RRS Discovery Cruise 255

Metabolism, activity and distribution patterns
in demersal deep-sea fish

14 August – 5 September 2001

Principal Scientist: Phil Bagley

Acknowledgements

I would like to take this opportunity to thank my fellow scientists, officers and crew of RRS Discovery. Through their help, hard work, and humour we had a productive and entertaining cruise. I would especially like to thank members of the Oceanlab team who worked extremely hard to make this cruise happen under difficult circumstances, and Emma Battle for her help with this cruise paperwork and this cruise report.

Phil Bagley

Cover Picture: Sunset from RRS Discovery

Scientific Party

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Rhys Roberts	UKORS - Mechanical
Phil Taylor	UKORS – Instrumentation
Liz Rourke	UKORS - Computing

Ship's Company

Robin Plumley	Master
Peter Sarjeant	Chief Officer
Malcolm Graves	2nd Officer
Karen McAlea	3rd Officer
Ian McGill	Chief Officer
Jim Royston	2nd Engineer
Rob Burdis	3rd Engineer
John Clarke	3rd Engineer
Pete Bennet	CPOD
Andy Maclean	POD
Gary Auld	SG1A
Steve Day	SG1A
Perry Dollery	SG1A
Harry Hebson	SG1A
Ian Thomson	SG1A
Nigel Tuppenney	SG1A
John Smyth	Motorman
John Haughton	Catering Manager
Dave Connelly	Chef
Winston Isby	Chef
Graham Mingay	Steward
Dennis Young	Steward

RRS Discovery 255 scientists and crew

Discovery 255 scientific party, left to right: Pete Bennett, Dave Billett, Martin Collins, Steve Hoskin, Camila Henriques, Alan Jamieson, Chris Wylie, Dave Turner, Amanda Brindley, Phil Bagley, Emma Battle, John Pringle, Murray Ross, Robin Plumley, Nigel Tuppenney, Berhard Hird, Louise Allcock, Ian Hudson, Sheena Jardine, Dave Bailey, Rachel McAllister, Uli Mattheus, Rob McAllen, Phil Taylor, Janine Guinan, Liz Rouke, Dan Mayor, Natacha De Soto Aguillar, Liz White, Rhys Roberts.

Itinerary

Depart: Southampton, Empress Dock — Tuesday 14th August 2001
Arrive: Glasgow, King George V Dock — Wednesday 5th September 2001

Background

The cruise was funded from two sources:

- 21 days by a NERC grant (GR3/12789: Metabolism, activity, and distribution patterns of deep-sea demersal fishes: *In situ* oxygen consumption, activity and fast starts in relation to depth, season and temperature in the NE Atlantic and Eastern Mediterranean) awarded to Priede, Collins & Bagley;
- 2 days by Tim Minshull to undertake dredging. During CD124 (September 2000) dredging was unsuccessfully attempted due to weather constraints. Funding had been secured to make another attempt sampling at sites south west of the Porcupine Seabight (40°30'N; 15°00'W).

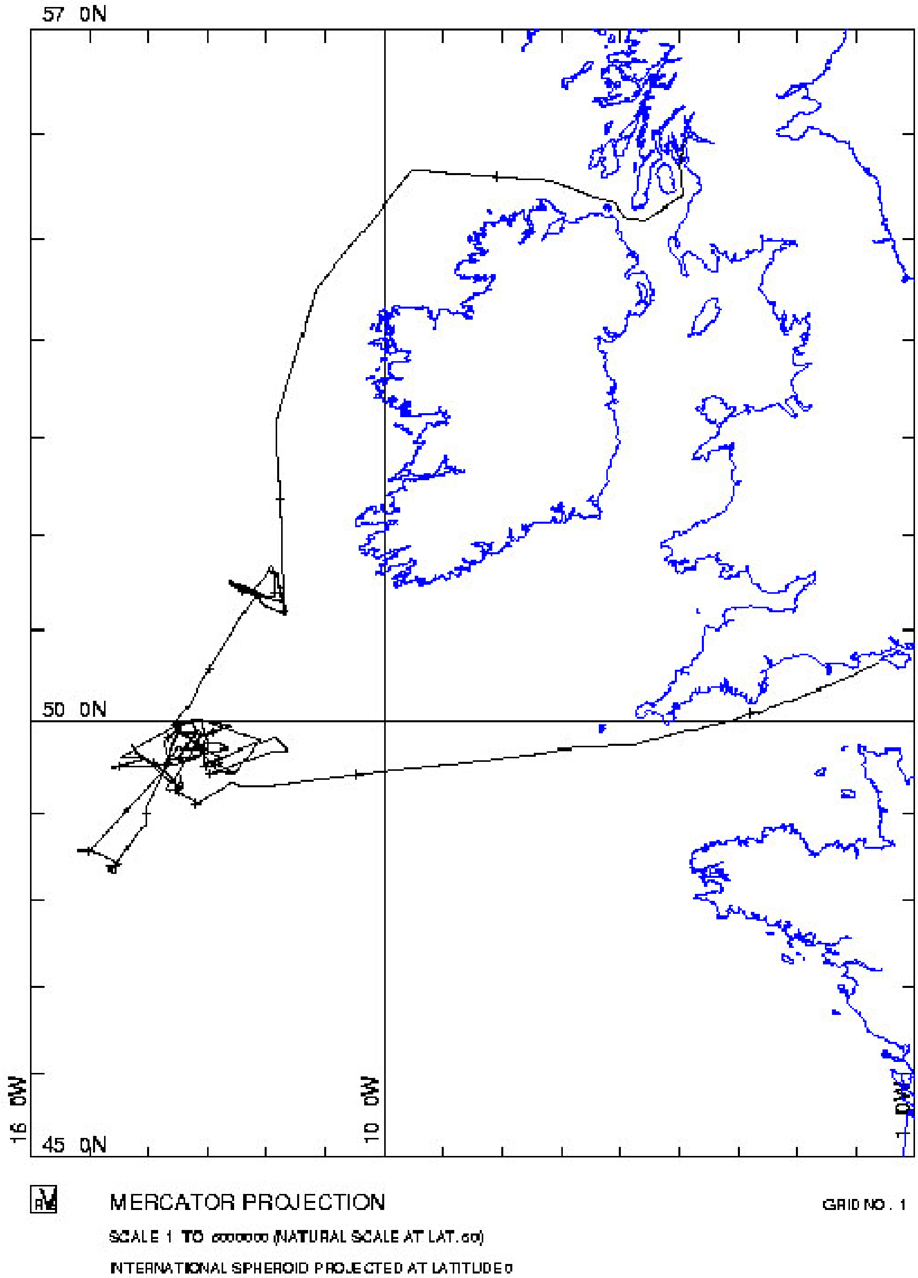
This was the third in a series of 5 cruises. The main objectives of the project are:

1. **Determine routine metabolism and activity of demersal fishes in relation to seasonal and environmental parameters.** This objective to be achieved using autonomous lander vehicles to conduct experiments *in situ* on the ocean floor. The Aberdeen University Deep Ocean Submersible (AUDOS) will collect data on routine swimming speed and three new systems will collect data on:
   - Resting metabolism (FRESP:- Fish RESPirometry Lander);
   - Fish fast start (SPRINT lander);
   - Long term scavenger abundance and activity (DOBO: Deep Ocean Benthic Observatory).
2. **Temporal changes in demersal fish populations in the Porcupine Seabight.** This objective to be achieved using trawl sampling (OTSB) and baited camera data (AUDOS) to examine seasonal and inter-annual changes in the composition of the ichthyofauna.

Specific Objectives

1. Test a new version of the FRESP lander targeting depths around 2500m and 4000m. This new version had a reduced bow wave, timed release and gravity deployed respirometry chamber.
2. Test the new DOBO lander on a short (7 day) deployment. If successful deploy DOBO on a long-term (7 month) deployment to be recovered during our next cruise in March 2002.
3. Deploy AUDOS at depths ranging from 1000m to 4800m to determine bathymetric trends in scavenging fauna.
4. Deploy the ISIT lander to investigate and quantify bioluminescent light at different depths.
5. Use the OTSB to determine the distribution and abundance of fish and invertebrates in the Porcupine Seabight. In addition samples will be used for molecular analysis, enzyme assays and work on brain morphology and visual pigments.
6. Recover Bathysnap
7. Perform 2 days dredging for Tim Minshull

Cruise track of Discovery 255



d255 Cruise Track:

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Cruise Narrative

Tuesday August 14th

11:00 Due to depart SOC, however delay in delivery of MAR71 for bilge system cleansing.
12:05 Departed SOC
14:45 Stern Gland leaking
15:50 Adjustments made and underway. Stern gland performance being monitored.

Wednesday August 15th

09:00 Science meeting with Captain, First officer, CPO, TLO and PSO. Harnesses to be worn for lander operations.
14:00 Science meeting with scientific party in Bar
15:00 Hove to in order to deploy tow fish, underway 5 minutes later.
16:15 Boat drill

Thursday August 16th

07:45 Deploy OTSB (sta. 14132#1)
07:55 Veer stopped. Warp spooler going wrong way, causing warp to snag.
08:20 Veering slowly
09:00 Error corrected, required veer speed achieved
14:00 Trawl in-board
18:26 Commenced acoustic release wire tests on CTD winch. Four releases attached per cast. Bottom water also taken on first cast.
22:15 Second cast

Friday August 17th

07:00 Deployed AUDOS in 4000m deep water. Successful deployment however AUDOS did not sink.
08:30 Recovered AUDOS in strengthening wind conditions. Ballast weights were found to be 35kgs not 40kgs.
10:01 Deployed AUDOS again (sta. 14134#2). This time with three 35kg ballast weights. This time AUDOS sank!
11:48 Prepared ISIT for deployment. Weather conditions deteriorating, work stopped due to bad weather.
15:30 Weather improved, sea state calmed so prepared ISIT for deployment
16:00 Deployed ISIT (sta. 14135#1)
18:37 Deployed FRESP (sta. 14136#1) with 5kgs of bait, weather worsening again.
19:00 Moving West to try to find better weather if found would commence OTSB trawl.
21:00 Weather deteriorating, work stopped.

Saturday August 18th

06:00 Review weather, although moderating still not suitable for lander recovery.
13:01 Weather improved. AUDOS released
14:00 Surfaced
14:40 In board
15:20 Moved to ISIT location and released. Lander very slow to surface.
18:20 ISIT surfaced. One float damaged, probably on deployment.
21:15 Deployed OTSB in approximately 4000m of water.

Sunday August 19th

08:30 OTSB trawl inboard (sta. 14137#1). Catch was low because the ground was much more uneven than the chart suggested.
09:15 Steamed back towards the FRESP site in glorious sunshine and calm seas.

12:47 FRESP released (sta. 14136#1). Surfaced at 14:00 ahead of schedule. Need to go back and learn hydrodynamics!
16:00 Deployed DOBO for a floatation test. Pellet, Dhan buoy and 20 double 6000m syntactic floats deployed. Three floats plus Dhan buoy and pellet on surface. Can remove one float only, leaving a total of six 13kg float total buoyancy. Ballast is 120kgs, positive buoyancy is 78kgs, thus 42kgs of negative buoyancy for deployment.
17:55 Commenced steaming toward AUDOS 2500m location.
21:47 Deployed AUDOS (sta. 14138#1)
23:04 Deployed ISIT (sta. 14139#1)

Monday August 20th
00:41 Deployed FRESP (sta. 14140#1). Increased the strength of the trap release mechanism.
02:00 Shot OTSB trawl (sta. 14141#1) in deteriorating weather
09:30 Trawl on board with loads of fish! Large amount of processing required which lasted until 17:30.
11:30 Released ISIT. Surfaced 1:05h later with no drama, Phew!
12:30 Prepared DOBO for deployment. Mounting of floats on lander greatly helped by Iain (AB) designing a net release system to lower the syntactic spheres into place.
17:32 Deployed DOBO (sta. 14142#1) in worsening weather conditions
18:00 Stood down scientific party due to weather conditions. Review weather at first light.

Tuesday August 21st
19:30 Weather moderated, trawl shot (sta. 14143#1). Very muddy with 150 fish. Scientific party finished processing by breakfast.

Wednesday August 22nd
06:15 Over AUDOS site (sta. 14138#1) released, fine weather, still medium swell.
06:48 AUDOS surfaced
07:30 AUDOS on deck in time for breakfast.
09:08 Over FRESP site (sta. 14140#1) released, seas calming, a day for shorts!
10:30 On surface. Lots wrong. Stirrer motor leaking, valve cables leaking, trap release wire caught underneath trap. Camera and sensor data looks wrong. 30 hours of data missing.
12:30 Deploy ISIT (sta.14144#1). As ISIT current meter flooded, used AUDOS current meter.
16:00 Deploy AUDOS (sta. 14145#1). Sprint current meter used as Aquadopp current meter needed for ISIT as it has a pressure sensor.
20:47 First of two OTSB trawls (sta. 14146#1). Only spent a short time on the bottom, few fish, but a few mid water species!!!

