JR230

Rothera to Rothera

2009

cruise report

benthic - pelagic coupling cruise

Cruise report *JR230* **RRS *James Clark Ross***

Marguerite Bay to shelf break, West Antarctic Peninsula, *December 2009*

Connectivity from surface to seabed life in Antarctica's barometer of rapid change on Planet Earth

British Antarctic Survey, Natural Environment Research Council, Madingley Rd, Cambridge, UK

Contents

1. Summary

Along the West Antarctic Peninsula (WAP) air and sea temperatures and glacial retreat are rapidly accelerating and sea ice is rapidly decreasing in area and duration – the East Bellingshausen Sea is a global hotspot of change. Experimental work suggests animals there may be amongst the most sensitive on the planet and that collapsing ice-shelves in the region are giving rise to new phytoplankton blooms generating complex feedback to climate change. The WAP region can be viewed as amongst the best places for understanding climate change and life's response. Although WAP surface waters are changing very rapidly, those underneath (Circumpolar Deep Water) are likely to be amongst the more slowly altering – yet many species are thought to habit both. During the JR230 cruise with RRS James Clark Ross expertise from seven countries has been pulled together to assess coupling and biodiversity from sea surface to sea bed, microbes to megafauna and across 1-km to hundreds of km scale; it is the first British Antarctic Survey (BAS) to attempt this. In doing so we intended to link several programmes and work packages of science in the Polar Science for Planet Earth programme of BAS and significantly contribute to knowledge of the interaction between the water column and seabed, understanding of Southern Ocean biodiversity structure and Census of Antarctic Marine Life (CAML). Our sample design spanned the inner shelf of Marguerite Bay to the shelf break, used multiple apparatus types and will feed the species collected into a network of experts spanning the planet. Although the pelagic, bacteria and benthic teams have each taken part in many Southern Ocean cruises prior to this expedition, there were still some significant differences and striking surprises amongst the organisms we found, which have been recorded by a professional photographer who joined the voyage. We sampled four complete areas, each consisting of a number of sites sampled by Agassiz trawl (AGT), epibenthic sledge (EBS), box core, Conductivity Temperature Depth (CTD), Bongo and N70 nets, Rectangular-Midwater-Trawl (RMT) 8+1 nets as well as acoustics. It will take many months and years before the full results, successes and conclusions can be drawn from this expedition but already it is clear that the plan, deployments, international and bentho-pelagic collaborations were all successful and the material collected will prove highly useful to many avenues of science.

2. List of personnel

2.1 Scientific and technical

D.K.A. Barnes	BAS	Chief Scientist
V. Afanasyev	BAS	AME (Electronic engineer)
P. Bucktrout	BAS	Photographer
P. Enderlein	BAS	Pelagic biologist and engineer
N. Ensor	BAS	Equipment support
S. Fielding	BAS	Acoustician
A. Janosik	Auburn Uni	Molecular ecologist
M.L. Jimenez	UNIS	Bacterial biologist
S.S.M. Kaiser	UHH	Benthic biologist
B. Korb	BAS	Phytoplankton biologist
D. Pearce	BAS	Bacterial biologist
J. Robst	BAS	ICT (Computing engineer)
C.J. Sands	BAS	Molecular ecologist
T. Saucède	Bourgogne Uni	Benthic biologist
T. Souster	BAS	Rothera Marine biological assistant
G. Stowasser	BAS	Trophic biologist
P. Ward	BAS	Pelagic biologist
J. Watkins	BAS	Science programme co-ordinator

BAS = British Antarctic survey, AME = Antarctic and marine engineering section, UNIS = University of Svalbard, Norway, UHH = University of Hamburg, Germany, ICT = Information communications technology section.

2.2 Ship's compliment

R.G.P. Chapman	Master	A.C. Campbell	SG1
R.C. Paterson	Ch Off	C. Mullaney	SG1
K. Dalvi	2nd Off	C.J Leggett	SG1
B.J. Du Feu	3rd Off	J.P. O'Duffy	SG1
J. Summers	Dk Off	J.F. Mcilhatton	SG1
C.A. Waddicor	ETO (Coms)	M.A. Robinshaw	MG1
J. Boswell	Cadet	C.J. Moore	MG1
D.M. Forward	Ch Eng	K.A.Walker	Cook
G. Collard	2nd Eng	G.R. Ballard	2nd Cook
J.C. Ditchfield	3rd Eng	K. Weston	Sr Stwd
S.J. Eadie	4th Eng	J. Newall	Stwd
S.A. Wright	Deck Eng	D.W. Lee	Stwd
G. Wales	Deck Eng	C. Motte	Stwd
N.J. Dunbar	ETO (Eng)		
J.S. Gibson	Purser		
J.M. Gregory	Doctor		
G.M. Stewart	Bosun		
D.G. Jenkins	Bosun's Mate		

3. Timetable of events

1st Dec –	Mobilisation
2nd Dec –	Leave Rothera Research Station wharf Emergency drills Reach research area A (Marguerite Bay) First deployments of apparatus
3rd Dec –	Trouble shooting with problem apparatus Successful completion of research at area A Planning of second target area Reach research area C (mid shelf)
4th Dec –	Deployments at Research area C Successful completion of research at area C Planning of third target area
5th Dec –	Reach research area D (shelf break) Deployments at Research area D
6th Dec –	Successful completion of research at area D Planning of fourth target area Arrival at research area E (shelf break) Abandonment of research at area E (due to ice)
7th Dec –	Arrival at research area B (mid shelf) Deployments at Research area B Abandonment of towed gear research at area B Re-planning of fourth target area
8th Dec –	Arrival at research area G Deployments at Research area G
9th Dec –	SWATH new sites during storm Deployments at Research area G
10th Dec –	Successful completion of research at area G Acoustic calibrations Visit to Horseshoe Island
11th Dec –	Arrival at Rothera Research Station wharf Disembarkation and consignment of samples

4. Introduction

David Barnes

In Antarctica one science cruise can make a big difference to biological knowledge and understanding. The Southern Ocean around Antarctica has, despite whaling, sealing and fisheries, been the least human influenced part of our planet. Levels of pollution, habitat alteration, seabed trawling and alien (non-indigenous species) infestation must be amongst the lowest anywhere – for example, it is the only environment where no known marine animal invaders have established. However studying it is hampered by recent rapid and diverse physical changes associated with rises in atmospheric CO_2 and how poor our baseline knowledge is.

We know almost nothing of abyssal life around Antarctica and very little about the continental slope. Shelf depths (mostly >800 m) are best known in the marine environment, yet that of the Amundsen Sea is comparable in size to the Mediterranean and was unsampled until 2008. The shore (intertidal) zone has been little studied and was assumed to be virtually denuded of fauna and on land, where most biological research has been undertaken, most ice-free sites are still yet to be visited. What little we do know of these environments has tended to stay strongly partitioned by environments because few biologists work across environments. Thus, for more than a century research in the water column and seabed around Antarctica has involved little exchange of ideas, knowledge or understanding. Increasingly it is becoming apparent that there is much important connectivity; key components of pelagos seem to feed on the seabed more than was suspected, some benthos record particular aspects of water column phytoplankton productivity very well and the contribution of benthos to meroplankton had been underestimated (until recently most benthos were considered to obey Thorson's rule which suggested [among other things] that pelagic larvae were rarer at high latitudes).

The British Antarctic Survey has been undertaking marine biological cruises for more than three decades focussed on water column productivity, particularly by krill. In the 1990s benthic cruises began, at first involving sampling at just SCUBA depths (0-30 m) then in 2006 across continental shelf and slope depths using towed apparatus. The current cruise, JR230, is the first attempt (by British Antarctic Survey) to look at water column to seabed assemblages in the same place at the same time. We planned to sample six areas (see figure 1) with the main purposes of:

1) Assessing key links between pelagos and underlying benthos (bentho-pelagic coupling).
2) Examining variability of benthic and pelagic richness across taxonomic and spatial scales.
3) Assessing the importance at typical shelf depths of key model species in the shallows.
4) Filling in a biogeographic 'gap' between previous Scotia and Amundsen benthic cruises.

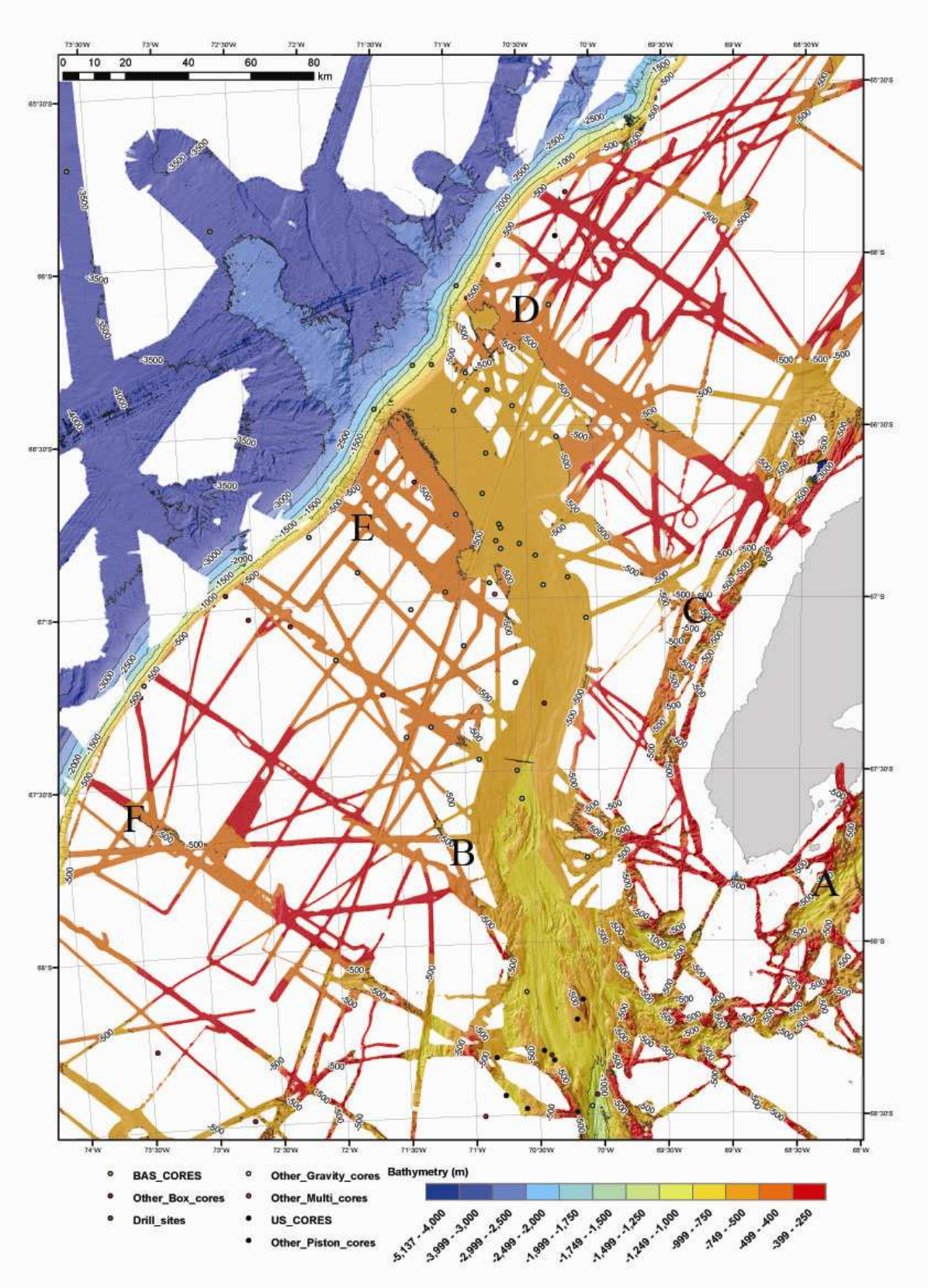


Figure 1 Location of planned sample sites (A-F) in the West Antarctic Peninsula.

5. Potential and realised sample regime *David Barnes*

The power of our intended sample regime was the potential to investigate various aspects of ecology across scales of 1, 10, 100 and 200 km. We enhanced the possibility for scaling by considering taxonomic levels using invited experts on differing animal groups (e.g. Alexis Janosik – asteroid echinoderms; Stefanie Kaiser – isopod crustaceans, and Thomas Saucède – echinoid echinoderms) as well as by prior establishment of a network of experts willing to take the samples of their taxa collected. By using multiple apparatus we intended to investigate organisms across several orders of magnitude in size from bacteria through phytoplankton to larger nekton and megabenthos.

The environment of the Southern Ocean, particularly wind, wave and ice conditions, along with interactions with other tasks (such as support of research stations) mean that realised sample regimes are often quite different to potential plans. Such events lead to JR230 leaving three days later than planned and being one day shorter. Thus, a new potential plan of sampling areas A, B, C, D and F was established prior to leaving Rothera Research Station, with the intention that a realised completion of four areas would be a significant accomplishment. The sample plan was to sample at ~500 m depth for each area:

Agassiz trawl (AGT): 3 stations at each of 3 sites (10 km apart) = 9 samples
Epibenthic sledge (EBS): 1 at each of 3 sites 10 km apart = 3 samples
Conductivity Temperature Depth (CTD): 1 at each of 3 sites 10 km apart = 3 samples
Box Core (BC): 1 at each of 3 sites 10 km apart = 3 samples
Bongo net: 2 samples
N70 net: 4 samples (varying mesh sizes)
RMT8+RMT1 nets: 3 samples (varying depths)
Acoustics: semi-continuous sampling

Accounts of realised sample regime for each apparatus is given separately, but overall five areas were sampled (four of the planned areas and one new areas, see figure 2), of which four were sampled by all apparatus (A, C, D & G).

