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Seasonal Variations in Phyto- and Zooplankton Biomass in Kagoshima Bay

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Keywords : Seasonal variation, Chlorophyll *a* concentration, Zooplankton biomass, Kagoshima Bay

Abstract

Seasonal variations in size-fractionated chlorophyll *a* concentration were investigated at two stations located in the inner and central areas of Kagoshima Bay from April 2001 to May 2002. Chlorophyll *a* concentrations at the inner station were several folds higher than those at the central station. At both stations, chlorophyll *a* concentrations showed large seasonal fluctuations throughout the year which resulted from micro-sized phytoplankton. Vertical distributions of chlorophyll *a* concentrations showed slightly different patterns between the two size classes. A surface distribution was observed for pico/nano-sized phytoplankton throughout the year. A high chlorophyll *a* concentration of micro-sized phytoplankton was limited in the surface water during the summer, and extended downward during autumn to winter. Although they suddenly disappeared from the water column during January to February, the chlorophyll *a* concentration was kept high thereafter. Compared with the annual mean wet and dry weights, zooplankton biomass in the inner area was slightly higher than that in the central area. The zooplankton biomass was high during June to July and during February to May in the central area, but an additional peak in November was observed in the inner area.

Kagoshima Bay is a large semi-enclosed bay which is located at the southernmost part of Kyushu, Japan. The sea surface area is 1130 km^2. The location of the volcano Mt. Sakurajima forms a narrow and shallow channel between the inner and central areas. The two areas are characterized by a crater topography of a more than 100-m depth. Thereby, the exchange of deep waters in Kagoshima Bay is highly limited.

In this Bay, oceanographic observations were often carried out to monitor for red-tides, focusing on harmful phytoplankton species. In the last two decades, Nozawa and Saisyo[1] reported the species composition of phyto- and zooplankton communities and the seasonal occurrence of dominant species. However, little was mentioned on the variability of phyto- and zooplankton biomass.

In the present study, we investigated phyto- and zooplankton biomass in the two different areas of Kagoshima Bay to compare their seasonal variation patterns.

Materials and Methods

Oceanographic observations and water samplings were carried out weekly to biweekly from April 2001 to May 2002 during T/S *Nansei-Maru* cruises. Sampling stations were located around the deepest sites of the inner and central areas (Fig. 1). The deepest was 225 m at Station A and 135 m at Station B.

Water temperature was determined with a thermometer at sea surface and a reversing thermometer fitted on a Nansen bottle at other depths. Water samples for chlorophyll *a* determination were taken from 9 depths (0, 10, 25, 50, 75, 100, 125, 150, 200 m) using Nansen bottles. Each water sample (200-1000 ml) was filtered through a plankton net (20-μm mesh opening) and a Whatman GF/F filter (0.7-μm pore size). Chlorophyll pigments on the filters were extracted in n, n-dimethylformamide[2]. Chlorophyll extraction was made by direct immersion of the filters into the solvent at - 5 ℃ in the dark overnight.

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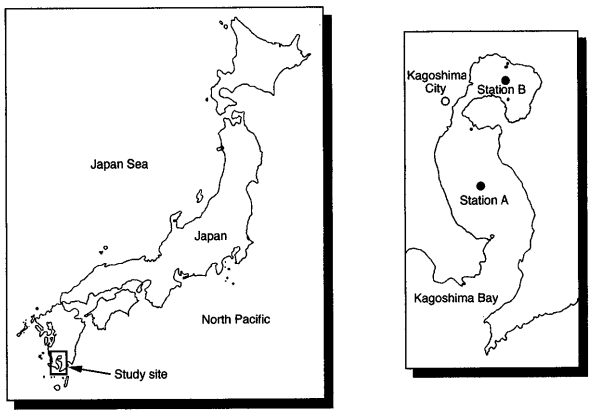

Fig. 1 Sampling stations in Kagoshima Bay, Japan.

Chlorophyll *a* concentration was measured by fluorometry[3] with a Turner Designs fluorometer (TD-700). The chlorophyll *a* concentration data at both stations are listed on Appendices 1 and 2.

Zooplankton samples were collected with a vertical haul from the near bottom (220 m at Station A or 130 m at Station B) to the sea surface, using a modified fast sinking mouth ring net (70-cm mouth diameter, 100-μm mesh size)[4] equipped with a Rigosha flow meter. After collection, zooplankton samples were preserved immediately in 5 % formalin-seawater buffered with borax. In the laboratory, these samples were divided into two subsamples, and measured for wet weight (WW) using a Mettler PB1502 balance (accuracy ±10 mg). Dry weight (DW) was determined after drying at 52 ℃ for 24 hours. The wet and dry weight data of zooplankton at both stations are listed on Appendix 3.

