I.O.S.

RRS CHALLENGER

CRUISE 9/79

29th JUNE – 11th JULY 1979

BENTHIC AND MID-WATER BIOLOGY OF THE PORCUPINE SEA-BIGHT AND THE ROCKALL TROUGH.

CRUISE REPORT NO 89

1980

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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CONTENTS

	Page
Itinerary	ii
Scientific personnel	ii
Ships officers	ii
Objectives	1
Narrative	1
Benthic invertebrates	6
Bottom triggers	7
Use of Challenger for RMT 1+8 work	8
Near bottom catches with the RMT 1+8	9
OTSB14 and Fish report	10
Underwater camera system	11
Epibenthic sledge	12
Acoustic command and listening system	14
Ship's Instruments	17
Telemetry	18
Gear abbreviations	21
Station List	22-24
Chart showing station positions	Figure 1

ITINERARY CHALLENGER CRUISE 9/79 (IOS Cruise 506)

Depart Barry 1000h GMT 29/6 1979

Arrive Barry 1000h GMT 11/7 1979

SCIENTIFIC PERSONNEL

R.G. Aldred

M.V. Angel

D.S.M. Billett

P.E. Collins

E. Darlington

N.R. Merrett

G. Phillips

A.L. Rice (Principal Scientist)

M.H. Thurston

C. Woodley

SHIP'S OFFICERS

P. Maw - Master

G. Long - Chief Officer

M. Putman - 2nd Officer

R. Hagley - 3rd Officer

R. Anderson - Chief Engineer

I. McGill - 2nd Engineer

R. Perriam - 3rd Engineer

B. Entwistle - 4th Engineer

F. Dunning - Fishing Skipper

R. Overton - Purser

OBJECTIVES

1. To test a new two-tier opening/closing epibenthic sledge.

2. To test the RMT 1+8 monitor and command systems at long slant ranges and particularly at shallow angles.

3. To obtain benthic samples, with the semi-balloon otter trawl (OTSB) and epibenthic sledge (BN) at a variety of depths in the Porcupine Sea-Bight and particularly at 2000 and 4000m for comparison with those taken at similar depths in April 1978 during Discovery Cruise 92.

4. To obtain near-bottom mid-water samples at a number of epibenthic sledge stations for evidence of concentration of mid-water organisms in this part of the water column.

5. To test a new acoustic "dolphin" and to examine the effects of changes in the orientation of the acoustic array in monitoring the towed gears and particularly the RMT 1+8.

NARRATIVE

The beginning of the cruise was somewhat inauspicious since the scientific personnel failed to arrive in time to transfer the gear to the ship, our van passing the returning empty lorry on the outskirts of Barry. Our tardiness could not have endeared us greatly to the crew who did the unloading for us, but any animosity was well hidden and all seemed to be sweetness and light by the end of the cruise.

The delay had been caused by the failure of the expected beam steering unit for the ship's PES fish to materialise in time and the resulting need to take with us the acoustic dolphin which had not originally been considered as essential for this cruise. The dolphin, with its remotely controlled drive for changing the orientation of the acoustic array, was completed at about 1100hr/28 June, and only then as a result of very laudable last minute efforts by C. Woodley and particularly by R.A. Wild. In the event, the gear-box for the drive was not sufficiently robust and the gears were rapidly stripped, so that the orientation of the array had to be fixed and could be altered only with the dolphin inboard.

Challenger eventually sailed at 1000h/29 having been delayed by a Magnavox fault. This delay was amply justified subsequently since the system performed perfectly satisfactorily throughout the cruise and station logging was much easier and more accurate than would otherwise have been possible.

The weather when we sailed was moderate but improving, and by the time we reached the first station, on the north-eastern slope of the Porcupine Sea-Bight, at 0130/1 July the wind speed had decreased to 12 kts. Thereafter the weather was excellent throughout the cruise, the sea even becoming dead calm for a period at station 3. This good weather was particularly important since there was considerable difficulty in handling both the RMT and the epibenthic sledge on Challenger because of the limited lift available beneath the "A" frame in the former case and the awkwardness of the gear in the latter. The experience gained with both gears in the very favourable conditions enabled the techniques used to be improved very considerably during the cruise (see below).