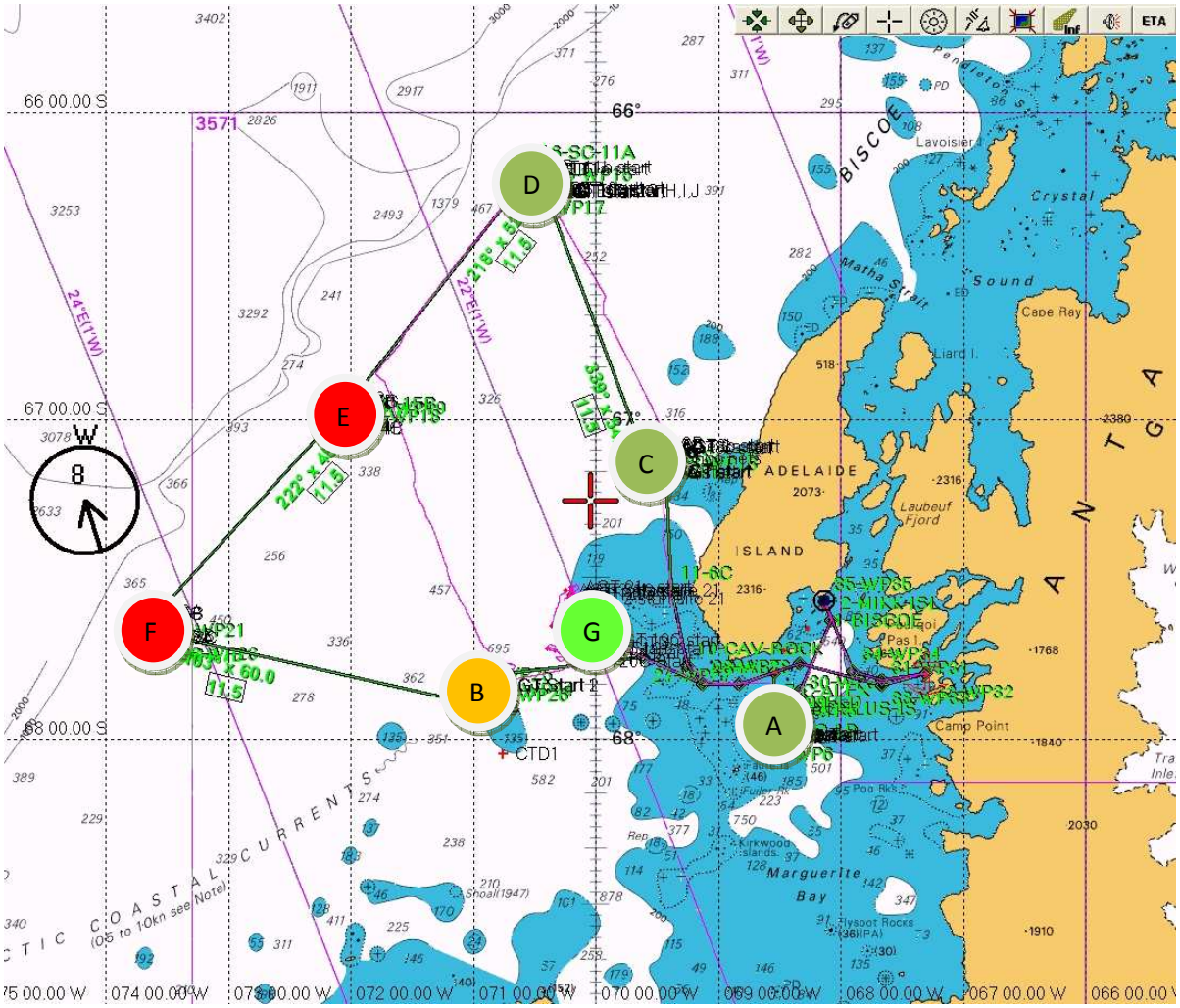


Figure 2 Location of realised, compared with planned, sample sites in the West Antarctic Peninsula. The symbols are; original and fully sampled (A, C, D), new and fully sampled (G), original and part sampled (B), and original and unsampled (E, F).

6. ICT

Jeremy Robst

6.1 Personal Computers

No problems were encountered with the personal computers used during this cruise. The wireless LAN in the UIC was useful for connecting personal laptops to the ships network.

6.2 Netware

JRNA ran without any faults and no work was required during the cruise.

6.3 Unix

JRLB had been configured with only 1 GB of memory and became overloaded on the 4th December and ran out of memory and crashed. The machine was reconfigured with 4 GB of memory and rebooted.

6.4 SCS Logging system / Data logging

v4.2.3 of the SCS logging system was used during the cruise. Software to produce graphs of the SCS variables was written and installed on the SCS display PC in the UIC. The graphing capabilities of the SCS software do not appear to work at present.

The Ashtech GPS regularly (approx. every 5 days) stops outputting heading information and requires power cycling, although this is less important now that the heading data from the Seatex GPS (which does not suffer this problem) is logged.

The Netmonitor had problems logging to the SCS when using the USB to serial converter. The output just stopped at times, including in the middle of some trawls. Rebooting the computer would fix this for a period. It was not clear if this was due to the USB converter or to a bug in LabView, as the LabView.exe process would often hang after the USB output stopped and take a very long time to reboot. When using the USB to serial, the machine should be rebooted shortly (5 minutes) before a trawl.

Table 1 Data acquisition events.

Date / Time	**Event / Reason**
2009/12/02	Data logging continuing from previous run to Rothera (Leg 20091112).
2009/12/04 22:40	JRLB crashed due to incorrectly configured memory amount. ACQ restarted 22:42 – 22:43 to resume logging to the U: drive.
2009/12/04 22:50	Recreated ACO files after JRLB crash – took approximately 90 mins for 22 days of data.

6.5 Network - No problems reported.

6.6 EM120 swathing

The EM120 was run during the cruise to swath the sites where no or minimal swath data existed; these data were then used to select suitable areas for AGT and EBS trawls. An example of this was for site 9 (Area C), see figure 3a (below).

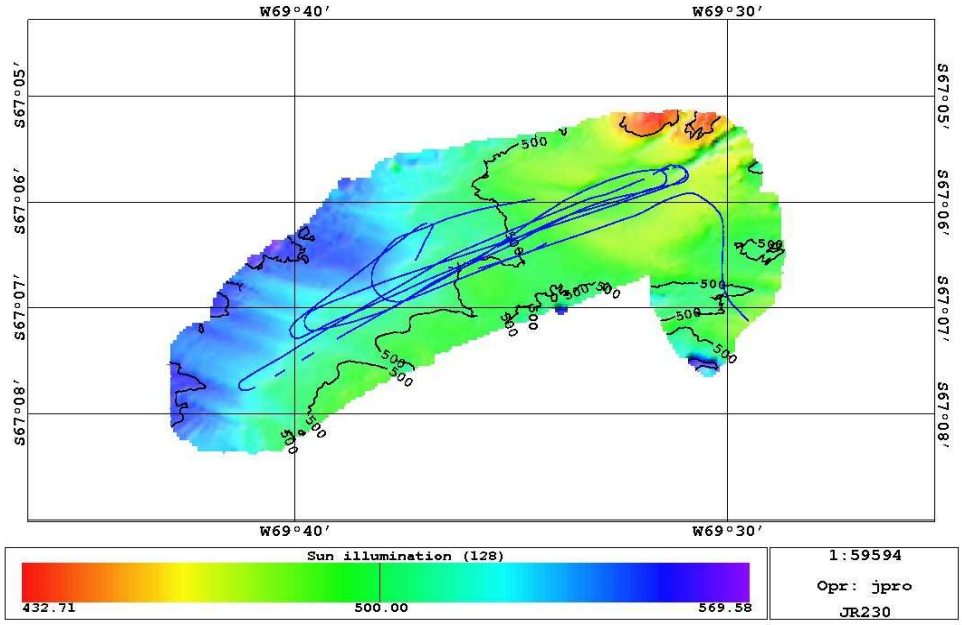


Figure 3a Site 9 Swath image of a single station bathymetry.

Minimal data clean was done on the data, just the removal of obviously incorrect depths due to ice conditions or ship motion (e.g. during turns). Minimal data clean was done on the data, just the removal of obviously incorrect depths due to ice conditions or ship motion (e.g. during turns). One entire new area was swathed to enable sampling with benthic apparatus (see figure 3b).

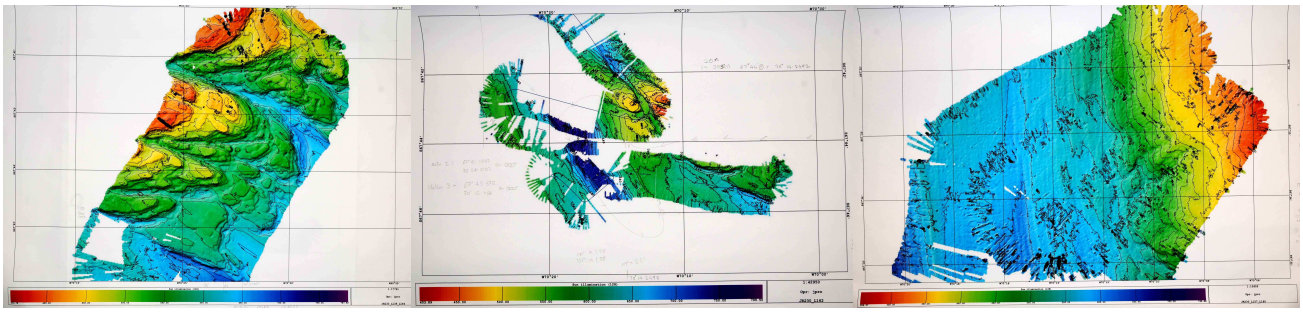


Figure 3b The new area sampled; Area G (Site 19-21) swath images.

7. Underway data

Sophie Fielding

7.1 Underway navigation data

7.1.1 Instrumentation and data collection

Navigational data were collected continuously throughout the cruise. Instrumentation was as follows:
Ashtec ADU2 GPS: antenna 1 used to determine the ship's position; antennae 2-4 used to determine pitch, roll and yaw.
Ashtec GLONASS GG24 (accurate to ≈15m)
Sperry Mk 37 Model D Gyrocompass
Seatex GPS (Seapath 200)
GPS NMEA
Navigational data were collected every second and bathymetric data were logged every 10 seconds.

7.1.2 Processing

Navigational data were processed in Unix and Matlab using modified versions of programs developed by Mike Meredith. Data were initially read into the Unix system, then transferred to Matlab, where the bulk of the processing was carried out.

Unix

get_nav Calls the scripts *get_gyro*, *get_bestnav*, *get_gpsash*, *get_gpsglos*, *get_gpsnmea*, *get_seatex* and *get_tsshrp*, which invoke the *listit* command to retrieve 24 hours of gyrocompass, bestnav, Ashtec (ADU2), Ashtec Glonass (GG24), GPS NMEA, Seatex and tsshrp (heave, pitch and roll) data. Data are saved in subdirectories 'gyro', 'bestnav', 'gpsash', 'gpsglos', 'gpsnmea', 'seatex', and 'tsshrp' as *gyro.NNN*, *bestnav.NNN*, *gpsash.NNN*, *gspglos.NNN*, *gpsnmea.NNN*, *seatex.NNN* and *tsshrp.NNN*, where NNN is the jday.

Matlab

load_daily.m Reads in navigation files output by the Unix processing (above) by calling the following functions:

- *load_daily_bestnav*: reads in text file *bestnav.NNN* and writes data to a Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *bestnav/bestnavNNN.mat*.
- *load_daily_gpsash*: reads in text file *gpsash.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gpsash/gpsashNNN.mat*.
- *load_daily_gpsglos*: reads in text file *gpsglos.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gpsglos/gpsglosNNN.mat*.
- *load_daily_gpsnmea*: reads in text file *gpsnmea.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gpsnmea/gpsnmeaNNN.mat*.
- *load_daily_gyro*: reads in text file *gyro.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *gyro/gyroNNN.mat*.
- *load_daily_seatex*: reads in text file *seatex.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *seatex/seatexNNN.mat*.
- *load_daily_tsshrp*: reads in text file *tsshrp.NNN* and writes data to Matlab structure array. Data are flagged, such that any variable with flag ≠ 50 are poor, and thus discarded. Output is *tsshrp/tsshrpNNN.mat*.

For a quick visual check, the program then plots bestnav, gpsash, gpsglos, gpsnmea and seatex data over one another (after plotting each dataset the user must hit return to continue), gyrocompass heading, and pitch and roll.

plot_seatex_all Plots entire cruise track (see Fig. 2). Loads *seatexNNN.mat* for all jdays and GEBCO bathymetry data.

Problems encountered: TSHRP was not recording for the duration of the cruise.

7.2 Underway Oceanlogger and meterological data

7.2.1 Instrumentation and data collection

Surface ocean and meteorological data (see figure 4) were logged continuously throughout the cruise. Ocean data were collected from the ship's uncontaminated seawater supply, whilst the meteorological data were measured by instruments on the forward mast. Instruments were as follows:

Oceanlogger

SeaBird Electronics SBE45 CTD

Turner Designs 10-AU Fluorometer

Meteorological data

Photosynthetically Active Radiation (PAR) 1, Parlite Quanum Sensor, Kipp & Zonen

Photosynthetically Active Radiation (PAR) 2, Parlite Quanum Sensor, Kipp & Zonen

Solar Radiation 1, Proto1 SPLite, Kipp & Zonen

Solar Radiation 2, Proto1 SPLite, Kipp & Zonen

Air temperature/humidity 1, Chilled Mirror Hygrometer MBW, PM-20251/1, Temperature Sensor Pt100, PM-20252/1 Anemometer (this logs wind speed relative to the ship. At this time there is no datastream for true wind, but this can be calculated from relative wind and navigational data, if required). Both surface ocean and meteorological data were collected at 5 second intervals.

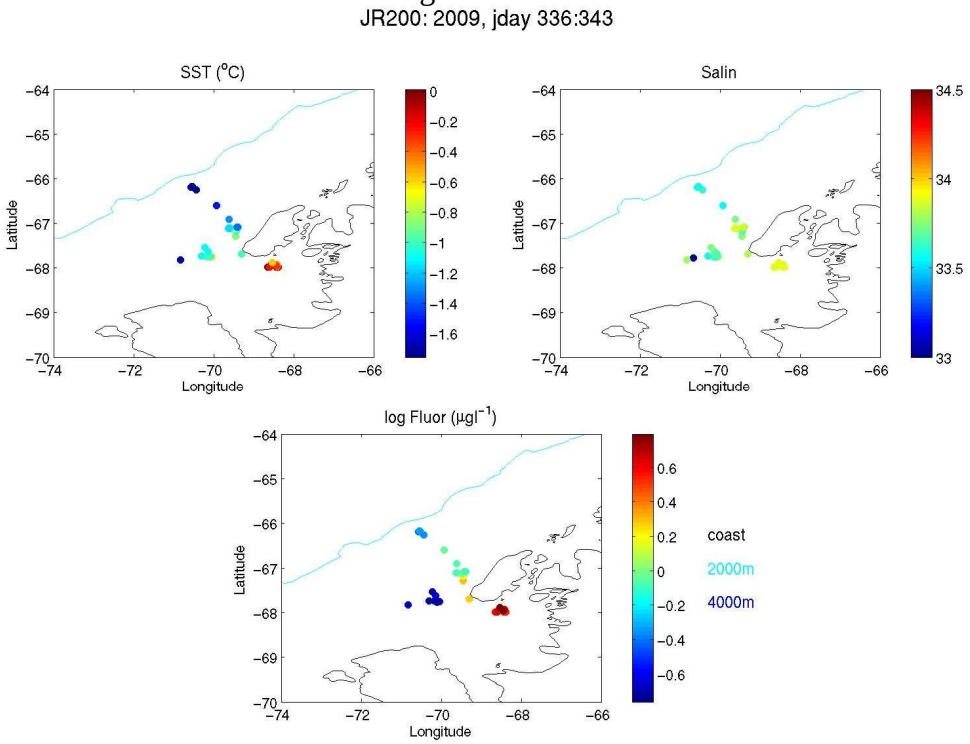


Figure 4 1 minute averages of sea surface temperature (SST), Salinity (Salin) and fluorescence (Fluor) across the study area, West Antarctic Peninsula [from the oceanlogger for Jday 336 to 343].