Results

Temperature

Seasonal variations in water temperatures at both stations showed a similar pattern (Fig. 2). The surface temperature was above 28 ℃ from July to August when the thermocline was well established at 10-50 m depths. A gradual decrease was observed for the surface temperature after September and no stratification occurred from January to April. Sea surface temperatures at both stations ranged from 16 ℃ in January to 31 ℃ in August. The temperatures under a 100-m depth were nearly constant at 15 ℃ at Station A and 17 ℃ at Station B throughout the year.

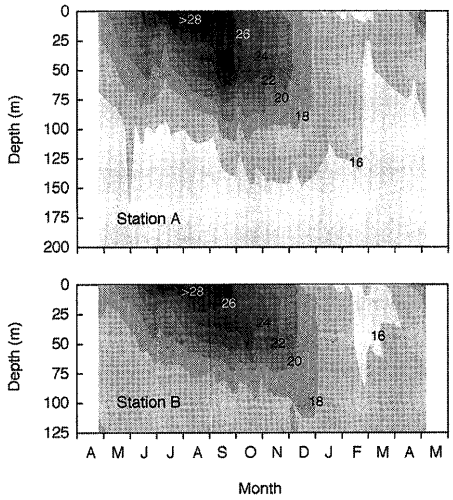

Fig. 2 Seasonal variations in vertical structures of temperature (℃) from April 2001 to May 2002 in the central area (Station A: top) and in the inner area (Station B: bottom). Note that the depth scale is not the same between the two panels.

Chlorophyll a concentration

Integrated mean chlorophyll *a* concentration over the water column (WCCHL) was several folds higher at Station B than at Station A (Fig. 3). Micro-sized phytoplankton was predominant at both stations throughout the year. Although they showed no distinct patterns during the summer, a gradual increase was observed from

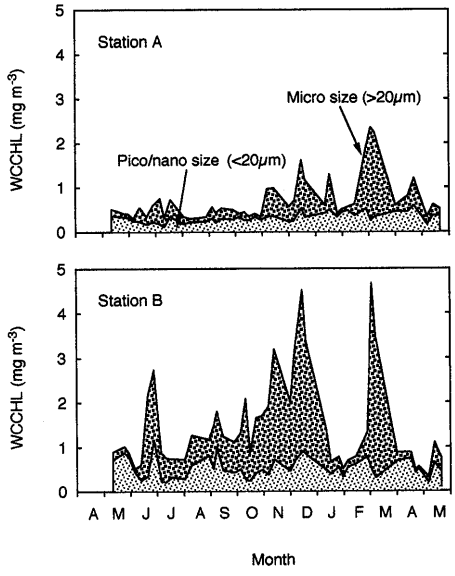

Fig. 3 Seasonal variations in cumulative mean chlorophyll *a* concentration in the water column (WCCHL: mg m^{-3}) of micro- and pico/nano-sized phytoplankton from May 2001 to May 2002 in the central area (Station A) and in the inner area (Station B).

November to December and abruptly disappeared during January to February. However, they rapidly increased again thereafter. Since pico/nano-sized phytoplankton revealed small seasonal variations at both stations, the large fluctuations of WCCHL resulted from micro-sized phytoplankton.

The vertical distribution of chlorophyll *a* concentration showed a slightly different pattern between the two size classes of phytoplankton (Fig. 4). Pico/nano-sized phytoplankton was observed at the surface above 50 m at both stations throughout the year. However, micro-sized phytoplankton occurred at the surface during summer, gradually extended downward from November to December, and then suddenly disappeared at both stations during January to February. After March, they were abundant in the water column.

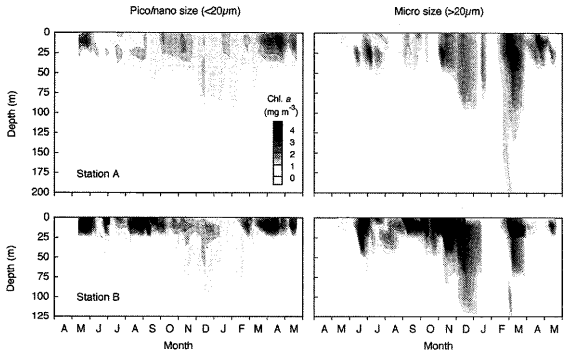

Fig. 4 Seasonal variations in vertical distributions of chlorophyll *a* concentration (mg m^{-3}) of micro-sized (right), and pico/nano-sized phytoplankton (left) from May 2001 to May 2002 in the central area (Station A: top) and in the inner area (Station B: bottom). Note that the depth scale is not the same between the two panels.

