R/V ALBATROSS IV
AL9605
Cruise Report

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Purpose of the Cruise

The cruise aboard R/V ALBATROSS IV (ALB 9605, 6-17 May), was the fifth in a series of six broadscale surveys conducted monthly from January to June to monitor the changing biological and physical status in the Georges Bank ecosystem. These six broadscale surveys are part of the 1996 U.S. GLOBEC Georges Bank Program. The previous cruises for the 1996 field season are: EN-276 (Miller) from 10-22 January, EN-278 (Garrahan and Horgan) from 11-23 February, OC-275 (Wiebe) from 11-22 March and EN-282 (Sibunka), 8-20 April 1996. The principal objectives of the cruises were to:

1),,,,,,,,,,, determine the distribution and abundance of the ichthyoplankton and zooplankton community on the bank and in adjacent Gulf of Maine and slope waters., Emphasis is on target fish (eggs, larval and juvenile cod and haddock) and copepod species (all stages of *Calanus finmarchicus* and *Pseudocalanus* sp.) and their predators and prey.

2),,,,,,,,,,, provide systematic collections of larval and juvenile cod and haddock for age and growth estimates and feeding habits.

3),,,,,,,,, collect individuals of *Calanus* and the euphausiid, *Meganyctiphanes norvegica*, for population genetics studies.

4),,,,,,,,,,, conduct a hydrographic survey of the bank.

5),,,,,,,,, map the bank wide velocity field using an Acoustic Doppler Current Profiler (ADCP).

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

In order to obtain uniform bank-wide coverage, 39 predetermined "standard stations" and 61 "bongo stations" were scheduled for this survey.,, During the cruise 38 standard stations, and 26 bongo stations (standard station #1 & bongo station #50 were reoccupied at the end of the survey) were occupied.,, The entire bank was surveyed, including the portion in Canadian waters (Figure 1). Adverse weather conditions in mid- survey, and an interruptin due to an emergency, resulted in both a limited number of bongo stations occupied and changes in the survey plan concerning subsequent bongo station locations.

The 39 standard stations were assigned a priority code number (from 1-4) that corresponded to the equipment used on a given station. Priority stations assigned 1 or 2 were "full stations" with "high priority" , and stations assigned 3 or 4 were "partial stations" and designated "low priority".

At full stations an oblique plankton tow from surface to near bottom was made with a bongo sampler along with a real-time CTD attached to the towing wire. A large volume zooplankton pumping system was used to sample the water column., A Neil Brown Mark V CTD-fluorometer unit was used to characterize the water column. Niskin bottles attached to a rosette were used to collect water samples at selected depths for biological and chemical analysis.

Water samples were analyzed on shipboard for chlorophyll-*a* and phaeopigment concentrations. Samples for phytoplankton species identification, cell count, and spatial distribution will be analyzed ashore. Water was also drawn for salinity determination and $H_2{}^{18}O/H_2{}^{16}O$ isotope concentration analysis. A 1-m^2 MOCNESS (Multiple Opening Closing Net Environmental Sampling System) was towed obliquely from surface to near bottom cycling twice to make vertically stratified collections of zooplankton with both 335 mm mesh and 150 mm mesh nets, and to make collections of fish larvae with 335 mm mesh nets. A 10-m^2 MOCNESS fitted with 3.0-mm mesh nets was towed obliquely from surface to near bottom to make vertically stratified collections of larger predators on target species. At lower priority stations, a bongo tow, a Neil Brown Mark V CTD cast, and 1-m^2 MOCNESS tow were made. At bongo stations, a bongo sampler and real-time CTD were towed obliquely from surface to near bottom. At selected stations, the real-time CTD and a Niskin bottle cast were made for calibration purposes. Appendix 1 is a¸ summary of sampling events that occurred during this cruise.

The ship's ADCP unit was used to make continuous measurements of the water current profile under the ship, in order to construct the current field over the whole bank. These data will be used to help in the interpretation of all the other observations made on the cruise.

Cruise Narrative

In this section, reference made to station number refers to standard station number.

The R/V *ALBATROSS IV* departed Woods Hole MA, at 1738 hrs on 6 May 1996. After a brief delay for compass calibration in Vineyard Sound the ship proceeded to the first station approximately 7 hrs away.

7 May

Sampling at station 40 began at 0341 hrs. Operations proceeded smoothly through the first 3 stations until difficulty with the Mark V CTD was experienced at station 2. The order of gear deployment was changed and the MOC1 put over the side first to allow time to troubleshoot the CTD. However, some difficulty in communicating with the underwater unit occured as well as an inability to print data files from the MOC1. Problems with both gears were solved and the station completed. Problems also occurred with the the first deployment of the MOC10 at sta. 3. The net was set and retrieved several times after just going down the stern ramp, each time breaking communication with the deck unit. Problems with the cable were suspected and the tow aborted.

8 May

Problems with the MOC10 continued at the second scheduled deployment even though all of the connectorions and the cable were checked.¸ Again the operator was unable to maintain contact with the underwater unit during launch. At around 0800 the ship¸s ETs began the process of reterminating the cable but the work was not completed in time for the next scheduled deployment at sta 7. All other gear was working properly.

9 May

The next deployment of the MOC10 (at sta. 9) resulted in another aborted tow due to cable problems. A careful inspection of the sliprings finally turned up the problem, an intermittent grounding of a conductor as the winch drum rotated. The first successful deployment of the MOC10 was then completed at sta 11. A second successful deployment was made at sta 12. Sampling operations were broken off at 1830 to steam to Chatham to disembark the bosun.

10 May

Sampling operations resumed at 1805 but the weather was deteriorating. Sampling continued successfully but vessel steaming was slowed between stations to allow time to repair the MOC10 nets between stations.