Thursday August 23rd
04:48 Second OTSB trawl (sta. 14147#1). Better trawl
10:46 Recovered ISIT
14:30 Recovered AUDOS. Camera worked OK, after previous film jam. 800 photos.
17:00 SPRINT floatation test. Calm conditions. SPRINT requires 5 double benthos float racks and a Dhan buoy and pellet.
20:20 Deployed ISIT (sta. 14148#1), calm seas, ideal conditions
21:42 After a full system test, fixing cables and camera connector, the FRESP was deployed (sta. 14149#1) one hour ahead of schedule.
23:45 AUDOS deployed. (14150#1) Using spare camera as AUDOS camera jammed again on deck test. Take up spool appears not to be working.

Friday August 24th

02:05 OTSB trawl (sta. 14151#1). Damaged net, hence low fish catch.

10:41 Recovered ISIT in calm seas

13:30 Tried to release AUDOS. Release failed. Although both releases fired and returned acoustic confirmation, the lander remained on the sea floor. Maintained a watch over the AUDOS location while attempting release commands every 30mins. Performed an acoustic survey of the local sea floor topography to determine the possibility of grappling. Acoustic release diagnostic function suggested that the lander was resting on its side and not vertical as would be the normal attitude for a tension mooring. A radio watch was also in operation. Visibility was excellent, and it should have been possible either to see or hear the radio beacon on the buoyancy, if the buoyancy had parted from the instrument package. Although no grappling gear was available there was a possibility that something could be put together, however only a few hundred metres of cable was available when 2km of cable would have been ideal to make up an efficient grapple. Data from the echo sounder survey showed very difficult sea floor topography. Steeply sloping from east to west and also very "hilly" terrain. The AUDOS tension mooring design should allow for this type of terrain, however grappling in these conditions would be very difficult.

21:45 Started steam towards the dredging site. Surface sea currents were sufficiently understood to enable us a reasonable chance of locating AUDOS should it surface while we were off site dredging. We had waited for the deep-sea tidal current to change to determine if this would dislodge the AUDOS from what ever was keeping it on the sea floor.

Saturday August 25th

07:00 Shot first dredge (sta. 14152#1), difficult to find the sea floor. However, over 5000m more cable paid out in 4000m of water depth.

13:30 First dredge on board, only collected mud.

15:00 Shot second dredge (sta. 14153#1)

10:00 Second dredge also returned only mud. Steamed towards third dredge site, deploying ISIT on the way.

Sunday August 26th

01:20 Deployed ISIT (sta. 14154#1), moved off to final dredge site.

05:00 Third dredge on bottom (sta. 14155#1) Martin having a go this time.

10:30 Dredge back in-board, this time plenty of rock!

12:08 Recovered ISIT.

20:30 Steamed back to the AUDOS position to determine if it was still on the sea bed. The lander was still in position and still indicating it was on its side. The possibility of grappling was again discussed but rejected due to the topography of the sea floor and the pressures on time for the remainder of the cruise.

Monday August 27th

03:40 Trawl (sta. 14156#1) on bottom.

10:08 Released DOBO from its 7 day trial deployment. Flag was low in the water, but rest of mooring was fine. At first everything appeared to have worked. Unfortunately the camera was loaded with the film emulsion the wrong way around. So although 1500 photographs were taken none will be able to be processed. ADCP and current meter data looks good.

16:45 Released FRESP. There was a fish caught by the trap. We got good video and were able to see reduced oxygen consumption from the oxygen sensor. The fish caught in the trap had been half eaten by amphipods. This was the first time we achieved this in many previous attempts. A good day!

19:30 Another OTSB trawl (sta. 14158#1) at 4000m

Tuesday August 28th

10:00 OTSB came up ahead of schedule due to an uncharted abyssal hill.
10:30 Fire and boat drill
11:00 Steam to investigate radar detection. Possibility that it may be AUDOS. On approach it was confirmed not to be AUDOS but an unattached buoy with a radar reflector. Authorities informed.
16:45 ISIT released and on the surface at 17:57
20:57 Deployed FRESP (sta.14159#1) in the dark again!

Wednesday August 29th

00:18 Deployed DOBO. Had some problems setting up the ADCP, however worked through it and managed to set it up correctly for a 6 month deployment.
07:54 OTSB trawl (sta. 14161#1) on bottom. Trawl came up with otter boards twisted, caught only 3 fish.
14:43 Deployed ISIT (sta. 14162#1) after steam from trawl location.
15:00 Planned to deploy fish trap first for a float test and then a deployment. However, we did not bring enough floats! Fish trap abandoned.
16:00 Two OTSB trawls back-to-back planned (sorry guys!).

Thursday August 30th

06:02 First OTSB (sta.14163#1)
09:53 Second OTSB (sta. 14164#1)
11:36 At ISIT location (sta. 14162#1)
11:42 Released and surfaced as normal.
12:41 ISIT grappled, but mooring line became caught on rudder as the ISIT mooring passed aft. Screw stopped before mooring passed under the stern quarter. Mooring ended up on port side. Turned ship starboard on bow thruster only.
12:51 ISIT clear aft.
13:07 Lander on-board.
17:13 At FRESP location (sta. 14159#1), and released.
19:12 FRESP on-board.
19:32 Set course for next OTSB trawl via the DOBO site.
21:12 DOBO location confirmed by acoustics, back to recover in March 2002.

Friday August 31st

06:30 Shot OTSB (sta. 14165#1)
13:34 On FRESP site (sta. 14166#1)
14:18 FRESP released, proceeded to ISIT location
18:26 ISIT released (sta. 14167#1)
18:38 Set course for 750m trawl location. Problems with too many fishing ships over proposed trawl location. Moved back to 1500m trawl location.

Saturday September 1st

00:14 Shot OTSB (sta. 14168#1)
04:21 Net in-board, net torn.
06:00 Steam to ISIT location
09:49 ISIT (sta. 14167#1) released
10:50 ISIT on deck. Results showed large amounts of bioluminescence. Very spectacular results. So good that we must do more deployments.
13:01 Released the Bathsnap after a 12 month deployment. Releases worked correctly and all inboard 48mins later.
15:54 Deployed ISIT (sta. 14169#1)
18:15 Shot OTSB trawl (sta. 14170#1)
21:35 Trawl in-board, took avoiding action as vicinity of fishing vessels causing concern. Due to good ISIT results, this was the last trawl. Good catch, very diverse species,

everyone seems happy! Steamed to FRESP site and held station to release FRESP so that it would be on the surface for first light.

Sunday September 2nd

05:40 Last day of science. Released FRESP (sta. 14166#1)
07:14 All in-board.
09:05 Problem with emergency steering gear, speed reduced, and eventually hove-to to enable repair.
10:54 Resumed passage to ISIT location.
11:42 ISIT released (sta. 14169#1).
12:37 ISIT on-board. Ship to remain close to station whilst we "turn round" the ISIT. Not enough time to fully charge batteries. Used hacksaw to remove built in ISIT battery and replaced with a fully charged battery.
14:33 ISIT deployed (sta. 14171#1), Remained on station for recovery.
17:32 ISIT released.
18:28 ISIT in-board, end of science.
18:42 Steam home.

Scientific Reports

1. AUDOS – Photographic Data

Camila Henriques

The AUDOS MK III was deployed as an autonomous vehicle equipped with the Ocean Instrumentation Camera System. Unlike in the previous cruises of this series there was no fish tracking equipment on the lander.
The aims for this trip were to deploy the lander at depths ranging from 1000 to 5000m. Priority focused on the depths studied previously (1000m, 2500m, 4000m) to establish a seasonal comparison. And, time allowing, the next step was to deploy at intermediate depths to achieve a more accurate bathymetry profile of the fish species attracted to baited cameras in the area.
St14134#1, 3977m –To compensate for the absence of the fish tracking system the 13Kg buoyancy was taken off the mooring, the ballast was left at 80Kg. The lander did not sink. Assuming all the calculations for the buoyancy were right a few ballast clumps were weighed. It turned out these clumps were approximately 35Kg, not 40Kg as expected. The AUDOS was re-deployed (14134#2) this time using 3 clumps (~ 105Kg) instead of two. On recovery the floating rope was tangled with the flag mast. A small strip of film was processed which indicated the camera system worked with no problems.
St14138#1, 2448m – The 6.5Kg pellet buoy was replaced with a 13Kg one to avoid tangling of the floating rope. The camera only took 214 shots and the film was heavily jammed.
St14145#1, 2500m – After bench tests with the camera showed no apparent faults it was thought that the previous problem had probably been due to a badly loaded take-up spool. On deployment the camera flashed at irregular intervals but it was too late to stop as the main buoyancy had already been released. It was decided not to bring the lander straight back because given the schedule that was of no advantage. The camera had not jammed and the full film had been used. The small strip of film processed revealed no problems. Although it may have taken photos at random intervals.
St14150#1, 3100m – More camera tests were run to check for problem with time lapse. Flash did go at 60sec intervals however after opening the camera the film was found to have jammed again. AUDOS was deployed using spare camera. The Aquadopp current meter was replaced with the 3DAcm97 Falmouth Instrumentation one. This was because the Sensortek one on ISIT had flooded and the 3DAcm97 does not give a depth reading, which is essential for the ISIT deployments. At the time of recovery both MORS releases were fired. There was no indication of them failing, however the lander did not rise off the bottom.

The ship remained on station for approximately 10hours in case the change of tide at the bottom was enough to free the lander. The AUDOS position was checked every 30 minutes during that period. An acoustic survey of the area was carried out to determine whether it would be possible to drag for the lander. This revealed extremely irregular terrain and therefore little chance of a successful salvage attempt. The lander’s last position was 49°32.8N, 13°37.2W.

2. Bathysnap

David Billett, Phil Taylor, Ian Hudson, Dan Mayor

A Bathysnap time-lapse camera deployed on RRS *Discovery* cruise 250 (27 September 2000, Station 13921#1, 982m) was recovered on 1 September 2001 having been on the seabed for over 11 months. The camera had been set to take 5 photographs per day (a total of about 1700 frames). It was deployed in an area adjacent to a giant coral mound (200m high and c. 1 km in diameter) in the Porcupine Seabight, but still within an area of seabed colonised by the coral *Lophelia pertusa*. The work was part of the EU-funded Atlantic Coral Ecosystem Study (ACES) project.

The Bathysnap was released from the seabed at the first time of asking at 1200H GMT. It ascended at a speed of about 1m per second and was at the surface at 1214H. Recovery went smoothly and the Bathysnap was inboard by 1255H. One of the pyro releases had not fired and was discarded. Everything appeared to be in order with the camera and flash, although the camera had not been set in the correct orientation during the deployment on September 2000.

Various pieces of old *Lophelia pertusa* and clamshells had been strapped to the Bathysnap frame on deployment and there was some colonisation of these substrates. This included one small piece of fresh growth of *Lophelia*. There were also other fragments of *Lophelia* present but these appeared to not have formed by colonisation of the old coral surface. Hydroids had colonised much of the Bathysnap frame, mooring line and buoyancy.

3. Deep Ocean Benthic Observer (DOBO)

David Bailey, Alan Jamieson, John Pringle, Phil Bagley

The DOBO lander is a long-term vehicle designed to operate overwinter in depths of up to 6000m. This vehicle consists of a titanium frame and is capable of supporting a range of experimental payloads.

We are using this platform to investigate the fate of large food falls in the deep-sea, in this case Harbour Porpoise carcasses. The present experiment utilises a 35mm stills camera, Acoustic Doppler Current Profiler and current meter. Photographs at 3hr intervals for 6 months will create a high-resolution photographic record of the consumption of the food fall. Throughout the deployment the hydrographic conditions (current velocity and direction in three dimensions) and extent of the benthic boundary layer will be recorded at 30min intervals by the ADCP and current meter.

Deployment 1

For deployment 1 a Harbour Porpoise was attached to a stretcher in view of the camera. The camera was set to fire at seven minute intervals. Both the current meter and ADCP were set to intervals of one hour. The DOBO was deployed on 20/08/01 at 50^o 00' 96N, 13^o 17' 06W (2555m) for seven days where upon it was recovered, establishing a descent rate of $30m.min^{-1}$ and an ascent rate of $32m.min^{-1}$. On recovery it was found that due to incorrect loading of the camera film it had in fact not taken any pictures. All other activities were completed successfully with useful lessons being learnt prior to the main deployment. The carcass of the porpoise used during the test deployment was recovered and dissected in order to investigate the process of consumption.

Deployment 2 (Station 14160)

For deployment 2 another Harbour Porpoise was attached to the stretcher in view of the camera. The camera was set to an interval of every 3 hours. Both the current meter and ADCP were set to intervals of one hour. The DOBO was deployed on 29/08/01 at 49^o 59' 00N 13^o 32' 59W (2710m) with the intention of recovering the vehicle in early 2002.

4. Fish Respirometer (FRESP)

David Bailey, Alan Jamieson, John Pringle, Phil Bagley

Version three of the fish respirometer was deployed for the first time during D255 (see summary of the deployments below). Very few measurements of deep-sea fish metabolism exist, and given the problems we have experienced it is becoming increasingly obvious why.

