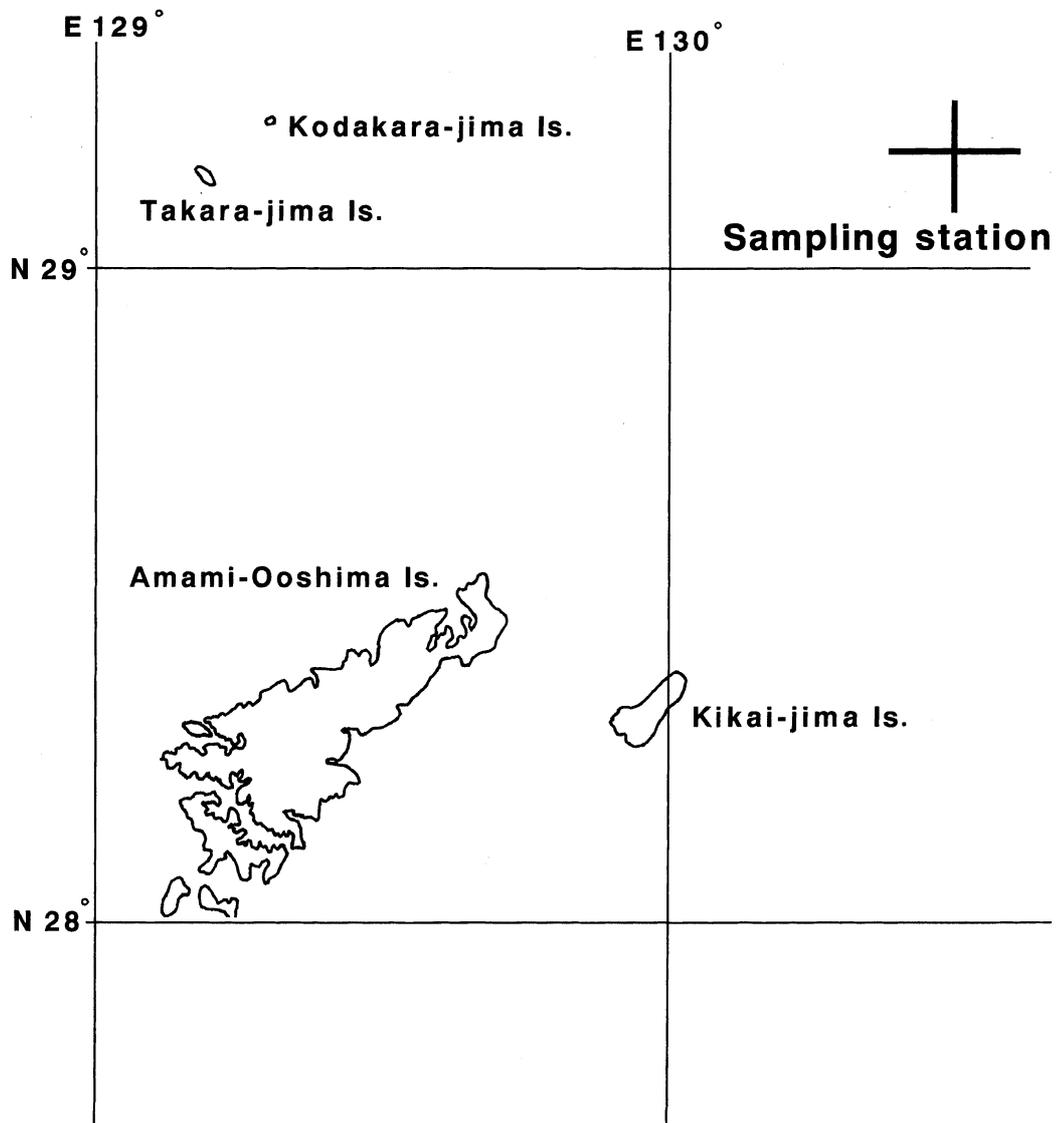


Fig. 1 Sampling station near Amami-Ooshima Island in September 1997

According to BÉ (1977), Rhumbler stated in 1911 that planktic foraminifera were more abundant in the daytime than in the nighttime at depths above 200m of the water column. This trend is completely the opposite of the diurnal pattern of the migration of most planktic and nektonic organisms. On the other hand, Boltovskoy mentioned in 1973 that he did not observe any daily vertical migration in the planktonic foraminifera collected with a pump in the South Atlantic surface waters at depths of 0m to 5m between Argentina and South Africa.

HEMLEBEN et al. (1989) asserted that vertical migrations may also occur and are reported at several locations, and the pattern of these migrations appears to be complicated and is not fully understood.