7.2.2. Processing

Initial processing was carried out in Unix, which generated files that could be further processed in Matlab.

Unix

get_underway Calls the scripts *get_oceanlog*, *get_anemom* and *get_truewind*, which invoke the *listit* command to retrieve 24 hours of underway data. Output files are *oceanlog.NNN*, *anemom.NNN* and *truewind.NNN*, where NNN is the jday.

Matlab

loadunderway Calls functions *loadoceanlog* and *loadanemom* to read *oceanlog.NNN* and *anemom.NNN*. Data are stored in structure arrays and saved as *oceanlogNNN.mat* and *anemomNNN.mat*. The program then calls the function *cleanoceanlog*, which sets unrealistic values to NaNs, uses *dspike* to remove large spikes in conductivity, housing (CTD) temperature and remote (hull) temperature. Linear interpolation is used to fill data gaps. Data from periods of flow >1.5 l/min or <0.4 l/min are also set to NaNs, as are data from 5 minutes after a drop in flow to allow variables to return to normal. Surface ocean data are further cleaned using an interactive editor, which allows manual removal of spikes and flier points. Salinity is then calculated using *ds_salt* and the interactive editor is used to remove spikes and flier points. The output is *oceanlogNNNclean.mat*.

plot_oceanlog_daily Loads *oceanlogNNNclean.mat* and *seatexNNN.mat*, calculates 1 minute averages and plots maps of sea surface temperature, salinity and fluorescence. Bathymetry data from GEBCO are included in the plots. Output files are *oceanlog_navNNN.mat* and *oceanlog_navNNN_1minave.mat*.

plot_oceanlog_all Loads *oceanlog_navNNN_1minave.mat* for all jdays and plots sea surface temperature, salinity and fluorescence for the entire cruise track. Bathymetry data from GEBCO are included in the plots.

7.2.3 Problems encountered

Jday 339 and 340 contained little underway information due to the underway water supply being turned off as a result of ice. Otherwise little cleaning of the data was undertaken.

8. Oxygen Isotope work

Sophie Fielding & Terri Souster

Water samples were collected for oxygen isotope analysis. Samples were taken from CTD Niskin bottles and from the underway supply. Standard procedure was to rinse each bottle three times then fill it to the neck, before drying the bottle and sealing it with a rubber insert. A metal cap was then added to the bottle using crimpers. Samples were packed in boxes for transfer back to the UK and will be sent to the NERC Isotope Geosciences Laboratory (NIGL, Keyworth, U.K.) for analysis.

9. Gear deployments

Peter Enderlein & Natalie Ensor

9.1 Agassiz Trawl

The AGT (see figure 5) used during the JR230 cruise was the same we used during JR144 and JR179. It is the BAS Trawl which shows sign of use on the frame, but it works perfectly fine. It was usually deployed with a ship speed of 0.3 kn, then increased to 1 kn, veering the cable with a maximum of 60 m/min up to 1.5 of water depth. The trawling time was 5 min. After the trawling the AGT was recovered at 30 m/min until AGT had cleared the seabed. Hauling speed was then increased to 45 m/min. It was used in winds up to 40 kn without any problems, as it is easy to handle on deck.

During the cruise the AGT net got entangled few times, resulting mostly in an empty net. At no time the AGT got stuck on the seafloor resulting in little wear on the wires. The net got occasionally ripped mainly by rocks, so it was repaired several times by ship crew`s ex-fishermen John O'Duffy and Derek Jenkins. At one point the rubber mat got ripped and was replaced.

9.2 Epibenthic sledge

The EBS (see figure 5) used during the current cruise was repaired over the summer period. The first deployment with the repaired sledge was successful. The EBS was usually deployed with a ship speed of 1 kn, veering the cable with max of 60 m/min up to 1.5 of water depth. It was trawled then for 10 min at 1 kn. After the trawling the EBS was recovered at 30 m/min until the EBS had cleared the seabed. Hauling speed was then increased to 45 m/min. It was used in winds up to 30 kn without any problems.

During the cruise the EBS only got stuck once on the seafloor resulting in little wear on the wires. The original nets for the EBS could not be found when the container was emptied so the spare nets have been used for all deployments. New springs have been used and there were no weights attached to the sledge.

9.3 Down-wire net monitor

During this cruise the DWNM was used on the ‘Biological wire’ for the RMT8+1. This was the second season of the new developed DWNM system. The equipment was all set up as the year before and was expected to work fine. In the beginning a few problems with the PCs where encountered. The PC struggled with serial cards again but worked fine after a restart. This problem consisted

throughout the whole cruise and the PC had to be restarted again and again. The other problem encountered was the Altimeter. They were all tested during the trial cruise in the summer and worked perfectly fine. Initially we thought the problem would be a connector problem, but over time it was clear something else was causing the problems. Therefore a test tube was rigged and the Altimeter tested. Also a bench test with just a power supply and an Altimeter for the output reading was conducted. The test revealed that the RMT25 Altimeter was not working at all and the RMT8 Altimeter was giving only intermittence readings. It seems that these two new sensors have a problem and should be tested. The old spare Altimeter worked in the test and was put on the unit. Also the RMT8 Altimeter was fixed on the unit and feed into the spare channel. Then the LabView program was modified to show the second Altimeter readings. The last near bottom trawl was done with this arrangement and gave no readings from the RMT8 Altimeter and not reliable readings from the old spare Altimeter. Further tests are needed to find exactly out what is wrong with the Altimeter and why they work on the bench but not properly during a deployment. Also the RMT8 par sensor cable did not work and was replaced by the RMT25 par sensor cable.

9.4 RMT8+1

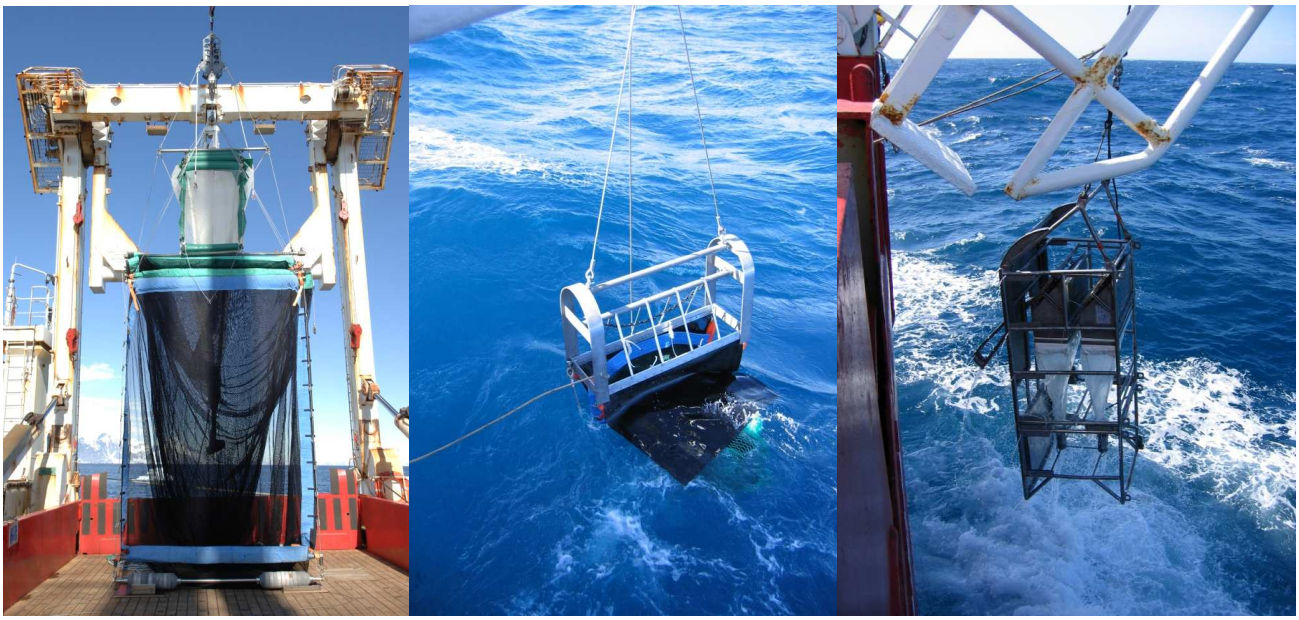
The RMT8+1 (see figure 5) was rigged with the RMT 1 nets above the RMT8 nets. It was deployed 11 times successfully and another 2 deployments which were unsuccessful; on these occasions the nets were not opened and the system was brought back onto deck. Due to problems with the Altimeter the deep water trawl occurred about 50 m off the sea floor. The net worked successfully. Each pair of nets was opened for 30 min for the depths of 400-300 m, 300-200 m, 200-100 m and 100 m- surface. For the deep water trawl only one pair of nets was opened for 30 min and then recovered. The new self securing catches put on the cod ends worked very well, although on several occasions they got caught on the net, when pulling it back on deck and resulted in small rips in the nets. These were then repaired.

9.5 Bongo and N70

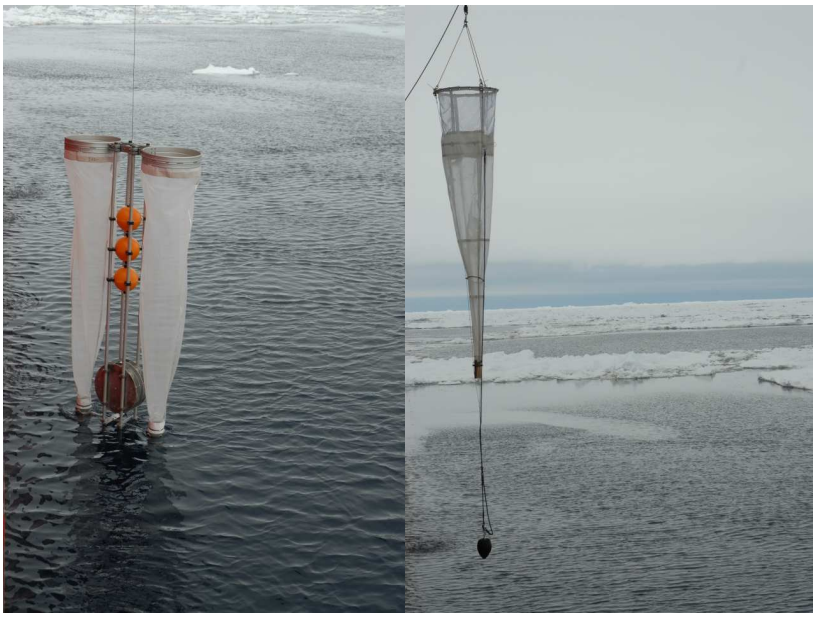
The Bongos (see figure 5) were deployed down to 200 m and worked successfully. The new spring unit was used. The springs should be replaced during next refurbishment, as they have been used for several years now.

The N70 is a new plankton net, which is a replicate of a net originally used on the discovery cruises. The net was deployed at 5 sites, midship. The nets were deployed to 200 m. The net did

encounter two small problems, the first being that the weight rope twisting around the net; this was fixed by adding a swivel. The other problem was that the 3 brass wires around the net would twist under the cod end, another swivel was added to the system but this failed to stop the problem. Possibly a different type of swivel may eradicate this problem, something to be looked at over the summer period. Apart from these few teething problems the net worked successfully.



RMT 8 + 1 AGT EBS



Bongo N70

Figure 5 Apparatus deployed for sampling animals. These included the pelagic nets RMT8+1, Bongos and N70 as well as benthic Agassiz trawl (AGT) and epibenthic sledge (EBS).

10. Prokaryote Biodiversity

David Pearce & Maria Jimenez

10.1 Introduction

In a recent study of benthic-pelagic coupling and sediment-water column interactions in the Indian Ocean, it was possible to compare the prokaryote biodiversity of two deep-sea sites, one with a high nutrient input from the surface (in the form of particulate organic matter), and one with a low nutrient input. The results were striking and are currently in submission. In this study, we adopted a similar approach to look at spatial scales of prokaryote biodiversity in the Marguerite Bay shelf area as part of the Ecosystems Core Science at BAS. A suite of techniques will be used to analyze samples taken at three spatial scales across the benthic-pelagic interface along a transect from Adelaide Island to the Marguerite Bay shelf edge. The spatial scales investigated were i) 200 km, ii) 5 km, iii) within sample and iv) vertical profile. It is anticipated that a further sample will be obtained from the RaTS profile using similar depths to tie in with existing data.

10.2 CTD

Physical profiles were taken with the CTD (Fig. 6) descent, and the profiles, in conjunction with altimeter data were used to select appropriate sample depths. Two-and-a-half liters seawater samples were collected at Bottom +10 m, Bottom +20 m, Bottom + 50 m, mid-water (250 m), the chlorophyll maximum (between 10 m and 50 m, depending on the site) and the surface (5 m) (Table 2). The chlorophyll maximum was deeper for the mid-shelf samples. Two liters of the water collected were filtered onto 0.2 µm cellulose nitrate filter papers, re-suspended in 5 ml of seawater and centrifuged to produce a pellet for subsequent analysis. Ten milliliters and 25 ml were also filtered onto 0.2 µm polycarbonate discs for cell enumeration. The remainder of the sample was used to pre-rinse the sterile filter apparatus and sample collection bottles.

Figure 6 The CTD

10.3 Box corer

Sediment samples were collected using a box corer (Figure 7). The sediment varied considerably in its composition and for this reason samples fell into two categories, i) those closer to the Peninsula with a high mud content and low rock content which produced real cores 30-50 cm in length (these cores maintained some of the vertical integrity), and ii) those closer to the shelf edge where there was a high number of small rocks in the sediment, such that the box corer frequently misfired. On each of these occasions mud brought to the surface was collected into plastic sample bags and will be treated as a combined sample. More stones were present in the sediment further out on the shelf, and it was these samples that did not core particularly well.

Figure 7 The box corer.

10.4 Laboratory analysis (UK)

On return to the UK, both benthic (i.e. sediment and sediment contact water) and pelagic (i.e. water) samples will be analyzed for total cell density (DAPI counts). Total community DNA will then be extracted for DGGE/tRFLP analysis to determine prokaryotic community profiles at each of the sites. Individual DGGE bands will be extracted and sequenced to identify dominant community members. Small clone libraries will be constructed and used for RFLP analysis to estimate diversity, and if funds permit, a representative sample of this diversity will be sequenced. Where possible organisms will be taken into culture and classified for potential novelty.

Benthic-pelagic coupling - Sequences from dominant organisms in both the sediment and the water column will be used to construct probes for fluorescence *in situ* analysis of both sets of samples in turn. Functional gene probes will also be used to determine where particular ecosystem functions occur across the profile and to determine whether it is consistent on different spatial scales.

10.5 Conclusion

In total 13 samples were taken (4 groups of 3) + 1, consisting of a vertical water profile, filtered down onto 0.2 µm cellulose nitrate filter papers, with two slides at each depth for total cell counts, and two sediment samples which comprised either a core 30-50 cm in length or bag of sediment. One replicate sediment sample was then stored at -20 °C and one at +4 °C for subsequent analysis.