FRESP 3 consisted of a polycarbonate chamber which dropped over fish feeding at bait. Water was drawn from the chamber across a Seabird “Beckman” type oxygen electrode. 300 minutes of oxygen measurements were taken per deployment of which 100 were from the chamber. The remaining 200 minutes were used to allow the sensor to stabilise and to correct for sensor drift by measuring ambient water oxygen content.

Fish behaviour before and after trapping was recorded using a digital video camera. Trapping, oxygen measurement and video recording were controlled by an onboard computer.

Deployment summary

Deployment	Depth	Result
14136	4000	Trap dropped early – no fish caught. Other systems worked allowing control measurements to be obtained. Trap modified.
14140	2507	No fish caught Controller malfunction prevented video or sensor recording.
14149	3975	Caught one large (720mm) *C. armatus*. Trap modified to reduce flushing of chamber.
14159	2557	Caught two *C. armatus*. Data not fully analysed yet but appears to be spoilt by a jellyfish partially blocking the sensor intake tube. Modifications made.
14166	1418	Trap dropped over several eels, but damage during deployment meant that all escaped.

We now have a system that consistently catches fish and has been tested across our operational depth range. An upgraded version of the trap will be developed and tested overwinter in our new facility at Newburgh to be deployed in March 2002.

5. ISIT – Bioluminescence Observations

Emma Battle, Phil Bagley, Monty Priede, Martin Collins

Background

The ISIT lander was successfully deployed on Discovery cruises 243, 250 and 252 to examine the presence of bioluminescence both in the water column and just above the sea floor using an ISIT (Intensified Silicon Intensifying Tube) camera. The primary aim of this cruise was to perform a number of deployments in the bungee mode to examine the changes in bioluminescence over as great a depth as possible. This would also allow any seasonal changes) between this cruise and the data collected in April to be observed.

During D250 a large number of bioluminescent events were observed from one deployment at 1000m. It was hoped that on the homeward run of D255 several baited deployments could be performed at or near this site to try to repeat these findings. If time allowed other baited deployments at a range of depths would also be performed.

Work undertaken

A total of 10 deployments were performed using the ISIT in both the baited (500g of mackerel) and bungee configurations. The first 6 deployments (2500, 2800, 4000 and 4800m) used the bungee set-up. These results will be analysed more fully on return to Aberdeen, to examine the change in the number of bioluminescent events with depth.

The next four deployments were in the baited mode (1000 and 1500m). Deployment 7 showed very little bioluminescence, whereas the next deployment at the position of the successful drop in D250 showed large, long lasting events. Deployment 9 was positioned further north along the 1000m contour, but unfortunately yielded relatively little bioluminescence by comparison with the previous drop. The final deployment used traps to bring back luminescent organisms for identification.

Future work

The baited deployments showed the presence of bioluminescence on the 1000m contour. During the next cruise in April 2002, further deployments at 1000m will again try to repeat and clarify the results obtained during this cruise and D250. A method to collect and identify the luminescent organisms from both baited and bungee set-ups needs to be investigated.

I would like to thank Team ISIT (John, Alan, Amanda, Louise, Janine and Ian) for their help in deploying the lander. Without them we would not have been able to deploy as efficiently as we did. Thanks especially to Dave and Rob for their help and suggestions during the last few deployments.

6. Other Landers

David Bailey, Alan Jamieson, John Pringle, Phil Bagley

Sprint

The Sprint lander is a new vehicle designed to investigate "fast-start" performance in deep-sea fish. Due to time pressure no deployments were possible, though a buoyancy test was carried out using Benthos Spheres. A total buoyancy of 225kg plus Dhan buoy and pellet buoy was required.

Fish Trap

The fish trap was included in D255 with the intention of investigating other possible techniques in *in-situ* fish respirometry. 5mm thick PVC plates were fitted to the inside of the funnels to establish whether or not deep-sea fish will swim though them. Miscalculations in the trap weight compared to available buoyancy, together with time restrictions resulted in the fish trap not being deployed.

7. Proprietary electronic equipment

John Pringle

Acoustic Releases

Thirteen Mors acoustic releases were taken on the cruise, seven RT and six AR models, eleven allocated to landers and two spares. All had batteries renewed just prior to departure and bench tested, they were again bench tested on board prior to depth testing. Only the ten allocated Mors releases were depth tested at 3400m along with one Sensordine acoustic release under evaluation, all were successfully activated. All releases functioned satisfactorily during the cruise apart from the RT on the ISIT (RT 384) which failed to make a full revolution of the release mechanism on several occasions, this needs to be looked at on return to Oceanlab.

Current Meters

Four current meters were taken , one Nortek Aquadopp, one Sensortec UCM-60 and two Falmouth Instrument 3Dacm97. The UCM-60 flooded on its second deployment on the ISIT lander and was replaced with one of the 3Dacm97. The UCM-60 was inspected and rinsed out with fresh water to minimise further corrosion and further detailed inspection will be carried out upon return to Oceanlab. The data from the Nortek Aquadopp appeared to be bit “noisy” and should be looked at upon return. Also, as we have never deployed the 3Dacm97s before the data should be closely examined to ascertain validity.

Cameras

Both still and video cameras were used on the cruise, the still cameras were Ocean Instrumentation M7 deep-sea cameras and the video camera was a custom built digital unit. The stills cameras were deployed on both AUDOS and DOBO, the digital unit on the FRESP. The AUDOS camera was lost after two successful deployments. For the stills camera’s first week long deployment on the DOBO it was loaded with high capacity spools capable of holding twice the usual amount of film, some 61m. This necessitated the splicing of two reels of film, and the construction of a splicing jig. The camera was programmed to take a picture at seven minute intervals on the first deployment, and took some 1500 frames. However due to operator error the film was incorrectly loaded resulting in no developable pictures. The second DOBO deployment was to be for approx. six months so picture interval was set at three hours.

ADCP

This was the first time we had deployed the acoustic Doppler current profiler, once again the first deployment was for seven days, current sampling was set for once every hour with 33 sample locations, one every three metres. Initial analysis of the data looked good, but with limited range, though this had been expected due to low level of ‘scatterers’ present at depth. The second deployment was for six months, sampling parameters exactly the same as for the first.

8. Dredging

David Billett, Martin Collins, Ian Hudson, Dan Mayor

Three rock dredge deployments were made in an area of the Porcupine Abyssal Plain to the south of the main working area for cruise D255. These dredges were undertaken for Dr Tim Minshull, Southampton Oceanography Centre, in support of his geophysical research on the structure and formation of the continental margin in the vicinity of the Goban Spur. In each case the dredges attempted to sample rocks on some abyssal hills that rose some 1000m above the general surface of the abyssal plain (c. 4800m).

The first two deployments were unsuccessful. Although the pipe of the rock dredge was full of abyssal mud, the basket was empty in each case. In one of the pipe samples, however, a sipunculid worm was recovered in exceptionally good condition.

The third dredge (St. 14155#1) was successful. After a few “bites” on rocks in quick succession the dredge stuck fast on the bottom. All way was taken off on the ship. Over the next hour the ship gradually went astern while the wire was hauled in. When the ship was almost over the point where the dredge was stuck (the pinger showed a height above bottom of about 150m), the tension on the wire released very suddenly. On recovery of the dredge, it was found that only the first weak link had parted and that the dredge basket has a sample of one rock and many pebbles. The dredge tube had a mixture of small pebbles and thick, cold, clammy mud. This sample included the stem of a sea lily, *Bathycrinus*.

The rock recovered by the third dredge was about 30cm in its largest dimension and had two distinct surfaces, one black and nodular and the other with evidence of a few channels about 5mm in diameter. This surface was also rather white, with traces of pink, and had a gritty feel.

9. OTSB Trawl Operations

Martin Collins, Dave Billett

The OTSB (Marinovich Semi-Balloon Otter Trawl) was deployed on 16 occasions to collect samples of fish and invertebrates. Minor modifications were made to the shooting and hauling procedures to increase the safety, most notably during recovery the stern rail was left up until the transfer on to the auxiliary winches had been achieved. In general the trawl performed well, although the absence of a net monitor system made it difficult to determine when the net was on the seafloor. The net was damaged during station 14151#1, but was repaired by Perry Dollery and Louise Allcock. Further damage occurred during station 14168, when the cod end was torn away from the rest of the net and was hauled in separately on the lazy decky. The spare net was used for the final trawl station (14170) and obtained a small tear in the belly.

The good weather encountered during much of the cruise provided the opportunity to train new staff on the preparation, shooting and hauling of the gear. During the cruise Ian Hudson, Steve Hoskin, Dan Mayor and Rob McAllen were trained in preparing the gear and Ian Hudson is now capable of overseeing the hauling and shooting operations and has experience of monitoring the net on the sea floor.

10. Processing fish from OTSB trawls

Amanda Brindley, on behalf of Aberdeen University

Background

An important aspect of the work carried out by Aberdeen University on this series of cruises is to investigate any seasonal patterns in the distribution, abundance, metabolism and reproductive cycles of deep-sea fish. The OTSB trawls provide a means by which this can be achieved.

Methods

All fish from the trawl were identified, weighed and measured and given an individual identification number. Once numbered the fish were distributed to the other working groups so specific tissue, eye, and brain samples could be recovered. Fish were kept on ice at all times to help maintain tissue samples. Following the removal of tissue samples each fish was sexed and the level of reproductive maturity assessed. Mature animal gonads were removed and preserved in formalin. Stomach content level was determined and any full stomachs were frozen for later analysis. Otoliths were recovered from a sample of all species except eels.

11. Fish fauna of the Porcupine Seabight and Porcupine Abyssal Plain

Martin Collins, Emma Battle.

Fifteen otter trawls were undertaken during the cruise, producing a varied collection of invertebrate fauna from depths between 775 and 4311m. The dominant fish fauna from each trawl are described below and listed in Table 1. A total of 57 demersal species were caught. The fish catches were used to determine seasonal changes in distribution and condition of the dominant species and to provide samples for a variety of studies, including taxonomy, trophic ecology, enzyme activity, brain morphology, melatonin distribution and production, otolith biochemistry and reproductive biology.

Station 14132#1; 16/8/01
1131 – 1158m
A reasonable fish catch, dominated by the morid *Lepidion eques*, but also including a good sample of *Coryphaenoides rupestris*, *Synaphobranchus kaupi*, and *Phycis blennoides*. Of particular interest was a redfish tentatively identified as *Trachyscorpia cristalata*, but did not precisely fit the description of this species.

St. 14137#1
4108 – 4146 m
As expected at this depth the catch was dominated by the grenadier *Coryphaenoides armatus*, but also included *C. leptolepis* and single specimens of *Bathysaurus mollis, Spectrunculus grandis, C. profundicola* and *Histiobranchus bathybius.*

St. 14141#1
2432 - 2494 m
The net was on the bottom for about 5km. Apart from a good catch of fish, there were several bottles, cans and a broken plate mixed in with a considerable amount of clinker and stones. The fish catch was dominated by the slope grenadier *Coryphaenoides guntheri*, but also included good samples of *Antimora rostrata*, *Halosauropsis machrochir, C. armatus* and *S. grandis*.

St. 14143#1
2275 – 2308m
A diverse fish catch from the upper slope, again dominated by *C. guntheri*, but also included a good catch of *A. rostrata* and five species of Alepocephalidae.

St. 14146#1
1625 – 1672m
Trawled at 3 knots to reduce the amount of mud collected, but the net was probably only briefly on the bottom and produced a disappointing fish catch.

St. 14147#1
1515 – 1520m
The second most diverse fish catch of the cruise, with 18 different species, and a good sample of the cut-throat eel, *Synaphobranchus kaupi* and the morid *A. rostrata*. Catch also included 10 large skate eggs (probably *Bathyraja richardsoni*), two of which contained early embryos.

St. 14151#1
1915 - 1976m
Relatively small catch, as the net was torn on the belly and probably not on the bottom for long. The eel, *S. kaupi* and the grenadier *C. guntheri* were the most abundant fish.

St. 14156#1
3089 – 3186m
Fish catch dominated by the grenadier, *C. armatus*, but also notable for a large *S. grandis* (930mm) and single specimens of *Bellocia keofedi* and *B. michaelsarsi.*

St. 14158#1
4286 – 4311m
While most of this sample came from the abyssal plain, the trawl also clipped the top of the abyssal hill. When the trawl was recovered on deck it was clear that some sort of impact had occurred because 5 of the bottom line bobbins had been smashed and the casing for the headline buoyancy sphere had also suffered some damage. The ichthyofauna was again dominated by the grenadier *C. armatus*, but also included *S. grandis*, *H. bathybius* and *C. leptolepis*.

St. 14161#1
1421 – 1468m
Rather disappointingly the catch from this depth was rather poor. It is likely that the net had not reached the seabed before trawling speed was established. In an attempt to get the net onto the seabed more wire was paid out. It is likely that the trawl doors crossed over at this stage closing the mouth of the net. The only fish caught was a single specimen of *Neocyttus helgae* (Oreosmatidae) which is relatively rare.