11 May

The wind moderated sufficiently to continue work at the normal pace. However the surge from seas remained which was most visibly manifest in the number of repairs required to the MOC10. A bongo haul at sta 67 hit the bottom and sampled the benthos quite successfully but not the water column. A retow was made

12 May

The rising wind and poor weather forecast necessitated that in order to continue to maintain schedule that some of the bongo stations around the northeast peak of the bank be dropped . Conditions had deteriorated sufficiently by the end of the 1200-1800 watch that the third priority stations were dropped and only bongo samples were taken , the weather being too foul for deploying the MOC1, the pump or the CTD. A fathometer failure provoked another very successful benthic bongo sample at sta 76 making it possible to verify the charted bottom type as coarse sand.

13 May

The wind remained high (25-35kt) during the approach to sta 25 but the sea state had improved sufficiently to allow the deployment of the MOC1. The weather continued to moderate through the rest of the day so that by the time the ship reached sta 39 it was possible to deploy all of the sampling gear. The net bar release indicator failed at sta 25 and was never revived for the remainder of the cruise. Drifters were released at station 26 for D. Limeburner, Woods Hole Oceanographic Institution.

14-16 May

The weather continued to improve as the cruise track headed west along the northern edge of the bank. Evidence of the relatively high plankton biomass seen in the plankton nets was verified by the regular occurrence of whales sounding near the ship at sta 34.

The second set of drifters was deployed at sta 38 as were a series of additional ring net tows to sample Calanus finmachicus for rearing experiments at the Univ. RI. An attempt was made to locate Limacina for rearing at WHOI but no significant concentrations were found.

17 May

The *Albatross IV* returned to port in Woods Hole, Mass. at 0700.

Individual Reports

Hydrography

Dan Almgren and Elisabeth Broughton

The primary hydrographic data presented here were collected using a Neil Brown Mark V CTD instrument (MK5), which provides measurements of pressure, temperature, conductivity, fluorescence and light transmission. The MK5 records at a rate of 16 observations per second, and is equipped with Niskin bottles mounted on a rosette for collecting water samples at selected depths.

Bongo hauls were made at each of the stations occupied. A Seabird Electronics Seacat model 19 profiling instrument (SBE19 Profiler) was used on each bongo tow to provide depth information during the tow. Pressure, temperature, and salinity observations are recorded twice per second by the Profiler. When weather conditions were not suitable for the deployment of the MOC-1, a second bongo haul was made. When weather did not allow for the deployment of the MK5, the Profiler was used to collect hydrographic data for that station. These stations were numbered by incrementing the cast number by 100 to indicate the different source of these data.

The following is a list of data collected from all of the CTD sampling systems used on the cruise:

Instrument # Casts

MK5 33

MK5 salinity calibration 33

SBE19/Bongo 139

SBE19 salinity calibration 10

The MK5 was deployed with 6, 1.7 Liter Niskin bottles mounted on the rosette and seawater samples were collected for various investigators. On each MK5 cast, samples were collected for oxygen isotope analysis at selected depths for R. Houghton (Lamont Dougherty Geological Observatory) and a sample was taken at the bottom for calibrating the instrument's conductivity data. On stations which included pump operations, rosette samples for chlorophyll analysis were collected from the bottom, 20 meters, and the surface. Chlorophyll samples (three, 50 ml replicates) were filtered for three size fractions: total, < 20 microns, and < 5 microns. Total chlorophyll filtration results were also compared with the data from the MK5 fluorometer. Surface samples for phytoplankton species composition were collected for J. O'Reilly (NMFS) at the 16 "full" standard stations occupied during the survey. The chlorophyll analysis was conducted at sea using an acetone extraction method and results were read 24 hours later on a calibrated fluorometer.

Parameter # of samples taken

Oxygen isotope 118

Chlorophyll 46

Species Composition 16

Overall, we experienced very few problems with the hydro-graphic equipment during this survey. During several Profiler casts data spiking was observed. This was caused by a poorly taped boom wire termination. Another problem was the appearance of many bottle fire marker lines during several of the MK5 casts. The exact cause of this was unclear. Electronics technician Henry Jenkins suggested that radio electromagnetic interference caused by the ship's walkie talkies could be affecting the CTD computer. A noticeable flicker in the monitor screens is apparent whenever the walkie talkie talk button was pressed in the vicinity of the computer. Another possible cause is a malfunctioning gofire box or MKV deck unit.

Standard station 22 was not occupied during this survey. The Profiler was used to collect hydrographic data at standard stations 19, 20, 21, 23, 24, 25 when weather conditions were too rough for the safe deployment of the MK5.

DATA:

The SBE19 Profiler and the MK5 data were post-processed at sea. The Profiler data were processed using the Seabird manufactured software: DATCNV, ALIGNCTD, BINAVG, DERIVE, ASCIIOUT to produce 1 decibar averaged ascii files. The raw MK5 data files were processed using the manufacturer's software CTDPOST in order to identify bad data scans by "first differencing." The latter program flags any data where the difference between sequential scans of each variable exceed some preset limit. The "Smart Editor" within CTDPOST was then used to interpolate over the flagged values. The cleaned raw data were converted into pressure averaged, pressure centered 1 decibar files using algorithms provided by R. Millard of WHOI, which had been adapted for use with the MK5.

Figure 2 shows the locations of the standard stations occupied during the survey including the intermediate bongo stations. The surface and bottom temperature and salinity distributions are shown in Figures 3, 4. Surface and bottom anomalies of temperature and salinity as well as a stratification index (sigma-t difference from the surface to 30 meters) were calculated using the NMFS MARMAP hydrographic data set as a reference. The anomaly distributions are shown in figures 5-7. Profiles of each MK5 CTD cast

with a compressed listing of the data are available upon request.