Table 2 Number of sediment and water samples collected during JR230 using CTD and box corer.

Sample identifier (Event number)	Water depth (m)	Depths sampled (m) by CTD	Filtered (ml)	Box core	Conditions
1e&f (5)	457	447, 437, 407, 350, 200, 10, 5	2000, 25 & 10	Success	Open
2 e&f (17)	483	473, 463, 413, 350, 200, 10, 5	2000, 25 & 10	Success	Open
3 e&f (8)	520	510, 500, 460, 350, 200, 10, 5	2000, 25 & 10	Success	Open
6e&f (87)	563	553, 543, 503, 350, 200, 50, 5	2000, 25 & 10	Success	60-750% ice
7 e&f (30)	424	414, 404, 354, 200, 10, 5	2000, 25 & 10	Success	Open
8 e&f (52)	457	447, 437, 397, 350, 200, 30, 5	2000, 25 & 10	Success	Open
9 e&f (49)	490	480, 470, 440, 350, 200, 40, 5	2000, 25 & 10	Success	Open
10e&f (61)	494	484, 474, 424, 350, 200, 10, 5	2000, 25 & 10	Success	60-75% ice
11 e&f (79)	487	487, 467, 427, 350, 200, 10, 5	2000, 25 & 10	Success	20% ice
12 e&f (76)	472	462, 452, 402, 350, 200, 10, 5	2000, 25 & 10	Success	50% ice
19 e&f (104)	622	612, 602, 572, 350, 200, 10, 5	2000, 25 & 10	Success	Open
20 e&f (115)	584	575, 565, 525, 350, 200, 10, 5	2000, 25 & 10	Success	Open
21 e&f (118)	546	536, 526, 486, 350, 200, 10, 5	2000, 25 & 10	Success	Open

11. Phytoplankton

Beki Korb

Both the type and quantity of phytoplankton in the water column will have important implications to the structure of the pelagic food web as well as determining the quality, timing, magnitude and vertical flux of carbon. As a contribution to the bentho-pelagic programme, phytoplankton biomass and species composition in the upper water column were measured at a number of CTD stations across the study region of Marguerite Bay.

11.1 Methods and coverage

11.1.1 Chlorophyll a (Chl a)

Chl *a* profiles were measured on water collected from CTD stations, exact station and event numbers can be found in Table 3. CTD bottles were fired at nominal depths of 5, 10, 15, 20, 30, 40, 50, 60, 80, 100 and 120 m and at a floating depth determined to be the chlorophyll maxima (from examination of fluorescence data on the downcast). At most stations, the Chl *a* maxima was located at ~ 10 m. Size fractionated chlorophyll *a*, was measured at 3 depths, 10, 50 and 100 m.

Water samples for total Chl *a* were filtered through 47 mm glass fiber filters (Fisher GF/F) under low (<70 mmHg) vacuum pressure and immediately frozen at -20 ºC until further analysis. For size fractionated Chl *a*, samples were filtered through 47 mm, polycarbonate membrane filters (20, 2 and 0.2 µm). After freezing, filters were extracted in 10 ml of 90% acetone in the dark, for 24 h. Fluorescence of the extract was measured before and after acidification with 1.2M HCl on a TD-700 Turner fluorometer. The instrument was calibrated against commercially prepared Chl-*a* standards (Sigma).

11.2 Species composition

Water samples were taken from the 10 m CTD bottle for species identification and were preserved with 2 % acidic Lugols' solution in 250 ml brown glass bottles. Cell counts were not carried out on the ship and this will need to be organised when the samples are returned to Cambridge in the summer of 2010. Potentially cell counts could be made by Alex Poulton at NOC. Alex has been paid to carry out such work for previous Discovery 2010 cruises. Pete Ward could act as the BAS contact to arrange this.

Table 3 Phytoplankton samples collected on JR230 (y- indicates sample taken).

Station	Event #	Chl profile	Size frac Chl (10, 50 & 100 m)	Extra size frac Chl	Lugols 10 m	POC (10m)	Extra POC
1e	5	y	y		y	y	
3e	8	y	y		y	y	
2e	17	y	Y		Y	Y	
7e	30	y	y		Y	Y	
9e	49	y	y	40 m (chl max)	Y	y	40 m (Chl max)
8e	52	y	y	30 m (chl max)	Y	Y	30 m (Chl max)
10e	61	y	y		Y	Y	
12e	76	y	y		Y	Y	
11e	79	y	Y		Y	Y	
6e	87	y	y		Y	y	50 m (Chl max)
19e	104	y	y		Y	Y	
20e	115	y	y		Y	Y	
21e	118	y	y		Y	Y	

11.3 Particulate Organic Carbon

Water samples were collected from the 10 m CTD bottle for **Particulate Organic Carbon** (POC). On occasion, POC samples were also taken from the Chl maxima (when this was deeper than 10 m). Approximately 300-500 mL of water was filtered through 25 mm GF/F filters which had been pre-ashed at BAS, Cambridge (450 ºC for 5 hours). Filters were then immediately frozen at -80 ºC and stored until analysis which will take place at BAS, Cambridge. Paul Geissler runs the CHN machine at BAS and is familiar with running such phytoplankton filters. However, the samples will need to be prepared before analysis. This involves drying the filters at 60 ºC overnight, fuming over concentrated HCl for 24 hours, drying again at 60 ºC overnight, and then packing the filters into pre-combusted nickel capsules (available from P. Geissler).

12. Pelagic assemblages

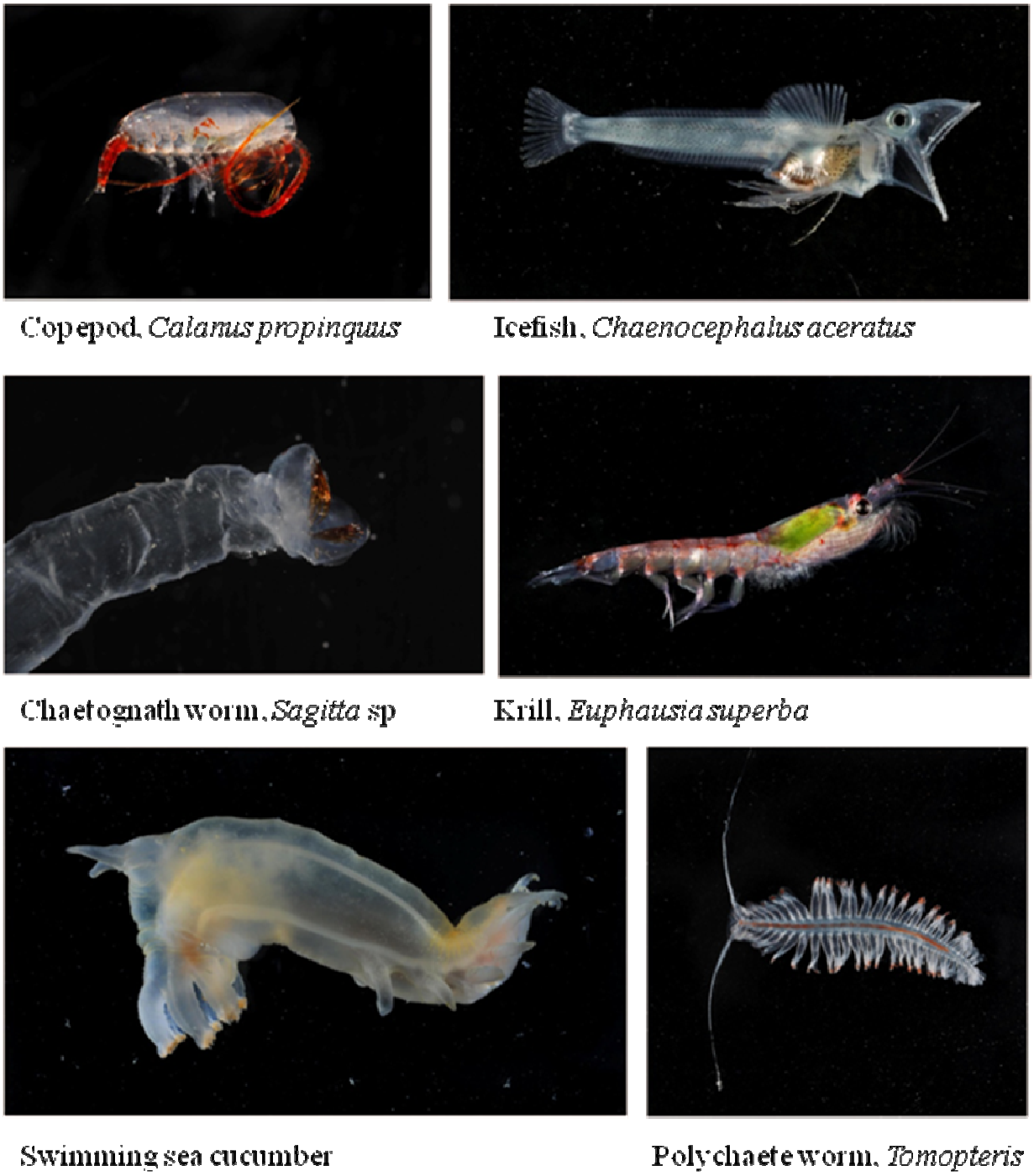


Figure 8 Some organisms representing common pelagos sampled during JR230 using Bongo, RMT8+1 and N70.

12.1 Mesozooplankton (Bongo and N70 nets) *Peter Ward & Natalie Ensor*

Sampling during this cruise took place at five of the stations/sites occupied (see event log). Both nets were deployed to 200 m and hauled vertically to the surface thus covering the upper half of the water column which was generally of the order of 500 m deep. Each deployment took in the order of 20 minutes. Two deployments of a paired bongo (2 x 200 μm nets) and 4 of the N70 (single net but variable mesh sizes of 455 μm and 190 μm) were carried out at each station/site. A total of 20 bongo and 20 N70 samples spread across five stations was obtained.

Following sample analysis, data from the bongo nets will be used to describe differences between sites and made available. As part of another project, investigating potential long-term change in plankton composition and abundance, data will be compared to catch composition and abundance as provided by the N70 which was the net widely used during the Discovery Southern Ocean Investigations of the 1920s-30s.

Additionally a number of species stages of the small cyclopoid copepod *Oithona similis* were removed from bongo net samples and placed individually in small vials containing chloroform. These were frozen at -80^{o}C and will be used in an ongoing project investigating individual variability of fatty acid composition under contrasting food regimes.

12.1.1 Preliminary results

Initial observations of the plankton indicate some interesting differences between stations. The first, inner shelf station in open water, sampled on 3rd December had a measurable bloom of large diatoms underway and was characterized by the presence of *Euphausia crystallorophias* and the silver fish *Pleurogramma antarctica* both members of a widely described continental shelf community. This was the only station at which there was evidence of spawning by krill (*Euphausia superba*) with eggs and nauplii present in samples. Remaining stations were relatively impoverished in terms of plankton, although small immature krill (*Euphausia superba*) and myriad small faecal pellets were seen at just about all of the ice covered stations. Large calanoid copepods were relatively rare and evidence from the RMT1 nets suggested that they lay deeper in the water column, although absolute numbers over the shelf are likely to be lower than in truly oceanic water.

The krill eggs and faecal material could be considered as potential benthic food sources albeit their occurrence will likely be sporadic. POC determinations will indicate how much of the suspended material under the ice is likely to make its way to the bottom.

12.2 Meso & macrozooplankton (RMT8+1)

Gabriele Stowasser, Sophie Fielding, Peter Ward & Jon Watkins

12.2.1 Introduction

JR230 was designed to examine the structure of benthic and pelagic biodiversity across spatial scales in Marguerite Bay. Through sampling both the benthic and pelagic realm we will examine the diversity and abundance of benthic taxa to study ecosystem function and how pelagic productivity is used. This section discusses the collection of pelagic samples.

12.2.2 Gear

The RMT8 and RMT1 were used to characterise the macro- and mesozooplankton community respectively in 100 m stratified hauls from the surface to 500 m. Due to the seasonal light cycle (24 hours daylight) all catches were carried out during daylight. The RMT8 and RMT1 were rigged on the same frame, both with 2 nets. Opening and closing of the nets was controlled through the DownWire Net Monitor system which also recorded depth, flow, temperature salinity and PAR.

12.2.3 Catch sorting and processing

Depth stratified hauls (400-300 m; 300-200; 200-100 & 100-surface) were conducted at all stations (see Table 4), with each net open for 30 minutes. In addition 3 hauls (stations 2 to 4) were undertaken at a constant depth as close to the seafloor as possible. Due to a failure in the altimeter system on the DWNM this was typically 50 m above the bottom. For all hauls of the RMT8 the total catch was sorted and quantified. Numbers caught and total weight (when > 1 g) was obtained for each species. For some groups specific identification was not possible and identification will be verified through re-examination in the laboratory in either Cambridge or by consulting colleagues specializing in these taxa outside BAS. Samples were collected from key species for stable isotope analysis and the remainder of the RMT8 catches, with the exception of the large jellies, was preserved in formalin. Subsamples of *Euphausia superba* (Stations 1 (Event 25) and 4 (Event 95)) were preserved separately for genetic studies in RNA later and frozen for iron excretion studies. In two hauls (Events 95 and 96), where sufficient numbers of *E. superba* were caught, length-frequency data was collected (Figure 9). All data were recorded in an Excel database.

For all hauls of the RMT1 the total catch was measured by volume (Table 5) and where possible halved. One half was preserved in formalin for mesozooplankton community analysis and one half frozen for lipid and stable isotope analysis of key species. Where catches were too small the full sample was preserved in formalin.