Zooplankton wet and dry weights

The wet weight and dry weights of zooplankton at Station B were slightly higher than those at Station A (Fig. 5). The seasonal variation in zooplankton biomass showed different patterns between the two stations. At station A, zooplankton biomass was high during June to July and during February to May. However, an additional peak was observed in November at Station B. The annual mean wet and dry weights were 83.1 and 8.5 g m^{-2} at Station A, and 73.4 and 8.7 g m^{-2} at Station B, respectively.

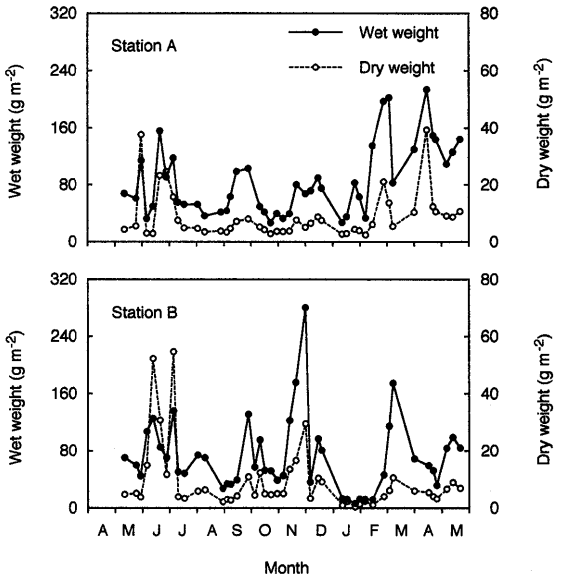

Fig. 5 Seasonal variations in zooplankton wet and dry weights (g m^{-2}) from May 2001 to May 2002 in the central area (Station A: top) and in the inner area (Station B: bottom).

Discussion

Biomass of phyto- and zooplankton was highly fluctuated in both areas of Kagoshima Bay. Especially, seasonal variations in phytoplankton biomass resulted from large-sized phytoplankton. In our regression analysis, there was no significant relationship between zooplankton dry weight and chlorophyll *a* concentrations of large and small-sized phytoplankton ($p>0.05$, Fig. 6). Thus, grazing by zooplankton might be of marginal importance for seasonal variations in phytoplankton biomass. Contrary to the top-down effect, nutrients might be a primarily important factor for phytoplankton. Active growth of

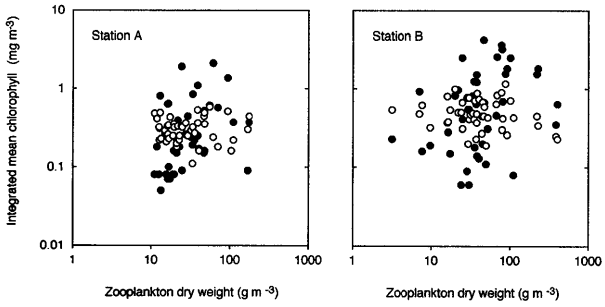

Fig. 6 Relationships between cumulative mean zooplankton dry weight (g m^{-3}) and chlorophyll *a* concentrations (mg m^{-3}) of micro-sized (open circles) and pico/nano-sized phytoplankton (solid circles) in the water column in the central area (Station A: left) and in the inner area (Station B: right).

large phytoplankton has been known in the nutrient-rich water[5]. In general, large fluctuations were observed for phytoplankton biomass in the coastal eutrophic environments[6]. According to the model simulation by N. Yoshie (personal communication), phytoplankton abundance decreased with nutrient shortage by rapid population growth and insufficient light condition by self-shading even in nutrient-rich areas. On the other hand, Ichikawa et al.[7] reported that the volcanic ash fall from Mt. Sakurajima in seawater accelerated the formation and downward export of large particles. As the large-sized phytoplankton predominated throughout the study period, downward phytoplankton exports by the volcanic ash fall are considered as a causal factor of these phytoplankton fluctuations. However, it is impossible to analyze these hypotheses because of little information on environmental variables such as nutrients and volcanic ash fall. To verify these hypotheses, more increment data will be needed.