Table 1. Time, position, drift and wind during sampling

Time	Lat. N29-	Long. E130-	Direction	Knot	Wind
21:30	9.89	30.40			
22:00	9.44	31.03	129.2	1.4	NE2
22:30	8.97	31.61	132.5	1.4	
23:00	8.40	32.21	137.2	1.6	N3
23:30	7.88	32.97	128.0	1.6	
1:00	9.58	30.62	130.2	1.4	N3
1:30	9.20	31.28	123.2	1.4	
2:00	9.05	31.99	103.4	1.2	N3
2:30	8.85	32.69	108.1	1.2	
3:00	8.61	33.46	109.4	1.4	N4
3:34	10.09	30.01			
4:00	10.08	30.57	91.1	1.0	N3
4:30	10.03	31.28	94.4	1.2	
5:00	10.02	31.97	90.6	1.2	N3
5:30	10.01	32.70	90.5	1.2	
6:00	10.04	33.46	87.2	1.4	N3
6:30	10.05	30.08			
7:00	9.98	30.97	95.1	1.6	N2
7:30	9.98	31.74	90.0	1.4	
8:00	9.97	32.55	90.5	1.4	NNW3
8:30	9.90	33.38	95.3	1.4	
9:00	9.78	34.32	98.2	1.6	NNW2
9:30	10.02	30.07			
10:00	9.77	31.08	105.5	1.8	NW3
10:30	9.45	32.25	107.2	2.2	
11:00	9.15	33.46	105.5	2.2	NW4
11:30	8.76	34.66	110.2	2.2	
11:56	8.44	35.72	109.0	2.0	NW3
12:30	10.08	29.99			
13:00	9.80	30.87	110.0	1.6	NW4
13:30	9.50	31.87	108.6	1.8	
14:00	9.31	32.90	101.6	1.8	NNW4
14:30	9.07	33.95	104.4	1.8	
14:50	8.82	34.75	109.4	2.1	
15:30	9.96	30.23			
16:00	9.31	31.14	129.2	2.0	NW4
16:30	8.77	32.07	123.4	2.0	
17:00	8.35	33.02	116.5	1.8	NW4
17:30	7.98	33.96	114.2	1.8	
17:41	7.87	34.38	107.2	2.2	
18:30	9.97	30.08			
19:00	9.24	31.08	129.6	2.2	NW4
19:30	8.47	32.00	133.5	2.2	
20:00	7.61	32.96	135.4	2.4	WNW4
20:30	6.88	33.93	130.4	2.2	
21:00	6.15	34.81	133.3	2.2	WNW4

### Sampling method and materials

The sampling station is shown in Figure 1. Planktic foraminiferal samples were taken from the point of lat. 29° 10' N, long. 130° 30' E near Amami-Ooshima. Sampling was executed from 21:22 on September 1 to 19:40 on September 2, 1997. Detailed time, sampling position, drift and wind direction during sampling are shown in Table 1.

Samples were collected at the same point for 8 times at intervals of 3 hours in one day by positioning the ship at the same latitude and longitude with the GPS(Global Positioning System).

Table 2. Sample number, start time, start position, inclination of wire, added length of wire, final time and final position near Amami-Ooshima on September 1-2, 1997

Sample number	1	2	3	4	5	6	7	8	
Start time	21:22	0:25	3:34	6:32	9:33	12:34	15:29	18:31	
Start position	N29.	10.001'	10.035'	10.099'	10.078'	10.072'	10.087'	09.977'	09.960'
	E130.	30.237'	29.950'	30.016'	30.148'	30.085'	30.002'	30.209'	30.134'
Inclination of wire at a depth of 200m	2°	22°	20°	31°	34°	28°	45°	48°	
Added length of wire at a depth of 200m	0m	15m	13m	33m	41m	26m	80m	90m	
Inclination of wire at a depth of 150m	6°	29°	22°	14°	34°	30°	38°	44°	
Added length of wire at a depth of 150m	1m	25m	12m	14m	31m	23m	40m	59m	
Inclination of wire at a depth of 100m	4°	21°	24°	12°	32°	24°	32°	40°	
Added length of wire at a depth of 100m	0m	7m	9m	2m	18m	9m	18m	31m	
Inclination of wire at a depth of 50m	0°	12°	13°	2°	20°	28°	32°	34°	
Added length of wire at a depth of 50m	0m	1m	1m	0m	3m	6m	9m	10m	
Final time	22:27	1:26	4:31	7:30	10:39	13:33	16:39	19:41	
Final position	N29.	09.001'	09.229'	10.045'	09.981'	09.359'	09.476'	08.666'	08.140'
	E130.	31.565'	31.222'	31.334'	31.776'	32.658'	31.978'	32.363'	32.346'