St. 14163#1
1340 – 1397m
The fish catch was a rather small fraction of a large catch dominated by sponges and holothurians. The most abundant fish was the morid *Lepidion eques*, but also included the upper slope grenadier *Nezumia aequalis* and the eel *S. kaupi*.

St. 14164#1
1022 – 1084m
A small fish catch, dominated by the cut-throat eel *S. kaupi*. Also included a good sample of *L. eques* and *N. aequalis*.

St 14165#1
1414 – 1509m
The most diverse catch (19 species) of the cruise, numerically dominated by the eel *S. kaupi*, but with good catches of *C. rupestris*, *T. murrayi* and *C. guntheri*.

St 14168#1
1498 – 1544m
Net snagged on the seafloor, causing the cod-end to be separated from the rest of the net, and hence producing a small catch of *S. kaupi*, *C. rupestris*, *C. guntheri* and *Coelorhynchus labiatus*.

St 13970#1
775 – 842m
The tension trace during the trawl indicated that it had been snagged on the seabed several times and, perhaps, had become entangled on the seabed. The net was indeed torn, but not as much as had been expected, and in the cod end there were some enormous boulders, which caused some damage to the fish catch. The ichthyofauna was dominated by the grenadier *N. aequalis* and the morids *Mora moro* and *L. eques.*

Table 1. Deep-sea demersal fish species caught in the Porcupine Seabight and on the Abyssal Plain.

Species	Code	Stations caught at:
Coryphaenoides armatus	COA	14137, 14141, 14143, 14156, 14158
Coryphaenoides guntheri	COG	14141, 14143, 14147, 14151, 14165, 14168
Coryphaenoides rupestris	COR	14132, 14147, 14163, 14164, 14165, 14168, 14170
Chalinura profundicola	COP	14137
Chalinura leptolepis	COL	14137, 14156, 14158
Chalinura mediteranea	COM	14146, 14147, 14151
Chalinura brevibarbis	COB	14141, 14143
Lionurus carapinus	COC	14156
Nezumia aequalis	NEA	14163, 14164, 14170
Coelorhinchus labiatus	CLL	14132, 14146, 14147, 14163, 14165, 14168
Trachyrincus murrayi	TRM	14163, 14165, 14168
Trachyrinchus trachyrinchus	TRT	14170
Antimora rostrata	ANR	14141, 14143, 14146, 14147, 14151,
Lepidion eques	LEE	14132, 14147, 14163, 14164, 14165, 14170
Mora moro	MOM	14132, 14164, 14170
Molva dipterygia	MLD	14165
Phycis blennoides	PHB	14132
Helicolenus dactylopterus	HED	14170
Spectrunculus grandis	SPG	14137, 14141, 14143, 14156, 14158
Cataetyx laticeps	CAL	14132, 14143, 14165
Lycodes crassiceps	PAC	14132, 14141
Hoplostethus atlanticus	HOA	14147, 14165
Neocyttus helgae	NEH	14161, 14165
Trachyscorpia cristulata	TSC	14132
Cottunculus thompsoni	COT	14132, 14147
Epigonus telescopus	EPT	14170
Aphanopus carbo	APC	14164
Lophius piscatotius	LOP	14170
Notacanthus bonapartei	NOB	14141, 14147, 14165
Polyacanthanotus rissoanus	POR	14165
Halosauropsis macrochir	HAM	14141, 14143, 14146, 14147, 14151, 14156,
Alepocephalus agassizii	ALA	14132, 14163
Alepocephalus bairdii	ALB	14132, 14146, 14147, 14165
Alepocephalus productus	ALP	14141, 14143, 14165, 14168
Alepocephalus rostratus	ALR	14143, 14165, 14168
Bathylaco nigricans	BLN	14143
Bathytroctes microlepis	BTM	14143
Bellocia koefedi	BEK	14156
Bellocia michaelsarsi	BEM	14156
Conacara macroptera	CNM	14146, 14147,
Conacara murrayi	CNR	14143, 14146
Narcetes stomias	NAS	14141
Xenodermichthys copei	XEC	14151, 14164
Bathysaurus ferox	BSF	14141, 14143, 14147, 14151
Bathysaurus mollis	BSM	14137
Bathyterois dubius	BPD	14132, 14146, 14147, 14151, 14168
Synaphobranchus kaupi	SYK	14132, 14146, 14147, 14151, 14163, 14164, 14165, 14168, 14170

Histiobranchus bathybius	HIB	14141, 14151, 14156, 14158
Galeus melastomus	GLM	14170
Centroscymnus coelolepis	CEC	14147
Bathyraja richardsoni	BRR	14141
Raja bigelowi	RAB	14147, 14151
Raja fyllae	RAF	14170
Chimaera monstrosa	CHM	14163, 14168
Hydrolagus mirabilis	HYM	14132
Rhinochimaera atlantica	RHA	14165
Myxine ios	MYI	14147

12. Invertebrate fauna of the Porcupine Seabight and Porcupine Abyssal Plain

Louise Allcock, David Billett, Martin Collins, Rob McAllen

Fifteen otter trawls were undertaken during the cruise, producing a varied collection of invertebrate fauna from depths between 775 and 4311m. The dominant invertebrate fauna from each trawl are described below. The samples were used for a number of studies, including feeding biology of deposit feeders (principally holothurians), the physiology and feeding biology of decapod crustaceans, the feeding biology of asteroids and molecular taxonomy.

Station 14132#1
1131 – 1158m

An exceedingly large catch indicating that the trawl had been on the seabed for a long time, perhaps as long as 90 minutes. It was dominated by the holothurian *Laetmogone violacea*, with a number of other echinoderms, notably another holothurian *Bathyplotes natans*, the asteroids *Plutonaster bifrons*, *Zoroaster fulgens* (thick arm form), *Psilaster andromeda*, and the echinoids *Cidaris cidaris*, *Echinus* ?*elegans, Phormosoma placenta* and *Spatangus raschi*. Other animals in the catch included the anemones ?*Bolocera tuediae* and ?*Amphianthus sp*., solitary corals (Madreporaria), the asteroid *Brisingella coronata*, the gastropod ?*Troschelia*, the hermit crab *Parapagurus pilosimanus* and its commensal zoanthid, some other crustaceans (*Nephropsis atlantica, Geryon trispinosus, Polycheles* sp. and *Munida* sp.), the holothurians *Mesothuria* ?*intestinalis* and *Stichopus tremulus*, the cirrate octopod *Opisthoteuthis massyae* and some unidentified asteroids.

St. 14137#1
4108 – 4146 m

The sample contained a good mixture of invertebrates and a lot of clinker, which affected the quality of the sample. The holothurians *Amperima rosea*, *Pseudostichopus villosus* and *Deima validum* and the asteroid *Freyella elegans* dominated the invertebrates. A number of other holothurians occurred, notably *Peniagone diaphana*, *Psychropotes longicauda*, *Oneirophanta mutabilis*, *Molpadia blakei*, *Pseudostichopus* sp. and *Benthothuria funebris* as well as the asteroids *Dytaster grandis*, *Paragonaster subtilis*, *Styracaster* sp., *Pteraster* sp. and a single small specimen of what is believed to be a new species of *Hymenaster*. Crustaceans, actiniarians and scaphopods were also quite common. Of note in the crustaceans was the hermit crab *Parapagurus* sp. (perhaps both *P. abyssorum* and *P.nudum*) living in association with both an actiniarian and a zoanthid, and several species of *Munidopsis*. A single specimen of *Plesiopennaeus armatus* was also collected. There were several species of actiniarian including what looked like several specimens of *Sicyonis* sp. Two pycnogonids were also sampled.

St. 14141#1
2432 - 2494 m

The net was on the bottom for about 5km. Apart from a good catch of fish, there were several bottles, cans and a broken plate mixed in with a considerable amount of clinker and stones. Madreporarian solitary corals, the asteroid *Hymenaster membranaceus* (*H. pellucidus*) and the ophiuroid *Ophiomusium lymani* were notable by their abundance. Of the crustaceans there were quite a number of *Munidopsis* ?*rostrata* and *Glyphocrangon sculpta*. A single soft-bodied specimen of *Neolithodes grimaldii* was also caught. Other important invertebrates were echiurans, the asteroid *Bathybiaster vexillifer,* the holothurians *Benthothuria funebris* and *Molpadia blakei*, cirripede barnacles, a few echinoids (*Echinus* sp.), a large polychaete, gastropods and a few actiniarians.

St. 14143#1
2275 – 2308m
A catch dominated by the holothurian *Benthogone rosea*, the ophiuroid *Ophiomusium lymani*, and madreporarian solitary corals. There were also several asteroids (*Plutonaster bifrons*, *Benthopecten simplex*, *Pectinaster filholi* and *Hymenaster membranaceus*), echinoids (*Echinus* sp.), crustaceans (*Glyphocrangon sculpta*, *Munidposis* ?*rostrata*, ?*Polycheles* sp., juvenile *Geryon trispinosus* and a very small *Neolithodes grimaldii*), holothurians (*Paelopatides grisea*), actiniarians and gastropods. The catch was also notable for the number of stones and clinker collected.

St. 14146#1
1625 – 1672m
This trawl was fished at 3 kts to try and reduce the amount of mud that we had sampled in previous trawls. It certainly did that, but also it reduced the total catch and only a small sample was obtained, dominated mainly by the holothurians *Benthogone rosea* and *Paelopatides grisea*. The catch was also notable for the actiniarians, madreporarians, gastropods, the ophiuroid *Ophiomusium lymani* and a very large crustacean *Neolithodes grimaldii*, which took a long time to be extracated from the net. There were several asteroids (*Plutonaster bifrons* and juvenile *Pectinaster filholi*), crustaceans (*Glyphocrangon sculpta*, *Polycheles* sp. and *Parapagurus* sp.) as well as a number of echinothuiriid echinoids (*Phormosoma placenta* and ?*Hygrosoma* sp.). Many small, orange ophiuroids occurred on the clinker.

St. 14147#1
1515 – 1520m
This trawl followed on directly from the previous trawl and produced a much better catch. It produced a monster catch of holothurians, mainly *Benthogone rosea*, once more, and *Paroriza pallens* and the ophiuroid *Ophiomusium lymani*. Several of the *Paroriza pallens* were very small specimens. There was also a large pennatulid (?*Umbellula* sp.), actiniarians (including *Actinoscyphia aurelia*), madreporarians, gastropods, crustaceans (*Parapagurus* sp., *Polycheles* sp., *Glyphocrangon* sp.) and a number of different asteroids, including *Plutonaster bifrons*, *Persephonaster patagiatus* and *Ceramaster grenadensis*.

St. 14151#1
1915 - 1976m
Another catch dominated by the holothurian *Benthogone rosea*, with some *Paelopatides grisea*. The catch was also notable for several actiniarians and for the abundance of echinothuriid echinoids of at least 2 species, some in moderately good condition. There were several pycnogonids, the asteroids *Plutonaster bifrons*, *Persephonaster patagiatus*, and *Pecinaster filholi*, the ophiuroid *Ophiomusium lymani* and the crustaceans *Glyphocrangon sculpta* and ?*Polycheles* sp.

St. 14156#1
3089 – 3186m
Although it appeared that the net had been on the seabed for a long time, the catch was not particularly large. There was a lot of clinker and a fair sample of old bottles too. Many of the clinker pieces, particularly the larger ones, had been colonised by actiniarians. Apart from the actiniarians, including one exceptionally large specimen (?*Sicyonis* sp.), there were several holothurians, notably *Benthothuria funebris*, as well as *Psychropotes depressa*, *Molpadia blakei* and an orangy-pink *Peniagone* sp. The catch was also notable for echinothuriid echinoids (?*Hygrosoma* sp.), a number of asteroid species and echiuran worms. Gastropods were abundant as were hermit crabs (*Parapagurus* sp.) in their empty shells. Three large specimens of the spider crab *Neolithodes grimaldii* was also collected. A single deep water squid, *Bathyteuthis abyssicola* was also captured.

St. 14158#1
4286 – 4311m
While most of this sample came from the abyssal plain, the trawl also clipped the top of the abyssal hill. When the trawl was recovered on deck it was clear that some sort of impact had occurred because 5 of the bottom line bobbins had been smashed and the casing for the headline buoyancy sphere had also suffered some damage.

The sample was full of clinker and a large number of stones, many colonised by a number of different species of actiniarians. Actiniarians were a feature of the trawl including a number of large *Sicyonis* sp. The trawl was also notable for the high number of the holothurian *Amperima rosea*, as well as a number of other sea cucumbers, including *Psychropotes longicauda*, *Oneirophanta mutabilis*, *Pseudostichopus villosus*, *Peniagone diaphana*, *Deima validum*, *Molpadia blakei*, an orangy-red *Peniagone* sp., and the rare apodid *Protankyra brychia*. The asteroids *Dytaster grandis*, *Styracaster* spp., *Freyella elegans*, *Hymenaster* sp. nov. were also common. Of the crustaceans, *Munidopsis* spp. and species of the hermit crab *Parapagurus* sp. occurred. The tunicate *Culeolus* sp., sipunculids, scaphopods and gastropods were common. Rarer animals of note included a pycnogonid, a few *Pteraster* spp. (Asteroidea), madreporarians and polychaetes.