The volume average temperature and salinity of the upper 30 meters were calculated for Georges Bank as a whole and for the four sub-regions shown in Figure 8. These values are compared with characteristic values that have been calculated from the MARMAP data set for the same areas and calendar days.¸ The volume of Georges Bank water (salinity < 34 psu) was also calculated and compared against the expected values.¸ Overall, the bank was found to be well mixed, colder (0.03¸ C to 0.3¸ C) and fresher (0.2 to 0.5 PSU) than expected for this time of year.

Zooplankton and Ichthyoplankton Studies based on Bongo tows, Plankton Pump, and MOCNESS tows.

John Sibunka, Maria Casas, Jack Green and Elaine Caldarone

Objectives:

1) using bongo and MOCNESS samplers, determine the composition and distribution of the larval fish community on Georges Bank, the factors that influence larval vertical distribution, and bank-wide versus "Patch-Study" mortality and growth rates.¸ Emphasis is on cod and haddock larvae, their predators and prey, feeding habits, and age and growth determinations.

2) determine the distribution, abundance, and stage composition of the target zooplankton species *Calanus finmarchicus* and *Pseudocalanus* spp. on Georges Bank, and identify and quantify the occurrence of the more abundant non-target species to describe the biological environment occupied by the target species.

3)¸¸ estimate recent growth and nutritional condition of cod and haddock larvae on Georges Bank, and provide larvae for related age and growth studies using otolith analysis.

¸4)¸¸ collect live *Calanus finmarchicus* (using a 1-meter plankton net) at standard station #38. These samples will be used for an ongoing experiment on molting rates being carried out by R. Campbell at the Univ. of Rhode Island, Graduate School of Oceanog¸raphy, Narragansett, RI.

5) collect the shelled pteropod, *Limacina* (using a 1-meter plankton net) for two ongoing experiments conducted by S. Gallager at Woods Hole Oceanographic Inst., Woods Hole, MA. The first is to study the vertical migration behavior of larval and adult pteropods, a study funded by the Office of Naval Research as part of the Young Investigators Award program. The second is to provide ground truth data for video plankton recorder studies on Georges Bank, a study funded by the National Science Foundation/ U.S. GLOBEC program.

6) take subsamples from 1-m^2 MOCNESS hauls for population genetic studies on *Pseudocalanus* spp. for A. Bucklin, Univ. New Hampshire.

7) collect and preserve phytoplankton at selected stations on Georges Bank to determine species composition and distribution, and to obtain a live sample of phytoplankton for studies subsequent to the cruise.

Methods:

Bongo tows were made with a 0.61-m frame fitted with paired 335 mm mesh nets. A 45 kg ball was attached beneath the bongo frame to depress the sampler. A digital flow meter was 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 tow of five minutes duration. A Seabird CTD was attached to the towing wire above the bongo to monitor sampling depth in real time mode and to measure and record temperature and salinity. After retrieval, the 335 mm mesh nets were each rinsed with seawater into a 335 mm mesh sieve. The contents of one sieve was preserved in 4% formalin for ichthyoplankton species composition, abundance and distribution analyses. The contents of the other sieve were preserved in 95% ethanol for age and growth analysis of cod and haddock larvae. The preservation procedure was the same as for the 1-m^2 MOCNESS.

A second 0.61-cm frame fitted with paired 505 mm mesh nets was also used at all stations. This frame was not fitted with flow meters. Tows were made according to standard MARMAP procedures, however, maximum sampling depth was to 80 m and wire payout and retrieval rates were 50 m/min and 10 m/min respectively. The contents of the 505 mm mesh nets were rinsed into a bucket and brought into the dry-lab for immediate sorting.¸ Most cod and all haddock larvae and juveniles found were frozen in liquid nitrogen for subsequent analysis of¸ DNA, RNA and protein content.

At stations where the 1-m^2 MOCNESS system could not be used due to adverse weather conditions, a second bongo tow was made.¸ This frame was fitted with both 335 mm mesh and 200 mm mesh nets. A digital flow meter was suspended in the mouth of each net to determine the volume of water filtered. Tows were made according to standard MARMAP procedures. 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 tow of five minutes duration. Upon completion of the tow, each net was rinsed with seawater into a corresponding mesh sieve. The sample from the 200 mm mesh net was retained for zooplankton species composition, abundance and distribution analyses, and preserved in 10% formalin.¸ The other sample from the 335 mm mesh net was kept for molecular, genetic, population analysis of the copepod, *C. finmarchicus*, 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.

The 1-m^2 MOCNESS sampler was fitted with ten nets. Nets 1-4 were fitted with 150 mm mesh for the collection of older and larger copepodite and adult stages of the zooplankton. Nets 0, and 5-9 were fitted with 335 mm mesh for zooplankton (nets 0 and 5) and ichthyoplankton (nets 6-9) collection. Tows were double oblique from the surface to within 10 m from the bottom. The maximum tow depths were 500 m for nets 0, 1 and 5, and 200 m for net 6. Winch rate for nets 0-5 was 15 m/min and for nets 6-9, 10 m/min. 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 1-4 were sieved through 150 mm

mesh, subsampled using a plankton splitter if the final volume was too large to fit appropriately in a quart jar, then preserved in 10% formalin.,, Samples from nets 0, 5-9 were sieved through 335 mm mesh and preserved in 95% ethanol. After 24 h of initial preservation, the alcohol was changed.

At selected sites, 90 ml subsamples from the bottom and surface 150 mm mesh nets were removed and preserved separately in formalin. Approximately 200 live C-5 *Calanus* copepodites from stations sampled during the cruise were frozen in liquid nitrogen for RNA/DNA analysis. Several hundred adult male and female *Calanus* from various stations were pretreated live for 2hr in a solution of colchicine, for chromosome analysis. These animals were then transferred to 0.075 molar potassium chloride for an hour, followed by fixing in 15 min rinses in 1:3 acetic alcohol and a final transfer to ethanol for analysis ashore. At priority 1 and 2 stations, 90 ml subsamples from nets 2, 3, and 4 were removed and preserved in 95% ethanol. These samples were collected for population genetic studies to distinguish between *Pseudocalanus* species (*P. moultoni* and *P. newmani*) found on Georges Bank.