Station 1 was close to Discovery 9773 and the objective was to obtain a second semi-balloon otter-trawl (OTSB) sample from the coral environment known to occur in this region. The trawl was therefore shot at 0200h/1 but it was then discovered that the warp metering system was not working. Since the depth of this station was only 1000m it was decided to measure the wire out by counting revolutions of the main warp sheave on the deck, and a successful haul was accordingly accomplished by 0630/1 with no serious problems apart from the presence in the cod-end of two large boulders weighing some 200lb each.

The manual measurement of metres of wire out was clearly impractical at the deeper stations, but the ship nevertheless made for station 2 (2000m) in the hope that the situation would be rectified before we reached it. No circuit diagrams were available on the ship, but after two fruitless telephone calls to Barry an unmade plug was found by Greg Phillips deep in the bowels of the equipment and the system, which was vital for this cruise, worked satisfactorily thereafter.

Station 2 was reached at 1230/1 and by 0600/2 an RMT test, a BN haul and an OTSB haul had been successfully completed, the latter bringing up an enormous catch of animals and mud which took some 3h to clear. Apart from a failure of the distance run wheel on the epibenthic sledge these three series were all completely successful. However, during the preparations for a second BN haul at this station a camera fault became apparent and the station was therefore abandoned successful haul was obtained, though again without a distance run wheel reading despite the bearings having been eased.

Since neither the RMT nor the OTSB could be worked at this depth with the available wire we proceeded to station 5 at about 3000m in the mouth of the Bight, arriving 2300/4. Again there was some difficulty in finding a suitable bottom, but a successful epibenthic sledge sample was obtained and followed by a near - bottom RMT 1+8 which was fished successfully using the bottom contact switches, though with some difficulty in interpreting the switch traces (see later).

Station 5 was completed by 1200/5 and Challenger proceeded to the next proposed station on the north side of the Sea-Bight, at a depth of 2500m at about 50°25'N: 14°00'W. Because of considerable discrepancies between the observed soundings and the available bathymetric chart an echo-sounding watch was begun on this run and was continued between stations for the remainder of the cruise programme.

During this passage, at 1600/5, there was a short power failure during which the Magnavox failed to switch automatically to battery power.

On the approach to the proposed station it was clear that the bathymetric chart was particularly unreliable in this area and a fairly extensive echo-sounding run was undertaken in an attempt to follow the 2500m isobath. The ground was far too rough for trawling or near-bottom RMT work and at 1830/5 this station was therefore abdandoned and Challenger proceeded north towards the proposed 1500m station. However, since the chart indicated that considerably more soundings had been available in the region of 1200m compared with 1500m, the shallower depth was sought. Suitable trawling ground was found and the RMT was shot at 2140/5 but was aborted after one hour because of monitor problems which turned out to have been caused in part by a leaking plug.

A successful epibenthic sledge haul was made in 1100m. The distance run wheel worked well during this haul, but whether this was because of a stop which had been fitted to the frame to prevent the wheel sinking too far into the sediment or because the sediment itself was firmer than at the earlier stations was not clear. A successful OTSB, a near-bottom RMT, a 500-400m RMT and a second epibenthic sledge haul completed this station by 1600/6.

in favour of station 3, some 9h steaming away, at a depth of 4000m in the mouth of the Bight.

The first series at station 3, a BN haul, was successfully completed by 0300/3 except that the distance run wheel once more failed to work, apparently due to tightness in the bearings which may also have caused the earlier failures. Two RMT hauls followed, one using monitor J5 and 9750m of wire, and the second using J13 and a total of 11000m of wire. Both hauls were successfully monitored and samples were obtained from approximately 200m horizons reaching to within 60 and 50m of the sea-bed respectively.

These long wire hauls were completed by 2230/3 and after about one hour's steaming to return to a 4000m sounding the OTSB was shot at 0020/4. This haul was expected to require about 10-11,000m of wire, but after paying out about 7200m a strand from the splice between the 16mm and 19mm sections was found to be unlaid. The haul was aborted in order to relay the splice, but when the wire was streamed out to the splice once more at 0900/4 it could not be stopped off since the ship's stopper was too worn to hold the warp.

While the warp was still streamed, permission was obtained from Barry to sever the wire at the faulty splice. We decided, however, to retain the outboard end of the warp until the deeper hauls had been completed since by so doing we would have some 6700m of usable wire, compared with only about 5800m if it was cut. In the event, when the warp was winched in a bad kink was encountered with about 400m out, presumably caused by laying on the bottom during streaming; this section had to be removed, leaving 6300m of usable warp.