Acknowledgements

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Appendix 1 Chlorophyll *a* concentration (mg m^{-3}) at station A in Kagoshima Bay from May 2001 to May 2002

Date	Micro-sized fraction									Pico/nano-sized fraction								
	0 m	10 m	25 m	50 m	75 m	100 m	125 m	150 m	200 m	0 m	10 m	25 m	50 m	75 m	100 m	125 m	150 m	200 m
11 May 01	0.44	0.67	0.70	0.16	0.04	0.02	0.02	0.01	0.01	1.11	2.35	1.21	0.14	0.08	0.05	0.04	0.04	0.03
24 May 01	0.35	0.70	0.17	0.06	0.03	0.02	0.01	0.01	0.01	1.79	2.62	0.53	0.31	0.08	0.04	0.02	0.02	0.01
30 May 01	0.43	0.39	0.26	0.10	0.05	0.02	0.01	0.01	0.01	1.64	1.70	1.02	0.23	0.08	0.03	0.03	0.03	0.01
5 Jun 01	0.20	0.15	0.23	0.03	0.02	0.01	0.01	0.01	0.01	1.11	1.17	0.93	0.15	0.09	0.03	0.02	0.02	0.01
12 Jun 01	0.16	0.15	2.73	0.14	0.05	0.01	0.01	0.01	0.00	0.73	0.69	1.23	0.18	0.06	0.02	0.02	0.02	0.01
20 Jun 01	0.63	0.83	0.75	0.08	0.02	0.01	0.00	0.01	0.00	0.65	0.55	0.67	0.28	0.04	0.01	0.01	0.01	0.00
27 Jun 01	1.17	1.82	1.96	0.15	0.03	0.02	0.01	0.01	0.00	0.61	0.70	1.19	0.13	0.11	0.02	0.02	0.01	0.01
5 Jul 01	0.55	1.33	4.04	0.38	0.07	0.03	0.02	0.03	0.01	0.24	0.69	0.96	0.16	0.05	0.01	0.01	0.01	0.01
10 Jul 01	0.99	0.29	1.17	0.12	0.03	0.02	0.01	0.02	0.00	0.47	0.67	0.35	0.10	0.02	0.02	0.01	0.01	0.01
17 Jul 01	1.27	0.42	2.14	0.73	0.06	0.03	0.03	0.02	0.02	1.30	0.79	1.55	0.51	0.07	0.05	0.03	0.03	0.02
1 Aug 01	0.64	1.22	0.31	0.09	0.07	0.03	0.01	0.01	0.01	0.89	0.74	0.72	0.20	0.06	0.02	0.01	0.01	0.00
9 Aug 01	0.14	0.18	0.33	0.09	0.06	0.03	0.01	0.02	0.01	0.43	0.56	1.11	0.30	0.08	0.02	0.01	0.01	0.01
27 Aug 01	0.55	0.14	0.56	0.06	0.02	0.01	0.01	0.01	0.01	0.50	0.35	1.48	0.22	0.06	0.02	0.02	0.01	0.00
3 Sep 01	0.93	1.42	1.31	0.07	0.02	0.01	0.01	0.01	0.01	1.09	1.46	1.31	0.20	0.07	0.02	0.02	0.01	0.01
7 Sep 01	1.49	1.06	0.85	0.18	0.04	0.01	0.01	0.02	0.01	0.89	0.88	0.69	0.28	0.08	0.02	0.02	0.02	0.01
14 Sep 01	0.57	0.66	1.04	0.43	0.11	0.06	0.02	0.02	0.02	0.96	0.84	0.90	0.69	0.13	0.08	0.03	0.03	0.01
27 Sep 01	2.46	0.99	0.46	0.31	0.06	0.02	0.02	0.01	0.01	0.96	0.93	0.82	0.62	0.11	0.08	0.02	0.01	0.00
4 Oct 01	0.28	0.23	0.18	0.09	0.06	0.02	0.04	0.04	0.02	1.76	1.72	1.09	0.23	0.17	0.05	0.03	0.04	0.02
10 Oct 01	0.85	0.74	0.80	0.14	0.08	0.02	0.01	0.01	0.00	1.00	1.05	1.03	0.19	0.11	0.05	0.03	0.03	0.03
15 Oct 01	0.23	0.16	0.17	0.32	0.04	0.02	0.01	0.01	0.01	1.11	1.10	1.06	0.28	0.05	0.03	0.01	0.01	0.01
