R/V Albatross IV
AL9806 Cruise Report
May 13 - 22, 1998

Acknowledgments

We thank the officers and crew of the R/V ALBATROSS IV for their professionalism and friendly support. Their assistance enabled us to successfully complete the sampling operations and achieve the objectives of the GLOBEC survey of Georges Bank.

This report was prepared by Jack Green, John Sibunka, David Mountain, Maria Casas, Jennifer Crain, Keska Kemper, and Debra Piemonte with assistance from colleagues in the scientific party. This cruise was sponsored by the National Oceanic and Atmospheric Administration and the National Science Foundation.

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Purpose of the Cruise

The U.S. GLOBEC Georges Bank Program is in its fourth full field season and this cruise was the fifth of six broad-scale cruises conducted monthly between January and June. The objectives of the cruise were:

1) To conduct a broad-scale survey of Georges Bank to determine the abundance and distribution of U.S. GLOBEC Georges Bank Program target species which are the eggs, larval, and juvenile cod and haddock and the copepods *Calanus finmarchicus* and *Pseudocalanus* spp.

2) To conduct a hydrographic survey of the Bank.

3) To collect chlorophyll and nutrient data to characterize the potential for primary production and to calibrate the fluorometer on the CTD.

4) To map the bank-wide velocity field using an Acoustic Doppler Current Profiler (ADCP).

5) To observe gonadal development in live specimens of *Calanus finmarchicus* to determine life history directions of pre-maturing individuals.

6) To deploy drifting buoys to make Lagrangian measurements of the currents.

7) To collect water samples for phytoplankton species identification, ^{18}O determinations, and bank-wide horizontal and vertical distribution of microzooplankton.

The cruise track was determined by the position of the 41 "Standard" stations and 40 "intermediate Bongo" stations (located half-way between the standard stations) that form the basis for all of the broad-scale cruises. The entire Bank, including parts that are in Canadian waters, was surveyed (Figure 1).

The work included a combination of station and underway activities. The along-track work consisted of an ADCP unit used to make continuous measurements of the water current profile under the ship, in order to measure the current field over the whole Bank. Meteorological data, navigation data, and sea surface temperature, salinity, and fluorescence data were measured aboard the Albatross IV.

A priority was assigned to each of the 41 standard stations that determined the equipment that was deployed during the station's activities. At high priority "full" stations, a bongo net equipped with a SeaBird CTD was towed obliquely to near the bottom. A CTD-fluorometer/transmissometer profile to the bottom was made and rosette bottles collected water samples for salinity and chlorophyll calibrations, chlorophyll concentrations, phytoplankton species counts, and $^{18}O/^{16}O$ water analysis. A large volume zooplankton pumping system was used to profile the water column. A 1-m^2 MOCNESS was towed obliquely to make vertically stratified collections for zooplankton (150 umm mesh) and then to make collections of fish larvae (335 um mesh). A 10-m^2 MOCNESS was towed obliquely to make vertically stratified collections of juvenile cod and haddock, and the larger predators of the target species. At lower priority stations, a bongo tow, CTD profile, and 1-m^2 MOCNESS tow were made. At intermediate stations a bongo tow was made and at some intermediate stations, the SeaBird CTD/Niskin bottle cast was made for calibration purposes. A summary of the sampling events that took place during the cruise is in Appendix 1.

Cruise Narrative

May 13

Albatross IV departed Woods Hole on 13 May at 0930 hrs, approximately 36 hrs late into to what appeared to be a subsiding Northeast gale. With the delay in departure time, all gear had been well stowed and the scientific labs were ready for the first station well in advance of arrival. The ship arrived at the first station at about 1845 hrs with winds at about 25kt and heavy seas that had built up over the previous 3 days. All of the gear was nevertheless deployed successfully, and with the forecast promising better weather to come, the ship headed south for the next station.

May 14

The winds remained in the 22-27kt range and the seas continued to be fairly heavy. The first full station, station 3, was completed in spite of the conditions but with some difficulties. During the station, the Mark V CTD began to have serious problems which resulted in no communications with the instrument during the upcast and no water samples collected. The problem was traced to a poor connection at the slip rings on the hydro winch. After repairs a second cast was made successfully. A net bar was bent on the MOC10 during the tow and the resulting damage to net 1 was unrepairable. The net was replaced with a spare which was apparently in poor condition because the corner rope broke on the next station, station 4. It was repaired.

May 15

The first sun to be seen appeared at around 0900 hrs while working at station 7. Within one half of an hour, the ship was surrounded in a white fog with the sun obviously shining brightly overhead but doing little to warm the air. The wind was back up to 20kt but had started to turn to the north. Although some time was lost at station 7 (a full station) to repairs to the pump hose, pumping proceeded well until the new diaphragm pump failed (to no ones disappointment) and the cast was restarted from the maximum depth of 90m with the backup centrifugal pump. During the CTD cast the ship was visited by a pod of 12 or so pilot whales which stayed for a time about 50m from the starboard side, allowing for good viewing and photographing before then disappearing under the bow. During the MOC10 tow the net counter on the deck readout began to increment, reinitializing the flow counts each time. The flow volumes were recovered and the problem was correlated with the time of transmission of e-mail suggesting some RF interference with the MOCNESS computer. Work progressed well at stations 49, 8, and 50. The diaphragm pump was tried at station 9 after repair by the crew, but it failed after 5 minutes and was set aside for the rest of the cruise. The remainder of the station proceeded with no problems.