With this restricted amount of usable wire none of the gear could be reliably worked at the 4000m station and this was therefore abandoned in favour of station 4 at 3500m. Since the course to this station passed close to the position of the fish-trap lost on Discovery cruise 88 a small detour was made to interrogate the acoustic release. The trap was located at 1145/4 and release attempts were made until 1230h. Although the electronics apparently responded correctly, no release was achieved and we proceeded to station 4, arriving at 1400/4.

Some difficulty was experienced in finding a suitable bottom for the epibenthic sledge due to the irregular topography associated with two canyons running through this area. Eventually, however, a reasonably flat area was found and a

The deeper stations for the RMT and OTSB now having been completed, the outer 7000m of main warp were dumped. To accomplish this a course was made for what appeared to be a fairly precipitous slope in the region of 50°40'N: 14°35'W. The bathymetric chart once more turned out to be very unreliable in this region, however, and whereas this position should apparently have been in a depth of almost 2500m, we did not encounter 2000m until we were some 5 miles further west. Since the slope at this position had become quite steep, and was clearly unsuitable for trawling, the wire was finally dumped at 50°39.4'N: 14°42.7'W.

A series of three stations (7, 8 and 9) at depths of 700m, 500m and 400m respectively, was now worked on longitude 14°W, approaching the Porcupine Bank. At each station an epibenthic sledge sample and a near bottom RMT sample were obtained and, in addition, OTSB samples were obtained at stations 7 and 9.

Moving down into the Sea-Bight once more, an epibenthic sledge haul was made at station 10 at a depth of about 1000m, this depth being difficult to work with this gear on the eastern side of the Bight because of the presence of abundant coral.

Moving further down-slope, an OTSB haul (Station 11) was obtained at about 1400m, and a near-bottom RMT (Station 12) at 1450m. In this latter haul the RMT 8 failed to close properly because the bridle caught on a shackle, but the RMT 1 was successful.

During the haul at station 11 the main warp sheave on the "A" frame began to bind rather badly. It could not be greased because the nipple was damaged, but an attempt was made to oil it. This improved matters somewhat, but if the programme had included many more hauls it is doubtful whether the sheave would have coped with them.

As it happened, only one more haul was made, an epibenthic sledge haul at 2500m (Station 13) in the centre of the Sea-Bight. At 1800/9, during the passage from station 13 towards the Goban Spur to work the final two stations of the cruise programme, on the main compressors failed and on the advice of the Chief Engineer it was considered prudent to abandon any attempt at further sampling. Challenger accordingly returned directly to Barry, docking at 1000/11.

BENTHIC INVERTEBRATES

The echinoderms dominated the invertebrate fauna in practically every benthic sample. The most notable exception was the catch from the coral area along the eastern border of the Porcupine Sea Bight (St. 50601, 770-927m), where the corals Lophelia pertusa and Madrepora oculata were particularly prevalent. The fauna generally associated with the coral area, such as cirripedes, the bivalve Bentharca nodulosa, and the worm Eunice floridanus, abounded, as well as several echinoderms including the echinoids Cidaris cidaris and Echinus elegans, and the filter feeding holothurian Psolus squamatus which occurred on rocks and boulders in the area. Another holothurian, Stichopus tremulus, was also common, although the specimens were considerably smaller than those taken in samples from shallower soft-bottom areas (St. 50608 510m, St. 50609 - 400m). At these stations the ophiuroid Ophiura affinis was very numerous, dominating the catches which also included the pennatulid Kophobelemnon, and the crustaceans Parapagurus and Geryon tridens.

Although S. tremulus also occurred at St. 50607 (700m), Laetmogone violacea became the dominant holothurian in a series of catches from this depth down to 1400m (St. 50610 - 980m, St. 50606 - 1100m, 50611 - 1400m). The samples from stations 50610 and 50606 were broadly similar, containing a number of anemones, pennatulids, gorgonians, gastropods, and the echinoids Phormosoma placenta and Echinus elegans which were particularly common. St. 50606 however, also included some solitary corals and the holothurians Ypsilothuria and Bathyplotes natans. Owing to a very large catch at St. 50611 the asteroids Zoroaster fulgens and Plutonaster bifrons, and the holothurians Laetmogone violacea and Benthogone rosea, had to be subsampled. In addition to sponges, anemones, solitary corals and cirripedes, several other echinoderms were also quite common, notably the echinoid Phormosoma placenta, and the holothurians Bathyplotes natans, Mesothuria lactea and Mesothuria intestinalis.