St. 14161#1
1421 – 1468m
Rather disappointingly the catch from this depth was rather poor. It is likely that the net had not reached the seabed before trawling speed was established. In an attempt to get the net onto the seabed more wire was paid out. It is likely that the trawl doors crossed over at this stage closing the mouth of the net. The small catch was caught up mainly in the mesh of the net and included the asteroids *Zoroaster fulgens* and *Plutonaster bifrons,* sponges and the holothurians *Bathyplotes natans* and *Mesothuria* sp. nov.

St. 14163#1
1340 – 1397m
On recovery of the net it was found to have a particularly large catch, mainly of sponges (*Pheronema grayi* and another species, ?*Thenea* sp.) and holothurians (*Laetmogone violacea*, *Paroriza pallens*, *Bathyplotes natans*, *Mesothuria lactea* and *Mesothuria* sp. nov.). There were a number of other invertebrates, most notably the asteroids *Plutonaster bifrons, Zoroaster fulgens, Hymenaster giganteus* and *Ceramaster grenadensis*, the echinoids *Echinus* sp. and *Phormosoma placenta*, the cephalopods *Benthoctopus normani*, *Opisthoteuthis massyae* and *Gonatus steenstrupi*, actiniarians and gastropods, as well as a reasonable amount of clinker.

St. 14164#1
1022 – 1084m
A shallower trawl was then carried out and sampled a good catch of echinoids (*Spatangus raschi*, *Echinus* sp., *Cidaris cidaris*), asteroids (*Stichastrella rosea*, *Psilaster andromeda*, *Brisingella coronata*), holothurians (*Laetmogone violacea* and *Stichopus tremulus*), crustaceans (*Parapagurus* sp.), actiniarians and two cephalopods (*Ommastrephes bartrami* and *Gonatus steenstrupi*).

St 14165#1
1414 – 1509m
Following a 10-hour steam to the northeast of the Porcupine Seabight another trawl was made on relatively flat ground at mid-slope depths. A good-sized and varied catch was obtained consisting mainly the holothurians *Benthogone rosea* and *Paroriza pallens*. Of particular note, however, were several specimens of the suspension-feeding asteroid *Brisinga endecacnemos* and three excellent and large individuals of *Hymenaster giganteus*. The

sample also contained other holothurians (*Bathyplotes natans*, *Mesothuria lactea* and *Laetmogone violacea*), and asteroids (*Zoroaster fulgens* and *Plutonaster bifrons*), echinoids (*Phormosoma placenta*), pycnogonids, actiniarians, sponges (?*Thenea* sp.), cirripedes, ophiuroids and polychaetes.

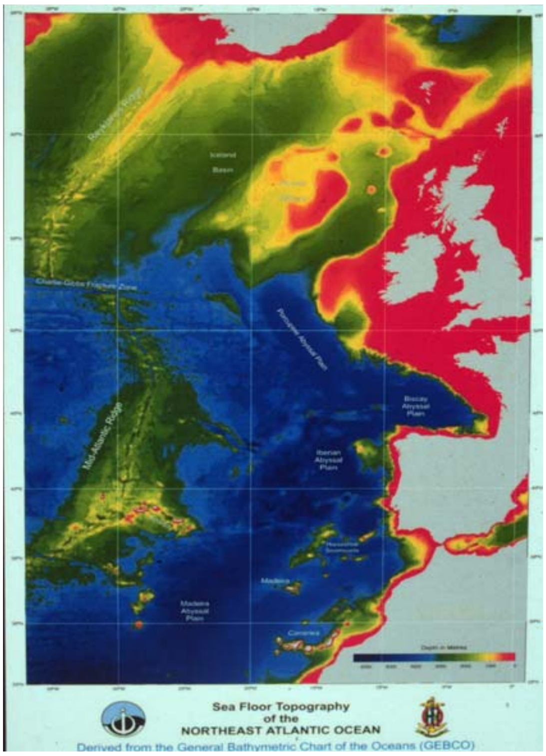
St 14168#1
1498 – 1544m
Despite the net snagging an obstacle on the seafloor and tearing itself into two parts, a reasonable catch of invertebrates was obtained. Of particular note were the holothurians *Mesothuria lactea*, *Paroriza pallens* and *Benthogone rosea*, and the asteroids *Zoroaster fulgens* and *Plutonaster bifrons*. There were also a number of sponges (?*Thenea* sp.), actiniarians, cirripede barnacles, gastropods and a large *Neolithodes grimaldii*.

St 13970#1
775 – 842m
The tension trace during the trawl indicated that it had been snagged on the seabed several times and, perhaps, had become entangled on the seabed. The net was indeed torn, but not as much as had been expected, and in the cod end there were some enormous boulders. These were colonised by many individuals of the suspension feeding holothurian *Psolus squamatus*. This holothurian was by far the most abundant organism in the catch, which was also notable for fragments of the corals *Lophelia pertusa* and *Madrepora oculata*, many *Echinus* sp. echinoids of a wide range in size, sponges, actiniarians and brachiopods. There were also some echinothuriid echinoids (*Calveriosoma hystrix*), one of which was in remarkably good condition considering the number of rocks found in the cod end. There were a number of small gastropods, an incirrate octopus (*Bathypolypus sponsalis*) a very small *Parapagurus* hermit crab with its commensal zoanthid (c. 10mm) already well developed, and a small specimen of the infaunal holothurian *Echinocucumis hispida*.

13. Holothurians

Ian Hudson and Dan Mayor, SOC.

Background



Deep sea holothurians, which often predominate their environment in terms of biomass, typically feed on bottom sediments. With little or no pressure from predators, and physical conditions remaining relatively constant, it seems intuitive to assume that food is often the limiting resource. Considering the nutritionally poor sediments, classical ecological theory predicts competitive exclusion, and single species domination for deposit feeders. However, it is clear that many species of deep-sea holothurian co-exist, suggesting either a plentiful food resource, or a means by which competition is reduced or avoided.

Sterol compounds have been identified as important precursors to holothurian development, and it is possible that simple inter-species differences in their removal from the sediments may be the key to understanding how many species are able to co-exist at a certain location.

Figure 1. A bathymetric view of the study site.

Through detailed dietary analysis, this study aims to examine and explain resource partitioning in holothurians from bathyal to abyssal depths.

Methodology

All animals used in this study were collected using an Otter Trawl Semi Balloon with a 14m head rope (OTSB14) (see Challenger cruise report C134 p.61 for operational details). This system is a simple and effective method of collecting holothurians, fish and many other invertebrates, with the main drawback being that a large catch has a tendency to crush the more delicate animals.

Internal cell lysis and subsequent contamination of gut contents with anomalous labile compounds was slowed by placing individuals into chilled seawater (4^{o}C) and taken to the constant temperature (CT) laboratory (also 4^{o}C) immediately after the trawl was retrieved.

To examine the compounds removed by digestive processes, an anterior foregut (close to the mouth and thus most representative of the original biochemical make up of the sediments prior to digestion) and posterior hindgut sample (near the anus, where biochemical removal processes are assumed to be most complete) was required from each individual.

Guts were exposed by cutting along the dorsal surface from posterior to anterior using blunt nosed scissors, taking care not to rupture the intestinal wall. To avoid contamination from the gut wall, it was firstly cut open using sharp nosed scissors and then gently teased back. All sediment that had been in contact with the gut wall was gently scraped away with a scalpel. Core samples from the very centre of the gut were then taken and placed into individual foil-wrapped petri dishes that had been sterilised with the organic solvent Dichloromethane (DCM). The samples were then frozen in a conventional deep freeze at –70°C. In an attempt to minimise cross contamination, all surfaces and equipment used were cleaned with DCM each time a new sample was taken, with scissors and scalpels being cleaned every time they were used.

To ensure a rigorous and repeatable sampling practice, the scientific staff involved with the dissections remained constant, and were familiarised with the techniques before meaningful samples were taken.

Abyssal Species Collected.
During the cruise, 2 trawls were shot on the Porcupine Abyssal Plain (stations 14137-1 (49°36.9 & 14°04.6) and 14158-1 (49°32.15 & 14°23.27)).
Species diversity at these abyssal depths is usually higher than at shallower depths, and this was true for the 2 abyssal stations examined on the cruise.

The following (total) complement of species were found at these stations: *Pseudostichopus villosus, Deima validum, Amperima ros*ea, *Peniagone spp, Psychropotes longicauda, Benthothuria spp, Molpadia blakei, Paroriza prohoui, Benthodytes spp* and *Oneirophanta mutabilis.*

At station 14137-1, *Pseudostichopus villosus* and *Deima validum* were selected for gut sample collection. Gut samples from *P. longicauda, P. prohoui, O. mutabilis, D.validum, M. blakei, Bethodytes spp and P.villosus* were taken from animals collected at station 14158-1.

Bathyal Species Collected.
For the majority of the cruise, animals were collected from depths between 1000 and 3200m at various points on the Porcupine Seabight and it's slopes. At these stations, a wide variety of bathyal holothurians were sampled, some being more numerous than others. From the 13 stations trawled, the following 10 species of deposit feeding holothurians were encountered: *Benthogone rosea, Bathyplotes natans, Paroriza pallens, Laetmogone violacea, Mesothuria milleri, Mesothuria lactea, Mesothuria intestinalis, Benthothuria spp, Paleopatides grisea* and *Psychropotes depressa.* A large number of the sessile, filter feeding *Solus spp.* were collected at station 14170-1.

Although in varying numbers, an individual sample of each species was taken and frozen in the deep freeze at -70 °C. In the case of the Mesothurians, whole animals were taken to ensure accurate identification.

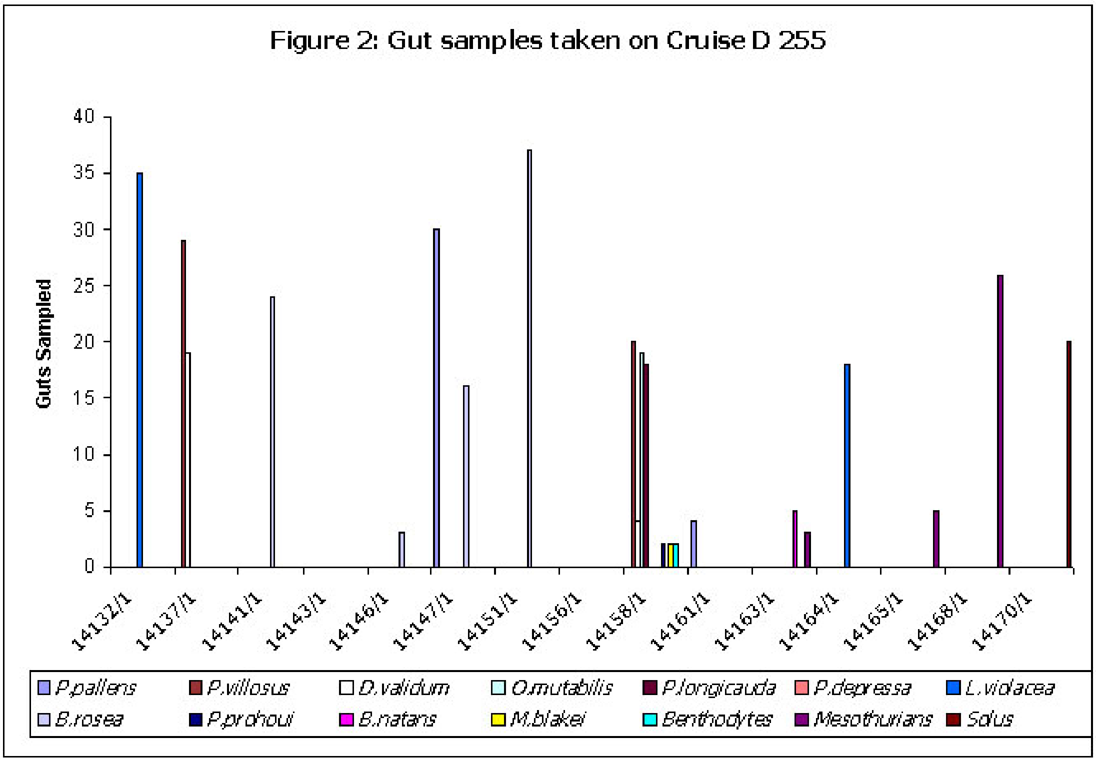


Figure 2. Stations at which holothurians were collected for gut sample analysis.

