Palmer LTER: Annual season October 1995 through March 1996

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In March 1996, the Palmer Long-Term Ecological Research (LTER) Program (Smith et al. 1995) completed a fifth season of sampling at Palmer Station. The Palmer LTER sampling strategy combines seasonal time series data from the nearshore Palmer grid and seabird observations from nesting sites near Palmer Station with annual cruises covering a regional grid along the western Antarctic Peninsula. The LTER January cruise aboard the *Polar Duke* (*PD*96-01) visited the inshore stations five times to provide continuity in the seasonal record (Vernet and Baker, *Antarctic Journal*, in this issue).

A summary of events for the 1995–1996 Palmer field season is given in figure 1. Significant dates include arrival of research teams at Palmer (7 October 1995), first bird observations (10 October 1995), first chlorophyll sample (16 November 1995), first zodiac profiling cast and acoustic transect (16 November 1995), the cruise beginning (8 January 1995), the cruise ending (10 February 1996), last profiling cast and acoustic transect (19 March 1995), departure of water-column research teams from Palmer (26 March 1996), and last bird observation (27 March 1996). In figure 1, each line summarizes one cycle of standard sampling (*see* the table in Smith et al., *Antarctic Journal*, in this issue) consisting of approximately 7 days where the initial event number, month the event began, day it began, day, and year are given in the first five columns. The sixth column summarizes the types of standard days included in this particular cycle. A summary of the 13 scuba dives to obtain krill samples for laboratory experiments, acoustic transects, hydrographic and optical profiling, phytoplankton sampling, targeted krill tows for physiological condition and instantaneous growth rate experiments, and zooplankton trawls are given in the next columns followed by general comments.

We made some changes from past seasons in the sampling program. For example, an equipment upgrade permitted us to run instruments, winch, and computers on the zodiacs on batteries rather than on a gasoline generator. Batteries have proven to be a more reliable, stable, cleaner, and quieter power source than the generator. In addition, chlorophyll

Event No.	Mo	Day Beg	Day End	Yr	Std. Day	dive	bio-ac	ctd/prr chl/sal	par hplc nuts poc	pico net Ppi	tep Psis	Pc/ chl	krilltarg	phyconl	igr	trwl	comments
1	10	7	7	95	arrive												ARRIVE PALMER
2	10	8	31	95	ice	1-3											
26	11	1	15	95	ice			TEST									
76	11	16	19	95	1	4-7		E-B	x	x	x			DK5;DK	DK		
135	11	20	27	95	1245		x	x	x	x	x			I	I	I	brash pushed E. of Stat
270	11	28	4	95	12345	8-13	x	x;600	x;600	x	x		GH	GH/HUGO		x	near B; brash ice & wind
411	12	5	10	95	123455		x	x	x	x	x	B	JI;IH;IJ			x	brash ice edge
503	12	11	16	95	11234		x	x	x	x	x	B	B	B	B		krill at transect end;wind&rain
613	12	17	25	95	ice												iced in Arthur Harbor
637	12	26	1	95	13425		x	x	x	x	x	B	2*AH				ice moved to .8nm from D;ice out
768	1	2	7	96	1325		x	x	x	x	x	B	AH	AH	2*AH	x	
	1	8	14	96	cruise												CRUISE: lterjan96: PD96-01
844	2	15	20	96	43		x	E	x	x	x		3*LIM	LIM	LIM		targ=no catch
914	2	21	25	96	123		x	x	x	x	x		D				batteries died
1015	2	26	4	96	1223455		x	x	x	x	x		2*SPUME			x	
1110	3	5	10	96	123		x	x	x	x	x	B	IJ;3*I	I	I		targ=no&small catch; hit bottom
1230	3	11	17	96	12345		x	x	x	x	x	B	B;TOR			x	larval fish targ=no catch
1362	3	18	21	96	1323		x	x	x	x	x		3*B;4*HI	B;HI	HI		
1433	3	22	26	96	depart									HI			DEPART PALMER

Figure 1. Palmer LTER 1995–1996 season event log overview by sampling week (*see* the table in Smith et al., *Antarctic Journal,* this issue, for definition of standard sampling week). Events include acoustics (bio-ac, Biosonics 120 kilohertz), discrete sample for chlorophyll analysis (chl), conductivity-temperature-depth (ctd, Seabird), scuba krill collection (dive), high-performance liquid chromotography of phytoplankton pigments (hplc), instantaneous growth rate (igr), targeted tow for krill (krilltarg, 50 kilohertz), microscopic analysis of net plankton (net, >5μm), inorganic nutrient analysis (nuts), photosynthetically active radiation (par), physiological condition of larvae (phyconl), microscopic analysis of picoplankton (pico, 0.5–5.0μm), particulate organic carbon (poc), production photosynthesis vs irradiance (Ppi), primary production simulated-*in-situ* (Psis), profiling radiometer (prr, BSI), discrete sample for salinity analysis (sal), transparent exopolymer particles (tep), and standard zooplankton tows (trwl).

samples, routinely run using HA 0.45-micron (μm) filters, were also run separately for the fraction of phytoplankton less than 20 μm at selected depths.