At 2000m (St. 50602) the echinoderms dominated once again with the holothurians Paelopatides gigantea and Benthogone rosea, the asteroids Plutonaster bifrons, Benthopecten armatus, and Bathybiaster vexillifer, the echinoids Phormosoma placenta and Echinus affinis, and the ophiuroid Ophiomusium lymani. Also of particular interest were the hermit crab, Parapagurus, and its commensal anemones.

The only echinoderms to occur in any significant numbers both at St.50602 and St. 50613 (2440m) were Ophiomusium lymani and Echinus affinis, although the dominant invertebrate in this case was the holothurian Psychropotes depressa. The asteroid Hymenaster and solitary corals were also common a catch that yielded little else apart from a great deal of clinker and stones, and a cow's horn and teeth!

Although the sample from 3000m (St. 50605) appeared at first to be rather poor, it in fact turned out to be one of the most interesting, producing the deepest known record of the ostracod Azygocypridina. Several large specimens of the holothurian Benthothuria were also taken, including one in the plankton net. Of greater importance, however, was the presence of thousands of small Kolga hyalina in the fine mesh net of the epibenthic sledge. These juvenile holothurians were first taken in the Porcupine Sea Bight on Discovery Cruise 92 in 1978 at a depth of 4000m (St. 9756#9, 9756#14). In contrast to the specimens of K. hyalina taken on that cruise, an average 0.5cm long, those in the present sample were some 1.0-1.5cm in length. Analysis of the photographic record, furthermore, failed to show any sign of the dense aggregations in which these holothurians had been found on cruise 92.

Many small K. hyalina were also taken at St. 50603 (4000m) but not at St. 50604, (3500m) where, apart from the asteroid Dytaster and several Echinothurians, the catch was rather poor. Many other holothurians occurred at 4000m, including Psychropotes longicauda, Oneirophanta mutabilis mutabilis, Peniagone diaphana and Benthodytes lingua. The ophiuroid Ophiocten sericeum was also particularly abundant, occurring in thousands, as experienced in the previous samples taken in the area. Several specimens of the asteroid Freyella spinosa were also taken, including one near perfect specimen that had been caught on the netlon covering the frame of the epibenthic sledge.

D.S.M. Billett

BOTTOM TRIGGERS

The great improvement in the shipside acoustic receiving system resulted in good bottom echo signals being detectable during near bottom tows in good weather conditions down to depths of at least 4000m. Even in rather rougher sea states (force 6 winds) sufficiently clear bottom echo signals were detectable for fishing to within 20m of the sea bed at a depth of 1500m. It was also possible to check out the performance of the present bottom triggers. During pay out, the second trigger tended to be operated, the buoyancy and drag of the diving line being sufficient to cock the weighted mercury switch. When the net was held 50m above the sea bed to settle, the switches took about 20 seconds to settle and both to open. Paying down, the lower switch closed when the bottom echo showed a 25m separation from the signal. With a 2 : 1 wire out : depth ratio, this would indicate a height of approximately 25m above the seabed or less if the ratio is larger. Paying on down, the second trigger closed at 8-10m separation i.e. the weight bar is almost touching the bottom. When hauling or when the net rose on its own, the second trigger opened with a 15m separation. The first trigger opened again with a separation of 25m. The trigger system is likely to be superceeded by the development of an echo-sounder device mounted on the net for general IOS work. However, the triggers would still offer a useful technique especially if, 1) a conducting line with less buoyancy and drag can be found to replace the present line, 2) the top ends of the weighted triggers can be better protected from abrasion during towing along the bottom.

THE USE OF CHALLENGER FOR RMT 1+8 WORK

The present layout of facilities onboard Challenger has two main limitations:- 1) the height above the deck of the block on the 'A' frame is not sufficient to permit smooth launching; 2) The fixed hauling and paying out speeds on the winch necessitates using alterations of ship's speed for some net operations normally conducted by winch control on Discovery.

When launching, the RMT 8 was laid out aft of the weight bar, so that when the weight bar was lifted outboard the RMT 8 preceeded it over the side. This greatly reduced tangling of the bridles and side wires. Initially, with the 'A' frame vertical, the monitor was lifted off its frame and then kept up close to the block. The slack was taken up on the wire lifting the weights. As the 'A' frame was moved outboard the main warp was paid out to keep the monitor out of the block and the weight bar lifting wires were also slacked off so that although the weight bar was not lifted clear of the deck they were kept under tension. Once the monitor was hanging beyond the stern ramp the weight bar was lifted, resulting in the RMT 8 pulling overside and the weight bar swinging clear. On half the launches, the weight bar was lowered away and the handling line shackled off to the top bar without problem. Tangles occurred on the other half, which usually meant the gear had to be brought inboard again. About half the tangles were minor rigging faults resulting from a) the difficulty of correct rigging when the nets could not be laid out, b) wires from other gear having to remain across the deck, and c) the constant need to dismantle and reassemble the gear during a mixed sampling programme. The other tangles occurred during the launch and it was these that could be greatly reduced if there was a greater lift on the 'A' frame.

