INSTRUMENT TESTING CRUISE TO SLOPE WATER AND WARM-CORE RING 86A

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INTRODUCTION

There were several objectives for this cruise. A principal objective was to test the new MOCNESS sensor package as part of the preparation for WSCORE (Winter/Spring Convective Overturn Restratification Experiment). A number of ancillary projects were conducted. These included studies of the size frequency distribution of animals in the samples collected with double MOCNESS using silhouette photography; studies of the relationship between 50 kHz echo sounding records and the vertical structure of the zooplankton in the MOCNESS samples; studies of the relationship between the abundance and distribution of Synechoccocus, chlorophyll, and the vertical structure of the water column; studies of the 15N in a variety of zooplankton species and particulate matter from varying depths in the Slope Water and ring 86-A; studies of the variability in genetic composition of several species of euphausiids in relation to the hydrographic regime in which the animals were living. In addition, ocean testing of two refurbished Neil Brown Instruments CTD's by the WHOI CTD Group and testing of proto-type expendable XCTD's by Sippican was done.

CRUISE PARTICIPANTS:

1) Peter Wiebe WHOI
2) Alfred Morton WHOI
3) Steven Boyd WHOI
4) Cabell Davis WHOI
5) Peter Franks WHOI
6) Armando Tamse BUMP
7) Diane Bennett WHOI
8) Victoria Kaharl WHOI
9) Rick Krishfield WHOI
10) Joe Montoya HARVARD
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12) Ann Bucklin U. DEL.
13) Anne Rader BOSTON U. HOS.
14) Bruce Dalton SIPPICAN

We departed Woods Hole on 29 May 1986 about 1230, steaming for a station in the Slope Water at 39 N; 70 W. This location was west of warm-core ring 86-A. Once past the continental shelf break XBT's were dropped periodically as we approached the station. Work commenced early in the morning of 29 May. Activities at this location included MOCNESS tows, 50 kHz echo sounding, CTD casts for Synechococcus and 15N, chlorophyll casts, meter net tows to obtain experimental animals, and XCTD tests. We began steaming towards the center of ring 86-A around mid-night on the 29th, taking xbt's and meter net tows along the route. Work in the ring, which was the same as that conducted at the Slope Water station, began about noon on the 30th and was completed in the late afternoon on the 31st. Along the route back to Woods Hole, we stopped at two ring peripheral locations for CTD casts and a meter net tow.

A series of short summaries of the work conducted by the investigators follows. Most objectives were successfully met due in part to the friendly and cooperative assistance we received from the RV/KNORR's officers and crew. We were also fortunate to have had excellent weather and sea conditions.

A special note should be made of the extraordinary occurrence of massive quantities of the salp, Salpa aspera, at nearly every site we sampled in the Slope Water and in the ring. This occurrence was unusual not only because of the high numbers, but also because it occurred in the late spring rather than during the summer when it has been observed previously.

MOCNESS SENSOR PACKAGE TESTS

Peter Wiebe

The MOCNESS sensor package was expanded with the addition of a Sea Tech transmissometer, a Q-Instruments fluorometer, an acoustic doppler flow sensor, and a downwelling light sensor. The latter two sensors were custom built at WHOI. In addition, a 16-bit (NEC APC-III) computer was used to replace the 8-bit CBM microcomputer that previously had been used for real-time processing of the data from the MOCNESS. On this cruise, our effort was designed to obtain data from the various sensors to see how well they worked, to evaluate their performance under conditions typical of those we expect to encounter in the future, to test out the computer data acquisition system and post processing software, and to obtain independent field data for calibration of the sensors. As part of the testing program, we studied the surface, near surface, and deeper water column physical and biological structure in warm-core ring 86-A and the Slope Water.

We made three deployments of the double MOCNESS (equipped with 20 1-m2 nets) in the Slope Water and four in ring 86-A (see table below). On tow #228, low battery voltage prevented the firing of the nets, so no samples were obtained although the data from the sensor package will be valuable in the sensor evaluation. The fluorometer (borrowed from J. Marra, LDGO) was on the MOCNESS for the 0-200 m tows, but had to be removed for the deeper 0-1000 m tows because it did not have a pressure housing to withstand depths greater than 200 meters.

The transmissometer, fluorometer, and downwelling light sensor provided what appear to be meaningful data on all of the tows. The limits of sensitivity of these sensors must await laboratory analyses. The acoustic doppler flow sensor worked intermittently. Sufficient data were obtained to permit S. Williams, the designer of the sensor, to make the next step in refining the design so that speed of the net system in the 0-200 cm/sec range can be measured to at least 1 cm/sec. The microcomputer based data acquisition and processing system performed reasonably well, although there are several software problems associated with interfacing the MOCNESS deck unit to the computer that need to be resolved to make the data acquisition fail-safe.