May 16

The morning dawned bright, sunny, and calm. Operations during the early morning hours went smoothly with the exception of the loss of a cod end bucket at station 10 on the MOC1 (net 5). Apparently the collar had come loose because the entire bucket was lost. During station 12, a corner rope parted on the MOC10 (net 3) resulting in a tear. While replacing the net it was learned that one of the replacement nets was sent out with the same problem. The last spare appeared to be in reasonable repair overlooking the lack of a grommet or two which were installed. The corner rope of the removed net was repaired by Tony Viera after the tow and set aside for the inevitable next net failure. Operations for the rest of the day proceeded without any problems. The first gadids seen since 6 cod larvae taken in the Great South Channel were some (5) large haddock at 22-28mm and 3 smaller cod, 8-18mm, at stations 9, 51, 11, 54 and 14. The MOC10 tows at station 16 the deep station, always a source of interest, produced among a large selection of medusae and decapods, some Nemichthiids, snipe eels, a large *Chauliodus sloani*, viper fish and a very nice Ceratioid angler fish specimen.

May 17

Sunday started cold and foggy with the wind rising from the NE again. The air temperature of 5.7¸ C. was quite a contrast from the warmth of Saturday morning. The ship's heading along the sequence of the stations tends to be "in the trough". No problems were experienced with the gear deployments. One half of Net 0 from the MOC1 haul at station 13 was placed in a cooler as a live collection of hydroids for Erich Horgan. By the end of the day the cloud cover had changed to a high bright overcast and the winds were back down. Few cod and haddock were seen in the nets. Stations 17-22 were completed.

May 18

Another high overcast day with smooth steaming in the AM. The towing protocol for the MOC1 was modified for stations 23 and 24 to collect *Calanus* as larval fish food for Todd Smith at the NOAA/NMFS Narragansett Laboratory. Nets 4 and 9 which are typically not used on shallow stations were towed obliquely from surface to 30m and back at 5m/min. Net 4 was towed after the first profile for zooplankton and net 9, which is usually brought aboard open after the ichthyoplankton profile, was lowered to depth and back. The resulting collections of almost pure *Calanus* were frozen. A cod end bucket from net 0 was lost at station 39. The covering tape from all of the cod end clamps were opened and all of the clamps retightened as necessary. A very large concentration of medusae was encountered in the bongo at station 26. There was serious concern that the there would be damage to the MOC1 nets and very likely loss of some of the cod ends. The decision was made to substitute a fine mesh bongo and not tow the MOC1 since it was a

low priority station. The first drifter was deployed at station 26 at the end of the day.

May 19

The weather continued calm but overcast. Over night there was some difficulty with the pump cast. Because of the calm weather the normal windrift that keeps the hose away from the ship was absent and the hose caught under the ship. After much maneuvering, the hose was freed and brought aboard intact. The weather improved and the afternoon and evening were bright and sunny which made the ship a prime target for "buzzing" by Canadian and US coast guard planes as it moved from the Canadian to the US side of the Hague Line. Standard stations 27, 28, 29, 30 and 40 were completed. At station 30 in what was considered to be prime hydroid territory, the 9 net of the MOC1 was towed from surface to just off the bottom and back to the surface. Few hydriods were found but the contents of the net were placed in a cooler with ice. During the MOC10 tow, the 0 net took a fairly good sample of the bottom community when a miscommunication occurred between the winch operator and the MOCNESS operator as to which direction the wire was going. Some stalked hydroids came up as part of the bottom sample and were also placed in the cooler to be brought back alive. At station 40 the CTD slip ring problem that was encountered early in the cruise reoccurred. Henry Jenkins made the repairs and a second cast was made.

May 20

The weather continued fine, calm and clear. The slip rings on the hydrographic winch continued to function properly after being repaired the previous night. A reed switch failure on the net response indicator necessitated a re-tow of the MOC1 at station 32. Samples from the aborted tow were discarded. A second cast of the CTD was made at station 33 after some of the bottles failed to close during the first cast. Also, around 1:00PM, a light cast was made at down to 40m. A few minor repairs were required to nets 0 and 1 on the MOC10 at station 33. After sunset the clouds moved in and NW winds began to pick up. Stations 31, 32, 33, 34 and 35 were completed. Ship speed was slowed to 5-6kt between station 34 and 35 to allow Jennifer Crain better conditions to examine the gonads of diapausing *Calanus finmarchicus*.

May 21

The weather was foggy and overcast. The increased winds anticipated over night never materialized. Stations 36 and 37 were completed overnight. Operations at station 38 went smoothly. A series of vertical ring net tows were conducted to collect live material for experiments at the URI Graduate School of Oceanography. Also two additional bongo hauls were made to collect *Calanus finmarchicus* for the larval fish rearing work at the Narragansett Laboratory. The last tows at 38 station were interrupted while the Albatross IV attempted to give assistance to a disabled fishing vessel. The vessel returned to the station site to deploy the last drifter before heading to port.

Hydrography
David Mountain, Elisabeth Broughton

The primary hydrographic data were collected using a Neil Brown Mark V CTD instrument (MK5), with a fluorometer, a transmissometer, and a rosette for collecting water samples. In addition a Seabird Electronics Seacat model 19 CTD (SBE19 Profiler) was used on each bongo tow to provide depth, temperature and salinity information during the tow.

The MK5 was deployed with 10 bottles on the rosette and samples were collected for various investigators. On each MK5 cast, samples were collected for chlorophyll/nutrient analysis (see Individual Report section), for oxygen isotope analysis by R. Houghton (Lamont Doherty Geol. Obs.) and a sample was taken at the bottom for calibrating the instrument's conductivity data. Water samples were collected for micro-zooplankton analysis for S. Gallager (Woods Hole Oceanogr. Inst.) and for phytoplankton species composition for J. O'Reilly (NOAA/NMFS, Narragansett, RI).

The data processing was done as described in previous Globec Broad-scale Survey cruise reports. The only problem encountered during the cruise was a connection to the slip ring assembly on the hydro winch, which initially caused some problems in the MK5 data stream. When the connection finally failed at standard station 3, the source of the problem was then located and easily repaired. The MK5 cast was repeated. MK5 cast 4 was replaced by cast 5, therefore cast 4 is not included in Appendix C. At standard station 40, a number of rossette bottles did not close properly. The cast was repeated and MK5 cast 35 replaced cast 34, which is not reported in Appendix C. Both the MK5 and SBE19 systems worked well, with no other problems in operation or apparent quality of the data.