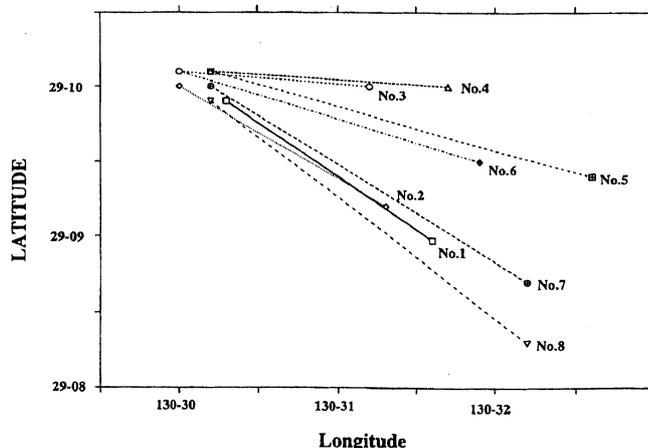


Fig. 2 Locus of ship move during sampling

Sample number, start time and position of sampling, inclination of wire, added length of wire, and final time and position are shown in Table 2. The locus of ship move during sampling is shown in fig.2. The ship drifted approximately from North-west to Southeast.

Planktic foraminifera were collected by vertical towing at depths of 0 to 200m which were divided into 4 zones, 0-50m, 50-100m, 100-150m, and 150-200m.

Table 3. Planktic Foraminifera at sampling station

(Total)	Sample No.							
Depth	1	2	3	4	5	6	7	8
150-200	37	49	61	122	95	110	104	250
100-150	8	34	80	61	136	81	69	149
50-100	39	69	43	96	365	185	69	196
0-50 (m)	39	53	73	79	140	146	94	220
Total	123	205	257	358	736	522	336	815

(Adult)	Sample No.							
Depth	1	2	3	4	5	6	7	8
150-200	0	4	6	9	4	1	6	37
100-150	4	7	12	10	27	5	6	34
50-100	1	2	11	50	134	46	11	56
0-50 (m)	0	0	35	10	36	66	20	9
Total	5	13	64	79	201	118	43	136

(Young)	Sample No.							
Depth	1	2	3	4	5	6	7	8
150-200	9	10	3	16	25	15	8	20
100-150	2	3	5	10	18	5	4	13
50-100	6	10	9	13	43	23	2	24
0-50 (m)	7	8	14	39	59	21	22	30
Total	24	31	31	78	145	64	36	87

(Juvenile)	Sample No.							
Depth	1	2	3	4	5	6	7	8
150-200	28	35	52	97	66	94	90	193
100-150	2	24	63	41	91	71	59	102
50-100	32	57	23	33	188	116	56	116
0-50 (m)	32	45	24	30	45	59	52	181
Total	94	161	162	201	390	340	257	592

### Features of the number of planktic foraminifera

The collected foraminiferal samples were first divided into adult, young and juvenile groups. The number of planktic foraminifera at the sampling station is shown in Table 3. The lowest total number of the collected foraminifera is 123 of sample No.1, and the highest is 815 of sample No. 8.

The number of the collected foraminifera is low in the nighttime and rises in the daytime. Figure 3 shows the frequency of the whole, adult, young, and juvenile planktic foraminifera.