The 10-m^2 MOCNESS was fitted with five 3.0 mm mesh nets., Tows were oblique from surface to ~10 m from bottom or a maximum depth of 300 m. The depth strata were the same as those sampled with the 1-m^2 MOCNESS. The winch rate for retrieval varied between 5 and 15 m/min depending on the depth stratum, 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 335mm mesh, and preserved in 10% formalin.

The samples collected at the GLOBEC broadscale standard and bongo stations for ichthyoplankton analysis from the bongo, 10-m and 1-m^2 MOCNESS (nets 6-9) nets were examined on shipboard for the presence of fish eggs and larvae to determine their occurrence on the Bank and obtain a qualitative estimate of distribution, abundance and size range. Bongo and 1-m^2 MOCNESS samples were examined visually in the jar after preservation.

A Pacer high-volume pump was used to collect nauplii and young, small copepodite stages of zooplankton. The intake hose was deployed off the port side by connecting the hose to a 1.7-L Niskin bottle cut in half lengthwise, and attached to the winch wire. A Seabird CTD was attached to the wire below the intake hose to monitor sampling depth during either adverse weather conditions or when a strong current was apparent on station. Two 45 kg weights were used to depress the array. Three 30-m sections of 7 cm diameter hose were connected to the pump, allowing the intake hose to attain a maximum depth of approximately 70 m., At shallow stations, the intake hose nozzle was lowered to 3-5 meters off the bottom. Three integrated depth samples were collected with 35 mm mesh nets, then sieved through a 30 mm mesh and preserved in 10% formalin. Sampling depths were from the maximum depth to 37 m, 37-12 m, and from 12 m to surface. Before samples were collected at maximum depth, water was diverted from going into the net and was allowed to flush for 60 s. This assured that the zooplankton from the desired stratum was obtained., The hose was again flushed at the surface for 60 s. This allowed the water to pass completely through the hose. Wire retrieval rate was approximately 4-5 m/min.

This rate was used to obtain a volume of 500 liters per 5-m depth interval sampled.

Tows for live specimens:

1) A 1-meter ring net fitted with a 335 mm mesh net and a 150 mm mesh collection bucket was used to collect live *Calanus finmarchicus* for shipboard experiments. Refer to the "Copepod Life History Studies" section of this report for at sea laboratory procedures. Net depression was obtained with a 45-kg weight. Tows were oblique from surface to 15 m , retrieval rate was 1m/min, vessel speed was 0.5 kts.

2) The above 1-meter ring net was also used to collect live of *Calanus finmarchicus* for experiments ashore. Depth of tows were determined after a visual observation of the 1-m^2 MOCNESS samples collected at the station, to determine at which depth the *Calanus* were most abundant. Tows were oblique and fished at maximum depth for five min., Winch rates were 10 m/min for payout and 10 m/min haulback. In order to collect the animals in good condition, the net was allowed to drift rather than be towed by the ship, thus vessel speed was minimal. The animals caught in the collection bucket were gently released into 30-gallon plastic trash cans previously filled with seawater using the Pac,er pump system., Water in this tank was kept cool by adding ice packs as needed. At the same time the shelled pteropods collected during this tow were placed in separate 30-gallon trash cans.

Phytoplankton samples:

Phytoplankton collections for species composition and distribution were made at selected stations on the bank. Tows were made with a 29-cm ring net fitted with a 20 mm mesh net., The net was fished at the surface for 3 min at a vessel speed of 1.5 kts. After the tow the net was rinsed with sea water and the sample preserved in 5% formalin. At station # 38, an additional tow was made for live phytoplankton. This sample was placed in a jar and kept cool in a refrigerator.

Zooplankton and Ichthyoplankton Samples:

Gear	Tows	Number of Samples
Bongo nets, 0.61-m: 335-mm mesh	66 tows	79 preserved, 5% formalin 91 preserved, EtOH
Bongo nets, 0.61-m: 505-mm mesh	66 tows	66 sorted
Bongo nets, 0.61-m: 505 & 200-mm mesh	4 tows	4 preserved, 10% formalin 4 preserved, EtOH
MOCNESS, 1-m^2: 150-mm mesh 335-mm mesh 335-mm mesh	35 tows	108 preserved, 10% formalin 35 preserved, 10% formalin 143 preserved, EtOH
MOCNESS, 10-m^2: 3.0-mm mesh	15 tows	49 preserved, 10% formalin
Pump: 35-mm mesh	16 profiles	47 preserved, 10% formalin
Ring net, 1-m: 335-mm mesh	8 tows	Live samples

Ring net, 29-cm: 20-mm mesh	5 tows	5 preserved, 5% formalin

Preliminary Summary - Zooplankton

Maria Casas, Pilar Heredia, and Alyce Jacquet

The samples collected using the finer mesh nets on the 1-m^2 MOCNESS were briefly examined on board in order to get a general idea of species composition, abundance, and distribution throughout the Bank. Following a brief summary is a station by station synopsis of the species encountered during this cruise.

In general, *Calanus finmarchicus* was encountered throughout the bank, with older stages making up the bulk of the biomass. However, very few adult females were seen at any of the standard stations occupied during the survey. The greatest concentrations of *Calanus* were found at stations 6 and 16 on the southern flank, stations 39 and 26 on the northeast peak, and at stations 31, 33, and 34 at the southern reaches of Franklin Basin bordering the northwest section of the bank.