Figure 2 shows the locations of the MK5 casts made during the bank-wide survey, identified by the consecutive cast number. The surface and bottom temperature and salinity distributions are shown in Figures 3 and 4. Surface and bottom anomalies of temperature and salinity, were calculated using the NMFS/Marine Monitoring, Assessment, and Prediction (MARMAP) hydrographic data set as a reference. The anomaly distributions are shown in Figures 5-6. An index of vertical stratification (sigma-t difference between 30 meters and the surface) and its anomaly from the MARMAP reference are shown in Figure 7. The distributions of surface and bottom fluorescence are shown in Figure 8. The volume average temperature and salinity of the upper 30 meters, and the associated anomalies, were calculated for the four sub-regions of the Bank and are shown in Figure 9. A profile of each MK5 CTD cast with a compressed listing of the preliminary data are found in Appendix 2.

The surface temperature and salinity distributions (Figures 3 and 4) show a tongue of cooler, fresher water extending from the northern edge of the eastern end of the Bank to the south and east along the eastern and southeastern part of the Bank. The indication is that water from the Scotian Shelf and Browns Bank moved across the Northeast Channel directly onto Georges Bank, without circuiting the Gulf of Maine. Overall, the Bank was

somewhat cooler than normal, except for the northwestern portion, which was 1-2¸ C warmer than the rest of the Bank. The salinities were lower than normal throughout the region. The development of seasonal stratification appears to be progressing normally (Figure 7). The highest fluorescence values were observed in the shallow, central part of the Bank.

The low salinity conditions observed in 1996 and 1997 have continued into 1998. The average surface layer salinity in the northwestern portion of the Bank observed in this survey (32.06 PSU) is the lowest value for that region for the entire GLOBEC time series.

The progressive shift from a warm to cold Slope Water at stations 7, 16 and 25 had been observed from January through March. The April observations did not indicate clearly whether the conditions persisted or not. The May observations show that the cold Slope Water conditions remained at stations 16 and 25, but warm Slope Water had returned in the area of station 7.

Zooplankton and Ichthyoplankton studies based on Bongo and MOCNESS tows.
John Sibunka, Maria Casas, Jack Green, James Pierson, Stephen Brownell, and Ana Thompson

Objectives:
(1) Principle objectives of the ichthyoplankton group in the broad-scale part of the U.S. GLOBEC Georges Bank Program were to study the composition of the larval fish community on Georges Bank, to define larval fish distribution across the Bank and within the water column, to determine those factors which influence their vertical distribution, and to determine bank-wide versus "Patch-Study" mortality and growth rates. Emphasis in this study is on cod and haddock larvae along with their predators and prey. This study also includes larval distribution and abundance, and age and growth determinations. Bongo nets and a 1-m^2 MOCNESS were used to sample the ichthyoplankton community.

(2) The primary objective of the zooplankton group was to complete a bank-wide survey of Georges Bank to determine the distribution, abundance, and stage composition of the target species *Calanus finmarchicus* and *Pseudocalanus* spp. A second objective was to identify, quantify, and describe the occurrence of abundant non-target species in order to provide a description of the environment occupied by the target species. A 1-m^2 MOCNESS, a vertically discrete, multiple opening and closing net system was used to sample copepods and larger zooplankton, and submersible pumps to sample the small, naupliar stages.

In addition to these objectives, the zooplankton group was responsible for: (a) obtaining subsamples from the 1-m^2 MOCNESS hauls for population genetic studies of *Pseudocalanus* spp. to be completed by Ann Bucklin at the University of New Hampshire. (b) Taking additional tows using a 1-meter diameter ring net at standard station 38 to collect live *C. finmarchicus* for William Macy, Graduate School of Oceanography/University of Rhode Island for an ongoing herring feeding experiment, and pteropods (*Limacina* spp.) for Scott Gallager at the Woods Hole Oceanographic Institution; and (c) Additional tows using a 0.61-m bongo at standard station 38 to collect and freeze *C. finmarchicus* for Dr. Todd Smith at the NOAA/NEFSC Laboratory, Narragansett, Rhode Island, for an ongoing larval cod and haddock feeding experiment.

Methods:
Bongo tows were made with a 0.61-m frame fitted with paired 335 um mesh nets. A 45 kg ball attached beneath the bongo frame was to depress the sampler. Digital flow meters were suspended in the mouth of each net to determine the volume of water filtered. Tows were made according to standard MARMAP procedures, (i.e., oblique from surface to within five meters of bottom or to a maximum depth of 200 m while maintaining a constant wire angle throughout the tow). Wire payout and retrieval rates were 50 m/min and 20 m/min respectively. These rates were reduced in shallow water (<60 m) to obtain a minimum of a five minute tow or reduced due to adverse weather and sea conditions. A Seabird CTD was attached to the towing wire above the frame to monitor sampling depth in real time mode and to measure and record temperature and salinity. Once back on board, the 335 um mesh nets were rinsed with seawater into a 330 um mesh sieve. The contents of one sieve were preserved in 5% formalin and kept for ichthyoplankton species composition, abundance and distribution. The other sample was preserved in 95% ethanol and kept for age and growth analysis of larval fish. The same preservation procedure was followed as for the 1-m^2 MOCNESS.

At stations where the 1-m^2 MOCNESS system was not used, a second bongo tow was made. This frame was fitted with both 335 um mesh and 200 um mesh nets. Digital flow meters were suspended in the mouth of each net to determine the volume of water filtered. Tows were made according to standard MARMAP procedures except maximum tow depth was 500 m. Wire payout and retrieval rates were 50 m/min and 20 m/min respectively. The nets were each rinsed with seawater into a corresponding mesh sieve. Large catches were subsampled so as to retain only one sample jar per net. The 200 um mesh sample was retained for zooplankton species composition, abundance and distribution, and preserved in 10% formalin. The other sample (335 um mesh) was kept for molecular population genetic analysis of the copepod, *Calanus finmarchicus*, and preserved in 95% ethanol. After 24 h of initial preservation, the alcohol was changed.

