RACER: Spatial and temporal variations in microbial biomass

G. TIEN, D. JONES, M.D. BAILIFF,
M. NAWROCKI, B. TILBROOK, P. HABERSTROH,
G.T. TAYLOR, *and* D.M. KARL

Department of Oceanography
and/or
Hawaii Institute of Geophysics
University of Hawaii
Honolulu, Hawaii 96822

As part of the microbiology and vertical flux component of the Research on Antarctic Coastal Ecosystem Rates (RACER) program, we obtained a comprehensive temporal and spatial inventory of particulate adenosine-5'-triphosphate (P-ATP) concentrations in the 25,000-square-kilometer study area (Huntley et al. *Antarctic Journal,* this issue) to assess the distribution of microbial biomass (Holm-Hansen and Booth 1966; Karl 1986).

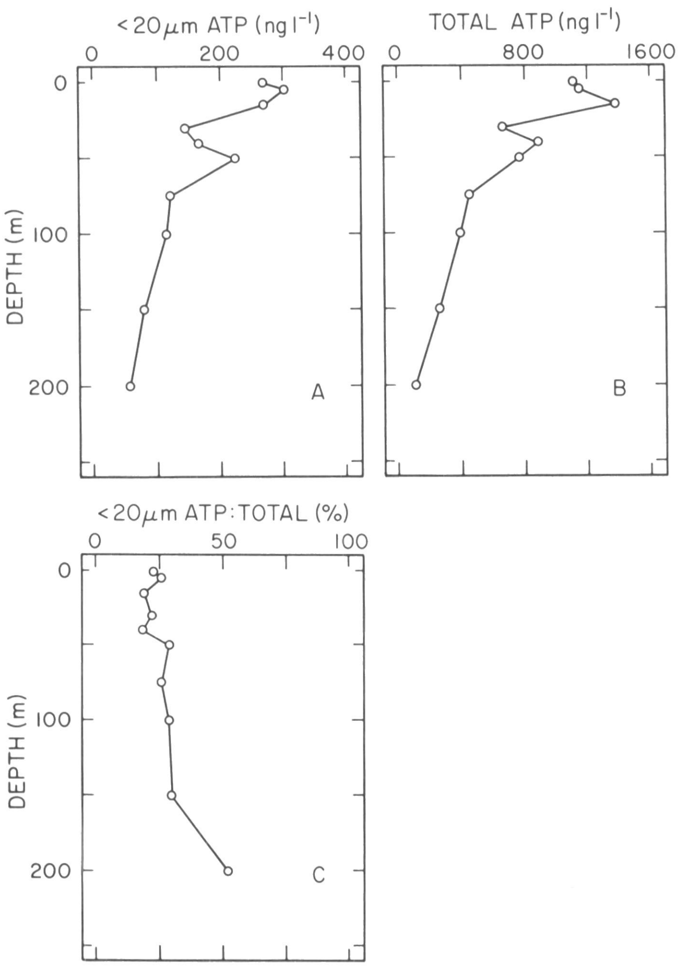

Figure 1. Vertical profiles of <20 micrometers ATP (A), total microbial ATP (B) and percentage of the total ATP contained in the <20-micrometer size fraction (C) for station 43 during the December 1986 RACER cruise. ("m" denotes "meter." "μm" denotes "micrometer." "ngl^{-1}" denotes "nanograms per liter.")

Surface waters were collected at 69 stations using a tethered bucket sampler and depth profile water samples (0–200 meters) were obtained at five preselected stations (Huntley et al., *Antarctic Journal,* this issue) using 10-liter Niskin bottles. Immediately following collection, each water sample was screened through 202-micrometer Nitex mesh to remove large particles and macrozooplankton and a portion of this <202-micrometer seawater was passed through 20-micrometer Nitex mesh, yielding two separate size fractions: <202 micrometers ("total microbial") and <20 micrometers ("nanoplankton"). Triplicate subsamples of both size fractions were processed and analyzed for ATP (Karl and Holm-Hansen 1978).

Station 43, located in the northern Gerlache Strait, was selected to illustrate the temporal and depth-dependent variation in microbial biomass observed during our field experiment. This station supported the highest seasonal rates of primary production (Holm-Hansen, Letelier, and Mitchell, *Antarctic Journal,* this issue) and the highest P-ATP concentrations (figure 1) of any station in the RACER study area (figure 2). During the initial cruise (December 1986) the spring bloom was already well established. Approximately 75 percent of the P-ATP was ≥20 micrometers indicating that a majority of the total microbial