22 Oct 01	0.39	0.20	0.16	0.20	0.03	0.03	0.01	0.01	0.03	1.48	1.42	1.16	0.46	0.07	0.03	0.02	0.02	0.03
29 Oct 01	0.31	0.34	0.26	0.03	0.02	0.01	0.01	0.01	0.01	1.07	1.14	1.22	0.17	0.07	0.02	0.03	0.02	0.02
5 Nov 01	1.60	1.57	4.71	0.08	0.06	0.01	0.01	0.01	0.00	1.53	1.76	1.53	0.09	0.07	0.02	0.02	0.02	0.01
12 Nov 01	3.20	2.70	3.33	0.27	0.09	0.03	0.02	0.02	0.01	1.32	1.52	1.52	0.30	0.09	0.03	0.03	0.01	0.01
30 Nov 01	0.79	0.97	1.10	0.87	0.11	0.05	0.04	0.03	0.05	0.72	0.76	0.66	0.38	0.11	0.07	0.01	0.04	0.10
6 Dec 01																		
14 Dec 01	2.91	2.58	2.69	2.16	2.43	0.05	0.03	0.02	0.01	0.94	1.07	0.97	1.25	1.23	0.08	0.08	0.04	0.02
18 Dec 01	1.45	2.04	1.89	2.01	1.63	0.13	0.04	0.03	0.02	0.67	0.86	0.67	0.66	0.50	0.10	0.07	0.05	0.03
10 Jan 02	0.23	0.17	0.24	0.27	0.17	0.17	0.22	0.14	0.12	0.81	0.76	0.72	0.59	0.69	0.19	0.22	0.17	0.21
15 Jan 02	1.73	1.68	2.08	2.12	0.69	0.16	0.13	0.22	0.09	1.53	1.12	1.00	0.79	0.43	0.24	0.27	0.24	0.21
24 Jan 02	0.16	0.15	0.13	0.12	0.11	0.06	0.04	0.03	0.04	1.16	1.08	1.12	0.24	0.17	0.13	0.11	0.10	0.08
29 Jan 02	0.09	0.15	0.09	0.17	0.10	0.04	0.03	0.03	0.02	0.97	0.88	0.91	0.77	0.93	0.12	0.09	0.07	0.06
5 Feb 02	0.13	0.13	0.12	0.11	0.14	0.10	0.05	0.02	0.01	0.86	0.88	0.84	0.83	0.72	0.66	0.16	0.07	0.04
13 Feb 02	0.83	0.91	0.79	0.40	0.16	0.15	0.06	0.02	0.01	0.69	0.71	0.69	0.50	0.47	0.41	0.31	0.05	0.03
26 Feb 02	3.51	3.42	3.35	1.19	0.85	0.87	0.94	1.12	0.36	1.04	1.35	0.98	0.33	0.40	0.45	0.44	0.43	0.16
4 Mar 02	9.46	9.56	4.59	2.02	1.44	1.36	0.37	0.20	1.04	0.66	1.04	0.42	0.23	0.17	0.17	0.11	0.07	0.14
8 Mar 02	2.99	3.42	5.36	3.58	2.75	1.03	0.69	0.24	0.25	0.45	0.52	0.75	0.68	0.51	0.15	0.13	0.08	0.06
1 Apr 02	0.28	1.28	0.23	0.10	0.05	0.05	0.04	0.03	0.03	1.79	3.10	1.62	0.12	0.05	0.03	0.04	0.04	0.03
15 Apr 02	1.65	1.58	2.09	0.05	0.03	0.01	0.02	0.03	0.02	2.38	2.98	1.53	0.15	0.04	0.02	0.02	0.03	0.02
22 Apr 02	2.19	5.65	1.72	0.14	0.03	0.02	0.01	0.02	0.02	1.81	5.23	1.72	0.13	0.03	0.02	0.02	0.03	0.06
25 Apr 02	0.61	3.62	2.55	0.08	0.03	0.01	0.01	0.01	0.02	2.26	3.35	1.89	0.11	0.04	0.02	0.03	0.04	0.04
7 May 02	0.59	1.94	0.23	0.03	0.02	0.01	0.01	0.01	0.00	1.02	1.47	0.19	0.08	0.04	0.01	0.01	0.01	0.01
14 May 02	0.19	0.31	2.08	0.05	0.06	0.02	0.01	0.02	0.00	1.72	2.54	1.12	0.17	0.08	0.04	0.02	0.02	0.01
22 May 02	0.27	0.42	1.11	0.07	0.02	0.01	0.01	0.01	0.01	1.51	1.94	1.64	0.11	0.04	0.04	0.03	0.02	0.01