The 1-m^2 MOCNESS sampler was loaded with ten nets. Nets 1-4 were fitted with 150 um mesh for the collection of older and larger copepodite and adult stages of the zooplankton. Nets 0, and 5-9 were fitted with 335 um mesh for zooplankton (nets 0 and 5) and ichthyoplankton (nets 6-9) collection. Tows were double oblique from the surface to within 5 m from the bottom. The maximum tow depth for nets 0, 1 and 5 was 422 m, and for net 6 was 200 m (if net 5 was sampled deeper than 200 m, it was returned to 200 m and closed). Winch rates for nets 0-5 were 15 m/min and for nets 6-9, 10 m/min. For those nets fished >200m, the descent rate was increased so the maximum vertical velocity of the MOCNESS was 25m/min. This was providing the net angle did not go below 25¸ E and the net horizontal speed did not drop below 0.5 kts. The depth strata sampled were 0-15 m, 15-40 m, 40-100 m, and >100 m. The first (#0) and sixth (#5) nets were integrated hauls. For shallow stations with only 2 or 3 of the depth strata, not all nets were fished. The contents of nets 0-4 were sieved through 150 um mesh sieve, subsampled using a 2-L plankton sample splitter if the final biomass volume was too large for one quart jar, and then preserved in 10% formalin. Samples from nets 5-9 were sieved through 330 um mesh sieve and preserved in 95% ethanol. After 24 h of initial preservation, the alcohol was changed. The used ethanol was retained for disposal or recycling ashore. At priority 1 and 2 stations, 90-ml subsamples from the 150 um mesh nets were removed and preserved in 10% formalin for Charles Miller, Oregon State University. In addition, at priority 1 and 2 stations, 90-ml subsamples from these same nets were removed and preserved in 95% ethanol. These samples were collected for Ann Bucklin for population genetic studies to distinguish the *Pseudocalanus* species found on Georges Bank.

The 10-m^2 MOCNESS was loaded with five 3.0 mm mesh nets. Tows were oblique from surface to ~10 m from bottom or a maximum depth of 425 m. The same depth strata were sampled as with the 1-m^2 MOCNESS. The winch rate for retrieval varied between 5 and 15 m/min depending on the depth stratum. The slow winch rates were used in order to filter at least 4,000-5,000 m^3 of water per depth stratum sampled. A stepped oblique tow profile during retrieval was used to achieve this, if needed. Catches were sieved through a 335 um mesh, and preserved in 10% formalin. A selected number of juvenile cod and haddock were removed from the catches, measured to the nearest millimeter, and preserved in 95% ethanol. These juvenile fish will be used for age and growth analysis.

In order to collect nauplii and younger, smaller copepodite stages of zooplankton, a gasoline powered single diaphragm pump was used at standard stations 3 and 4. Following station 4 however, mechanical problems forced the use of the Pacer high-volume centrifugal pump for the remainder of the cruise. The same intake hose was used for both pumps and was deployed off the main boom by connecting the intake end, fitted with a 1.7-L Niskin bottle cut in half lengthwise, to the winch wire. The boom winch meter block was zeroed at the surface and the wire out reading was used to determine the depth of the cast. Two 45 kg weights were used to depress the array. Three or four 30-m sections of 7 cm diameter hose were connected to the pump (depending on the depth of the station), allowing the intake hose to attain a maximum depth of approximately 100 m. At shallow stations, the intake hose nozzle was lowered to 3 meters off the bottom. The output from the diaphragm pump was diverted to a surge dampener through an 8 cm fire hose while samples were collected. This caused the flow to be more laminar as it passed the flow meter and into the net, allowing a more accurate measurement of flow rate. Integrated depth samples were collected with 35 um mesh nets, sieved through a 30 um mesh sieve and preserved in 10% formalin. At stations with a maximum sampling depth of more than 85 m, samples were taken from the maximum depth to 75 m, 75-40 m, 40-15 m, and from 15 m to surface. At stations with a maximum sampling depth of less than 85 m, samples were taken from the maximum depth to 40 m, 40-15 m, and 15 m to surface. Before samples were collected, water was diverted from the net and the hose was allowed to flush completely, to assure that the zooplankton from the desired strata were obtained. At the last depth interval, the intake section was held just below the surface for 51 or 88 s for the Pacer pump, and 79 or 120 s for the diaphragm pump (when using three or four hose sections, respectively), allowing the sample to pass completely through the hose. Wire retrieval rate was approximately 4 m/min. This rate was used to obtain volumes of 500 L per 5 m depth interval sampled with the Pacer pump, and 200 L per 5 m depth interval with the diaphragm pump.

To collect *Calanus finmarchicus* for the live feeding experiments, a vertical haul was carried out using a 1-meter diameter ring net fitted with 300 um mesh. The net was attached to the winch wire with a book clamp together with a 45-kg weight. This array was lowered to a depth of 60 meters and retrieved at approximately 5 m/min. The animals caught in the cod end bucket were gently released into 30-gallon plastic trash cans previously filled with seawater using the Pacer pump system. At the same time, the shelled pteropods collected during this tow were placed in separate 30-gallon trash cans.

Calanus finmarchicus were also collected with the 0.61-m bongo frame fitted with paired 335 um mesh nets. Tows were single oblique to maximum depth of 50 meters. Vessel speed was 1.5 kts with wire payout and retrieval rates of 5 m/min. The catches were frozen.

Preliminary Summary -- Zooplankton
Maria Casas, James Pierson, and Ana Thompson

Preliminary observations were made from the samples collected using the 1-m^2 MOCNESS. *Calanus finmarchicus* was widespread throughout the Bank. All developmental stages were present. Younger stages were primarily seen along the western section of the southern flank and at station 38. Older stages, C5 and adults were everywhere. *Pseudocalanus* spp. was also present, if not abundant, at most stations sampled. Scatterings of *Centropages typicus* were seen at some stations (i.e. sta. 41 and 34). *C. hamatus* was extremely abundant on the crest of the Bank at stations 12, 30, 32 and 33, 36, and 37 almost to the exclusion of all else. *Temora longicornis* also seemed to be present whenever C. hamatus was present, but in lesser numbers.