Recovery was by bringing the monitor to the block, bringing the 'A' frame inboard close to the vertical position. The side lifting wires were unshackled from the top bar and attached to the auxillary winches. Raising the weight bar then resulted in the bar swinging inboard, damped by the drag of the RMT 8. The weight bar was rested on the deck while the monitor was lowered onto its frame. The RMT 8 was then brought inboard by swinging the 'A' frame a little more foreward and raising the weight bar again. Recovery was relatively simple and presented no problems even in force 6 wind conditions.

Speed control of the ship appeared to be less fine than on Discovery, although the response time to alterations was shorter. Opening the RMT 1+8 caused a reduction of 1/4 knot in the ship's speed. Paying out after opening the net could be minimised by allowing the unopened net to stabilise for ten minutes before opening. This was particularly important since the slowest pay out speed on the winch was about 0.8m s^{-1}, so the ship needed to steam at $2\frac{1}{2}$ - $2\frac{3}{4}$ knots to compensate for this fast pay out speed.

The Challenger, with experience, will be a thoroughly practical vessel to consider using for future midwater sampling programmes using the RMT 1+8. It is very doubtful if the RMT 1+8M could be fished successfully from her, unless the effective lift of the 'A' frame is at least doubled.

M.V. Angel

NEAR BOTTOM CATCHES WITH THE RMT 1+8

The two one-hour tows taken during the tests of our ability to communicate both ways with the monitor over slant ranges of 10-11km, showed that at 4000m very little plankton or nekton lives 50 or 60m above the sea bed. Working up the slope, the haul taken 10-20m above the sea bed in a depth of 1200m resulted in a massive catch dominated by gelatinous organisms, which were predominantly *Aglantha digitale*, a deep-living medusa. The near bottom tow in 700m produced an even more voluminous catch of gelatinous organisms. This catch was about an order of magnitude larger than would be expected at a similar depth off the slope in midwater. The catches at shallow depths were progressively smaller, with the proportion of crustaceans increasing. Later on the RMT 1 catch at 1500m suggested that the near-bottom plankton at that depth, while being more abundant than in midwater, was not startlingly more copious. Although the RMT 8 failed to close because of the hang up of one closing bridle (the only fishing failure) so that it fished all the way back to the surface, the volume of the catch implied that the abundance of near-bottom nekton is not substantially larger than in midwater in similar depths.

So the samples imply that where oceanic communities impinge on the shelf, there is a dramatic increase in concentrations of gelatinous organisms between 700-1200m. These high concentrations must be a substantial food resource for the benthic communities. In deeper water, if any marked increase in abundance of midwater organisms occurs near the sea bed it must be nearer than within 50m of the bottom.

M.V. Angel

OTSB14 AND FISH REPORT

Sampling with the semi-balloon otter trawl was confined to the slope regions (405-1930m soundings), owing to the restriction on the usable length of the deep warp imposed by the stranding of a long splice. No difficulty occurred in finding suitable trawling grounds. Six hauls were completed without major damage to the gear. The beacon used to monitor the arrival and departure of the net on the sea-floor worked reliably and unattended throughout the cruise. The additional facility of telemetering temperature was a considerable advantage to the data obtained.

The total collection of fish from the OTSB14 comprised at least 57 species, one as yet undescribed, from around 25 families. On the other hand, 25 species of fish were sampled by the BN1.5, 20 of which were common to both gears. The OTSB14 hauls yielded 423kg of fish. Notable were individual catches of *Lepidion eques* (13.5kg), *Coryphaenoides rupestris* (62kg), *C. guntheri* (23kg) and *Nezumia aequalis* (20 kg). Calculation of relative biomass in each haul indicated a broad peak at 700-1400m sounding. Zonation of species down the slope was apparent. Among the more abundant families represented (e.g. synaphobranchids, alepocephalids, morids and macrourids) a size-depth dependence was evident, with juveniles occupying the shallower part of the sounding range. In this connection, the near bottom samples of the RMT combination net over the upper slope were of particular interest. Larvae of several species of macrourid, mainly of the genera Coryphaenoides and Chalinura, were collected in relative abundance close to the sea bed. In addition, a unique capture was made of an early transforming stage of a notacanth leptocephalus larva, with a long filamentous tail, in the same region.