Appendix 2 Chlorophyll *a* concentration (mg m^{-3}) at Station B in Kagoshima Bay from May 2001 to May 2002

Date	Micro-sized fraction							Pico/nano-sized fraction						
	0 m	10 m	25 m	50 m	75 m	100 m	125 m	0 m	10 m	25 m	50 m	75 m	100 m	125 m
11 May 01	0.30	1.06	0.21	0.07	0.04	0.02	0.00	1.76	4.83	0.50	0.26	0.09	0.06	0.00
24 May 01	0.68	0.76	0.11	0.05	0.03	0.01	0.01	5.25	5.52	0.45	0.08	0.06	0.05	0.02
29 May 01	0.36	0.44	0.11	0.04	0.02	0.02	0.02	4.63	4.70	0.51	0.06	0.03	0.06	0.06
5 Jun 01	0.51	0.42	0.04	0.03	0.01	0.01	0.00	2.72	2.26	0.35	0.09	0.04	0.05	0.02
12 Jun 01	1.39	2.35	0.28	0.04	0.01	0.02	0.01	0.59	0.95	0.63	0.07	0.03	0.03	0.02
20 Jun 01	6.44	4.30	6.26	0.38	0.13	0.09	0.06	0.72	0.85	1.03	0.17	0.08	0.05	0.05
27 Jun 01	11.61	4.47	2.27	0.96	0.30	0.14	0.13	14.63	3.15	0.92	0.37	0.12	0.06	0.05
5 Jul 01	2.86	2.11	0.83	0.32	0.24	0.25	0.14	0.92	0.73	0.38	0.12	0.08	0.06	0.08
10 Jul 01	2.24	0.70	1.55	0.39	0.15	0.12	0.09	1.01	0.69	0.32	0.08	0.06	0.05	0.05
17 Jul 01	3.98	0.64	0.72	0.21	0.02	0.11	0.07	2.77	1.16	0.31	0.10	0.04	0.03	0.03
1 Aug 01	0.71	0.33	2.10	0.15	0.07	0.03	0.03	0.83	1.12	0.59	0.08	0.05	0.02	0.02
9 Aug 01	1.17	2.12	2.27	0.14	0.04	0.03	0.03	2.44	3.60	0.61	0.11	0.03	0.04	0.03
29 Aug 01	0.90	2.75	0.26	0.03	0.03	0.01	0.01	5.55	4.93	0.45	0.04	0.02	0.01	0.01
3 Sep 01	17.64	2.18	0.20	0.06	0.02	0.02	0.01	3.93	2.82	0.23	0.07	0.01	0.03	0.01
7 Sep 01	3.86	5.82	0.32	0.06	0.03	0.03	0.02	2.97	7.88	0.36	0.08	0.02	0.03	0.01
14 Sep 01	3.09	5.74	0.31	0.06	0.01	0.02	0.02	5.60	1.81	0.32	0.04	0.01	0.01	0.01
27 Sep 01	1.46	5.04	0.57	0.11	0.05	0.02	0.04	1.81	2.85	0.25	0.05	0.03	0.02	0.03
4 Oct 01	4.25	4.64	0.74	0.12	0.06	0.06	0.06	2.39	3.08	0.40	0.06	0.03	0.01	0.02
10 Oct 01	6.36	11.73	1.94	0.32	0.08	0.03	0.01	1.29	1.35	0.25	0.11	0.02	0.01	0.01
15 Oct 01	2.22	2.24	1.79	0.09	0.05	0.04	0.07	1.09	1.07	0.37	0.05	0.03	0.01	0.03