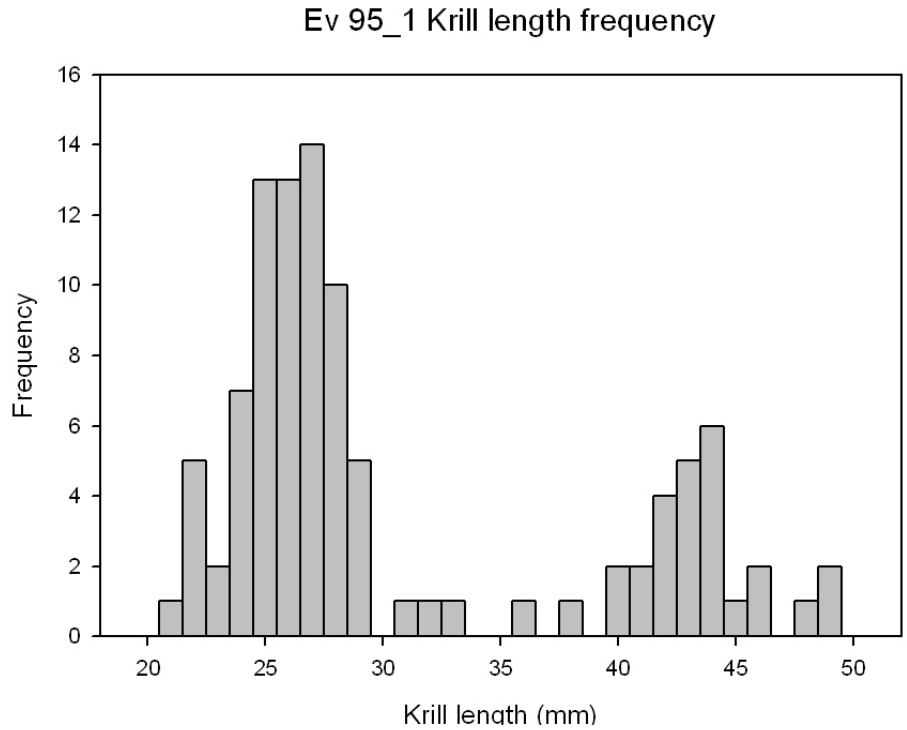


Figure 9 Length frequency distribution of krill (*Euphausia superba*) caught in RMT8 fishing during JR230 (Event 95, net1)

Table 4 RMT 8/1 stations during cruise JR230

Event	Net	Start time	End time	Start Lat.	Start Long.	End Lat.	End Long.	Water Depth	Net depth min.	Net depth Max.
25	1	03/12/2009 16:39	03/12/2009 17:16	-67.1122	-69.6112	-67.9589	-68.4145	526-736	100	200
25	2	03/12/2009 17:19	03/12/2009 17:49	-67.9572	-68.4144	-67.937	-68.4153	720-862	9.4	110
26	1	04/12/2009 17:28	04/12/2009 17:58	-67.1016	-69.5584	-67.1115	-69.6077	502-519	420	453
26	2	03/12/2009 19:35	03/12/2009 20:05	-67.9510	-68.4147	-67.9292	-68.4186	723-846	206	304
42	1	04/12/2009 17:28	04/12/2009 17:58	-67.1016	-69.5584	-67.1115	-69.6077	502-519	420	454
43	1	04/12/2009 19:32	04/12/2009 20:02	-67.1011	-69.5626	-67.1097	-69.6116	499-522	300	402
43	2	04/12/2009 20:03	04/12/2009 20:33	-67.1102	-69.6138	-67.1214	-69.6599	523-534	200	300
44	1	04/12/2009 21:37	04/12/2009 22:07	-67.1011	-69.5527	-67.1099	-69.6017	506-517	97	195
44	2	04/12/2009 22:08	04/12/2009 22:38	-67.1103	-69.6043	-67.119	-69.6527	520-533	7	100
69	1	06/12/2009 14:43	06/12/2009 15:13	-66.2560	-70.3741	-66.2555	-70.4253	481-513	105	200
69	2	06/12/2009 15:14	06/12/2009 15:44	-66.2555	-70.4275	-66.2551	-70.4800	509-527	13	106
70	1	06/12/2009 16:49	06/12/2009 17:19	-66.2554	-70.3901	-66.2543	-70.4401	490-515	309	400
70	2	06/12/2009 17:19	06/12/2009 17:50	-67.7113	-69.9841	-66.2547	-70.4931	522-551	206	300
71	1	06/12/2009 19:28	06/12/2009 19:58	-66.2557	-70.3955	-66.2552	-70.4469	497-515	439	451
95	1	08/12/2009 17:51	08/12/2009 18:21	-67.7568	-70.0571	-67.7371	-70.0399	574-606	101	191
95	2	08/12/2009 18:21	08/12/2009 18:50	-67.7366	-70.0258	-67.7179	-70.0215	587-614	8	100

Table 4 continued

Event	Net	Start time	End time	Start Lat.	Start Long.	End Lat.	End Long.	Water Depth	Net depth min.	Net depth Max.
96	1	08/12/2009 19:54	08/12/2009 20:24	-67.7545	-70.0524	-67.7366	-70.0258	614-622	303	407
96	2	08/12/2009 20:24	08/12/2009 20:54	-67.7363	-70.0253	-67.7197	-69.9977	614-654	201	303
97	1	08/12/2009 22:34	08/12/2009 23:05	-67.7530	-70.0708	-67.7372	-70.0440	579-600	521	527

Table 5 RMT1 catches of cruise JR230. Event number, depth horizons fished, volumes of catches and preservation techniques applied.

Event	Depth horizon	Volume (ml)	Frozen	Formalin
25	200-100 m	10	x	x
25	100-surface	60	x	x
26	400-300 m	10	x	x
26	300-200 m	50	x	x
42	450 m	70	x	x
43	400-300 m	20	x	x
43	300-200 m	25	x	x
44	200-100 m	35	x	x
44	100-surface	10	x	x
69	200-100 m	8	x	x
69	100-surface	30	x	x
70	400-300 m	10	x	x
70	300-200 m	30	x	x
71	450 m	35	x	x
95	200-100 m	75	x	x
95	100-surface			x
96	400-300 m	30	x	x
96	300-200 m			x
97	540 m	net was empty		

12.2.4 Tissue sampling for stable isotope analysis

Study: Bentho-pelagic coupling in the food web of Marguerite Bay. Investigating trophic pathways through stable isotope analysis

Background

The use of stable isotopes as dietary tracers is based on the principle that isotopic concentrations of consumer diets can be related to those of consumer tissues in a predictable fashion. It has been extensively applied in the investigation of trophic relationships in various marine ecosystems and has been used to determine feeding migrations in numerous species. The stepwise enrichment of both carbon and nitrogen in a predator relative to its prey suggests that the predator will reflect the isotopic composition in the prey and isotope values can be used to identify the trophic position of species in the food web investigated. Additionally ^{13}C values can successfully be used to identify carbon pathways and sources of primary productivity. Stable isotope analysis will allow us to quantify spatial variability in resource use and energy flow within the Marguerite Bay food web and will enable us to estimate aspects of bentho-pelagic coupling.

Sampling

Whole specimens of invertebrate species were collected from the RMT 8 and Agassiz Trawl nets during both day and night hauls. Animals were identified, bagged, labelled and frozen at –80°C (pelagic species catalogue see Table 6). Fish samples were frozen whole and tissue samples will be taken at BAS at the time when samples are returned to Cambridge and the fish will be processed for stomach content analysis. Particulate organic matter (POM) was filtered onto ashed glass fibre filters sampled from CTDs at chlorophyll maximum depth and from depths 100 m, 200 m and 20 m off the seafloor, once per station (Events 5, 52, 61,87). Samples were again stored at –80°C prior to analysis in the laboratory. A further sample of POM at chlorophyll maximum depth was filtered for lipid analysis and stored in Chloroform:Methanol (2:1 v/v). All biochemical analysis will be carried out at BAS, Cambridge and the NERC Mass-spectrometry facility in East Kilbride.

Table 6 Pelagic species collected for stable isotope analysis during cruise JR230

Species	St. 1 (sites 1-3)	St. 2 (sites 7-9)	St. 3 (sites10-12)	St. 4 (sites 4-6+20)
POM	x	x	x	xx
Calycopsis borgrevichi		x	x	x
Diphyes sp.		x	x	x
Periphylla periphylla		x		x
Tomopteris sp.		x	x	
Calanoides acutus			x	
Calanus propinquus			x	
Rhincalanus gigas		x	x	
Themisto gaudichaudii		x	x	
Euphausia crystallorophias	x	x		x
Euphausia superba	x		x	x
Euphausia triacantha	x	x	x	x
Thysanoessa sp.	x	x	x	x
Spongiobranchia sp.		x	x	x
Chaetognata spp.	x	x	x	x
Elapsidae sp.		x		
Salpa thompsoni		x	x	
Notolepis sp. larvae		x	x	x
Electrona antarctica	x	x	x	
Pleurogramma antarctica	x			

12.3 Acoustics

Sophie Fielding, Peter Enderlein & Jon Watkins

12.3.1 Introduction

JR230 is a bentho-pelagic survey in Marguerite Bay. No dedicated acoustic transects were run, but the EK60 was run continuously throughout the cruise. The EK60 was synchronised with the ADCP, EA600 and EM120 through the SSU. However, some interference did occur occasionally in the 38 kHz no matter how the settings were changed. It was depth dependant and presumed to result from the EM120 – but no solution was discovered. Given the importance of the benthic and pelagic component it was decided to accept the interference and run with all instruments on. Trigger settings were ADCP and EK60 for 3 pings at a 2 second ping rate, interspersed with 1 ping of the swath and EA600 (passive) set with a fixed time of 750 ms.

12.3.2 Aim

1) Collection of acoustic data to accompany all transits and net tows during the Marguerite Bay cruise
2) Backup and process the acoustic data

12.3.3 Methods/System specification

Software versions

Simrad ER60 v. 2.0,10.07.2003
Sonardata Echolog 60 v 4.10.1.6230
Sonardata Echoview v 4.20.59.8698 Live viewing
Sonardata Echoview v 4.280.43.15788 Processing

HASP Dongle BAS3 licensed for base, bathymetry, analysis export, live viewing, school detection and virtual echogram was used to run the echolog and echoview in live viewing mode. The echosounder pc AP10 and the EK60 workstation 2 are integrated into the ship's LAN. ER60 .raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. All raw

data were collected to 700 m. Echolog was run on workstation 2 and wrote compressed files also directly to the Sun workstation via a Samba connection.

Echolog compression settings

Final compression settings used in Echolog for all frequencies were:

1) Power data only (angle data is still available from the raw files)
2) From 0 - 500 m (38 kHz), 0 – 500 (120 kHz) and 0 – 500 (200 kHz) data only (data from greater depths are available from the raw files)
3) Average samples where both Sv below –100 dB and TS below –20 dB
4) Maximum number of samples to average: 50
5) DO NOT use average samples below echosounder detected bottom unless sure of bottom detection

File locations

All raw data were saved in a general folder JR230, all echolog data were saved in the folder JR230\ek60 files. All files were prefixed with JR230. Calibration data were saved to the calibration folder.

EK60 (ER60) settings

The EK60 was only calibrated at the end of the cruise; hence it was run with the same settings as JR200 (post-calibration settings from JR200). Table 7 lists the settings the EK60 was run with during JR230. The EK60 settings were not updated following calibration – it is assumed that calibrated settings will be used in post-processing only.

The EK60 was controlled through the SSU, under a group EK60 and ADCP, the swath system was in a different group EM120 and EA600. The EK60 was the master, with a ping rate set to 2 seconds. The ADCP was run in water column mode (as a slave with an external trigger). Within this setup the ADCP only pings every other trigger, therefore its resolution is slightly reduced at 1 ping every 4 seconds.

Table 7 Acoustics_1 EK60 settings

Variable	38 kHz	120 kHz	200 kHz
Ping interval (per sec)	2	2	2
Salinity (PSU)	33	33	33
Temperature (°C)	4	4	4
Sound velocity (m/s)	1462	1462	1462
Mode	Active	Active	Active
Transducer type	ES38	ES120-7	ES200-7
Transceiver Serial no.	009072033fa5	00907203422d	009072033f91
Transducer depth (m)	0	0	0
Absorption coef. (dB/km)	10.02	28.61	41.65
Pulse length (ms)	1.024	1.024	1.024
Max Power (W)	2000	500	300
2-way beam angle (dB)	-20.70	-20.70	-19.60
Sv transducer gain (dB)	24.07	21.38	22.03
Sa correction (dB)	-0.63	-0.39	-0.31
Angle sensitivity along	22	21	23
Angle sensitivity athwart	22	21	23
3 dB Beam along	0	-0.12	0.17
3 dB Beam athwart	0	-0.07	-0.24
Along offset	7.0	7.48	6.44
Athwart offset	7.10	7.48	6.43

SSU settings

EM120	external trigger	Fixed time (750ms)
EA600	external trigger	Tx pulse
EK60	external trigger	Fixed time (2000ms) (Set to 2 seconds in ER60 software)
ADCP	external trigger	Tx pulse (this setting only works if the bottom tracking mode is off)

EK60 Calibration

Horseshoe Bay. 20:14 (GMT) 10/12/2009.

An acoustic calibration was carried out in Horseshoe Bay, Marguerite Bay on 10/12/2009. The ship was anchored, its movement balanced by minimal DP usage. The EK60 was synchronised with the EA600 (a bridge requirement) and set to a 1 second ping rate. All other acoustic instruments (including the Doppler logger) were switched off. Each transducer was calibrated in turn, although all transducers were operating at the time. Standard ER60 calibration procedures were used as documented for previous cruises (the relevant copper sphere was moved through all quadrants of each transducer). In addition the sphere was held on-axis for extra periods of time to enable calibration variables to be determined in Echoview.

A CTD (event 123) was undertaken immediately prior to calibration. Temperature and salinity were averaged from 5 (depth of the transducers) to 30 m (depth of the calibration sphere) and were -0.25°C and 33.785 PSU resulting in a speed of sound constant of 1446 m/s. These values were used to update the environmental constants on the EK60.

Parameters following two different procedures for calibrating are given in Table 8 and 9.

Table 8 Acoustics_2 Echoview calibration

Parameter	**38 kHz**	**120 kHz**	**200 kHz**
Alpha (dB/km)	9.72	24.85	38.70
Theoretical TS (dB)	-33.85	-40.4	-44.8
TS gain	25.94	21.95	23.99
Sa correction	0.12	-0.05	0.08

Table 9 Acoustics_3 ER60 Calibration

Variable	**38 kHz**	**120 kHz**	**200kHz**
Date	10/12/2009	10/12/2009	11/12/2009
Location	Horseshoe Bay	Horseshoe Bay	Horseshoe Bay
Time (GMT)	21:41	23:01	00:25
Transducer serial no	23080		24574
GPT serial no	009072033fa5	00907203422d	9072033191
Comments	EA600 synched in	EA600 synched in	EA600 synched in
Water temperature (°C)	-0.245	-0.245	-0.245
Salinity (PSU)	33.785	33.785	33.785
Sound velocity (m/s)	1446	1446	1446
Absorption coefficient (dB/km)	9.72	24.85	38.70
Ping rate	1	1	1
Transmit power	2000	500	300
Sample interval	0.186	0.186	0.186
Original gain	24.07	21.38	22.03
Original Sa correction	-0.63	-0.39	-0.31
Theoretical TS of sphere	-33.85	-40.4	-44.8
TS deviation allowed	5	3	6
Depth of target	26.1	26.3	26.6
Min distance layer	24	25	25
Max distance layer	28	29	29
New TS gain	26	21.9	24.08
New Sa correction	-0.52	-0.43	-0.25
Athw Beam angle	7.03	7.66	6.35
Along Beam angle	6.96	7.72	6.34
Athw offset angle	-0.04	-0.05	-0.21
Along offset angle	-0.11	-0.13	0.21
Calibration applied	No	No	No

The calibration values for the 120 and 200 kHz are relatively consistent with previous calibrations. The TS gain for the 38 kHz is significantly different to the previous settings. A 2 dB change in TS gain is the greatest variation since the transducers were installed. Conversation with the ship and AME identified that the 38 kHz transducer protective cover (and oil filling) on the hull had been replaced during the last refit (due to a crack). This is considered to be the likely cause of the large change in TS gain. Further calibration later in the season around South Georgia should confirm the stability of this new calibration.