Hydroids were observed mostly on the central part of the Bank, but the numbers were fairly low compared to other years. Station 26 was a monoculture of anthomedusae, possibly *Euphysia* spp. Observation of the sample at this station under the microscope showed the almost complete absence of any other zooplankton in the water column. The shelled pteropod, *Limacina* was present at most stations sampled, but was usually in low abundance.

Observations of zooplankton species composition were made at most standard stations sampled during this cruise. These observations were made from the net #0 samples

(335 um mesh), 1-m^2 MOCNESS, unless otherwise stated. Brief descriptions appear below.

Station 1 *Calanus finmarchicus* was very abundant at this station, stage C5 being the most common, but younger animals were present as well. Moderate numbers of *Pseudocalanus* spp., *Temora longicornis* and *Centropages* spp. were seen. Other zooplankton were the naked pteropod, *Limacina*, the chaetognath, *Sagitta elegans*, and thousands of brittle stars.

Station 2 A similar mix of copepods as at previous station, but *younger stages* (C2's and C3's) of *C. finmarchicus* were the most common. *Limacina* and hyperiid amphipods occurred here in moderate numbers.

Station 41 *C. typicus* was more abundant here than *C. finmarchicus*. Numbers of the shelled pteropod *Limacina*, larvacean houses, hyperiid amphipods, and chaetognaths were present at this station.

Station 3 Similar to station 1, although *C. finmarchicus* were mostly C5.

Stations 4, 5, and 6 Strawberry daiquiri of *C. finmarchicus*.

Station 7 *C. finmarchicus* was again the most abundant copepod, mostly C5's and females. Other copepods in moderate numbers here were *Euchaeta* spp. and *Metridia lucens*. Euphausiids were plentiful.

Station 8 *C. finmarchicus* was the most abundant copepod. Predominantly stages C1-C3. Young stages of *Metridia* spp. were also present.

Stations 9, 10 and 11 *Calanus*, *Calanus* everywhere. A mix of both older and younger stages. Low numbers of *Pseudocalanus* spp., and *T. longicornis* present. Also seen were moderate numbers of *Limacina*, a few gammarid amphipods, larvaceans, and chaetognaths.

Station 12 Many hydroids here! *Centropages* spp. was the dominant copepod. *T. longicornis* was also very plentiful, as was *Pseudocalanus* spp.

Station 13 Hydroids again! Typical bank mix of copepods: *C. typicus*, *T. longicornis*, few *C. finmarchicus*. Also a mix of larvaceans,

gammarid amphipods, and brittle stars.

Station 14 The majority of the copepods were *Pseudocalanus spp*., with some *C. finmarchicus* and *T. longicornis*. In addition, hydroids were again abundant, with moderate numbers of *Limacina* and chaetognaths.

Station 15 *C. finmarchicus* and hyperiid amphipods were the two most abundant species here.

Station 16 *C. finmarchicus* was very abundant here with mostly C5 and older stages. Also a mix of *Euchaeta* spp., *Euchirella rostrata*, and *M. lucens* was present. Non copepods included euphausiids, chaetognaths, and ostracods.

Station 17 A mix of *C. finmarchicus* and *Pseudocalanus* spp. Many hyperiid amphipods were seen here as well as chaetognaths and euphausiids.

Stations 18 and 19 Predominant younger stages of *C. finmarchicus* were present, as well as a mix of *Pseudocalanus* spp., *T. longicornis*, *Centropages* spp., and *Oithona* spp. Chaetognaths, hydroids and *Limacina* made up the rest of the zooplankton.

Station 20 Many anthomedusae, possibly *Euphysa* spp. were in all the nets. Also larvaceans and polyps were present in large numbers. The zooplankton component was similar to the previous station.

Station 24 *C. finmarchicus* was the primary component of the zooplankton. Pink nets.

Stations 25 and 39 Mostly older stages of *C. finmarchicus* were abundant. A mix of

C. hyperboreus, and *Pseudocalanus* spp. were the other copepods. Chaetognaths and hyperiid amphipods were also seen.

Station 26 A bongo haul was completed at this station. The nets were just filled to the brim with anthomedusae, possibly *Euphysa* spp. The water column seemed devoid of all other zooplankton.

Stations 27 and 28 A mix of *C. finmarchicus*, *M. lucens*, *Pseudocalanus* spp., and

T. longicornis were present here. Also hydroids were abundant in station 27 as well as chaetognaths.

Station 29 Mostly older stages of *C. finmarchicus* were at this station. *Euchaeta norvegica* was also present in significant numbers. Lesser numbers of *Pseudocalanus* spp. and *M. lucens* were also here. Large chaetognaths ~3 cm were also in abundance.

Station 30 *C. hamatus* was extremely abundant. The highest concentrations of the species on the bank to date. *T. longicornis* was also fairly abundant. Lesser numbers of *C.finmarchicus* were present. Hydroids were present in low numbers. Many chaetognaths in the samples.

Station 31 An equal mix of *C. finmarchicus* and *Pseudocalanus* spp. in high concentrations. All developmental stages were observed. Other copepods in moderate numbers were *M. lucens*, *T. longicornis*, and *Centropages* spp. *Limacina* was abundant at this station as well as chaetognaths.

Stations 32 and 33 Almost a monoculture of *C. hamatus* with some *T. longicornis*. Very few numbers of *C. finmarchicus* were in the samples. A few hydroids were also seen, but the numbers were low.

Station 34 Zooplankton were very abundant at this station with an equal mix of

C. finmarchicus, and *Pseudocalanus* spp. Lesser numbers of *C. typicus* and *C. hamatus*, and *M. lucens* were seen. Brittle stars were present.