22 Oct 01	4.50	4.30	3.59	0.21	0.07	0.03	0.03	1.74	1.82	0.74	0.12	0.04	0.02	0.02
29 Oct 01	4.74	7.59	1.24	0.28	0.06	0.03	0.02	0.80	1.96	0.69	0.34	0.32	0.04	0.00
5 Nov 01	10.09	9.61	0.37	0.34	0.13	0.05	0.05	1.70	1.90	0.25	0.25	0.06	0.04	0.02
12 Nov 01	7.63	6.95	6.58	1.30	0.66	0.11	0.07	1.21	1.83	1.22	0.68	0.64	0.07	0.06
30 Nov 01	4.45	4.82	3.46	1.29	0.23	0.13	0.07	0.78	1.45	0.57	0.54	0.19	0.15	0.06
5 Dec 01														
14 Dec 01	6.07	5.32	6.73	5.43	1.78	1.50	0.23	0.94	1.52	1.19	1.23	0.72	0.59	0.16
18 Dec 01	0.31	4.21	3.53	3.68	2.35	1.68	0.18	0.23	2.16	1.13	0.72	0.75	0.54	0.17
10 Jan 02	0.63	2.05	2.06	1.23	0.22	0.22	0.28	0.48	0.97	0.97	0.59	0.24	0.19	0.03
15 Jan 02	0.10	0.26	0.28	0.27	0.34	0.31	0.24	0.60	0.73	0.36	0.32	0.33	0.31	0.32
24 Jan 02	0.27	0.30	0.26	0.23	0.21	0.19	0.18	0.91	0.75	0.59	0.49	0.50	0.50	0.42
29 Jan 02	0.18	0.31	0.24	0.19	0.16	0.10	0.21	0.45	0.33	0.40	0.31	0.31	0.17	0.44
4 Feb 02	0.13	0.21	0.18	0.15	0.14	0.11	0.11	1.00	0.60	0.86	0.45	0.44	0.38	0.53
13 Feb 02	0.26	0.23	0.17	0.19	0.18	0.10	0.06	1.35	0.78	0.80	0.69	0.65	0.36	0.18
26 Feb 02	2.49	2.07	0.54	0.35	0.17	0.13	0.23	2.29	3.39	0.93	0.30	0.23	0.26	0.33
4 Mar 02	17.76	25.70	2.06	0.56	0.15	1.98	0.74	2.88	1.31	0.34	0.17	0.11	0.36	0.18
8 Mar 02	3.98	14.54	4.11	4.04	0.39	0.03	0.51	0.80	0.62	0.63	0.22	0.14	0.12	0.11
1 Apr 02	0.09	1.42	0.13	0.00	0.04	0.04	0.02	2.07	5.06	0.35	0.07	0.03	0.03	0.03
17 Apr 02	0.38	0.90	0.09	0.03	0.04	0.01	0.00	4.14	4.08	0.63	0.25	0.05	0.04	0.01
22 Apr 02	0.22	0.24	0.04	0.06	0.01	0.01	0.01	1.00	2.76	0.26	0.20	0.04	0.03	0.01
26 Apr 02	0.19	0.20	0.08	0.05	0.01	0.01	0.01	3.08	2.53	0.55	0.09	0.03	0.02	0.02
7 May 02	0.31	0.81	0.04	0.02	0.03	0.00	0.00	0.65	1.11	0.19	0.08	0.03	0.02	0.01
14 May 02	0.68	3.97	0.17	0.03	0.01	0.01	0.01	2.82	4.14	0.49	0.10	0.03	0.02	0.02
22 May 02	1.28	1.95	0.08	0.23	0.02	0.00	0.01	2.75	2.46	0.17	0.15	0.04	0.02	0.02