Pseudocalanus occupied the bank at many of the stations. All stages were represented from nauplii to adult females, some carrying egg sacs. The bank crest had the greatest concentration of *Centropages hamatus* and some *C. typicus*, specifically stations 12, 19, and 32.

Hydroids constituted a major part of the plankton on the bank. They were seen at a majority of the stations in great numbers. Although phytoplankton such as *Coscinodiscus*, *Chaetoceros*, and *Phaeocystis* were present at some stations, they were not dominant in the plankton during this survey.

Summary of plankton species composition of 1-m^2 MOCNESS samples collected during AL9605. Not every standard station that was sampled is described in this summary.

Station 1

Hydroids were dominant at this station together with the shelled pteropod *Limacina*, the chaetognath *Sagitta elegans*, and juvenile brittle stars--even in the surface net. All stages of *Pseudocalanus* spp. seemed to be abundant. Other copepods present were *Calanus finmarchicus*, *Centropages hamatus*, *Temora longicornis*, *Metridia lucens*, and *Candacia armata*.

Station 2

Hydroids were again numerous at this station together with the diatom *Coscinodiscus*, many small medusae, and some chaetognaths. *Calanus*, the most abundant copepod, was dominated mostly by older stages and a few females. *Pseudocalanus* was also very abundant. Present in lesser numbers were *Metridia* spp., *C. hamatus* and *Oithona* spp.

Station 4

Again hydroids were in abundance at this station together with a fair number of small medusae, chaetognaths, bivalve larvae, and polychaetes. *Pseudocalanus* was in abundance including adult females with egg sacs attached. Older stages of *Calanus* were also present. Crab zoea were seen.

Station 5

Very few hydroids were seen but bivalve larvae were extremely numerous. A few shelled pteropods were observed but the quantities were not as great as in the previous cruise on EN282 in April. Chaetognaths were present in low numbers. Many copepod nauplii were in the samples. Copepods were represented by *Pseudocalanus*, including adult females, and *Calanus*, all stages.

Station 6

Many *Calanus* were in the nets, mostly older stages, with a few adult females. *Pseudocalanus* was in abundance including many adult females. Other copepods were represented by *Oithona*, *Metridia*, and *C. hamatus*. Hydroids were absent from this station. However, gastropod larvae were very abundant. There were also a few euphausiids and hyperiid amphipods in the samples.

Station 7

The sample consisted of *Metridia lucens*, *Calanus* (mostly C4 and C5, and a few adult females), and *Pseudocalanus*, and also some *Oithona*, *Clausocalanus* spp., young *Centropages*, and *Euchaeta* spp.

Station 9

All stages of *Calanus*, from C2 to adults were present. C5 was the most abundant while C6 females were rare. All stages of *Pseudocalanus* including adults were abundant. Other species encountered were *Centropages*, *Metridia*, and *Calanus*.

Station 10

Hydroids were back in abundance, with some *Coscinodiscus* and *Phaeocystis*. Older stages of *Calanus* were present, but few females. *Pseudocalanus* was abundant with a mix of stages, including adult females. *C. hamatus* was also present. Many small medusae were mixed in with the hydroids.

Station 12

Very abundant hydroids. Great quantities of small medusae, a moderate amount of juvenile bivalves and euphausiids were present.

The copepods seemed to be dominated by *C. hamatus*. *Calanus* and *Pseudocalanus* were also present, mostly older stages in both cases. A fair number of adult female *Pseudocalanus* were in the sample.

Station 14

Many hyperiid amphipods were at this station, and hydroids. *Calanus* was abundant mostly in the C4 and C5 stages. *Pseudocalanus* was also abundant, including adult females. A lot of small copepods and nauplii were also in the sample, such as *Clausocalanus* spp.

Station 15

The samples were completely pink due to the abundance of *Calanus*, mostly older stages and quite a few males. Moderate amounts of *Metridia* and *Pseudocalanus* were also present. Again the smaller components of copepods were present in the form of *Clausocalanus*, *Microcalanus*, *Paracalanus*, and nauplii. A lack of hydroids was noticeable. Some pteropods and gastropod larvae were also present.

Station 16

Calanus was most prominent at this station, mostly C5. Additional species observed were *Rhincalanus* spp., *Euchaeta* spp., *Metridia* spp., and *C. hyperboreus*.

Station 17

The same species composition was at this station as at the prior one. Younger stages of *Calanus* were in the sample, as well as many adult male. *Pseudocalanus* was also encountered with many adult females.

Station 18

Hydroids were present, as well as numerous gastropods and pteropods, and small medusae. *Calanus* were again abundant, older stages and many adult males. Younger stages of *Pseudocalanus*, C1, C2, and nauplii represented a large portion of the sample, as well as females. In addition mysids and chaetognaths were seen.

Station 19

Hydroids were present in enormous quantities. Fewer *Calanus* were at this station, but again a lot of adult males were present. *Centropages* and *Pseudocalanus* were most abundant. *Metridia* was also present.

Station 20, 21, and 23

The hydroids were absent from these samples, but quite a few gastropods were present. *Calanus* and *Pseudocalanus* continued to be dominant, mostly older stages of the former and mostly younger stages of the latter including nauplii. *Oithona* was also prevalent.

Station 24

The dinoflagellate, *Ceratium*, made up large masses in the sample. Older stages of *Calanus* were most abundant, and while *Pseudocalanus* was also present, the proportion was not as great as in the previous stations. Young *Oithona* and young *Temora* were also present in small numbers.

Station 39

This was a homogeneous sample of *Calanus* from C3 to adults, with C5 being most common. Also present were *C. hyperboreus*, and *Pseudocalanus* including adult females.

Station 26

This station was again almost all *Calanus*, mostly stage C5. There were also young stages of *Pseudocalanus*, together with females, some with egg sacs attached. Other copepods consisted of *Oithona*. In addition, siphonophores and brittle stars were present.