This season included service to the Hugo automatic weather station. Although visits were made during the LTER annual January cruise, a later return attempt was made on 23 March to correct a temperature probe failure but high swells prevented landing.

The season was preceded by a heavy ice winter as was also true of the first Palmer LTER season 1991–1992 when Arthur Harbor did not clear of pack ice until early December (Ross and Quetin 1992). During the 1995–1996 season, the timing of the ice departure differed. Sea ice began to clear from the nearshore Palmer grid in November 1995, but a return of sea ice on 17 December prevented sampling for over a week until high winds blew the harbor clear of ice on 24–25 December.

Figure 2 shows the seasonal progression in selected parameters versus time. These preliminary data provide an overview of the season. The 1995–1996 season was a period of high biomass with an initial phytoplankton bloom of 15 milligrams per cubic meter (mg m^{-3}) in November 1995, chlorophylls greater than 10 mg m^{-3} after January, and another bloom reaching 35 mg m^{-3} in February 1996. The silicate and nitrate decreased concurrently, reaching low values of 36.5 micromolar (μ*M*) silicate and 2.24 μ*M* nitrate when chlorophyll peaked at 38.9 mg m^{-3}.

Between 20 November and 19 March, 21 acoustic transects were run from stations A to E and 15 from F to J. Net samples indicate that young-of-the-year krill dominated the zooplankton; salps were absent. Acoustic estimates of zooplankton biomass ranged from 0 to 382 grams per square meter g m^{-2}; most of the higher values found were from the third week in February to the middle of March. Some of the reproductive events associated with breeding chronology of Adélie penguins on Humble Island this season (Fraser et al. in press) are noted by arrows in figure 2*C*. The breeding success of these penguins was 1.58 chicks creched per pair, representing a small increase relative to last year.

The LTER seasonal observations of the marine environment, the lower-trophic level abundance and distributions for the area, and the seabird observations at nesting sites near Palmer were recorded from October 1995 to March 1996. The sampling event log, participant list, and other project information for the season are available online (*http://www.icess.ucsb.edu/lter*).

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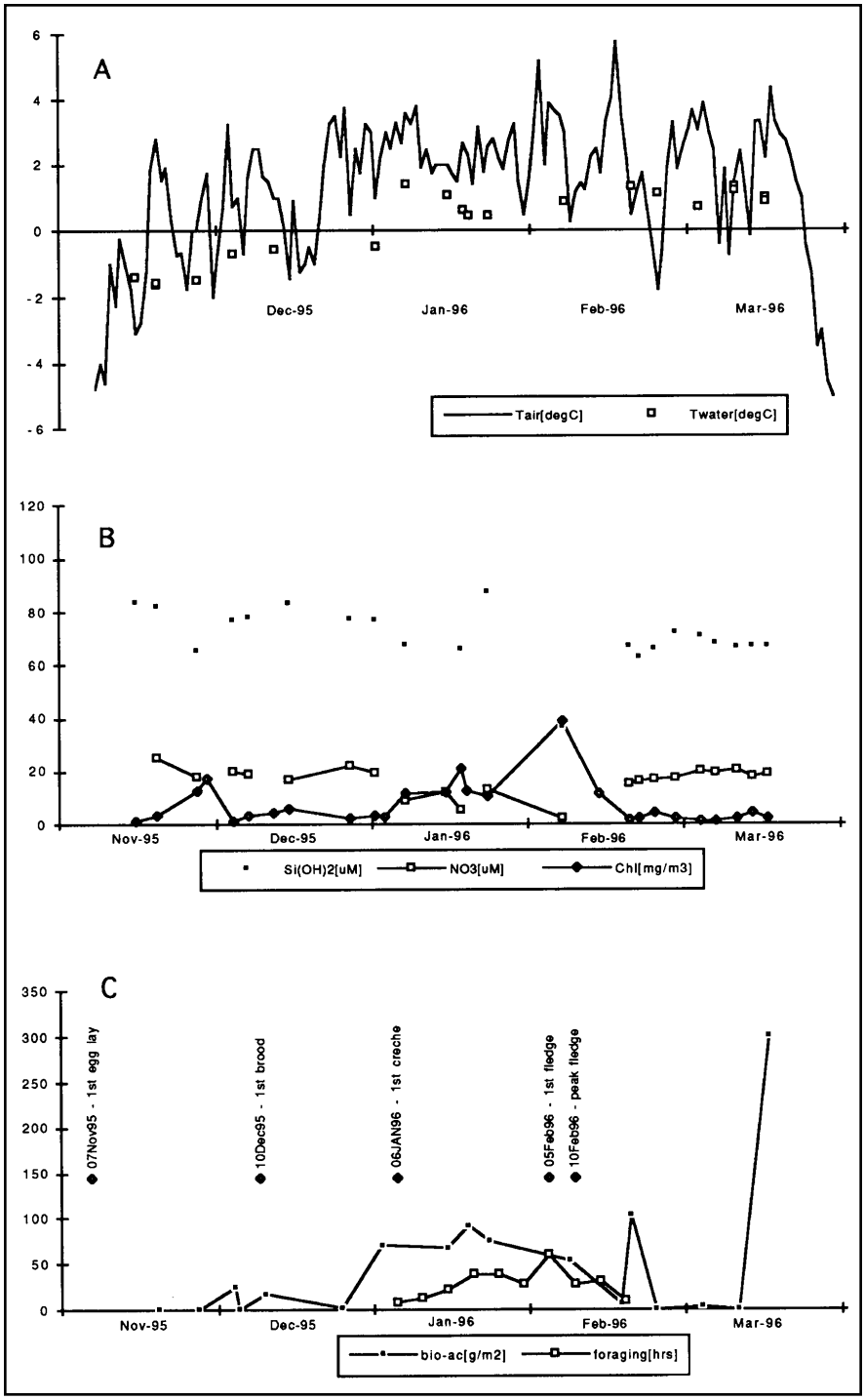