Appendix 3 Zooplankton wet and dry weights at Stations A and B in Kagoshima Bay from May 2001 to May 2002. Mean (g m^{-3}) and total values (g m^{-2}) in the water column

Date	Staion A				Date	Station B			
	Wet weight		Dry weight			Wet weight		Dry weight	
	Mean	Total	Mean	Total		Mean	Total	Mean	Total
11 May 01	0.30	68.21	0.19	4.35	11 May 01	0.52	70.14	0.36	4.80
24 May 01	0.27	61.15	0.25	5.54	24 May 01	0.44	59.81	0.38	5.12
30 May 01	0.51	114.25	1.67	37.65	29 May 01	0.33	45.22	0.28	3.84
5 Jun 01	0.14	32.44	0.13	3.00	5 Jun 01	0.79	106.69	1.11	14.92
12 Jun 01	0.22	49.98	0.13	2.86	12 Jun 01	0.93	125.38	3.87	52.21
20 Jun 01	0.69	155.72	1.04	23.33	20 Jun 01	0.63	85.28	2.27	30.66
27 Jun 01	0.40	90.71	1.10	24.76	27 Jun 01	0.52	70.21	0.87	11.75
5 Jul 01	0.52	117.76	0.70	15.80	5 Jul 01	1.01	135.93	4.05	54.69
10 Jul 01	0.25	55.49	0.33	7.50	10 Jul 01	0.37	50.23	0.29	3.95
17 Jul 01	0.23	52.50	0.22	4.88	17 Jul 01	0.36	48.52	0.25	3.36
1 Aug 01	0.23	52.52	0.21	4.71	1 Aug 01	0.55	74.04	0.44	5.91
9 Aug 01	0.16	36.25	0.15	3.48	9 Aug 01	0.52	70.47	0.47	6.36
27 Aug 01	0.18	41.55	0.17	3.74	29 Aug 01	0.20	27.37	0.16	2.15
3 Sep 01	0.19	43.74	0.15	3.35	3 Sep 01	0.25	34.32	0.22	2.96
7 Sep 01	0.28	63.40	0.21	4.71	7 Sep 01	0.25	33.33	0.20	2.69
14 Sep 01	0.44	98.79	0.32	7.17	14 Sep 01	0.29	39.55	0.31	4.23
27 Sep 01	0.46	102.85	0.35	7.95	27 Sep 01	0.97	131.06	0.81	10.88
4 Oct 01					4 Oct 01	0.42	57.17	0.34	4.52
10 Oct 01	0.22	49.77	0.23	5.11	10 Oct 01	0.71	95.21	0.91	12.32
15 Oct 01	0.19	41.76	0.19	4.23	15 Oct 01	0.39	52.63	0.37	5.00
22 Oct 01	0.12	26.59	0.12	2.81	22 Oct 01	0.38	51.92	0.35	4.68
29 Oct 01	0.18	39.68	0.16	3.65	29 Oct 01	0.29	38.95	0.38	5.08
5 Nov 01	0.15	32.69	0.16	3.60	5 Nov 01	0.34	45.51	0.38	5.09
12 Nov 01	0.18	39.46	0.16	3.70	12 Nov 01	0.90	122.08	1.01	13.58
20 Nov 01	0.36	79.96	0.34	7.58	19 Nov 01	1.30	175.52	1.24	16.68
30 Nov 01	0.30	67.48	0.23	5.09	30 Nov 01	2.08	280.85	2.18	29.48
6 Dec 01	0.32	71.80	0.29	6.51	5 Dec 01	0.27	36.43	0.25	3.33
14 Dec 01	0.40	89.66	0.39	8.69	14 Dec 01	0.72	96.69	0.77	10.45
18 Dec 01	0.33	75.08	0.33	7.53	18 Dec 01	0.60	81.01	0.68	9.22
10 Jan 02	0.12	27.16	0.12	2.66	10 Jan 02	0.10	13.27	0.07	0.95
15 Jan 02	0.16	35.11	0.13	2.90	15 Jan 02	0.09	12.19	0.16	2.20
24 Jan 02	0.37	82.56	0.19	4.38	24 Jan 02	0.05	6.26	0.03	0.42
29 Jan 02	0.28	63.53	0.17	3.89	29 Jan 02	0.09	12.78	0.10	1.31
5 Feb 02	0.15	33.26	0.11	2.47	4 Feb 02	0.09	12.27	0.17	2.35
13 Feb 02	0.60	134.58	0.27	6.13	13 Feb 02	0.09	12.02	0.08	1.03
26 Feb 02	0.88	197.25	0.94	21.06	26 Feb 02	0.34	46.49	0.30	4.06
4 Mar 02	0.90	202.43	0.61	13.73	4 Mar 02	0.85	114.25	0.46	6.23
8 Mar 02	0.37	82.76	0.24	5.43	8 Mar 02	1.29	174.39	0.79	10.64
1 Apr 02	0.58	129.78	0.46	10.46	1 Apr 02	0.51	68.87	0.45	6.04
15 Apr 02	0.95	213.83	1.75	39.34	17 Apr 02	0.44	59.46	0.40	5.41
22 Apr 02	0.66	149.26	0.55	12.38	22 Apr 02	0.39	52.18	0.30	4.07
25 Apr 02	0.64	143.78	0.47	10.64	26 Apr 02	0.24	32.06	0.24	3.23
7 May 02	0.49	109.30	0.40	9.06	7 May 02	0.62	83.95	0.49	6.66
14 May 02	0.56	125.96	0.39	8.72	14 May 02	0.73	99.02	0.67	8.98
22 May 02	0.64	144.04	0.48	10.71	22 May 02	0.62	84.18	0.52	6.99