Station 27

Hydroids were present, together with some pteropods and chaetognaths. *Calanus* and *Pseudocalanus* were the dominant copepods. Mostly older stages of both species made up the bulk of the biomass.

Station 30

Many hydroids, small medusae, and the diatom, *Chaetoceros*,, were at this station, together with moderate amounts of pteropods and *Coscinodiscus*. Younger stages of *Calanus* were observed, as well as, a moderate amount of *C. hamatus* (younger stages), and a few *Pseudocalanus*. Overall zooplankton were not numerous.

Station 31

A clean sample. Absent were the hydroids and the phytoplankton present at other stations. Instead many hyperiid amphipods were present. A great abundance of *Calanus*, mostly all older stages, and a moderate amount of *Metridia* were in the sample. Also in the sample were moderate numbers of *Oithona* and *Pseudocalanus*, and small amounts of *C. typicus* and *Temora*. As seen last month in April on EN282 at several stations, a great number of molts were at this station.

Station 32

Most abundant at this station were *C. hamatus*, *C. typicus*, and *Temora longicornis*. Present but not in great numbers were *Calanus* from C3 to C5. Some hydroids were observed at this station.

Station 33

A clean sample containing *Calanus* only, with stages ranging from C2-C5. There were very few hydroids.

Station 34

Station 34 was similar to station 33, although more adult female *Calanus* were seen at this station than in the previous one. Also moderate amounts of *Metridia*, mostly older stages, were present. A few *Pseudocalanus*, many *Clausocalanus*, and some *Oithona* were also in the sample.

Station 35

This station was a mix of *Calanus finmarchicus* and small amounts of *C. hyperboreus*. Also *C. hamatus* and *C. typicus* were present together with *Pseudocalanus* (young and adults) and *Temora*.

Station 36

The phytoplankton at this station consisted mostly of *Coscinodiscus*. The zooplankton composition was similar to the previous station.

Station 37

Hydroids were again dominant together with some *Chaetoceros* and *Coscinodiscus*. Shrimps, chaetognaths, bivalve larvae and small medusae were also in the samples. The copepod portion of the plankton was made up of *Calanus*, *C. hamatus*, *Pseudocalanus*, and *Temora*.

Preliminary Summary - Ichthyoplankton

Antonie Chute, Rebecca Jones, Jack Green, John Sibunka and Alyse Weiner

The samples collected at the GLOBEC broadscale ¸standard¸ and ¸bongo¸ stations from the bongo, 10-m^2 and 1-m^2 MOCNESS (nets 6-9) nets were examined on shipboard for the presence of fish eggs and larvae to obtain a qualitative estimate of abundance, distribution, and size range of ichthyoplankton on Georges Bank. The following observations are based on examination of bongo and 1-m^2 MOCNESS samples in the jars following preservation.

Cod (*Gadus Morhua*) and Haddock (*Melanogrammus aeglefinus*): Bongo and 1-m^2 MOCNESS sample jars rarely contained more than four or five larvae--catches were light. The cod larvae occurred¸ in two size classes: less than or greater than 15mm total length. In the larger class, most were longer than 20mm. The small larvae (size range 6-15mm) were found on the southwest part of the bank, whereas the larger larvae (size range 16-35mm) were found on both the northeast peak / northern edge of the bank, and in an area overlapping but slightly northward of the patch of smaller larvae (i.e. in general, the larger cod were found to the north of the smaller). Small numbers of haddock were found sporadically (at only four stations), and all of them were 10mm or less in total length. Catches of these small haddock occurred in the same general region as the smaller size class of cod larvae.

Sand Lance (*Ammodytes* sp.): Sand lance catches were light, although most appeared large enough to allow them to escape an approaching net. The only sand lance larvae less than 20mm in length found in the samples were at station 24 on the northeast peak. The rest of the sand lance found ranged from 20 to 60mm and were generally located over the middle of the bank, along the edge of the shoals.

Atlantic Herring (*Clupea harengus*): Three herring larvae 50mm in length were seen in samples from station 27. Herring spawning season is all but over and these three larvae may have been among the last of the season.

Sculpins (*Myoxocephalus* sp.): The sculpin larvae, like the sand lance larvae, were concentrated on the northern portion of the shoaler areas at stations away from the edge of the bank. There were rarely more than 2 larvae seen in a sample, with larval lengths ranging from 7 to 20mm.

Fish eggs: In contrast to the concentration of gadid-sized eggs observed on the northeast peak earlier this year at the start of the cod spawning season, the cod, haddock, and pollock eggs observed in the samples¸ during this cruise were widespread over the bank and low in abundance (i.e. eggs were found at stations all over the bank, but generally only a few per sample).

Miscellaneous larvae - The following larvae were also identified in the ichthyoplankton samples:

Rock gunnell (*Pholis gunnellus*)

Plaice (*Hippoglossoides platessoides*)

Paralepidids

Myctophids

Redfish (*Sebastes* sp.)

Preliminary Summary - Biochemistry

E. Caldarone, K. Lindner

Bongo tows for larval cod and haddock were conducted at 66 GLOBEC broadscale standard stations as previously described in the methods section. The contents of both 505 µm mesh bongo nets were immediately wet-sorted in chilled sorting trays. Individual cod and haddock were collected, videotaped, and placed in liquid nitrogen. When more then 30 cod were collected, a subsample of 30 was kept for biochemical analysis.¸ The RNA, DNA, and protein content, and length of each fish will be analyzed ashore to determine the growth rate and nutritional condition of the larvae.