<u>Summary</u>

In conclusion, the cruise has been a resounding success for 'team holothurian'. It is hoped that the gut sampling techniques developed here will yield useful and reliable results, though they will not be known until early next year. The study has posed many further questions relating to resource partitioning. Though not addressed in this study, it would be interesting to examine whether there are intra-specific differences in sterol removal in relation to size (presumably related to age) or stage of sexual maturity. It is quite feasible that with the onset of maturity, there is a shift in the demand for certain biochemical compounds.

14. Cephalopod biology

Louise Allcock

The cephalopods of the deep sea are poorly known and their taxonomy is generally confused. The increase in deep sea fishing in the North East Atlantic has provided much needed specimens and the taxonomy of both the cirrate and incirrate octopods is now under revision.

Beak and radula were removed from incirrate octopods for subsequent electron microscopy. Animals were fixed in 4% formalin and will be scored for a suite of morphological characters for traditional and cladistic analyses.

A proportion of the cirrate octopods were frozen for biochemical analyses (water, lipid, protein content). The shell will be dissected from frozen specimens and compared to shells fixed in formalin, to investigate distortion effects which appear to be causing taxonomic confusion. Standard morphological characters will be studied.

Tissue samples from each species were preserved in 70% ethanol for ongoing phylogenetic analyses. Fixed specimens will be deposited in the National Museums of Scotland.

Cephalopods captured during cruise D255.

Station	Species	Nos. caught
14132	*Opisthoteuthis massyae* (Grimpe, 1920)	13
14147	*Histioteuthis reversa* (Verrill, 1880)	1
14156	*Bathyteuthis abyssicola* Hoyle, 1885	1
14163	*Opisthoteuthis massyae* (Grimpe, 1920)	7
14163	*Gonatus steenstrupi* Kristensen, 1981	1
14163	*Benthoctopus normani* (Massy, 1907)	1
14164	*Ommastrephes bartrami* (LeSueur, 1821)	1
14164	*Gonatus steenstrupi* Kristensen, 1981	1
14170	*Bathypolypus sponsalis* (Fischer & Fischer, 1892)	1

15. Decapod crustaceans: Physiological adaptations to the deep-sea

Rob McAllen

Background

At temperate latitudes, food supply to the deep-sea benthos is strongly seasonal, with the deposition of phytodetritus, large carcasses and faecal matter. There has been clear evidence of the use of this seasonal organic input by microbiota, meiofauna and the deep-sea megafauna. However, there have been very few studies investigating the physiological consequences and adaptations of the deep-sea fauna to this seasonal input. Most previous work has been on deep-sea fish and echinoderms with the phylum Crustacea (apart from the amphipoda) being particularly neglected. This is somewhat surprising since decapod crustaceans have been shown to appear in large numbers at large cetacean food falls and constitute an important part of the deep-sea benthic community.

Study Aim

This study will investigate the adaptations of benthic decapod crustaceans by measuring how metabolically related variables change with depth and season. Variables to be investigated will include protein and lipid content of the tail muscle and the haemocyanin and ionic content of the haemolymph of deep-sea decapods. In addition, morphometric and feeding ecology studies will be undertaken.

Work on board *RRS Discovery*

Deep-sea benthic decapod crustaceans were obtained by semi-balloon otter trawls at depths ranging from 780 to 4200m. Individuals were immediately immersed in cold seawater and taken to the constant temperature room. Haemolymph samples were removed immediately from individuals by hypodermic needle through the arthrodial membrane of the legs and frozen at -20ºC for later analysis of haemocyanin and ionic content. Tissue samples were removed from the abdomen and flash frozen in liquid nitrogen before storage at -70ºC for protein and lipid analysis at Aberdeen University (see Table 1 for sample collection summary). Morphometric measurements were made on all collected individuals and a number of additional individuals from several species were frozen whole to allow for feeding ecology studies to be performed back at Aberdeen University at a later date.

In addition to the physiological studies outlined above, several additional collections were performed. A number of decapods from all sample depths were preserved for later analysis. Amphipods were collected from the FRESP lander for a possible Scanning Electron Microscopy study on position maintenance capabilities. Eleven sediment samples were collected from OTSB, Dredge and Lander deployments and stored in seawater at 4ºC for microbial analysis by Dr Fiona Hannah, a collaborator from the University Marine Biological Station, Millport. Any coral material collected in the OTSB deployments was preserved for Dr Jason Hall-Spencer from Glasgow University.

Table 1: Summary of Crustacean samples collected for blood and tissue analysis during Discovery Cruise 255 (14/8/01 to 5/9/01)

Depth range (m)	Station	Number of haemolymph samples collected	Number of tissue samples collected	Key genus Sampled
780-840	14170	7	6	*Parapagurus*
1131-1158	14132	20	19	*Parapagurus, Polycheles, Geryon*
1539-1550	14147	22	15	*Polycheles, Glyphocrangon, Neolithodes*
1650-1700	14146	3	0	*Neolithodes*
1939-1954	14151	13	13	*Polycheles, Glyphocrangon*
2434-2496	14141	21	21	*Glyphocrangon, Munidopsis*
3000-3200	14156	17	14	*Neolithodes, Parapagurus*
4108-4147	14137	26	25	*Parapagurus, Munidopsis Plesiopennaeus*
Total		**129**	**113**	

16. Brain Morphology

Dr. B. Hirt & U. Mattheus
Institute for Anatomy, Graduate School for Neural and Behavioural Sciences, and Department of Otorhinolaryngology, University of Tuebingen, Germany

We collected samples for following persons / projects:

- **Dr. med. B. Hirt**, Institute for Anatomy, Graduate School for Neural and Behavioral Sciences, Department of Otorhinolaryngology, University of Tuebingen, Germany:

<u>Ganglion cells as possible predictors for visual abilities of deep sea fish</u>
In ganglion cells, the output neurons of the retina, the morphology is highly correlated with its function. In most vertebrates examined so far, morphological features like the diameter of dendritic fields, dendritic branching and stratification patterns are indicative of functional abilities such like motion detection, contrast detection and image formation. Deep sea fish have to cope with a very special visual environment: deeper then 1000m the visual input exclusively is provided by bioluminescence which is presented to fish as point sources or patterns of point sources. Therefore contrast detection as well as motion detection should play a major role in the visual world of fish with habitats deeper than 1km while shallower fish still should have the ability for image formation.
To investigate ganglion cell morphology of deep sea fish in detail we use following techniques: i) In the last two discovery cruises we succeeded in labelling ganglion cells of *S kaupi* via retrograde axonal transport with fluorescent labelled dextranes as marker molecules. ii) Intracellular microinjection in ganglion cells of lightly fixed retinae can reveal dendritic morphology of single cells and has been performed in *S. kaupi* and *C.(N.) armatus*. In both approaches after visualisation with confocal laser scanning technology we analysed ganglion cells based on the ramification pattern of their dendrites and in comparison with data we obtained from mesopelagic fish (prior cruises) we were able to confirm the presumptions mentioned above on a morphological basis *(H.-J.Wagner & B. Hirt (2001), Retinal Ganglion Cells in Deep-Sea Fish –Distribution and Differentiation‘, Association for Research in Vision and Ophtalmology, suppl.).* Paper in prep.
The aim of our recent investigations is to study i) ganglion cells in other demersal species as possible predictors for their visual abilities, ii) the variability of ganglion cell morphology within species that live in habitats deeper than 1000m (bioluminescence) as well as shallower (photons from above) to look for neuronal plasticity.
On this cruise we prepared and traced 30 eyes of 8 species and prepared and lightly fixed 10 eyes of 4 species for microinjection.

<u>Histological analysis of projection sides of sensory organs in deep sea fish</u>
To evaluate the sensory capabilities of deep-sea fish in a greater detail, the identification of neuronal projection sites are of major interest (identifying target nuclei, collaterals, connections etc. histologically). In a pilot test with shallow water fish we applied fluorescent dextrane tracers to the optic nerve in vitro and were able to visualise ganglion cells (retrograde tracing) as well as their central projection sites (anterograde tracing) in wholemount and slice preparations.
In an in vitro experiment on board we did intact brain/nerve/sensory organ preparations and applied dextranes to the optic nerve, the saccule nerve and the utricule nerve of *Synaphobranchus kaupi* and kept them in a subvital status in culture medium for 4 days and fixed them afterwards (4% buffered paraformaldehyde). Further processing (sectioning, confocal laser scanning microscopy, analysis) will be done in Tübingen.

Plastination of deep sea fish.

Recently a new technique for transferring fixed specimen into long-term exhibits was established at the Institute of Anatomy in Tübingen. During a procedure lasting several months, intracellular fluids get exchanged by special plastic compounds. Shape and colour of specimen will be maintained. We plan to introduce this technique into deep-sea fish to prepare permanent exhibits that can be touched and used for teaching purposes. Therefore we collected 5 mesopelagic fish of small size. The future plan is to extend this technique also to deep-sea fish with larger size.

- **U. Mattheus**, Institute for Anatomy, Graduate School for Neural and Behavioral Sciences, University of Tübingen, Germany:

The localisation and morphology of pineal glands in demersal fish species was investigated in Discovery cruise 250. We added a biochemical approach collecting pineals for determination of melatonin content in cruises 250 and 252. First results of these studies were published in our latest paper *(Wagner HJ, Mattheus U; Pineal organs in deep demersal fish; Cell and Tissue Research, in press)*. Besides morphology, the main objectives were to ascertain that the pineal gland is effectively synthesising melatonin, and to collect preliminary data on potential diel or infradian (seasonal) differences.

A consistent result of our assays is that pineal organs in the two demersal teleosts studied do indeed contain melatonin. The amounts are quite variable, and it will be a challenge to correlate these differences with external or internal factors.

Our findings on the variations in melatonin content of demersal pineals indicate that rhythmic, i.e. seasonal patterns of swimming activity, annual migration, and reproduction have a structural and neurochemical counterpart and would suggest that melatonin may be involved in their control. This begs the question what zeitgebers other than the solar day and night may govern rhythmic activities in the deep sea. Infradian, seasonal signals reach the bottom of the sea in the form of phytoplankton flocs “snowing” down the water column after the peak of the algae bloom in late summer and in autumn. This gives rise to a surge in microbial activity on the sea floor and fuels the food chain from there. They thus constitute an indirect way by which the sun can influence processes in the benthos. Ultradian signals may also come into play: Currents induced by the tides reflect a lunar rhythm. Fish would require pressure sensors to perceive changes of the tides. The swim bladder connected to sacculus or utriculus of the inner ear could serve this role relying basically on the same transduction mechanisms as audition. The cyclic changes in currents which reverse directions with the tides would be perceived by the lateral line organs. Thus, the effect of light as a zeitgeber could have been substituted by alternative sensory cues, which would impose both infradian and ultradian rhythms on the demersal fauna.

In order to compare with earlier results, we collected pineals from *Coryphaenoides armatus* and *Synaphobranchus kaupi* for determination of melatonin content. Retinae from the same specimens were also collected for melatonin assay in order to compare the amount of melatonin contained in pineal glands and retinae. As these results, however, will give few hints only to solar / lunar rhythms, we started a different approach to melatonin in pineals. The aim of this present experiment is to obtain data on melatonin release. For this we collected live (or moribund) specimens of *Synaphobranchus kaupi*, and cultivated pineals and a few retinae in cell culture medium for at least 50 hours, changing medium every two hours in order to determine melatonin content in the supernatant.

- **Prof. Lynda Williams**, The Rowett Institute, Aberdeen:

We collected brains, retinae, and pineals of *Coryphaenoides armatus* and *Synaphobranchus kaupi*, cryofixed and aldehyde-fixed for Prof. Williams in order to determine melatonin receptor areas in these organs.

- **Prof. H.J. Wagner**, Institute for Anatomy, Graduate School for Neural and Behavioral Sciences, University of Tübingen, Germany:

Sensory brain areas in deep sea fish and seasonal and developmental changes in the sensory modes

A paper on the results of the of the brain areas in 35 demersal species (from Discovery cruises 243, 250 &252) is in press (*H.-J. Wagner (2001), 'Brain Areas in Abyssal Demersal Fishes'; Brain, Behaviour and Evolution*). Four areas of the Brain which receive primary projections from the eye, hair cell based systems, mechanosensory and chemical senses have been studied and relative size differences used to make deductions on the sensory preferences of 35 demersal fish species. Vision seems to be the single most important sense suggesting the presence of relevant bioluminescent stimuli. However in combination, the chemical senses, smell and taste, surpass the visual system; most prominent among them is olfaction. The trigeminal/octavolateral area indicating the role of lateral line input and possibly audition is also well represented, but only in association with other sensory modalities. A large volume telencephalon was often observed in combination with a prominent olfactory system, whereas cerebella of unusually large sizes occurred in species with above –average visual, hair cell-based, but also olfactory systems, confirming their role as multimodal sensorimotor co-ordination centres. The results corroborate observations with the lander vehicles in that they identify species with well-developed olfactory systems which turn up regularly at the baited cameras in situ.

In order to analyse possible changes in the sensory modes related to seasonality (e.g. relative volume of olfactory bulb) as well as developmental changes during growth, on this cruise we collected 45 brains of 13 species. The brains were dissected and isolated on board and will be measured back in Tübingen.