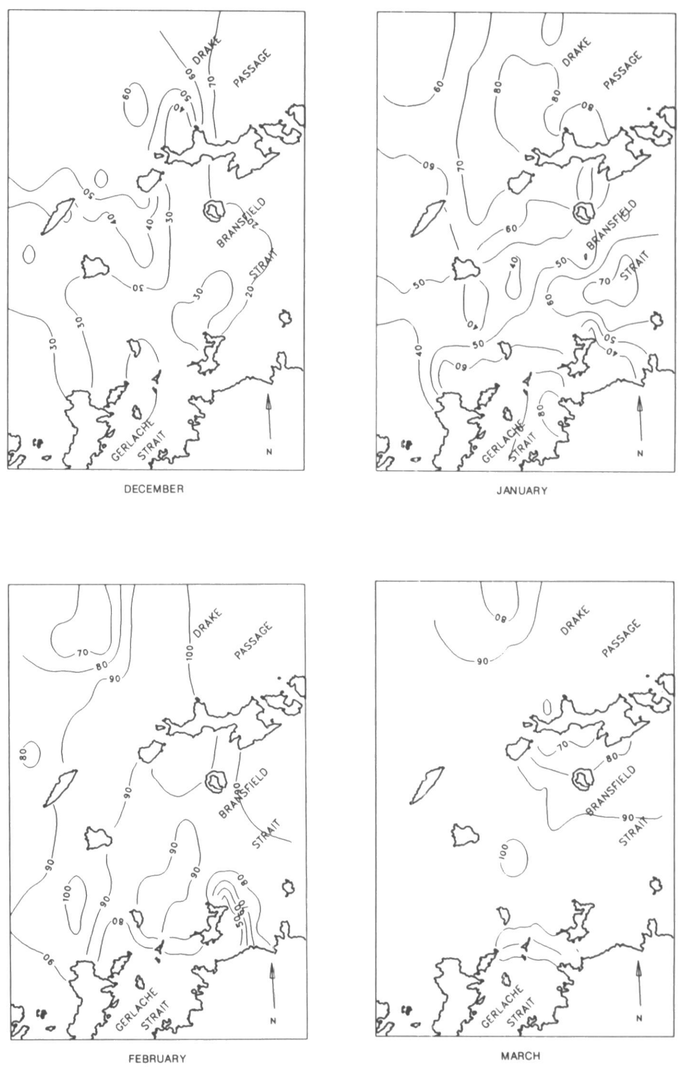

Figure 2. Seasonal changes in the spatial distribution of the ratio of <20 micrometers: total ATP (as percentage) over the 25,000-square-kilometer RACER study area from December 1986 to March 1987.

P-ATP concentrations and concentration ratios for two distinct size fractions. Data were collected at RACER station 43 in the northern Gerlache Strait.

Depth[a]	<20 micrometer ATP[b]				Total ATP[b]				<20 micrometers/ total[c]			
	Cruise				Cruise				Cruise			
	Dec.	Jan.	Feb.	Mar.	Dec.	Jan.	Feb.	Mar.	Dec.	Jan.	Feb.	Mar.
0	267	1130	630	65	1104	1393	1117	71	24	81	56	92
5	298	897	549	70	1144	1311	961	86	26	68	57	82
15	267	517	139	81	1376	967	391	83	19	54	36	99
30	144	615	106	57	660	957	263	63	22	64	40	90
40	165	415	125	39	890	863	281	49	19	48	44	80
50	222	349	109	28	769	767	287	28	29	46	38	98
75	75	143	82	23	453	351	270	51	26	41	30	45
100	113	145	55	19	395	383	140	38	29	38	39	50
150	78	63	48	20	263	162	97	24	30	39	50	83
200	56	33	34	18	107	82	66	18	52	40	52	99

[a] In meters.
[b] In nanograms per liter.
[c] Percentage.

biomass comprised large phytoplankton cells. These ATP-based microbial biomass values correlate well with the size distribution of chlorophyll *a* measured at this station (Holm-Hansen, Letelier, and Mitchell, *Antarctic Journal*, this issue) and are consistent with our own direct microscopic observations.

By January 1987, the phytoplankton bloom had subsided and rates of primary production at station 43 had decreased to values that were approximately 25–30 percent of the maximum values measured in December (Holm-Hansen, Letelier, and Mitchell, *Antarctic Journal*, this issue). Although total ATP also decreased, there was an approximately twofold increase in ATP in the <20-micrometer size fraction, indicating a shift in biomass toward nano- and picoplankton (table). Direct epifluorescence microscopy of proflavin-stained preparations of the <20-micrometer water samples revealed the presence of both autotrophic eukaryotes and heterotrophic bacteria.

By March, total P-ATP at station 43 had decreased to very low concentrations comparable to the values observed at the oceanic Drake Passage station. The March total ATP values were approximately an order of magnitude less than the peak bloom concentration, and on average more than 80 percent of the total ATP was present in the <20 micrometer size fraction. Based on a carbon-to-ATP ratio of 250 (Karl 1980) our results indicate a substantial seasonal progression in total depth-integrated (0–200 meters) microbial biomass at station 43 from a spring bloom maximum of 25.3 grams of carbon per square meter to a late summer minimum of 2.0 grams of carbon per square meter.

The surface water P-ATP contours (figure 2) present regional data on the size distribution of total microbial ATP over the entire field season (December 1986 to March 1987). It is evident that the temporal shift in microbial biomass that we observed at station 43 was not an isolated phenomenon. These data indicate that the mean size structure of the microbial population changes with time over large regions in the RACER program study area.

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