Stations 35, 36, and 37 Copepods were very abundant at this station made up mostly of *C. hamatus* and *T. longicornis*. Lesser numbers of *C. finmarchicus* and *Pseudocalanus* spp. were also present. Hydroids were seen in significant numbers.

Station 38 An almost all *C. finmarchicus* station with many younger stages, C3 and below, although C5's and adults were also here. Other copepods included *Euchaeta* spp., *Centropages* spp., *Pseudocalanus*, and *M. lucens*. Echinoderm larvae, ostracods, and chaetognaths were in moderate abundance.

Samples Collected by the Zooplankton and Ichthyoplankton Groups:

Gear	Tows	Number of Samples
1. Bongo nets, 0.61-m	82 tows	81 preserved, 5% formalin
335-um mesh		1 preserved, 10% formalin
		82 preserved, EtOH
2. MOCNESS, 1-m^2	40 tows	
150-um mesh (Nets 1-4)		126 preserved, 10% formalin
335-um mesh (Net 0)		39 preserved, 10% formalin
335-um mesh (Nets 5-9)		164 preserved, EtOH
3. MOCNESS, 10-m^2	21 tows	
3.0-mm mesh		67 preserved, 10% formalin
4. Pump	19 profiles	
35-um mesh		62 preserved, 5% formalin

Preliminary Summary -- Ichthyoplankton
John Sibunka

All samples from the bongo net B (samples preserved in 5% formalin) were examined for fish eggs and larvae while on shipboard. The following qualitative observations of the larval size, abundance and egg abundance were made in the jars after preservation.

American plaice(*Hippoglossidies platessoides)* yellowtail flounder(*Pleuronectes ferrugineus*):
Microscopic examination is required to separate American plaice from yellowtail flounder larvae at sizes <14mm standard length (SL). Transformation for American plaice begins at 18-34mm SL (usually >25mm SL), whereas yellowtail flounder commence transformation at 11.6-16.0mm SL. Since most of these two flatfish collected during this survey were less than 10mm SL, they were combined into one category. The overall size range of these two flatfish was between 3-14mm SL. Most of these larvae were collected within the 60m isobath on Georges Bank (Figure 10). The largest catches of larvae (40- ~200 larvae/station) occurred in the area of stations 10 to 13. It was in this area that most of the smaller larvae (3-8mm SL, most < 6mm SL) collected during the cruise were caught. Few of these flatfish larvae were taken along the southern portion of the Bank, and none were seen in the samples examined from the Northeast Peak region. American plaice/yellowtail flounder were also caught in the Great South Channel area. Two American plaice were seen in the samples examined. This identification was based on the large sizes of the untransformed larvae. One specimen was collected at standard station 40 (size ~25mm SL), and one at standard station 38 (size ~28mm SL).

Cod (*Gadus morhua*) and Haddock (*Melanogrammus aeglefinnus*):
The catches of both cod and haddock larvae in the bongo samples were scattered, intermittent and low in numbers of individuals collected (Figures 11 and 12). An estimated total catch of 32 cod (size range 7-35mmSL) and 14 haddock (size range 8-28mm SL) were taken during this May survey of Georges Bank. The smaller cod larvae (<9mm SL) were collected at standard stations 11 and 69, and the smaller haddock larvae were found at standard station 22. Larval cod were collected at 11 stations and larval haddock were taken at nine stations during this survey. Most larval cod were found on both the Northeast Peak and the northwest and west-central portion of the Bank. Haddock larvae were mainly concentrated in the south-central to the southeast portion of the survey area.

Sand lance (*Ammodytes* sp.):

Sand lance catches were small and intermittent with an estimated 37 larvae collected at 13 stations during this cruise. Most of these winter spawned larvae have grown to a size where they are able to avoid the plankton samplers. The size range of the sand lance collected during this survey was between 18-43mm SL, with most larvae between 25-35mm SL. The majority of sand lance larvae were caught on the eastern portion of Georges Bank. A single specimen was also collected at standard station 4.

Cod/haddock eggs:
The collections of cod/haddock eggs during this cruise were both infrequent and low in abundance. There were small catches of gadoid eggs in the eastern portion of Georges Bank including the Northeast Peak area. There was an estimated catch of 100 eggs at standard station 32. These results indicate that the major spawning for these two species on Georges Bank had past its peak for 1998 season.

Miscellaneous Fish Larvae:

The following fish larvae were also identified in the ichthyoplankton samples collected during this broad-scale survey:

Sand lance (*Ammodytes* sp.)
Atlantic mackerel (*Scomber scombrus*)
Sculpin (*Myoxocephalus* sp.)
Redfish (*Sebastes* sp.)
Sea snail (*Liparis* sp.)
Pollock (*Pollachius virens*)
Hake (*Urophycis* sp.)

Preliminary Summary -- 10-m^2 MOCNESS samples.
Maria Casas and Stephen Brownell

The samples collected from the 10-m^2 MOCNESS were examined on shipboard for a qualitative estimate of abundance, distribution, and size range of both the invertebrate and the fish community at selected stations. The following observations are based on examination of the samples subsequent to preservation.

Station 3, Haul 1

naked pteropods, *Clione* spp.
ctenophores
hyperiid amphipods
cod

Station 4, Haul 2

Crangon
hyperiid amphipods
isopods
ctenophores
medusae
cod, eel, windowpane, American plaice

Station 7, Haul 3

hyperiid amphipods
ctenophores,
naked pteropods, *Clione* spp.
euphausiids
paralepidid post-larvae

Station 9, Haul 4

Crangon
ctenophores
hyperiid amphipods
isopods
cod
eel

Station 12, Haul 5

hydroid stalks
isopods
small crabs (~1-2 cm carapace)
medusae (between 1-3 cm bell diameter)
hyperiid amphipods
cod

Station 13, Haul 6

naked pteropods, *Clione* spp.
ctenophores
hydroid stalks
cod

Station 16, Haul 7

hyperiid amphipods
large shrimps
several squid (~2-3 cm)
euphausiids
myctophid
viper fish

Station 17, Haul 8

ctenophores
hyperiid amphipods
euphausiids
cod

Station 18, Haul 9

naked pteropods, *Clione* spp.
ctenophores
hyperiid amphipods
cod
eel

Station 20, Haul 10

branches of hydroids
naked pteropods, *Clione* spp.
ctenophores
medusae
shelled pteropods, *Limacina* spp.