Data processing in echoview

Post-processing was undertaken in Echoview. A template EV file was set up. Table 10 summarizes the virtual variables that were created, where Freq represents both 38 and 120 kHz data.

Table 10

Variable name	Operator	Operand1	Operand2
Freq resampled even	Resample by number of pings	Fileset1: Sv raw pings T?	
Freq bad data	Region bitmap	Freq resampled even	
Freq surface bottom	Line bitmap	Freq resampled even	
Freq all bad	And	Freq bad data	Freq surface bottom
Freq bad masked	Mask	Freq resampled even	Freq all bad
Freq resample 1ping	Resample by number of pings	Freq bad masked	
Freq resample original	Resample by number of pings	Freq resample 1ping	
Freq dropout range	Data range bitmap	Freq resample original	
Freq no dropout	Mask	Freq bad masked	Freq dropout range
Freq noise	Data generator	Freq no dropout	
Freq-noise	Linear minus	Freq no dropout	Freq noise
Freq convolute	3x3 convolution	Freq-noise	
Freq spike detect	Minus	Freq-noise	Freq convolute
Freq spike mask	Data range bitmap	Freq spike detect	
Freq-noise-spike	Mask	Freq-noise	Freq spike mask
Freq-500m	Resample by distance interval	Freq-noise-spike	

12.3.4 Problems encountered

The EK60 crashed on several occasions, typically associated either with the order in which it had been synchronised with the SSU (set SSU to trigger on then set trigger on EK60) or when in the ice and all echosounders were experiencing glitches. The Echoview software at the beginning of the cruise did not work with the updated samba system so a later version was installed – which then ran fine. On the occasions where the ER60 software crashed it reloaded with test settings (test2009) which only saved data to 200 m, but this was noticed within an hour or two of running and data transferred across to the JR230 folder.

Interference also started to occur on the 08/12/09 at ~17:00. Possibly the EM120 (although appearing in bursts lasting 3 pings covering a depth of ~40m), although during the RMT8 hauls the settings were not changed as the swath data was also required for later AGZ trawls. Later it was realised that during one of the crashes, the EK60 had been restarted without correctly synchronising with the other instruments and this was the likely source of interference.

13. Benthic assemblages

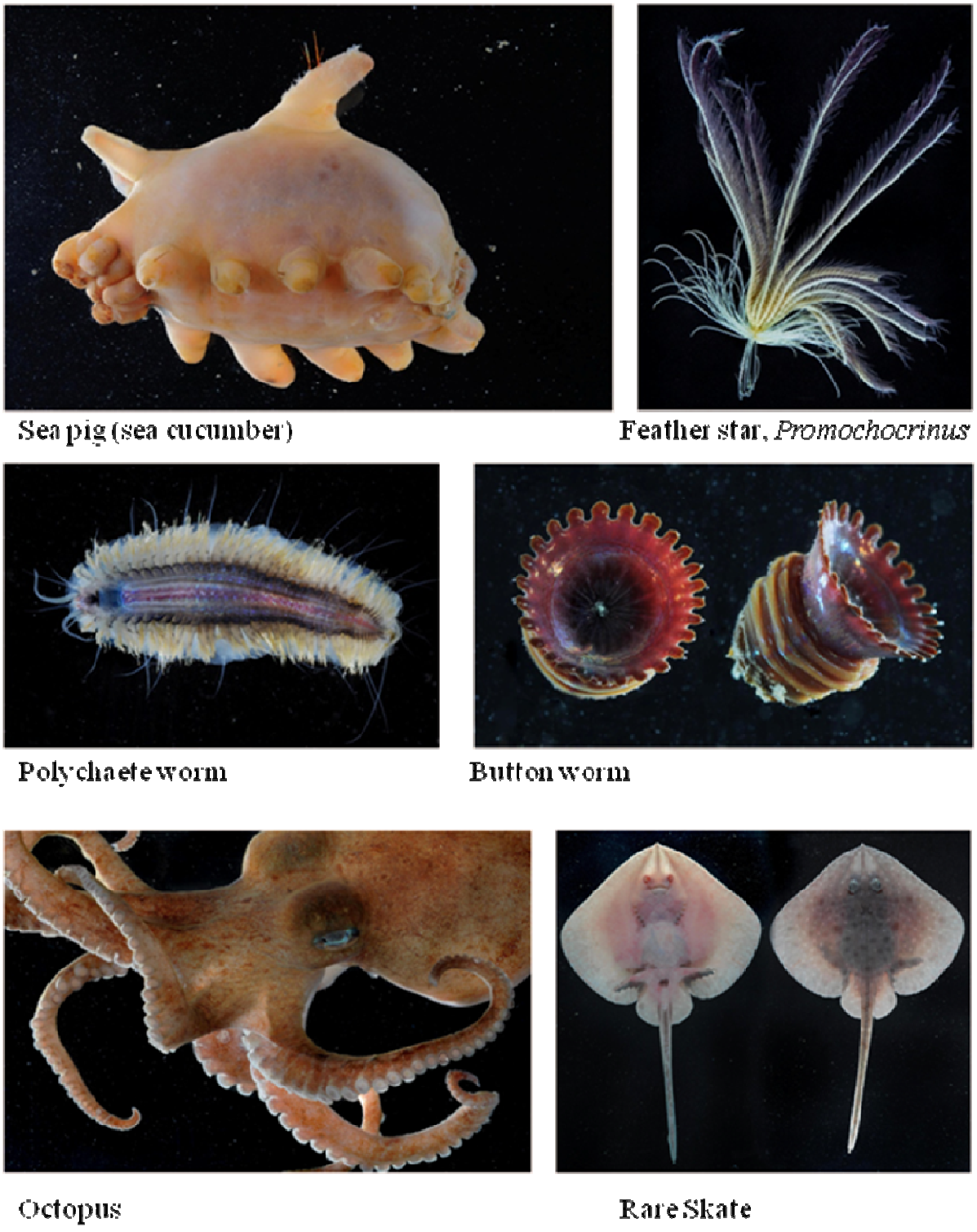


Figure 10 Some of the common benthos representatives sampled during JR230 using Agassiz trawl and epibenthic sledge

13.1 Macrobenthos (EpiBenthic sledge) *Stefanie Kaiser & David Barnes*

13.1.1 Objectives

The aim of this study was to assesses i) the role of macro-zoobenthos in benthopelagic coupling, ii) the structure of macrobenthic richness and abundance across spatial scales and iii) whether particular taxa can be strong models for whole assemblage patterns, on a west Antarctic Peninsula shelf. These data should effectively provide an important baseline for a key shelf around Antarctica in that it is the fastest warming in the shallows but likely to be amongst the slowest changing at typical shelf depths due to being overlain by 'old' Circumpolar Deep Water. The data are also biogeographically complementary to the sampling of the Amundsen Sea (JR179, BIOPEARL 2) and Scotia Sea (JR144, BIOPEARL I).

13.1.2 Work at sea

Samples were collected by means of a modified epibenthic sledge along a transect from Marguerite Bay to the shelf break of the Eastern Bellingshausen Sea. Sampling consisted of a total of 12 deployments in four different areas, each of which was ~500 m depth. Key to our aspirations was collecting samples at distances of three spatial scales (1, 10 and 100 km) apart.

The epibenthic sledge (EBS, Fig. 5) is proven apparatus for sampling small benthic macrofauna. The sledge is equipped with an epinet (below) and a supranet (above). The mesh size of the nets is 500 µm. The cod ends are equipped with net-buckets containing a 300 µm mesh window. The EBS was trawled for 10 min on the sea bed on each occasion. Each deployment took about 45 minutes. Samples were sieved with cold sea water and immediately fixed in 96% pre-cooled ethanol and kept for at least 48 hours in -20 °C for later DNA extractions.

13.1.3 Sample processing and outlook

The first stage of examination of the samples was rapid photography (in ambient aquaria) of charismatic species (see figs 8 and 9). Following fixation and preservation samples were investigated using stereo-zoom microscopes and identified to class level where possible and for some groups (i.e. isopods, see figure 11) to family and genus level. Following these specimens will be sent to recognised world experts in the taxonomy of differing classes; (cruise participants marked with *):

Symplasma & Sponges – Dorte Janussen

Hydroids – Alvaro Pena Canteras

Corals – Michelle Taylor

Amphipods – Cedric d'Ukem d'Oz

Isopods - Stefanie Kaiser*
Tanaids – Magdalena Błażewicz-Paszkowycz
Harpacticoid copepods – Gritta Veit-Köhler
Ostracods – Simone Brandao
Pycnogonids – Thomas Munilla
Mites – Ilse Bartsch
Polychaetes – Adrian Glover
Gastropods & bivalves – Katrin Linse
Cephalopods – Jan Strugnall
Brachiopods – Bernie Cohen
Bryozoans – David Barnes*
Crinoids – Marc Eliaume
Holothurians – Mark O'Loughlin
Echinoids – Thomas Saucede*
Brittlestars – Igor Smirnov
Sea stars – Alexis Janosik*

13.1.4 Results

All deployments were successful and meio-, macro- and megabenthos taxa were evident even prior to analysis. The largest specimens were several ˜0.5 m sponges (*Rosella nuda*) and the smallest were nematodes, copepods and mites which were four orders of magnitude smaller. Representatives of at least 15 phyla were obvious and most samples seemed to be rich (particularly in amphipods and isopod crustaceans, see figure 11). Analyses to be undertaken will include 1) investigation of suspension feeding predominance (import from water column) and reproductive strategies (export of larvae to water column); 2) body size; 3) biodiversity patterns across taxonomic levels, guilds and taxa as well as from inner to outer shelf and across spatial scales; 4) how well overall richness and biogeographic patterns in 'model' taxa, such as bryozoans and isopods, represent wider trophic levels or assemblages. It was notable that many of the larger morphotypes seemed to be in common with Scotia and Amundsen shelf samples.

Figure 11 Epibenthic sledges (EBS) are particularly good at capturing small fragile animals with minimal damage, such as the antarcturid isopod (left) and amphipod (right).

13.2 Megabenthos (Agassiz trawl) *Chester Sands & David Barnes*

13.2.1 Introduction

The distributions of most organisms are patchy, probably at more than one scale; at what spatial scales though is very poorly known - even for the most common Antarctic marine animals. It has been established that ice-scour is a strong driver of patchiness and regional diversity at shelf depths around the Southern Ocean. However JR230 aimed to sample at ~500 m, below typical levels of ice scour. Patchiness makes representative sampling difficult to achieve in any environment, particularly one that is difficult to visualise (except for epibenthos by Remote Operated Vehicle). Even more difficult is to have confidence that the catch obtained is representative of the habitat sampled. In this cruise our original strategy was to take samples at a range of different spatial scales (1 km / 10 km / 100 km / 200 km) with replication to gain some insight into the spatial arrangement of habitats from inner Marguerite Bay to the shelf break. Such a design should test how well a single Agassiz trawl represents any given area. The AGT is designed to sample benthic organisms that catch in a 1 cm square mesh net. Our sample design consisted of a series of triangles, depicted in Figure 12, to maximise replication of each spatial scale and include sites from inner, mid and outer shelf regions.

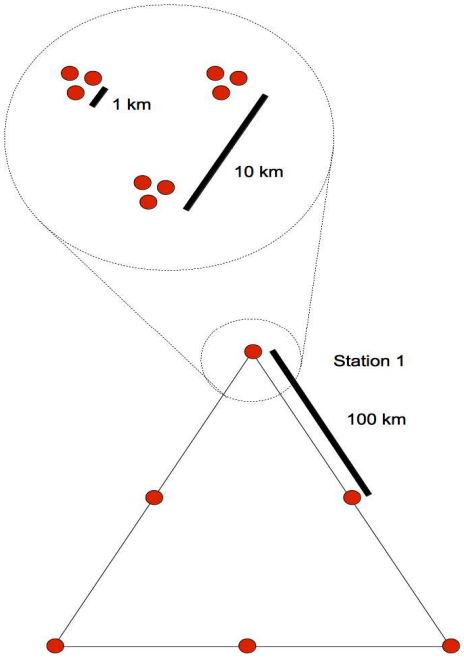


Figure 12 Sampling strategy to maximise replication of spatial sampling.

13.2.2 General results

Ice conditions determined sampling followed the northern 200 km transect. Megabenthos from many (sometimes more than 10) phyla were recorded in every trawl. Certain groups were evident in most trawls, notably echinoderms dominated biomass and often abundance. Six classes of molluscs were present and the scaphopods were particularly well represented. Cnidarians showed high patchiness with both anemones, octocorals and hydroids well represented at some sites. Shelf break sites appeared superficially similar to each other and different to those in the mid and inner shelf. Initial observations suggested mud hosted lower diversity than rocky surfaces. Unfortunately we were only able to recover animals from a single trawl south of the major channel. Given time constraints and ice conditions towards the cruise end we sought out an ice free area of ~500 m depth to sample (station G). Station G yielded the highest catch biomass with large numbers of corals providing habitat for large numbers of brittle stars, isopods and polychaetes. Thus we successfully sampled 4 complete stations with partial sampling of a fifth station.

13.2.3 Asteroids *Alexis Janosik*

Benthic organisms in the Antarctic play an important role in the understanding of a vastly changing and dynamic ecosystem. In particular, many endemic sea stars (Asteroidea) can be thought of as key players in the Antarctic ecosystem. Asteroids act as predators, scavengers, filter feeders, and grazers. One sea star in particular, *Odontaster validus,* has been named a keystone species in the Antarctic based on its considerable ability to regulate benthic invertebrate populations by consuming larvae and by acting as a dominant predator. A specific target of the BASWAP JR230 scientific cruise was collection of benthic sea stars via Agassiz trawling.

In total, approximately 13 species of sea stars were represented by collections made during the cruise period (see table 11). This list is boastful given the 500 m depth of trawling. Identifications were based the literature as well as previous studies in the Antarctic and of the NMNH collections.

Collected specimens were photographed and preserved for morphological and DNA work. Other independent objectives included observing occurrence of species abundance, brooding, and living colour/morphological variation. Colour of living specimens, which is largely absent to lacking in much of the primary taxonomic literature was observed in several species and is potentially important for systematic and population questions.

Post-cruise, specimens will be used in studies which include phylogeography and population genetics, in an attempt to provide an evolutionary understanding of how marine benthic organisms are genetically structured and physically distributed in the western Antarctic. In addition, this information will have direct implications for understanding past and future range shifts of organisms in response to climate change.

Table 11 Asteroidea collected in AGT samples during JR230.