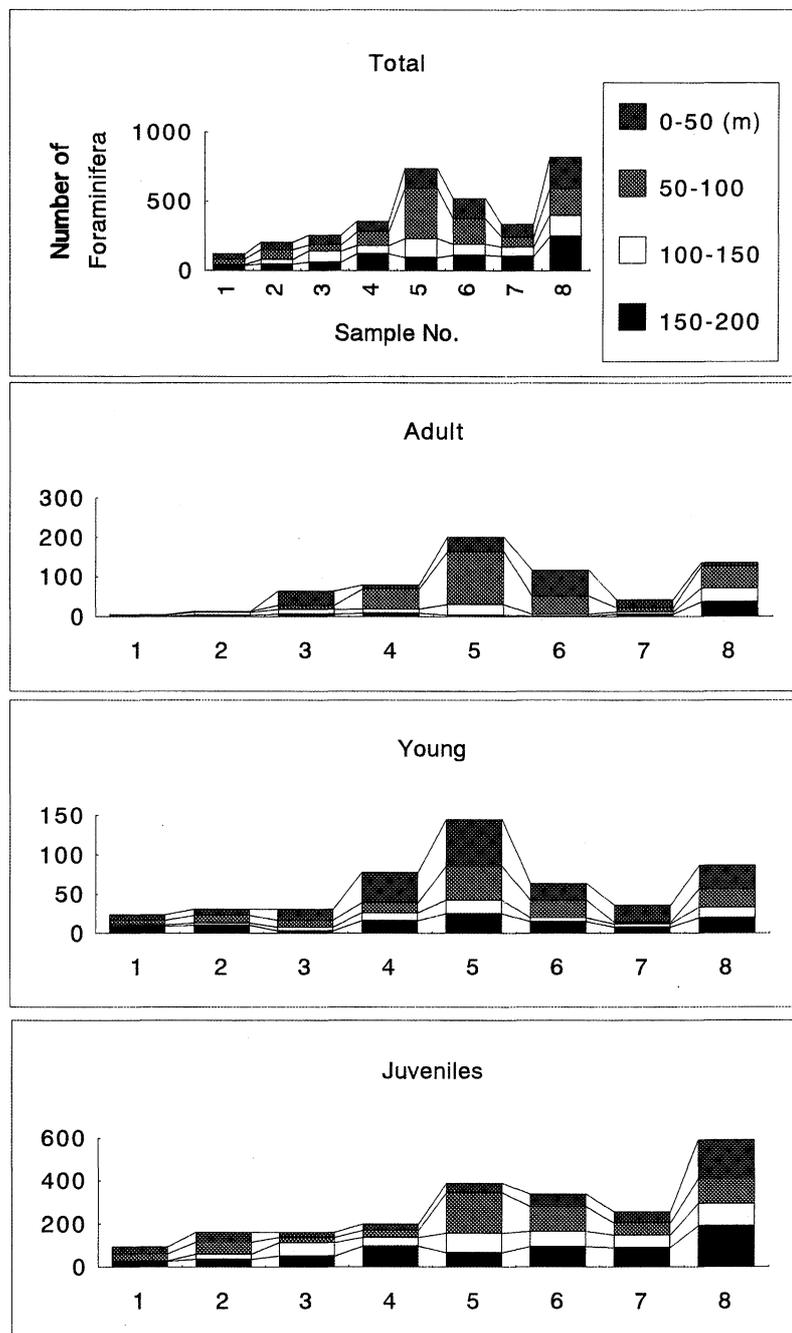


Fig. 3 Frequency of the total, adult, young, and juvenile of planktic foraminifera

## **Discussion and prospect**

The difference of the total number of the collected planktic foraminifera between nighttime and daytime may be explained by either the variation of capture quantity being prominent because of patchy distribution or nocturnal migration below depths of 200m. However, the gradual increase of number from night to daytime suggests that nocturnal migration is a more likely cause. The length of added wire indicates that the planktic foraminifera of sample No.8 were collected from depths deeper than 200m.

To confirm this hypothesis, we must collect planktic foraminiferal samples from greater depths.

## **Acknowledgement**

We express our gratitude to Associate Professor Toru AOYAMA of Kagoshima University Research Center for the Pacific Islands for his reading of the first draft.

## **References**

- BÉ, Allan. W. H. (1977): An ecological, zoogeographic and taxonomic review of Recent planktonic Foraminifera. *Oceanic micropalaeontology*, (ed. Ramsay, A. T. S.), Vol.1, p.1 - 100. Academic Press, London, New York & San Francisco.
- HEMLEBEN, Christoph, Michael SPINDLER, and O. Roger ANDERSON (1989): Vertical distribution; Patchiness and daily vertical migration. in *Modern Planktonic Foraminifera*, p.235-239, Springer-verlag.
- HATTA Akio, Yasutaka YUWAKI, Toru NISHI, Sunao MASUMITSU, and Masataka HIGASHI (1990): Planktonic Foraminiferal Assemblages and Meridional Hydrographic Sections in the West Pacific Ocean. *Kagoshima Univ. Res. Center South Pacific, Occasional Papers, No.20*, p.72 - 81, pls.1 - 3.
- HATTA Akio, Yasutaka YUWAKI, Kiyoshi SHIMADA, Sunao MASUMITSU, and Masataka HIGASHI (1992): Meridional Hydrographic Sections and Planktonic Foraminiferal Assemblages in the West Pacific Ocean in 1991. *Kagoshima Univ. Res. Center South Pacific, Occasional Papers, No.23*, p.79 - 90, pls.1 - 3.
- HATTA Akio, Kiyoshi SHIMADA, Masaki UCHIYAMA, Keisuke YOSHINAGA, Shigeru FUJIEDA, Shigeki TERADA, Shiro SUWA, and Hirotaka FUJISAKI (1996): Meridional Hydrographic Sections and Planktonic Foraminiferal Assemblages in the West Pacific Ocean in 1995. *Kagoshima Univ. Res. Center South Pacific, Occasional Papers, No.30*, p.69 - 83, pls.1 - 3.