Station 23, Haul 11

isopods
ctenophores
Crangon
shrimps (~3 cm)
naked pteropods, *Clione* spp.
hyperiid amphipods
cod
wolf fish

Station 25, Haul 12

ctenophores
hyperiid amphipods
several squid (~2-3 cm)
medusae

Station 27, Haul 14

Crangon
hydroid stalks
gammarid amphipods
isopods
naked pteropods, *Clione* spp.
cod
herring

Station 29, Haul 15

large shrimp (~5-7 cm)
1 large medusa (~5 cm)
naked pteropods, *Clione* spp.
hyperiid amphipods
small medusae
ctenophores
myctophid
paralepidid post-larvae

Station 30, Haul 16

hydroid stalks
ctenophores

Station 40, Haul 17

euphausiids
hyperiid amphipods
naked pteropods, *Clione* spp.
ctenophores
cod

Station 32, Haul 18

hydroid branches
euphausiids
1 nudibranch (~1cm)
eel

Station 34, Haul 19

euphausiids
large shrimp (~3-4 cm)
the shelled pteropod, *Limacina*
cod
eel
American plaice

Station 36, Haul 20

Crangon
isopods
ctenophores
cod
hake

Station 38, Haul 21

the shelled pteropod, *Limacina*
ctenophores
medusae
hyperiid amphipods
naked pteropods, *Clione* spp.
cod
American plaice

Microzooplankton Studies
Debra Piemonte and Matthew Beaton

The primary objective of this study is to characterize changes in the potential prey field for newly hatched cod larvae (Jan-June) with

respect to prey motility patterns and the prey size spectrum.

The goal during the survey of Georges Bank is to observe, record, and analyze the size spectra and motility patterns of microzooplankton species from three distinct pelagic zones on Georges Bank (near-bottom, the pycnocline region, and the well-mixed region of the photic zone) at all priority #1 and #2 broad-scale stations.

Water samples were obtained from Niskin bottles on a Neil Brown Mark V CTD at completion of each cast. Water was collected by siphoning from the top of the Niskin bottles, instead of using the available valve, in order to minimize zooplankton disruption. The samples were placed in 75 cm^2 tissue culture flasks that had been dipped into soapy water and allowed to air dry in order to prevent fogging. Immediately after the samples were collected, flasks were transferred to an incubator at 5 C. so that they were maintained at a constant low temperature.

Each flask, in turn, was placed in a holder across from a B/W high-res Pulnix camera fitted with a 50 mm macro lens and directly in front of a fiber optic ring illuminator fitted with a far-red filter. This apparatus was suspended within the incubator by a bungee cord to reduce vibrations produced by the ship. Recordings were made using a Panasonic AG1980 video recorder with SVHS formatted cassettes, a Panasonic TR-124MA video monitor, and a time code generator to record a period of 5 to 6 minutes for each sample. The field of view was calibrated for each new videotape by focusing on the front and back of the flask, and recording in the log the width and height of the field of view in the record book as well as the F-stop. Information was recorded on the video tape and in the log book including latitude and longitude, times of recording and preserving, station numbers and priorities and time of day.

Samples were collected from all Priority #1 stations, recorded, then preserved in 20 ml of 10% Lugol's solution. Water samples from priority #2 stations (with the exception of station #32) were recorded but not preserved. Samples from priority stations #3 and #4 were recorded intermittently but no samples were preserved. At station #32, no samples were collected and at station #4, no pycnocline sample was collected.

Post Cruise Processing:

Samples will be processed at Woods Hole Oceanogr. Inst. (S. Gallagher, P. Alatalo). Motility patterns will be analyzed with the Motion Analysis EV system. The final output will be particle size distribution and a motility spectra associated with each particle. This will be compared with species composition in the microzooplankton fraction preserved in Lugol's solution.

Calanus Life History Studies -
J. Crain, Oregon State University

We have been examining the differences between the gonads of *Calanus* C5's that are maturing versus preparing for diapause. *Calanus* juveniles which are preparing for diapause tend to have smaller, less developed gonads than those in the process of maturing directly into adults. In May of 1997, the first sampling of our gonad development series, small, undifferentiated gonads were typical among C5's examined. By contrast, in January of 1998, as the recently emerged resting stock of C5's was getting ready to molt into adults, nearly every individual sampled had a large, well-developed gonad, often with the oviducts easily distinguishable. Most of these animals were recognizably female, with a few gonads identified as possible testis. Observations of C5 gonads from the February and March cruises were virtually identical to those made in January.

On AL 98-06, *C. finmrchicus* is clearly the dominant zooplankton in the waters surrounding Georges Bank. The population is made up almost entirely of C5's, with adult females from the previous generation still numerous. Younger *Calanus* copepodites and adult males are present as well, but in smaller numbers. Many of the C5's were quite active still, indicating that widespread diapause was not yet beginning to set in, but many had large oil sacs and had a slower response to being touched than the others. Live sorting of subsamples from deep and shallow nets at standard stations 7, 9, 13, 18, 25, 29, 40, 34 and 38 yielded plenty of healthy C5s for gonad examinations. In most cases, detailed examinations of the developmental status and length of each animal's gonad were impossible due to the ship's vibration. Cursory observations revealed that although there was a significant proportion of C5's well into the process of maturation, most of the gonads were small undifferentiated rudiments enclosed in well-defined membranous structures resembling sacs. These "sacs" were approximately the same size and shape as large maturing gonads, and each animal needed to be examined carefully in order to differentiate between the two types. It is possible that the "rudiment-in-a-sac" gonad morphology is indicative of animals bound for diapause. As a cross-check of this hypothesis, approximately 100 C5's with gonads identified as diapause-bound, maturing or rudiment-in-a-sac were individually cryopreserved for a preliminary test of correlation's between gonad type and RNA:DNA ratio at the Durbin lab at URI.