More than 223 cod were caught at 37 stations (Table 1).¸ A plot of the larval and juvenile cod collected is shown in Figure 9. The majority of the larval cod were found on the southern and western portion of the bank between the 60 and 100 meter isobaths. Juvenile cod were collected on the northern edge and northeast peak.¸ Fifty-three larval haddock were collected at 14 stations (Table 1). Haddock abundance was highest along the southern flank (Figure 10).¸¸¸

Table 1 .¸¸ Number of larval and juvenile cod and haddock collected in 505 mm mesh bongo nets at the standard broadscale stations.¸ Stations are listed in the order in which they were occupied during the cruise (n = number of larvae per tow).

Standard Station #	Cod (n)	Haddock (n)		Standard Station #	Cod (n)	Haddock (n)
40	6	0		69	0	0
1	4	1		17	0	0
50	18	0		71	0	0
2	11	0		18	0	0
44	7	8		72	0	1
45	0	0		73	1	0
3	7	15		74	1	0
49	1	0		19	1	0
4	6	0		76	0	0
5	5	1		20	0	0
52	1	1		21	0	0
6	5	0		23	0	0
54	0	0		24	0	0
55	0	1		25	0	0
7	0	0		39	1	0
57	0	0		26	0	0
8	0	8		27	1	0
58	1	6		28	0	0
9	1	0		29	0	0
59	4	1		30	1	0
10	61	8		31	0	0
60	1	0		32	1	0
11	2	0		33	3	0
61	0	0		34	3	0
12	3	1		35	1	0
63	0	0		36	3	0
13	0	0		98	2	0
64	2	1		99	13	0
14	1	0		37	7	0
66	1	1		100	9	0
67	0	0		38	5	0
15	0	0		50	16	0
16	0	0		1	6	0

Copepod Life History Studies

Jennifer Crain, Charles B. Miller, Oregon State University

The Oregon State University (OSU) project in the GLOBEC Georges Bank Broadscale program to examine the life history patterns of *Calanus finmarchicus* and *Pseudocalanus* spp. currently has three components, all concerned with *Calanus*, pending improved ability to identify *Pseudocalanus*.

(1) We are examining the frequency and environmental correlates of the male to female sex change which occurs at maturation. The signature of females resulting from this change is a male setal pattern on the first antenna. Preserved subsamples from the deep and surface 150 ¸m nets on the 1 m^2 MOCNESS are used for determining frequencies of this pattern in females from different depths, stations and months. On the AL9605 cruise, several hundred adult female and male Calanus from 6 stations were pretreated in colchicine and potassium chloride prior to fixation in acetic alcohol for chromosome preparation in the lab. Our hope is that we will be able to identify sex chromosomes in cells taken from the gonads of these animals and correlate genetic maleness with the quadrithek antennal morphology.

(2) Jaw facies of fourth and fifth copepodites are used to examine the fractions of *Calanus* stocks that are A) entering the copepodite resting stage typical of this species, and B) preparing for immediate maturation.¸ Copepodites of the A group retain the postmolt facies, a large hemocoele extension into the mandibular gnathobase, which looks like a bubble. Copepodites of the B group quickly loose this 'bubble'. Thirty five subsamples from 17 stations were collected for tasks (1) and (2) on AL9605. In addition, three

repetitions of a molt experiment also performed on the previous cruise were conducted to confirm, specifically for *C. finmarchicus*, that the bubble disappears quickly in animals headed for immediate advance to the next stage. ¸In the expectation that virtually all C4 at this season will be advancing to C5, 12 groups of 3 C3 were held in 125 ml of water at sea surface temperature for 48 hours. The animals were kept covered with dark plastic and fed an ample amount of phytoplankton, Tetraselmus laevis and Heterocapsa triquetry. They were examined at approximately 2 hour intervals for newly molted C4, which were preserved after increasing intervals of 0, 2, 4 , 8, 14, 16, and 30 hours. Individuals were separately preserved for examination of mandibular gnathobases ashore. In an attempt to correlate the jaw facies with RNA/DNA determinations of diapause phase, jaws were dissected from 80 individual fifth copepodites aboard ship. The jaws were individually preserved in formalin for later examination under higher magnification, and the bodies were cryopreserved for RNA/DNA analysis.

(3) We are studying the large store of oily wax which *C. finmarchicus* secretes into a tubular sac in the prosome of the fifth copepodite stage (C5), prior to either maturation or rest. Actually all copepodite stages have such sacs and accumulate some oil. The question under study in 1996 is the areal and seasonal variation in quantities of oil in C5. Oil is quantified by an integration of oil sac projected area in video pictures and approximate conversion to oil volume. On AL9605, sets of video recordings were taken at 10 stations scattered all along the track around the bank. Most of those stations produced photos for 150 individual C5 selected in as close to random fashion as could be arranged. All individuals with even slight graying of tissue were rejected, as were individuals with no residual swimming ability.¸ This is because death often results from breaking of the body wall, which is often accompanied by oil extrusion.¸ Animals from which oil has been extruded show no obvious sign of it, except that they tend to die ahead of uninjured animals. Death is preceded by 'graying out.' Given clear tissue and some swimming capability, animals were grabbed, in so far as possible in the order encountered, with forceps by the antennule.¸ Of course, many jumped away and could not be individually identified again. Thus, true random sampling is not achieved. There may be some bias against the very smallest C5's, which can be confused with the very largest C4's. However, we have no feeling that strong biases are present in the sampling.¸ Fifth copepodites are recorded in groups of five. Additional images of individuals dissected for jaw and RNA/DNA analyses were captured at higher magnification for the purposes of correlation with diapause condition and to add to our knowledge of oil sac shape in order to refine our calculations of sac volume from area measurements.