- **Prof. A. Popper**, University of Maryland, U.S.A.:

Auditory system.

There are several reports indicating that some demersal fish (grenadiers, in particular) are capable of producing sounds. However, there is no detailed information about the structure of the ear in this community of fish. It is therefore unclear which species are capable of perceiving sounds, and how elaborate this capability might be. A leading expert in the field of fish hearing, A. Popper, has expressed a great interest to study this problem. We fixed 28 heads of 12 demersal species in glutaraldehyde. They will be shipped to his lab upon our return. The results of this study will be of major interest for our own work on the sensory biology of demersal fishes.

- **Prof. R. H. Douglas**, City University, London:

Prof. Douglas has been studying the differentiation of lens and visual pigments for a long time. We'll provide him with 13 dark adapted, frozen retinae from 3 species to have a look at regeneration of deep-sea visual pigments.

Further on he intends to so some simple physiological optics (distance between cornea and retina, location of lens etc.) from a number of frozen whole eyes.

- **Prof. S. P. Collin**, University of Queensland, Brisbane, Australia:

Prof. Collin is interested in eyestalks. Besides chondrichthyans, alepocephalids are among few groups of osteichthyans that have eyestalks. These structures are made of connective tissue, which connects the sclera with the back of the orbit, next to the foramen opticum. We collected a small number of Alepocephalid heads for him.
Prof. Collin also investigates a number of morphological / morphometrical features comparing demersal, mesopelagic, and surface-dwelling fish. Main targets to be screened for are: photoreceptor and ganglion cells in retina, optic nerve, olfactory nerve, and olfactory tract. We will provide Prof. Collin with several samples of above-mentioned organs of *Corphaenoides armatus*, *Coryphaenoides profundicola*, and *Synaphobranchus kaupi*, which we fixed and dissected on board.

Sampling numbers: 25 species
182 fish
579 samples

Detailed lists available on request

17. Molecular adaptations to high pressure and low temperature in deep-sea fish.

Amanda Brindley

This is a joint project with **Professor Martin J Warren**, School of Biological Sciences, Queen Mary, University of London, **Professor David M Hunt**, Department of Molecular Genetics, Institute of Ophthalmology, University College London and **Dr Julian C Partridge**, School of Biology, University of Bristol. This project is funded by the BBSRC for three years from September 2000.

Background

The physical properties of the deep-sea create an environment that is characterised by high pressures and low temperatures. Very little is known about the molecular changes that allow the proteins of deep-sea fish to function in such an environment, although it is clear that molecular adaptations have taken place, leading to alterations in the thermal and kinetic properties of proteins.

Previous studies have shown that proteins of deep-sea fish have increased resistance to thermal denaturation and lower catalytic efficiencies relative to shallow-water homologues. Thermal stability is thought to be due to the evolution of especially rigid proteins that are able to resist disruption of tertiary and quaternary structure under high pressure. Thermal compensation in cold-adapted enzymes is reached through improved turnover number and catalytic efficiency. This optimisation of catalytic parameters can originate from a highly flexible structure. It would appear that there is a dichotomy between adaptations for high pressure and those for low temperature.

The objective of this project is to contribute to the understanding of the structural adaptations of certain deep-sea fish enzymes that permit them to operate at both high pressures and low temperatures. Three enzymes have been selected for this work; lactate dehydrogenase (LDH), 5-aminolaevulinic acid dehydrogenase (ALAD) and porphobilinogen deaminase (PBGD).

Work on board ship

Small liver and white muscle samples were collected from several species to try to complete sampling carried out on previous cruises, 250 and 252. Species sampled were, *Coryphaenoides armatus, Coryphaenoides carapinus, Coryphaenoides leptolepis, Coryphaenoides guentheri, Coryphaenoides profundicola, Trachyrincus murrayi, Nezumia aequalis, Alepocephalus bairdii, Alepocephalus rostratus, Histiobranchus bathybius* and *Xenodermichtys copei.* All samples were stored in RNA later ™ at 4°C for sequence analysis on return to London.

18. Spectral sensitivity of deep-sea fish visual pigments

Elizabeth White, University of Bristol

Understanding of the visual capabilities of animals can assist in understanding their behaviour. Deep-sea fish live in an extreme environment and have visual systems maximised to make use of available light; both down-welling, where available, and bioluminescence. Visual pigments are the light sensitive pigments found in the retina of the eye and their peak absorbance (λ_{max}) is usually maximised to the animal's light environment. Deep-sea fish possess rod photoreceptors with peak sensitivities of around 470-490nm, in the short-wave section of the visible range. The aim of my work was to collect retinas from deep-sea fish from a range of species and depths in order to measure their spectral sensitivity capabilities.

Fish were collected from the trawl nets as soon as possible and transferred to a light-tight bag to avoid pigment bleaching. They were taken to the dark room and, under dim red light, the eyes were removed and the lens and retinal tissue collected. These were stored at –70°C. On return to Bristol, the visual pigments will be extracted from the retinas in the form of detergent extracts or suspensions of the purified outer segment membrane of the cells and their absorbance will be measured.

In total, retinas of over 90 fish of 31 species were collected, from a depth range of between 775 and 4311m. This study will contribute to my PhD thesis on vision and visual behaviour in fish.

List (and number) of species sampled:

Alepocephalus agassizii	3
Alepocephalus bairdii	2
Bathytroctes microlepis	1
Borostomias antarcticus	1
Chimaera monstrosa	1
Bathypterois dubius	1
Molva dipterygia	1
Halosauropsis macrochir	1
Coelorhyncus occa	3
Coryphaenoides armatus	13
Coryphaenoides guentheri	12
Coryphaenoides leptolepis	4
Coryphaenoides mediterraneus	2
Coryphaenoides rupestris	6
Lionurus carapinus	1
Nezumia aequalis	3
Trachyrinchus murrayi	3
Trachyrinchus trachyrinchus	1
Antimora rostratus	4
Lepidion eques	8
Mora moro	4
Notocanthus bonapartei	1
Spectrunculus grandes	1
Helicolenus dactylopterus	2
Galeus melastomus	1
Histiobranchus bathybius	2
Synaphobranchus kaupi	2
Bathysaurus ferox	4
Bathysaurus mollis	1
Hoplostethus atlanticus	2
Aphanopus carbo	1

19. Collection of deep-sea fish brains

Emma Battle, Martin Collins and Monty Priede

Background

During Challenger cruise C134 (August 1997) a total of 101 brains, from 14 species, were collected and frozen to examine melatonin receptor distribution in deep-sea fish living in the absence of solar light. Priede *et al.* (1999) showed binding of radioactive melatonin (2-[^{125}I]iodomelatonin) in the optic tectum as well as melatonin receptors throughout the visual structures of all the brains studied.

Brains were collected from 3 species (*Coryphaenoides* (*N.*) *armatus*, *C. guentheri* and *C. rupestris*) during D252. During this cruise more brains were obtained to allow seasonal comparison of melatonin receptor binding and distribution at the Rowett Institute on return to Aberdeen.

Work undertaken

The brains were removed as soon as possible after initial processing (identification, measuring and weighing) had occurred. Dissecting scissors were used to cut the nerves connected to the brain. Each brain was removed with forceps and placed in a beaker of iso-pentane that was kept on dry ice throughout. Once frozen, the brains were wrapped in aluminium foil and placed in universal tubes on the dry ice, before transfer to the –70°C freezer.

Ten brains of *C. armatus* were collected at trawl station 14137. Eleven brains of *C. guentheri* were also collected from trawl 14141. Lack of dry ice prevented the freezing of further brains.

20. Cetaceans and Seabirds Survey

Natcha Aguilar de Soto

Introduction

The Cetaceans and Seabirds at Sea team of the National University of Ireland (Cork) is working on a three years research project to establish reliable baseline information on the distribution and abundance of seabirds and cetaceans off western and south-western Ireland throughout the year, and to identify major concentrations of cetaceans and seabirds in these waters and evaluate seasonal trends in distribution;

Study Area

The general study area for the project encompasses the offshore waters to the south-west and west of Ireland, stretching from the Goban Spur to the Porcupine Seabight, Rockall Trough and including adjoining continental shelf areas. The primary reason for studying this area is the presence of currently-licensed hydrocarbon exploration blocks along this "Irish Atlantic Margin". The broad scale of this study area also takes into account the dynamic nature of cetacean and seabird movements through Ireland's offshore waters both spatially and seasonally.

The present survey "Discovery 255" covered mainly the Goban Spur and Porcupine abyssal plain sub-areas. A long transect along the 1000m isobath was also surveyed on the way to the final port (Glasgow).

Methods

While on survey, the observer records positional and effort-related data. This information forms the basis of the observer effort plots, which are charted on ¼ ICES (International Council for the Exploration of the Seas) area blocks measuring 15' latitude x 30' longitude. The method was devised by Tasker *et al*. (1984) from the Joint Nature Conservation Committee (JNCC) in Scotland. The standard full survey method requires that the wind force be no greater than Beaufort six, and that vessels should travel at a constant speed while on a constant course.

Results

Weather conditions allowed full or partial sighting effort on 17 cruise days. A total number of 35 sightings of at least 9 species of cetacean and 19 species of seabirds were recorded.

21. ISG

ISG Representative: Elizabeth Rourke

Data Logging

Data was logged using the ISG ABC System. The Level A system collects data from individual pieces of scientific equipment. The Level B collects each of the Level A SMP messages and writes them to a disk, monitoring the frequency of the messages and warns the operator when messages fail to appear. The Level C system takes these messages and parses them into data streams.

The following list shows the data collected on D254

Chernikeef Log	LOG_CHF	MkII Level A
Ships Gyro	GYRONMEA	MkII Level A
Trimble GPS	GPS_4000	MkII Level A
Ashtec ADU	GPS_ASH	MkII Level A
Ashtec Glonass GPS	GPS_GLOS	MkII Level A
Echo-Sounder	EA500D1	MkII Level A
Surface Logger	SURFMET	SIG PC

Problems during the cruise

Email System:

This has worked well during the cruise with the only problem being there appeared on occasions to be a large delay in the incoming data with the system dropping out partway through the transfer.

GroupWise and Arcserve

The Novell system had to be rebooted several times during the start of the cruise. This was resolved by disconnecting the servers to the UPS and plugging them directly into the main power supply using a mains distribution board.

Data Processing

Wide use was made of the plotting and data extraction routines on the Level C system for the Principal Investigators.

22. Irish Observer report

Janine Guinan – Irish Observer

Every year between 40 and 50 foreign research vessels enter into Irish waters to carry out a range of marine related studies. The Irish authorities have the opportunity to participate in this work by placing a scientific observer onboard any one of these vessels to report on their behalf. As an observer with the Discovery Cruise 255 I proposed to learn as much as possible about the research activities and to foster good relations with the scientific staff and ship's personnel.

In the absence of a personal research interest, I became involved in different aspects of the research onboard. Deep-water trawling at different depth ranges provided me with the experience of working with a combination of abyssal and bathyal fish species. Tissue samples were collected for both the University of Aberdeen and the J.F. Rees team in Belgium. Species sampled included *Coryphaenoides armatus, Coryphaenoides guentheri, Coryphaenoides rupestris*, *Coryphaenoides leptolepis* and *Antimora rostrata.* The tissue samples were subsequently stored at – 70 ° c to be later homogenised, centrifuged and assayed in supernatant. Results from this work will be used to determine enzymatic activities in the tissues of deep-sea fishes and establish depth and season dependant variables. The use of lander vehicles on the cruise to obtain *in situ* measurements offers an exciting alternative to conventional methods of deep-sea sampling. Assisting in the deployment and recovery of the ISIT lander in particular developed my interest in how the landers operate and perform at great depths. The ability of the ISIT to record deep-sea bioluminescence is truly fascinating. As the cruise progressed I observed the AUDOS and FRESP landers being regularly deployed for the purpose of measuring oxygen consumption, routine metabolism and tail beat frequencies in demersal fish. Results obtained from lander deployments will supplement data collected from trawl species.

Altogether I found the cruise both educating and inspiring. I have no doubt that the nature of this ongoing research will greatly benefit deep-sea studies in the North-East Atlantic. I wish to thank all the scientific team and crew for a most enjoyable and memorable trip, I had a whale of a time.

23. Student reports

23.1 Murray Ross

Well it has come to that time of the cruise where I explain my position on the Discovery and my feelings about it. But where do I begin?

After a night in Southampton on the 13th we set sail for the big blue, smiles beaming and sun shining, a good omen if ever one was needed. Apprehension as well as excitement was in the air as I prepared for my stint at sea. With the added excitement of potentially taking Stugeron every eight hours as my sea legs were as yet unfamiliar to me (luckily this proved not to be the case).

After slowly navigating the ships interior for a couple days, and often ending up in the gym or the bridge, when I required my cabin, the work began. I was unsure what to expect as the first trawl came in but I was informed to expect eyes "detached" and stomachs "regurgitated". Not one trawl failed to deliver this promise. After the first trawl my honour's project was decided, the biology and fecundity of the *Alepocephalids*, and from there on in my interest grew stronger.