In addition to obtaining sufficient engineering information to complete the sensor package additions, we were fortunate to be able to sample a warm-core ring which had been formed in the winter (early January 1986) and had undergone deep winter/spring convection. We were also able to quantitatively assess the vertical distribution and migration patterns of the salp, Salpa aspera, in the core of the ring. This species was present in the surface waters (upper 50 m) in massive concentrations during the nighttime and by mid-day had migrated to between 500 and 1000 m (and perhaps deeper). The changes in phytoplankton standing stock (chlorophyll a and phaeophytin) described below suggest that these salps were having a very significant impact on the plant material.

DOUBLE MOCNESS TOW DATA

Date	Time	Tow Number	Lat	Long	Maximum depth of tow
29 May	1122	MOC-1D-227	39 17.60N	70 04.73W	200 m (4 samples)
29 May	1333	MOC-1D-228	39 15.97N	70 01.33W	490 m (0 samples)
29 May	2056	MOC-1D-229	39 15.79N	70 20.38W	1000 m (16 samples)
30 May	1340	MOC-1D-230	39 21.00N	68 45.18W	200 m (17 samples)
30 May	2008	MOC-1D-231	39 19.00N	68 31.90W	1000 m (16 samples)
31 May	0900	MOC-1D-232	39 26.00N	68 26.25W	1000 m (16 samples)
31 May	1417	MOC-1D-233	39 33.38N	68 15.14W	200 m (17 samples)

50 kHz ECHO SOUNDING

Cabell Davis

A 50 kHz echo sounder belonging to Dr. F. Carey (WHOI Biology) was used throughout most of the cruise to monitor acoustic scattering layers. The transducer was mounted in a fish which was towed from the port side at a depth of 10 m and the acousitic return was displayed on a video monitor and chart recorder. Diel vertical migration of deep scattering layers to surface from >400 m was observed. Special attention was paid to the records when MOCNESS tows (1-m2 nets) were being made in order to study the identity of organisms in and around the scattering layers. Positions of the MOCNESS tows were recorded on the chart paper as were transmitter, receiver, monitor, and chart recorder settings.

MEASUREMENT OF ZOOPLANKTON SHRINKAGE AFTER FIXATION USING SILHOUETTE PHOTOGRAPHY

Armando Tamse

The determination of size-frequency distributions of zooplankton communities using silhouette photography is very conveniently applied to preserved zooplankton samples. However, not much is known how different these distributions are from live zooplankton size-frequency distributions. This cruise provided an opportunity to determine the amount of shrinkage of zooplankton by taking silhouette photographs of fresh and preserved zooplankton samples. More shrinkage is expected from gelatinous zooplankton than from crustaceans. I was able to take six photographs of fresh zooplankton samples from 150-200 m and 900-1000 m from one of the Slope Water MOCNESS tows. Taking additional silhouette photographs of fresh and fixed zooplankton samples became impossible when the transformer of the flash unit short-circuited and burned. The zooplankton samples that have been photographed and then preserved in formalin will be photographed in the laboratory in Woods Hole.

GENETIC VARIABILITY OF EUPHAUSIIDS

Ann Bucklin

Collections of euphausiids were made with a meter net towed obliquely in the upper water column. Three tows were made during the night of May 29-30 in the Slope Water which yielded good collections of Euphausia krohnii, Thysanoessa gregaria, and several other species. Two tows were made in ring 86-A, yielding good samples of the same species for comparison with Slope Water specimens. A final tow just off the shelf on the night of 31 May also provided useful specimens. Euphausiids for this study were also taken from the MOCNESS tows.

Two samples of E. krohnii were analyzed for allozymic variability to indicate genetic variability of the individuals. Starch-gel electrophoresis and staining for 6 enzyme systems was done on board the KNORR. The remaining samples were frozen immediately following collection for later starch-gel electrophoretic analysis. Allozymic variability will be analyzed in Slope Water and ring populations of E. krohnii (by A. Bucklin) and T. gregaria (by D. Bennett) to determine whether entrainment in rings is associated with genetic divergence of the populations.

15N ANALYSIS OF SELECTED ZOOPLANKTON AND PARTICULATE MATTER

Joe Montoya

The objectives of 15N work were the following:

1) to obtain samples of PN and selected zooplankton taxa for 15N- isotope analysis.

2) to freeze aliquots of filtered sea water from selected station for N-nutrient analysis (NO3, NH4).

3) to freeze seawater from the thermostad of ring 86-A for N-isotope analysis of dissolved nitrate.

4) to conduct experiments to test the effect of gut clearance and starvation on the N-isotope composition of representative zooplankton.

5) to test the effect of various preservation methods (formalin, freezing, desiccation) on animal isotopic composition.

Approximately 60 samples of PN from selected depths at stations in the Slope Water and ring 86-A were obtained. About 130 individuals of representatives of zooplankton from oblique tows (meter net or MOCNESS) were dessicated, 50 were frozen, and 100 were preserved in formalin. Sea Water samples from selected depths at stations in the Slope Water and ring 86-A which were frozen numbered approximately 50. Animals maintained on board in filtered seawater for varying lenghts of time and fecal pellets and molts from these animals numbered approximately 70.