Calanus finmarchicus was the dominant copepod everywhere on Georges Bank during May, 1996. Few adults were seen at any of the stations subsampled, with the predominant stages being C4 and C5 everywhere. Earlier stages were also seen, especially on or at the edges of the bank. The only station at which *Pseudocalanus* was abundant was station 26. Preliminary impressions were that C5 oil sacs were already quite full everywhere, as they were on the prevoius cruise, with particularly fat individuals widespread in the deeper layers. Variation in oil quantity was greater in C4's and in C5's up over the bank, where sacs could be just a thin line or quite a large tube. The main contrast is between this cruise and the January cruise, when the residual stock of C5's at the end of the rest phase had relatively little remaining oil. It is also possible, however, that the C5's of January were newly produced by advance from the rest stock of C4's, having relatively little oil as a result of the size of the individual's original store, rather than because of metabolic reduction.¸ These hypotheses can be tested.

Genetic Studies.

Genetic studies are essential for understanding variations in the winter production of zooplankton on Georges Bank, identifying the sources of the target species *Calanus finmarchicus* and *Pseudocalanus* sp., as well as the spring zooplankton bloom. ¸*Calanus* and *Pseudocalanus* are believed to come onto the bank from the Gulf of Maine, Gulf of St. Lawrence, Scotian Shelf, and possibility the Slope Water. However, it is impossible to determine through the morphology of the individuals where zooplankton currently found on the bank originated.¸ Population genetics studies of *Calanus, Pseudocalanus*, and several other species (e.g. the euphausiid, *Meganyctiphanes norvegica*) are being conducted at the University of New Hampshire by A. Bucklin. This in an effort to identify viable genes to characterize dispersal patterns and to provide a genetic basis upon which to gauge Bank production as a function of recruitment of source populations. An attempt is being made to distinguish between the morphologically similar *Pseudocalanus* species found year round on the bank (ie. *molutoni* and *newmani*) as well as a genetic based analysis of their circulation patterns and dispersal pathways on the bank. The work mentioned above is tied directly to other efforts to identify water sources and losses for the Bank, as well as circulation and exchange processes across the bank boundaries. On this cruise, samples were collected at every station for genetic studies with net #5 on the 1-m^2 MOCNESS, except in the occurrence of adverse weather when a bongo tow with a 335 mm mesh net was substituted. At selected stations, 90 ml subsamples were taken from the bottom and surface 1-m^2 MOCNESS with 150-mm mesh nets.

All samples were preserved in 95% ethyl alcohol which was changed 24 hours after the samples were collected.

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. This drifter is constructed with a holey sock drogue (a Dacron cylinder 90 cm diameter by 3 m tall with 5 circular hoop stays) at the bottom connected by either a 10 m or a 40 m cable to a small float (18 cm diameter) which in turn is connected by about 2.6 m of cable to a larger spherical surface float (about 32 cm diameter). The surface float contains a sea surface temperature sensor, a GPS receiver, and an ARGOS satellite transmitter. Temperature, time, and position data are transmitted periodically to shore through the ARGOS telemetry system. On this cruise two drifters (drogued at 10 m and 40 m) per station were deployed at standard stations 26 and 38.

Shipboard ADCP (Acoustic Doppler Current Profiler) Measurements.

The flow field over Georges Bank is driven by a complex set of forces. A primary factor is the strong semidiurnal tides which dominate the high frequency variability (<1cpd) of the currents. Tidal rectification gives rise to a persistent subinertial clockwise circulation over the bank. This circulation process can be substantially modified by the frequent storms common to the area, changes in the stratification of the bank. and interactions with currents generated by offshore circulation features (i.e. warm-core rings).

The Acoustic Doppler Current Profiler is one of the instruments being used to study the circulation process on the bank by J. Candela and C. Flagg. Water current measurements were obtained using a 150 kHz RDI ADCP continuously during the entire cruise. The transducers were mounted on the hull of the ship (5 m below the surface with a heading offset (OH) of -1.5¸). The instrument was programmed to measure the current profile under the ship with a vertical resolution of 2 m, from 10 m depth to about 10 m from the

bottom or up to a depth of about 120 m, which ever was shallower at a given location. The current profiles were generated by 60 s data averages. Transformation to geographical North and East current components was performed using real time gyro information fed into the ADCP from the ship's navigation instrumentation.¸ Also fed to the instrument was real time GPS positioning which was stored directly in the minute average profile data files. The ADCP measures currents with respect to the ship. To obtain the water current with respect to the ocean bottom, the ship's motion needs to be removed from the current observations. The ship's motion will be removed using the bottom track (BT) velocity measured by the ADCP. Depending upon sea conditions, the ADCP can perform this operation in depths shallower than 200 to 230 m. When the BT is lost, accurate navigation will be used to remove the ship's velocity from the current.

The ADCP data collected on this cruise will be post-processed at Woods Hole Oceanographic Institution by Candela and Flagg.

Personnel List

Scientific Personnel

Name	**Title**	**Organization**
John R. Green	Chief Scientist	NOAA/NMFS, Narragansett, RI
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***Albatross IV* Personnel**

Gary Bulmer	Commanding Officer
Derek Sutton	Executive Officer
Denise Gruccio	Operations Officer
Joel Michalski	Navigation Officer
Kevin Cruse	Chief Mechanical Engineer
John Hurder	First Assistant Engineer
Chuck Hersey	Second Assistant Engineer
Larry Jackson	Third Assistant Engineer
Royce Folks	General Vessel Assistant
Orlando Thompson	Junior Engineer
Kenny Rondeau	Chief Bosun
Willy Amaro	Lead Fisherman
Gene Magan	Skilled Fisherman
John Cravo	Skilled Fisherman
Anthime Brunette	Skilled Fisherman

Tony Alvernaz ,,,,,,,,,,,, Skilled Fisherman

Richard Whitehead,,,,,,,,,,,, Chief Steward

Jerome Nelson,,,,,,,,,,,, Chief Cook

Doug Roberts,,,,,,,,,,,, General Vessel Assistant

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Henry Jenkins,,,,,,,,,,,, Electronics Technician

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