Order	Family	Species	Distribution
Forcipulatida	Asteriidae	*Diplasterias brucei*	S. Atlantic & Antarctica
		Lysasterias sp.	S. Atlantic & Antarctica
		Neosmilaster georgianus	Antarctic
Spinulosida	Echinasteridae	*Rhopiella hirsuta*	Antarctica
Velatida	Pterasteridae	*Pteraster* spp.	S. Atlantic & Antarctica
	Solasteridae	*Cuenotaster involutus*	Antarctica
Valvatida		*Oreaster sp.*	Antarctica
	Odontasteridae	*Acodontaster* sp.	Antarctica
		Odontaster spp.	Antarctica
	Poraniidae	*Porania antarctica*	S. Atlantic & Antarctica
Paxillosida	Astropectinidae	*Bathybiaster loripes*	Antarctica
		Psilaster charcoti	Antarctica
Notomyotida	Benthopectinidae	*Luidiaster gerlachei*	S. Atlantic & Antarctica

13.2.4 Echinoids *Thomas Saucède*

Thirty-seven AGT samples were collected during the cruise JR230, in which were a total of 460 specimens of echinoids. Echinoids were sampled at 32 stations – only stations 3c, 7a, 6a, 19a and 20c yielded no echinoid specimens. Specimens of interest were photographed. In particular, pictures have been taken of rare echinoids like *Pourtalesia*, or echinoids with ecological specificities like cidarid echinoids which commonly brood their young and display many epibiotic organisms living on their primary spines. All specimens collected were either fixed in 96% ethanol or frozen at -80°C for further investigations, that is to say: 1) species identification at Rothera Research Station, and 2) tissue sampling for further molecular analyses (to be conducted later on by colleagues from France and Chile).

Following the cruise schedule, specimens were identified at genus-level, as species determination is based on the meticulous examination of pedicellariae, spines and plate patterns that is time-consuming and require the use of a microscope. Samples were the less abundant and the poorest in stations of sites 1, 2 and 3, whereas stations of sites 19, 20 and 21 and especially station 20a yielded the most abundant and rich samples.

All the echinoids sampled belong to the six following genera: *Sterechinus*, *Ctenocidaris*, *Notocidaris*, *Amphipneustes*, *Abatus* and *Pourtalesia*. The two genera *Ctenocidaris* and *Amphipneustes* seem to be represented by at least three different morphotypes each, and it is likely that the total number of echinoid species sampled during the cruise is about 10. *Sterechinus* is by far the most abundant and frequent genus. It was sampled in 78.4% of the stations and represent 81.3% of the specimens collected (see table 12). The second most abundant and frequent genus is the irregular echinoid *Amphipneustes*. Genus abundance and frequency seem to be directly related (see table 12).

Table 12 Echinoids sampled during JR230, with frequency (number and percentage of stations) and abundance values (number and percentage of specimens) for each genus.

Family	Genus	No. stations	% stations	No. specimens	% specimens
Cidaridae	*Ctenocidaris*	14	37.8	21	4.6
	Notocidaris	1	2.7	1	0.2
Echinidae	*Sterechinus*	29	**78.4**	374	**81.3**
Pourtalesiidae	*Pourtalesia*	2	5,4	2	0.4
Schizasteridae	*Amphipneustes*	22	**59.5**	51	**11.1**
	Abatus	4	10.8	11	2.4

Sterechinus abundance and frequency, along with higher species richness in Cidaridae and Schizasteridae is a common pattern on Antarctic continental shelves. In this respect, samples of the cruise are representative of that large-scale pattern. The presence of *Pourtalesia* at stations 7b and 21b is more particular, as it is an abyssal genus with a global distribution. However, it is already known from the continental shelf and break of the Antarctic Peninsula where it has been sampled at few hundred meters deep.

14. Photographic support

Pete Bucktrout

14.1 Purpose

Two primary tasks were identified prior to the cruise as follows:

1) **Record the benthic & pelagic life** collected during the cruise as a catalogued record, as identification tool and as a valuable resource for the cruise scientists, the BAS image collection and BAS press & PR activities.

   During the cruise specimens to be identified for photography on both scientific and pictorial grounds.

2) **Record the science & equipment deployments** during the cruise this will again be a valuable resource for the image collection for BAS staff talks, for use within BAS PR activities & publications

14.2 Animal Photography

a) Onboard RRS James Clark Ross a small photographic studio was set up in the main laboratory immediately to port of the main entrance as you pass into the lab from the wet lab, where specimens are sorted identified and collated.

b) The studio consisted of a copy stand; a black field background box with detachable sides to allow back lighting; a series of differing sized tanks to hold sea water and specimens; a number of manual flash guns for side, top & back lighting (held on magnetic articulated stands). The Metz flash guns were run from the mains & 'hard wired' to the camera eliminating sync' issues on a previous cruise. There was a collection of black plastic & card to eliminate reflections and a number of brushes/tweezers to manipulate the subjects.

c) Camera Equipment The camera equipment used was a selection of Nikon digital SLR's (D3X + D2X's) with a 60 mm macro lens, a number of zoom lenses, extension tubes and a right angle viewfinder.

Alongside this there were a number of chargers/power supplies and a flash meter.

A Log book was used to record and cross reference, science deployment locations with image & specimen ID numbering sequences

d) Specimens ranged in size from around 4 mm for the smallest animals to around 40 cm. These were photographed in a range of tank sizes to keep the minimum of movement as the ship rolled. In every case water depth was the minimum to completely cover the animal removing reflection issues from the specimens` surface

e) Image manipulation using Photoshop was done on some images for 2 reasons:

1 **Remove some of the background 'spots'** caused by sediment deposited from the animals

2 **To combine two images of a specimen on a single** page for identification (e.g. top & bottom of urchins)

14.3 Photography of equipment deployment

Deployments of key equipment and the sorting of specimens were filmed and photographed during the scientific deployments, at a number of the sites.

14.4 Additional recorded material included

1) **RRS James Clark Ross** from the air. Film & stills taken from a twin otter aircraft from Rothera Research Station, as JCR approached Adelaide Island, the day before the start of JR230.

2) **Ice observations** for the science sites in Marguerite Bay. Again working from a twin-otter aircraft I flew over the ships planned route taking still images from 10,000 feet. The images were used for both navigation and assessment & identification of target deployment sites.

14.5 Number of images

In total there were over 2,000 images and over 30 GB of video recorded during the 9 day JR230 cruise.

Figure 13 The images from this form a unique, unusual and beautiful record of the wonderful and bizarre benthic (such as the basket star, *Gorganocephalus* right) & pelagic life. This rich, largely endemic fauna maybe under extreme threat in one of the world`s fastest warming seas.

15. Acknowledgements

The science team are very grateful for all the effort and drive of the officers and crew of RRS James Clarke Ross. We experienced many remarkable offers of help without it even being asked for and great patience in putting up with over-anxious and frustrated scientists when things were not going our way. One moment which seemed to signify this amazing work ethic and attitude was when we ripped our Agassiz trawl net. We were all tired and thought we would need to do something later, but meanwhile John O'Duffy and Derek Jenkins had just gone out and sown it back up – we really couldn't have asked for more all cruise. We are also keenly aware that had the engineers not fixed the winch when it catastrophically failed at the shelf-break our cruise would have been an outright failure – thank you to you for your skill and effort. We are also grateful the Rothera pilots and ops managers for the fantastic ice obs and weather forecasts which aided us significantly. Finally there are a few people in Cambridge who significantly helped our effort which include Ali Graham, Peter Fretwell and Chris Hindley.

16. Appendices

16.1 Deployments summary

Date	Lat	Long	Area	depth	gear	Event	sample no.
AREA A							
02.12.2009 14:43	-67,916	-68,532	BASWAP1-**AGT-1B**	568.77	AGT	1	0001-0019
02.12.2009 15:51	-67,908	-68,547	BASWAP1-**AGT-1C**	493.54	AGT	2	0020-0040
02.12.2009 17:09	-67,907	-68,528	BASWAP1-**AGT-1A**	543.95	AGT	3	0041-0062
02.12.2009 18:12	-67,908	-68,545	BASWAP1-**EBS-1D**	499.61	EBS	4	
02.12.2009 19:40	-67,908	-68,553	BASWAP1- CTD1e		CTD	5	
02.12.2009 20:48	-67,908	-68,553	BASWAP1-BC1f	484.3	BC	6	
02.12.2009 21:43	-67,99	-68,6	BASWAP1-BC3f	543.3	BC	7	
02.12.2009 22:35	-67,99	-68,6	BASWAP1- CTD3e		CTD	8	
02.12.2009 23:48	-67,99	-68,604	BASWAP1-**AGT-3A**	505.1	AGT	9	0063-0081
03.12.2009 01:46	-67,986	-68,639	BASWAP1-**AGT-3C**	521.11	AGT	10	0082-0093
03.12.2009 03:09	-67,984	-68,614	BASWAP1-**AGT-3B**	424.4	AGT	11	0094-0133
03.12.2009 04:52	-67,986	-68,617	BASWAP1-**EBS-3D**	452.07	EBS	12	
03.12.2009 06:38	-67,985	-68,397	BASWAP1-**AGT-2C**	556.22	AGT	13	0134-0149
03.12.2009 07:56	-67,98	-68,427	BASWAP1-**AGT-2A**	590.92	AGT	14	0150-0164
03.12.2009 09:18	-67,983	-68,438	BASWAP1-**AGT-2B**	585.71	AGT	15	0165-0174
03.12.2009 10:42	-67,979	-68,439	BASWAP1-**EBS-2D**	601.8	EBS	16	
03.12.2009 11:38	-67,99	-68,401	BASWAP1-CTD2e		CTD	17	
03.12.2009 12:50	-67,99	-68,4	BASWAP1-BC2f	499.59	BC	18	
03.12.2009 13:18	-67,99	-68,4	BASWAP1-BONGO1		BO	19	
03.12.2009 13:34	-67,99	-68,4	BASWAP1-BONGO2		BO	20	
03.12.2009 14:00	-67,99	-68,4	BASWAP1-N71		N7	21	
03.12.2009 14:18	-67,99	-68,4	BASWAP1-N72		N7	22	
03.12.2009 14:36	-67,99	-68,4	BASWAP1-N73		N7	23	
03.12.2009 14:54	-67,99	-68,4	BASWAP1-N74		N7	24	
03.12.2009 16:37	-67,986	-68,414	BASWAP1-RMT81-1	200-0	RMT	25	
03.12.2009 18:46	-67,986	-68,415	BASWAP1-RMT81-2	400-220	RMT	26	
03.12.2009 21:09	-67,989	-68,405	BASWAP1-RMT81-3	Nr bottom	RMT	27	
03.12.2009 22:52	-67,992	-68,402	RMT control		RMT	28	
AREA C							
04.12.2009 04:46	-67,173	-69,428	BASWAP1-BC7f		BC	29	
04.12.2009 06:02	-67,173	-69,428	BASWAP1- CTD7e		CTD	30	
04.12.2009 07:40	-67,171	-69,427	BASWAP3-**AGT-7b**	442.62	AGT	31	0175-0200

04.12.2009 08:45	-67,17	-69,447	BASWAP3-**AGT-7a**	454.41	AGT	32	0201-0216
04.12.2009 10:05	-67,163	-69,45	BASWAP3-**AGT-7c**	460.37	AGT	33	0217-0252
04.12.2009 11:22	-67,175	-69,451	BASWAP3-**EBS-7D**	459.49	EBS	34	
04.12.2009 12:44	-67,125	-69,475	BASWAP3-BONGO1		BO	35	
04.12.2009 13:00	-67,125	-69,475	BASWAP3-BONGO2		BO	36	
04.12.2009 13:23	-67,125	-69,475	BASWAP3-N71		N7	37	
04.12.2009 13:40	-67,125	-69,475	BASWAP3-N72		N7	38	
04.12.2009 13:59	-67,125	-69,475	BASWAP3-N73		N7	39	
04.12.2009 14:17	-67,125	-69,475	BASWAP3-N74		N7	40	
04.12.2009 15:17	-67,098	-69,517	BASWAP3-RMT81-1	Nr bottom	RMT	41	
04.12.2009 17:04	-67,097	-69,518	BASWAP3-RMT81-2	400-220	RMT	42	
04.12.2009 19:10	-67,095	-69,525	BASWAP3-RMT81-3	200-0	RMT	43	
04.12.2009 21:29	-67,099	-69,537	BASWAP3-RMT81-4		RMT	44	
04.12.2009 23:36	-67,107	-69,618	BASWAP3-**AGT-9A**	535.27	AGT	45	0253-0302
05.12.2009 07:18	-67,112	-69,632	BASWAP3-**AGT-9b**	549.47	AGT	46	0303-0342
05.12.2009 08:45	-67,114	-69,612	BASWAP3-**AGT-9c**	528.85	AGT	47	0343-0385
05.12.2009 10:04	-67,116	-69,625	BASWAP3-**EBS-9D**	531.66	EBS	48	
05.12.2009 11:21	-67,11	-69,607	BASWAP3-CTD9e		CTD	49	
05.12.2009 12:01	-67,11	-69,607	BASWAP3-BC9f		BC	50	
04.12.2009 12:33	-67,084	-69,392	BASWAP3- BC8f		BC	51	
05.12.2009 14:19	-67,084	-69,39	BASWAP3- CTD8e		CTD	52	
05.12.2009 16:01	-67,083	-69,402	BASWAP3-**AGT-8A**	473.23	AGT	53	0384-0417
05.12.2009 17:28	-67,079	-69,405	BASWAP3-**AGT-8b**	461.46	AGT	54	0418-0449
05.12.2009 18:47	-67,084	-69,412	BASWAP3-**AGT-8c**	473.2	AGT	55	0450-0476
05.12.2009 20:03	-67,082	-69,408	BASWAP3-**EBS-8D**	472.83	EBS	56	
AREA D							
06.12.2009 04:32	-66,26	-70,411	BASWAP4-**AGT-10a**	507.65	AGT	57	0477-0504
06.12.2009 05:46	-66,258	-70,421	BASWAP4-**AGT-10b**	514.04	AGT	58	0505-0527
06.12.2009 06:55	-66,253	-70,42	BASWAP4-**AGT-10c**	511.29	AGT	59	0528-0554
06.12.2009 08:16	-66,256	-70,434	BASWAP4-**EBS-10D**	515.48	EBS	60	
06.12.2009 09:28	-66,256	-70,434	BASWAP4-CTD10e		CTD	61	
06.12.2009 10:37	-66,256	-70,434	BASWAP4-BC10f		BC	62	
06.12.2009 11:24	-66,256	-70,434	BASWAP4-BONGOA1		BO	63	
06.12.2009 11:41	-66,256	-70,434	BASWAP4-BONGOA2		BO	64	
06.12.2009 12:05	-66,256	-70,433	BASWAP4-N71		N7	65	
06.12.2009 12:25	-66,257	-70,433	BASWAP4-N72		N7	66	
06.12.2009 12:56	-66,256	-70,43	BASWAP4-N73		N7	67	
06.12.2009 13:14	-66,255	-70,428	BASWAP4-N74		N7	68	