Figure 2. *A.* Air temperature (in degrees Celsius, solid line) at Palmer station and water temperature (in degrees Celsius, boxes) at station E for the 1995–1996 season. *B.* Surface chlorophyll (in mg m^{-3}, filled diamonds), nitrate (in μ*M*, open squares), and silicate (in μ*M*, filled squares) at station E for the 1995–1996 season. *C.* Krill abundance (in g m^{-2}, filled squares) from transect A to E and Adélie penguin foraging (in hours, open squares). Arrows indicating day of first egg laying, first brood, first creche, first fledging, and peak fledging at Humble Island for the 1995–1996 season.

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Palmer LTER: Palmer Station air temperature 1974 to 1996

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Climate variability is of central importance to long-term ecological studies in general and to bioclimatology in particular. As a consequence, the Palmer Long-Term Ecological Research (LTER) program has gathered historical meteorological data taken for Palmer Station as well as initiated the quality control and archiving of this data. The following is a preliminary report summarizing Palmer Station air temperature records from May 1974 to August 1996.

Meteorological measurements began after the first scientific occupation of Palmer Station in 1968. Over the years, the reporting of these data has undergone some change. Two separate records available from Palmer Station include

- monthly weather starting in 1974 and
- daily weather initiated in 1989.

Historical data in addition to the Palmer data provide the basis for this preliminary report.

Although early data is scarce, monthly measurements for Palmer Station beginning in 1974 have been published primarily in *Antarctic Journal of the United States.* Subsets have also been archived in other locations. For instance, the station holds some digital records for this early period whereas the National Climatic Data Center (NCDC) archives a subset of daily observations. A report of Palmer Station weather from 1975 to 1983 (Jacka, Christou, and Cook 1984) provides a few missing points in the *Antarctic Journal* series. Monthly maximum, minimum, and average temperatures available in *Antarctic Journal* were compared for consistency. Statistical outliers and obvious mistakes were corrected. For example, one average temperature reported was twice the reported maximum, and inspection showed that a negative sign had been dropped.

In April 1989, consistent daily weather records were begun (Oxton personal communication), and observations were made four times a day by Antarctic Support Associates personnel at Palmer Station. Daily measurements include maximum and minimum air temperature, wind speed, and wind direction. Daily mean air temperature is determined by taking the average of the daily maximum and minimum observed for that day. These daily air temperature observations were found to be well correlated with the higher frequency sampling of the automatic weather station at Bonaparte Point located roughly 750 meters west-southwest from the station (Baker and Stammerjohn 1995).

The daily temperature observations have been averaged into monthly values and combined with earlier data to create a 22-year composite record (May 1974 to August 1996) of monthly data. As a check of internal consistency for this combined data set, a subset of this series was compared with Faraday station temperature data (1974 to 1991).

As discussed elsewhere (Smith, Stammerjohn, and Baker in press), the Palmer Station air temperature data are well correlated with the Faraday data, and Faraday data can, when necessary, be used as a proxy for Palmer data. Palmer data outside two standard deviations from the Faraday regression were flagged and removed for the subsequent analysis.

The resultant monthly averages and standard deviations for Palmer Station are shown in figure 1 and summarized in table 1. A harmonic, known to describe seasonal variation (Lynn 1967; Van Loon 1967; Schwerdtfeger 1984) fit through these data, provides a simple method for calculation of the 22-year average value given julian day. Further, it provides an average against which one may view the variability of a single year's air temperature. For example, the Palmer Station 1995 daily temperature values are plotted along with the fit in figure 2.

The monthly data in the Faraday temperature record (1946–1991) have shown a warming trend, particularly in winter months (Smith et al. in press). A trend analysis for each month of the Palmer Station weather record (1974–1996) is summarized in table 2, and the January results are illustrated in figure 3. In agreement with previous reports (King 1994;