General Comments: We were surprised by the very high abundance of gelatinous zooplankton, especially Salpa aspera. With notable exception of the amphipod, Vibilia sp, the large crustacean zooplankton were relatively scarce in our tows. We accomplished all our general objectives, though the taxonomic composition of our samples is rather different than we expected.

VERTICAL DISTRIBUTION AND ABUNDANCE OF SYNECHOCOCCUS

Peter Franks

Sampling was undertaken during this cruise to examine the vertical distribution of the cyanobacter, Synechococcus, inside and outside a warm-core ring. Synechococcus tend to have high concentrations of phycoerythrin, which appear to enable them to carry out photosynthetic carbon fixation at depths greater than the 1% light level. Two patterns of vertical distribution could be expected, ignoring features such as streamers transporting water outside the ring into the ring's interior.

1) due to convective overturn in the ring, the Synechoccocus will be found in homogenous concentrations throughout the thermostad, and at shoaler depths in the stratified Slope Water and HVC.

2) due to a higher extinction coefficient in the ring, the Synechococcus would be found at shoaler depths in the ring than the Slope Water.

Seven stations were sampled outside the ring, at ring edge, and at ring center. Samples were collected using a CTD - rossette sampler, with samples taken at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 150, 200 m, and in some cases at 25, 35, and 45 m for higher vertical resolution. Twenty ml aliquots filtered onto 0.4 Nuclepore filters will be examined with epifluorescence microscopy to determine cell counts. These data, combined with chlorophyll data from Steve Boyd, XBT data, and fluorescence, transmittance, and temperature data of P. Wiebe should indicate the relative contribution of Synechococcus to the phytoplankton standing stock, and elucidate the mechanisms leading to their vertical distribution. Cursory examination of the data indicates a great deal of structure in chlorophyll and temperature in the ring. It will be interesting to see how Synechococcus distributions correlate with the multiple chlorophyll maxima seen inside ring 86-A.

CHLOROPHYLL A AND PHAEOPIGMENT MEASUREMENTS

Steve Boyd

Chlorophyll and accessory pigments were measured in 7 vertical profiles in and around warm-core ring 86-A. Water samples were acquired using a 24 1.2 liter bottle CTD rosette system equipped to measure temperature, salinity and depth. Samples on "low" resolution casts (4) were taken at 10m intervals to 100 m and at 50 m intervals to 200 m and on "high" resolution casts (3) were taken at 5 m intervals to 100 m.

Standing stocks of chlorophyll pigments were higher in the ring core than either the high velocity region or ring edge. The concentration of phaeopigments was markedly higher in the night and early morning than the day.

Time	Station number	Latitude	Longitude
0742	1	39 16.58	70 03.81
1246	3	39 17.62	70 04.87
1254	7	39 21.50	68 45.15
1625	9	39 17.70	68 47.18
0600	12	39 23.42	68 28.00
1232	14	39 30.53	68 17.12
2000	16	39 51.76	68 46.05

REFURBISHED CTD TESTS

Rich Krishfield

Two Neil Brown CTD's and 24 bottle GO rossettes with 1.2 liter bottles were deployed in the Slope Water and ring 86-A to obtain data from below 1000 m for use in calibrating the instruments. Water from these casts was stored in glass bottles for salinity analysis in the laboratory. These deep casts and other intermediate and shallow water casts were also used to obtain water samples for the analyses described above. A total of 6 deep casts (to near the sea floor, generally >2000 m), 8 intermediate casts (to between 250 and 350 m), and 2 shallow casts (to 100 m) were made.

EXPENDABLE XCTD PROBE TESTING

Bruce Dalton

The objectives of the XCTD testing were:

1) to determine if interaction between signal wire and conductivity cell has been eliminated on the XCTD.

2) to determine if 'in factory' calibration produces a product that compares favorably with a standard CTD.

3) to determine if manufacturing process produces a probe that will operate reliably and correctly through a complete deployment and drop.

Actions taken on the Cruise:

Two probes were dropped on 29 May aprroximately 10 minutes apart during a deep CTD cast. The acquisition system had been set up and its operation verified the evening before. The first probe produced no response from the deck gear. The system was reset and the program reloaded. The second probe was successfuly dropped.

On 30 May, a probe was launched during another CTD cast and a scope was attached to the deck gear. The scope showed the proper signal at the deck gear, but the deck gear did not respond. A simulator was connected to the deck gear and showed there was some difficulty in communications between the MK9 and the HP85. After some contact cleaning and installation of a new cable, the system appeared to be working. Another probe was dropped, but the deck gear stopped shortly after the start of the deployment.

On 31 May, the deck gear appeared to be working and two successful casts were made. Later a check showed that the microprocessor in the MK9 would periodically halt and further attempts at starting the acquistion program failed.

Summary:

The three successful deployments indicated that there was no interference from the BT wire. The completed casts indicated no catastrophic failures such as leaks, battery failure, or BT wire breakage. Evaluation of the second objective can not be completed until an intercomparison is made between the standard CTD data and the probe results.