On Globec Broad-scale survey OC 319, I continued to gather data on correlation's between gonad development, oil sac volume, and tooth phase in *Calanus finmarchicus* fifth copepodites. An image of each individual C5 examined was captured and oil sac volumes were calculated from areal measurements using image analysis software. Each animal was individually preserved in formalin for later verification of field observations of the gonads using differential interference contrast microscopy. Correlation's between gonad development and oil sac volume will be assessed with respect to relative age-within-stage, as evidenced by tooth phase.

I also continued to collect formalin-preserved subsamples from the 150 micron-mesh MOC-1 nets at all priority 1 and 2 stations for ongoing studies of jaw phase distributions and possible secondary environmental sex determination in *Calanus finmarchicus*. Ethanol-preserved subsamples were taken from MOC-1 net 5 at the same stations, to be used for molecular determination of the underlying genetic sex of individual Calanus.

Drifter Deployments

As part of the physical oceanographic studies of the current structure and circulation on Georges Bank being conducted by R. Beardsley and R. Limeburner, GLOBEC Drifter Buoys are deployed at strategic locations periodically throughout the year to track the Lagrangian flow from the point of deployment. On this cruise, a drifter was deployed at stations 26, 35, and 38.

Nutrients and Phytoplankton Studies

Keska Kemper and David W. Townsend
University of Maine

see also: [http://grampus.umeoce.maine.edu/globec/globec.html]

Overview:

We are collecting water samples on five of the six broad scale cruises in 1998 (February to June) to analyze for a suite of nutrients and phytoplankton biomass. During this cruise, water samples were collected for analyses of:

- *dissolved inorganic nutrients* (NO_3+NO_2, NH_4, SiO_4, PO_4);
- *particulate organic carbon and nitrogen;*
- *phytoplankton chlorophyll* a *and phaeophytin*, and
- *phytoplankton species composition*

Methods:

Water collections were made at various depths at all of the regular hydrographic stations (Stations 1 - 41) sampled during the May 1998 broad scale survey cruise aboard *R/V Albatross*, using the 1.7 liter Niskin bottles mounted on the rosette sampler. Additional near-surface water samples were collected at positions between the regular stations (Stations numbered >41) using a Kimmerer surface bottle.

Samples for dissolved inorganic nutrients (DIN) and chlorophyll were collected at all stations, 1-41, and at all the intermediate stations (near-surface). Water samples for DIN were filtered through 0.45 ?m Millipore cellulose acetate membrane filters, and the samples were frozen in 20ml polyethylene scintillation vials by first placing the vials in a seawater-ice bath for about 10 minutes. Samples will be analyzed on shore following the cruise using a Technicon II AutoAnalyzer. Samples for particulate organic carbon and nitrogen were collected by filtering 500 mls from 2 depths (2 and 20m) at each of the main stations onto pre-combusted, pre-ashed GF/F glass fiber filters, which were frozen for analysis ashore. The filters will be fumed with HCl to remove inorganic carbon, and analyzed using a Control Equipment Model 240-XA CHN analyzer (Parsons *et al.*, 1984).

Phytoplankton chlorophyll *a* and phaeopigments were measured at all stations (see Table 1) and determined fluorometrically (Parsons *et al.*, 1984). The extracted chlorophyll measurements involved collecting 100ml from bottle samples taken at various depths. Samples were filtered onto GF/F filters, extracted in 90% acetone in a freezer for at least 6 hours, and analyzed at sea using a Turner Model 10 fluorometer.

Samples for phytoplankton species composition were collected from the surface at stations 1-41 by preserving a volume of 125 mls in Lugol's solution. These samples will be available for analysis of the larger species using the Uttermohl inverted microscope method. It is anticipated that these samples, and those to be collected on the April and June cruises, will constitute a Master of Science thesis by Keska Kemper at the University of Maine.

Preliminary Results:

At this point, the only available data are chlorophyll a, phaeophytin (Table 1), and CTD data (D. Mountain). Generally, chlorophyll a concentrations were low over the entire bank. Chl a concentrations were lowest on the south-east edge of the bank. It appears that the spring bloom observed by D. Townsend in April on the top of the bank has long since ended. The highest chlorophyll a concentrations were found in the Great South Channel and along the NW flank of Georges Bank, however, we found no chlorophyll measurements were greater than 3.5 ug¸L^{-1}.

References:

Parsons, T.R., Y. Maita and C.M. Lalli. 1984. *A Manual of Chemical and Biological Methods for Seawater Analysis* . Pergamon, Oxford. 173 pp.

Table 1. Station positions and chlorophyll data.

Personnel List

Scientific Personnel

Name Title Organization

John R. Green Chief Scientist NOAA/NMFS, Narragansett, RI

Stephen Brownell Biol. Technician NOAA/NMFS, Narragansett, RI

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David Nelson Sci. Technician URI, Narragansett, RI

Matthew Beaton Volunteer WPI, Worcester, MA

Debra Piemonte Volunteer BU (grad), Boston, MA

R/V *Albatross IV* Personnel

Derek Sutton Commanding Officer

Jason Maddox Executive Officer

Scott Sirois Operations Officer

Kevin Cruse Chief Engineer

John Hurder First Engineer

Chuck Hersey Second Engineer

Richard Whitehead Chief Steward

Jerome Nelson Second Cook

Ernie Foster General Vessel Assistant

Tony Alvernaz Chief Bosun

Willie Amaro Skilled Fisherman

Jorge Barbosa Skilled Fisherman

Tony Viera Skilled Fisherman

Anthime Brunette Fisherman

Doug Roberts Fisherman

Henry Jenkins Electronics Technician