On a serious note, the trawling for me was invaluable. It taught me many different aspects of biology such as sex and reproductive stage identification, which had only loosely been dealt with in my degree so far. Added with the identification of *Alepocephalids* and otolith removal from many different species, my knowledge of fish taxonomy has been increased twenty fold thanks to this cruise. I also know now just how bad "Gunts" smell, especially at 4am. However, it was not only in fish processing that my knowledge grew thanks to this cruise. Being given the chance to watch lander deployments and discover what footage they recorded was a completely new and fascinating experience. Something I had no experience in before but enjoyed.

I would not be able to sum up my cruise without of course the gratitude I owe to people. Martin and Monty principally, for picking me to come along, as well as all the other Aberdeen team members for their help and advice. A big thank-you also to all the other scientists for their help and good will shown. Thanks go to all the crew for their invaluable behind the scenes work, and of course, the galleys staff for making me even fatter than I was before. Lastly, Louise of course, for making me the fine all round street entertainer that I am today.

23.2 Rachel McAllister

When I was asked to come on the D255 Research Cruise with the Zoology department by one of my lecturers, I didn't know what to expect. I felt as though I was being sent on a mission to Mars as I'd never really experienced anything like this before. Little did I know, in some ways, I would be proved right!

Off I set on the ship from Southampton with a bunch of people I hadn't really met before to study rocks I had never had the opportunity to study before. As the first few days went by, I found my way around the ship, met everyone, including the crew, and got over the seasickness. The next thing on the hit list was the first OTSB trawl and I was excited and really didn't know what to expect. Everyone bustled about collecting what he or she came to find, and then it was my turn, and all I found was some 'clinker'. I began to wonder what my aim at sea really was, but as time went on, and trawls progressed, I began to find out why, and became more intrigued as I found rocks and boulders that I didn't expect to find. After trawling, dredging also took my interest and I was given the opportunity to lead a dredge, which was an experience in itself.

Not only was I intrigued by the rocks, but also was amazed by the variety in fish species, crustaceans and many other animals that live in the sea, which I helped to process.
Every day was a new challenge, seeing different rocks and fish, getting to know people better, being isolated on a ship at sea, and seeing some amazing sights including sunsets and dolphins. It'll be an experience I'll never forget and thoroughly enjoyed, much like a mission to mars might be!

Thank you to all, especially those who made it possible for me to be here, and to the crew who looked after and entertained us with so much enthusiasm.

23.3 Sheena Jardine

After spending three weeks at sea on board the RRS Discovery, I think it's fair to say I've received a valuable and eye-opening insight into deep-sea scientific research. After getting used to the initial ups and downs of sea life, the work began, and for the first time, I experienced the ins and outs of numerous deep-sea fish as part of the fish processing team.

Following the first few OTSB trawls, I decided to base my honours project on the identification and structure of deep-sea fish otoliths. Subsequently, specimens were extracted from fish of each species to be examined on my return to Aberdeen. It was interesting to see all the different projects under study, from brain extraction to tissue sampling, and I think the smell of fish innards will be the one thing I'm glad to forget! It was useful to learn how trawling and dredging works in the deep-sea, and the diversity of species caught was far greater than I imagined.

Generally speaking, the trip was great, aided by the fantastic weather and friendly crew who helped with the feeling of being out of plaice. I spent much of my time with the crew and scientists alike, and they helped fillet with fun!

So without skating around the issue, many thanks to all aboard – great food, great fun, great samples, fabulous experience!! Not something I'm like to forget in a hurry, and I'd like to give particular thanks to both Martin and Monty for giving me this opportunity, and for helping out with any problems I had while on board. I learned a lot more from the practical experience, than I could have anywhere else, and not just about fish!

23.4 Chris Wylie

With a B.Sc. and an M.Sc. behind me, I felt great trepidation going to sea for the first time. Would all the years spent in academia pay off? Is working on the open seas something that I could do? I'm glad to say that it appears that it is. I don't think I've enjoyed myself as much for a long time. Whether it be relaxing, or working, I've had tremendous fun.

After a night of the high-life in Southampton, we set out in fine weather. The black cloud of seasickness passed quickly, and soon a rag-tag, squabbling band of scientists, engineers and students blossomed into a rag-tag, squabbling team. The work has been fascinating. Watching, and helping, deploy the landers that I read about for my Masters project, has been a rollercoaster ride. From the anticipation and celebration, as the FRESP lander finally repaid all the hard work put into it, the rapturous smile on Emma's face, as something in the deep ocean finally bioluminesced, to the disappointment of initial DOBO deployment and the shock of the loss of the AUDOS (she will be missed!).

Fish have always been my "thing", and working on the fish processing after trawls has been a highlight. Seeing and learning to identify numerous species I've never encountered before, the new practical skills in sexing and staging or tissue sampling, all have been invaluable experience.

That’s not to say to say it was all work. The new friends I’ve made, sunning myself on the aft deck as we steamed to a new location, beautiful sunsets, watching common dolphins bowriding or hunting pelagic fish drawn up at night by our deck lights, or a quiet drink in the bar, have all helped to make this cruise more than simply “something good to put on your CV”, and I would like to thank all the people who have made this trip, both possible for me, and so great once I was here, crew, scientists, engineers, students and squabblers alike. Whether it was seeing the insubstantial mist that marked the exhalation of a minke whale or standing elbow deep in the guts of the smelliest fish ever dragged, kicking and screaming from the bottom of the ocean, at four o’clock in the morning, it has been a joy.

Appendix I D255 Station List

		Start				End				Depth		
Station	Gear	Date	Time(BST)	Latitude	Longitude	Date	Time(BST)	Latitude	Longitude	Min	Max	Comments
14132#1	OTSB	16/08/2001	10:45	49 17.00	12 22.17	16/08/2001	12:30	49 17.9	12 28.4	1131	1156	haul halted due to warp spool prob.
14133#1	CTD+W	16/08/2001	18:26	49 05.03	13 11.47	16/08/2001	21:24	-	-	-	3392	
14133#2	CTD	16/08/2001	22:15	49 04.97	13 11.80	16/08/2001	-	-	-	-	3401	
14133#3	CTD	17/08/2001	01:51	49 05.03	13 12.03	16/08/2001	-	-	-	-	3380	
14134#1	AUDOS	17/08/2001	07:00	49 13.10	13 29.24	-	-			-	-	AUDOS did not sink, recovered
14134#2	AUDOS	17/08/2001	10:01	49 13.09	13 29.46	18/08/2001	14:00	49 12.83	13 29.46	-	3977	Worked, strobe lose on recovery
14135#1	ISIT	17/08/2001	16:12	49 16.03	13 28.95	18/08/2001	18:20	49 16.54	13 29.17	-	4020	Electronic on at 16:05 Released at 15:20. One float damaged on deployment
14136#1	FRESP	17/08/2001	18:37	49 20.90	13 33.04	19/08/2001	12:47	49 20.90	13 32.61	-	4012	Trap appeared to close before FRESP landed. Plenty of fish around bait. Trap release being investigated.
14137#1	OTSB	19/08/2001	03:40	49 36.9	14 04.6	19/08/2001	04:40	49 37.8	14 07.8	4108	4146	Ground uneven, and trawl was not on the bottom evenly. Hence low catch.
14138#1	AUDOS	19/08/2001	21:47	49 50.01	13 07.98	22/08/2001	06:15	49 50.01	13 07.98	-	2448	
14139#1	ISIT	19/08/2001	23:04	49 51.10	13 02.21	20/08/2001	12:04	49 51.22	13 01.94	-	2487	Replaced damaged benthos float with double syntactic floats. Current meter flooded.
14140#1	FRESP	20/08/2001	00:41	49 53.05	12 55.07	22/08/2001	09:08	49 53.05	12 53.84	-	2507	
14141#1	OTSB	20/08/2001	06:05	49 59.3	12 53.4	20/08/2001	07:25	49 59.6	12 57.7	2494	2514	Loads of fish, took until tea to process
14142#1	DOBO	20/08/2001	17:32	50 01.01	13 17.06	27/08/2001	10:08	50 00.96	13 17.06	-	2555	
14143#1	OTSB	21/08/2001	23:08	49 45.7	12 53.5	22/08/2001	00:30	49 45.7	12 58.3	2275	2308	Very muddy, 150 ish fish
14144#1	ISIT	22/08/2001	13:19	49 51.11	13 02.80	23/08/2001	10:46	49 51.31	13 01.28	-	2494	
14145#1	AUDOS	22/08/2001	15:53	49 53.06	13 27.85	23/08/2001	14:30	49 53.06	13 27.85	-	2500	
14146#1	OTSB	22/08/2001	20:47	49 35.2	12 52.21	22/08/2001	22:10	49 33.63	12 56.49	1625	1672	
14147#1	OTSB	23/08/2001	04:48	49 31.9	12 50.7	23/08/2001	06:18	49 30.8	12 56.3	1515	1523	
14148#1	ISIT	23/08/2001	20:20	49 30.1	13 42.3	24/08/2001	10:41	49 29.92	13 42.98	-	4000	
14149#1	FRESP	23/08/2001	21:42	49 32.1	13 43.0	27/08/2001	16:45	49 32.1	13 43.3	-	3975	Fish in the box!
14150#1	AUDOS	23/08/2001	23:45	49 32.8	13 37.2					-	3100	AUDOS released but did not

												return
14151#1	OTSB	24/08/2001	03:00	49 41.9	13 11.8	24/08/2001	06:25	49 42.0	13 15.5	1915	1976	
14152#1	DREDGE	25/08/2001	08:15	48 39.3	14 21.36	25/08/2001	11:12	48 21.81	14 33.35	4791	3890	No Rocks
14153#1	DREDGE	25/08/2001	16:32	48 23.1	14 41.6	25/08/2001	19:09	48 23.04	14 33.32	4786	4273	No Rocks
14154#1	ISIT	26/08/2001	01:20	48 33.99	15 00.11	26/08/2001	12:08	48 33.69	15 00.52	-	4784	
14155#1	DREDGE	26/08/2001	05:00	48 33.58	15:12.0	26/08/2001	08:50	48 33.95	15 09.36	4812	4420	Rocks!
14156#1	OTSB	27/08/2001	03:40	49 52.1	13 34.1	27/08/2001	05:25	49 57.37	13 24.29	3089	3186	
14157#1	ISIT	27/08/2001	13:46	50 00.03	13 23.07	27/08/2001		50 00.03	13 23.07	-	2809	
14158#1	OTSB	28/08/2001	04:35	49 32.15	14 23.27	28/08/2001	06:15	49 33.03	14 19.27	4311	4286	
14159#1	FRESP	28/08/2001	20:57	50 01.00	13 05.30	30/08/2001	17:25	50 00.62	13 05.04	-	2557	2 fish, O2 sensor blocked
14160#1	DOBO	29/08/2001	00:18	49 59.00	13 32.99					-	2710	Long term deployment
14161#1	OTSB	29/08/2001	07:54	49 29.63	12 41.55	29/08/2001	09:33	49 31.43	12 48.18	1421	1489	Ships position
14162#1	ISIT	29/08/2001	14:43	49 46.96	12 07.01	30/08/2001	10:45	49 48.10	11 55.32	-	1476	
14163#1	OTSB	29/08/2001	19:30	49 26.68	12 41.48	30/08/2001	20:25	49 26.61	12 48.15	1340	1397	Ships position
14164#1	OTSB	30/08/2001	07:50	49 44.30	11 43.08	30/08/2001	08:50	49 45.00	11 45.46	1022	1084	
14165#1	OTSB	31/08/2001	09:25	51 26.20	12 25.97	31/08/2001	10:30	51 27.13	12 30.25	1414	1509	Ships position
14166#1	FRESP	31/08/2001	14:18	51 29.05	12 26.88	02/09/2001	05:39	51 29.05	12 27.00	-	1500	Eels trapped, trap did not shut properly, sensor stopped recording after 18 hours.
14167#1	ISIT	31/08/2001	18:27	51 10.00	11 40.69	01/09/2001	09:48	51 09.83	11 39.37	-	1019	Much Bioluminescence!
14168#1	OTSB	01/09/2001	02:35	51 27.60	12 29.13	01/09/2001	03:20	51 28.86	12 31.36	1498	1544	Ships position
14169#1	ISIT	01/09/2001	15:55	51 18.02	11 42.87	01/09/2001	11:40	51 18.02	11 42.87	-	1048	Bioluminescence but less.
14170#1	OTSB	01/09/2001	19:30	51 36.37	11 53.29	01/09/2001	20:39	51 37.07	11 57.18	775	842	Ships position Rocks!, and very diverse catch, even an octopus for Louise!
14171#1	ISIT	02/09/2001	14:35	51 11.97	11 40.78	02/09/2001	17:30	51 11.97	11 48.80	-	1009	Poddy traps in view of camera

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APPENDIX III: D255 Cruise statistics