06.12.2009 14:37	-66,256	-70,363	BASWAP4-RMT81-1	200-0	RMT	69	
06.12.2009 16:29	-66,256	-70,354	BASWAP4-RMT81-2	400-220	RMT	70	
06.12.2009 19:04	-66,256	-70,353	BASWAP4-RMT81-3	Nr bottom	RMT	71	
06.12.2009 21:56	-66,186	-70,525	BASWAP4-**AGT-11a**	502.05	AGT	72	0555-0580
06.12.2009 22:59	-66,18	-70,536	BASWAP4-**AGT-11b**	499.61	AGT	73	0581-0607
06.12.2009 23:57	-66,187	-70,556	BASWAP4-AGT-11c	491.91	AGT		
07.12.2009 01:07	-66,187	-70,559	BASWAP4-**AGT-11k**	499.94	AGT	74	0608-0631
07.12.2009 02:25	-66,179	-70,542	BASWAP4-**EBS-11D**	492.95	EBS	75	
07.12.2009 03:18	-66,18	-70,545	BASWAP4-CTD11e		CTD	76	
07.12.2009 04:22	-66,179	-70,545	BASWAP4-BC11f		BC	77	
07.12.2009 06:46	-66,256	-70,647	BASWAP4-BC12f	473	BC	78	
07.12.2009 07:31	-66,259	-70,649	BASWAP4-CTD12e		CTD	79	
07.12.2009 08:48	-66,261	-70,641	BASWAP4-**AGT-12b**	509.74	AGT	80	0632-0649
07.12.2009 09:58	-66,258	-70,654	BASWAP4-**AGT-12c**	509.61	AGT	81	0650-0667
07.12.2009 11:16	-66,252	-70,642	BASWAP4-**AGT-12a**	507.88	AGT	82	0668-0679
07.12.2009 12:34	-66,255	-70,648	BASWAP4-**EBS-12D**	507.29	EBS	83	
AREA B							
08.12.2009 09:01	-67,831	-70,843	BASWAP2-**AGT-6a**	588.98	AGT	85	0680-0694
08.12.2009 10:18	-67,828	-70,828	BASWAP2-**AGT-6b**	580.27	AGT	86	
08.12.2009 11:36	-67,825	-70,824	BASWAP2-CTD6e		CTD	87	
08.12.2009 12:33	-67,824	-70,822	BASWAP2-BC6f		BC	88	
08.12.2009 12:59	-67,824	-70,822	BASWAP2-BONGOA1		BO	89	
08.12.2009 13:18	-67,824	-70,822	BASWAP2-BONGOA2		BO	90	
08.12.2009 13:39	-67,824	-70,823	BASWAP2-N71		N7	91	
08.12.2009 13:58	-67,824	-70,824	BASWAP2-N72		N7	92	
08.12.2009 14:12	-67,825	-70,825	BASWAP2-N73		N7	93	
08.12.2009 14:28	-67,825	-70,828	BASWAP2-N74		N7	94	
AREA G							
08.12.2009 17:38	-67,765	-70,064	BASWAP5-RMT81-1	200-0	RMT	95	
08.12.2009 19:34	-67,767	-70,071	BASWAP5-RMT81-2	400-220	RMT	96	
08.12.2009 22:15	-67,764	-70,088	BASWAP5-RMT81-3	Nr bottom	RMT	97	
09.12.2009 01:02	-67,742	-70,167	BASWAP5-BONGOA1		BO	98	
09.12.2009 01:19	-67,742	-70,167	BASWAP5-BONGOA2		BO	99	
09.12.2009 01:42	-67,742	-70,168	BASWAP5-N71		N7	100	
09.12.2009 01:58	-67,742	-70,168	BASWAP5-N72		N7	101	
09.12.2009 02:15	-67,742	-70,168	BASWAP5-N73		N7	102	
09.12.2009 02:31	-67,741	-70,166	BASWAP5-N74		N7	103	

09.12.2009 03:16	-67,741	-70,166	BASWAP5-CTD19e		CTD	104	
09.12.2009 05:17	-67,75	-70,08	BASWAP5-BC19f		BC	105	
09.12.2009 16:02	-67,752	-70,063	BASWAP5-**AGT-19a**	586.23	AGT	107	0694-0716
09.12.2009 17:42	-67,719	-70,058	BASWAP5-**AGT-19b**	463.95	AGT	108	0717-0747
09.12.2009 18:54	-67,692	-69,992	BASWAP5-**AGT-19c**	472.02	AGT	109	0748-0786
09.12.2009 20:26	-67,747	-70,074	BASWAP5-**EBS-19D**	593.85	EBS	110	
09.12.2009 22:04	-67,73	-70,238	BASWAP5-**AGT-20a**	545.59	AGT	111	0787-0818
09.12.2009 23:27	-67,716	-70,4	BASWAP5-**AGT-20b**	588.82	AGT	112	0819-0850
10.12.2009 01:00	-67,755	-70,202	BASWAP5-**AGT-20c**	610.71	AGT	113	0851-0859
10.12.2009 02:17	-67,751	-70,202	BASWAP5-**EBS-20D**	609.99	EBS	114	
10.12.2009 03:13	-67,751	-70,202	BASWAP5- CTD20e		CTD	115	
10.12.2009 04:40	-67,751	-70,202	BASWAP5-BC20f	609	BC	116	
10.12.2009 06:29	-67,553	-70,22	BASWAP5-BC21f	567	BC	117	
10.12.2009 07:15	-67,553	-70,219	BASWAP5-CTD21e		CTD	118	
10.12.2009 08:22	-67,546	-70,189	BASWAP5-**AGT-21a**	507.59	AGT	119	0860-0891
10.12.2009 09:33	-67,537	-70,206	BASWAP5-**AGT-21b**	523	AGT	120	0892-0920
10.12.2009 10:48	-67,526	-70,195	BASWAP5-**AGT-21c**	530	AGT	121	0921-0963
10.12.2009 12:14	-67,537	-70,205	BASWAP5-**EBS-21D**	549.45	EBS	122	
10.12.2009 20:37	-67,801	-67,304	Acoustic calibration		ACO		

16.2 EBS event log

Time	Latitude	Longitude	Station event name	Depth (m)	Speed (kn)	Action	Cable length (m)	Comment
02:42:35 10/12/2009	-67.75077	-70.20220	BASWAP5-EBS-20D	608.92	0.1	EBS on deck	-5	
02:27:26 10/12/2009	-67.75077	-70.20218	BASWAP5-EBS-20D	609.30	0.4	EBS off bottom	618	
02:17:44 10/12/2009	-67.75093	-70.20220	BASWAP5-EBS-20D	609.99	0.4	EBS stop trawling	900	
02:08:00 10/12/2009	-67.75363	-70.20207	BASWAP5-EBS-20D	611.64	1.0	EBS start trawling	900	
02:03:33 10/12/2009	-67.75487	-70.20203	BASWAP5-EBS-20D	609.60	1.0	EBS on bottom	652	
01:49:08 10/12/2009	-67.75885	-70.20185	BASWAP5-EBS-20D	608.12	1.0	EBS of deck	-10	
20:55:17 09/12/2009	-67.74719	-70.07389	BASWAP5-AGT-19D	592.20	0.0	EBS on deck	-8	
20:40:56 09/12/2009	-67.74713	-70.07360	BASWAP5-EBS-19D	595.50	0.1	EBS off bottom	582	
20:26:22 09/12/2009	-67.74716	-70.07360	BASWAP5-EBS-19D	593.85	0.1	EBS stop trawling	880	
20:15:08 09/12/2009	-67.74949	-70.06923	BASWAP5-EBS-19D	589.09	1.0	EBS start trawling	879	
20:10:46 09/12/2009	-67.75048	-70.06736	BASWAP5-EBS-19D	586.47	0.9	EBS on bottom	629	
19:59:01 09/12/2009	-67.75312	-70.06236	BASWAP5-EBS-19D	588.24	1.0	EBS of deck	0	

12:59:08 07/12/2009	-66.25478	-70.64849	BASWAP4-EBS-12D	507.62	0.1	EBS on deck	-5
12:46:11 07/12/2009	-66.25479	-70.64844	BASWAP4-EBS-12D	507.29	0.0	EBS off bottom	527
12:34:56 07/12/2009	-66.25479	-70.64844	BASWAP4-EBS-12D	507.29	0.0	EBS stop trawling	527
12:23:46 07/12/2009	-66.25696	-70.65298	BASWAP4-EBS-12D	506.65	0.9	EBS start trawling	760
12:20:00 07/12/2009	-66.25772	-70.65465	BASWAP4-EBS-12D	505.99	0.9	EBS on bottom	538
12:09:30 07/12/2009	-66.25983	-70.65975	BASWAP4-EBS-12D	505.79	1.0	EBS of deck	-3
02:50:43 07/12/2009	-66.17887	-70.54173	BASWAP4-EBS-11D	495.03	0.2	EBS on deck	-5
02:37:19 07/12/2009	-66.17885	-70.54170	BASWAP4-EBS-11D	495.29	0.2	EBS off bottom	506
02:25:41 07/12/2009	-66.17884	-70.54153	BASWAP4-EBS-11D	492.95	0.8	EBS stop trawling	749
02:15:46 07/12/2009	-66.17951	-70.53487	BASWAP4-EBS-11D	500.62	1.0	EBS start trawling	749
02:11:54 07/12/2009	-66.17974	-70.53225	BASWAP4-EBS-11D	499.26	1.0	EBS on bottom	531
02:00:47 07/12/2009	-66.18035	-70.52489	BASWAP4-EBS-11D	497.55	0.9	EBS of deck	-4
08:41:56 06/12/2009	-66.25553	-70.43431	BASWAP4-EBS-10D	516.08	0.2	EBS on deck	-9
08:27:18 06/12/2009	-66.25558	-70.43430	BASWAP4-EBS-10D	515.64	0.0	EBS off bottom	534
08:16:44 06/12/2009	-66.25560	-70.43419	BASWAP4-EBS-10D	515.48	0.3	EBS stop trawling	748
08:06:56 06/12/2009	-66.25435	-70.42860	BASWAP4-EBS-10D	512.26	1.0	EBS start trawling	750
08:03:02 06/12/2009	-66.25383	-70.42634	BASWAP4-EBS-10D	512.57	1.0	EBS on bottom	540
07:51:00 06/12/2009	-66.25224	-70.41946	BASWAP4-EBS-10D	512.24	0.8	EBS of deck	-5
20:28:45 05/12/2009	-67.08172	-69.40786	BASWAP3-EBS-8D	473.73	0.1	EBS on deck	-6
20:16:11 05/12/2009	-67.08174	-69.40786	BASWAP3-EBS-8D	472.19	0.0	EBS off bottom	495
20:03:38 05/12/2009	-67.08175	-69.40784	BASWAP3-EBS-8D	472.83	0.0	EBS stop trawling	727
19:52:48 05/12/2009	-67.08403	-69.41194	BASWAP3-EBS-8D	473.07	1.0	EBS start trawling	727
19:48:55 05/12/2009	-67.08491	-69.41349	BASWAP3-EBS-8D	472.31	0.9	EBS on bottom	511
19:38:15 05/12/2009	-67.08744	-69.41742	BASWAP3-EBS-8D	474.57	1.0	EBS of deck	-7
10:29:46 05/12/2009	-67.11653	-69.62702	BASWAP3-EBS-9D	528.23	0.3	EBS on deck	-6
10:15:26 05/12/2009	-67.11614	-69.62583	BASWAP3-EBS-9D	532.62	0.1	EBS off bottom	540
10:04:53 05/12/2009	-67.11603	-69.62539	BASWAP3-EBS-9D	531.66	0.9	EBS stop trawling	759
09:54:27 05/12/2009	-67.11461	-69.61910	BASWAP3-EBS-9D	531.13	0.8	EBS start trawling	760
09:50:37 05/12/2009	-67.11414	-69.61698	BASWAP3-EBS-9D	532.46	0.9	EBS on bottom	551
09:36:56 05/12/2009	-67.11222	-69.60876	BASWAP3-EBS-9D	524.74	1.0	EBS of deck	-4
11:48:07 04/12/2009	-67.17475	-69.45122	BASWAP3-EBS-7D	458.26	0.1	EBS on deck	-10
11:35:57 04/12/2009	-67.17474	-69.45123	BASWAP3-EBS-7D	459.85	0.1	EBS off bottom	465
11:22:52 04/12/2009	-67.17476	-69.45123	BASWAP3-EBS-7D	459.49	0.1	EBS stop trawling	660
11:11:52 04/12/2009	-67.17204	-69.44889	BASWAP3-EBS-7D	456.09	1.0	EBS start trawling	660
11:08:21 04/12/2009	-67.17109	-69.44806	BASWAP3-EBS-7D	455.90	1.0	EBS on bottom	471
10:59:00 04/12/2009	-67.16868	-69.44566	BASWAP3-EBS-7D	437.47	1.0	EBS of deck	-6
11:03:13 03/12/2009	-67.97850	-68.43969	BASWAP1-EBS-2D	600.98	0.2	EBS on deck	-4
10:48:04 03/12/2009	-67.97849	-68.43938	BASWAP1-EBS-2D	601.10	0.0	EBS off bottom	632
10:42:32 03/12/2009	-67.97851	-68.43935	BASWAP1-EBS-2D	601.80	0.7	EBS stop trawling	797
10:32:06 03/12/2009	-67.98140	-68.43901	BASWAP1-EBS-2D	589.66	1.0	EBS start trawling	798
10:28:41 03/12/2009	-67.98236	-68.43889	BASWAP1-EBS-2D	571.45	0.8	EBS on bottom	609
10:15:15 03/12/2009	-67.98606	-68.43770	BASWAP1-EBS-2D	567.46	1.0	EBS of deck	-7

05:14:23 03/12/2009	-67.98557	-68.61661	BASWAP1-EBS-3D	472.79	0.0	EBS on deck	-20	
04:59:43 03/12/2009	-67.98556	-68.61663	BASWAP1-EBS-3D	455.87	0.0	EBS off bottom	502	
04:52:43 03/12/2009	-67.98555	-68.61661	BASWAP1-EBS-3D	452.07	0.2	EBS stop trawling	700	
04:41:37 03/12/2009	-67.98342	-68.61169	BASWAP1-EBS-3D	432.09	1.0	EBS start trawling	700	
04:38:14 03/12/2009	-67.98272	-68.61006	BASWAP1-EBS-3D	429.80	1.0	EBS on bottom	514	
04:27:09 03/12/2009	-67.98039	-68.60467	BASWAP1-EBS-3D	428.28	1.0	EBS of deck	0	
18:47:49 02/12/2009	-67.90773	-68.55249	BASWAP1-EBS-1D	479.70	0.0	EBS on deck	-6	doors open
18:34:49 02/12/2009	-67.90775	-68.55251	BASWAP1-EBS-1D	483.95	0.0	EBS off bottom	507	
18:24:15 02/12/2009	-67.90772	-68.55249	BASWAP1-EBS-1D		0.1	EBS stop trawling	800	
18:12:53 02/12/2009	-67.90804	-68.54487	BASWAP1-EBS-1D	499.61	1.0	EBS start trawling	799	
18:08:50 02/12/2009	-67.90816	-68.54191	BASWAP1-EBS-1D	492.70	1.0	EBS on bottom	572	
17:57:07 02/12/2009	-67.90848	-68.53334	BASWAP1-EBS-1D	541.93	1.0	EBS of deck	-11	