N.R. Merrett

UNDERWATER CAMERA SYSTEM

Following evidence of system malfunction during operation at depth in November 1978 the decision was taken to monitor the Mk 4 camera system performance carefully under normal sea going conditions on this cruise.

Circuit modifications had been carried out in the interim period, but from previous experience their effectiveness could not be proved under laboratory conditions. The opportunity also arose, to evaluate the performance of a new high capacity, controlled level flash unit and to test the operation of a redesigned time base circuit expected to achieve an overall accuracy of 0.015%.

Film was processed on completion of each station and resultant records studied to check equipment performance and initially to confirm the suitability of a revised camera location on the new sledge.

The camera mounting had been raised from a height of 0.5 to 0.9 metres from the sledge runners and the inclination increased from approximately 10° to 30° from the horizontal. One basic advantage gained by this modification was an increased latitude in sledge angle before loss of subject matter occurred in the camera field of view, which undoubtedly contributed to an increased success rate achieved during the cruise.

Initially random operation of an elapsed time display was evident in one of the cameras used. Replacement of a faulty circuit board component rectified this problem and the system performed correctly in both units during the remaining stations.

Prior to the third haul attempted, sea water contamination of an external electrical connector gave rise to false system triggering on deck. Elimination of this fault was achieved by lowering the input impedance of associated circuitry by a factor of ten.

A total of eleven stations were carried out with the camera system in operation, colour film being used on two occasions during the later stages. Examination of black and white records obtained indicated that long runs of fairly constant density negative material had been obtained on each haul and in general the performance of this equipment is now considered to be satisfactory.

E.P. Collins

EPIBENTHIC SLEDGE

The new epibenthic sledge (BN1.5/3MSB) was used for the first time on this cruise. The basic benthic sampling part of the sledge is the same as the previous gear (BN1.5/3M), but the frame has been heightened to accommodate a 0.6 m^2 mouth area, 0.33mm mesh suprabenthic plankton net. This net is opened and closed by pivoting the mouth through 90°, using a mechanical linkage from the opening/closing mechanism of the lower nets, and it is therefore fishing only while the sledge is on the bottom.

The acoustic telemetry has also undergone considerable sophistication. Besides the previous functions there are, in addition, traces indicating depth, temperature, angle of the mouth of the top net and camera function. The new monitor worked perfectly throughout the cruise and gave precise information as to the behaviour of the gear.

Unfortunately, the odometer, the prototype of which worked well on Discovery cruise 92, gave considerable trouble. It did not revolve at all on the deep stations, where the sediment was soft, despite the spindle bearings being eased, but it worked well on the firmer substrate encountered at the shallower stations. It is not certain whether this success was due entirely to the nature of the sediment or whether a stop added after the 3000m station, to prevent the wheel falling too far below the skid, made the difference. The last station (2500m) should have given the answer; however, the odometer wheel moved slightly in its mounting and jammed against the newly added stop.

The increased height of the sledge frame allowed the camera to be mounted higher and consequently at a much steeper angle. The resulting photographs, although of a smaller area, were at a less oblique angle and therefore should be of more use for quantitative analysis. After a few initial minor problems the camera worked well throughout the cruise. Colour film was used at two stations and the black and white film used at all the other stations was developed on board, to check the camera operation. Two of these films have been compared with the monitor records and the blank frames (i.e. with the camera looking into midwater) correspond with times when the inclinometer showed that the sledge was beginning to lift off the bottom.

The new sledge was used at eleven stations, in depths ranging from 400 to 4000m, and good samples were taken on all occasions. At the 400m station (50609#1) the bottom bar weak link broke on the left hand side and consequently the catch in the coarse net on that side was considerably smaller than that taken by the right hand side.

The sledge was launched with the ship's speed at 2 knots and the wind fine on the bow. The tendency for the sledge to roll as it passed through the disturbance of the ship's propeller was still apparent but on no occasion did it turn over. Consequently, no extra buoyancy was added to the top of the frame, as was the practice with the old sledge when used from Discovery. Once a hundred metres of wire had been paid out the winch was stopped for a few minutes to allow the net to stabilize. Paying out was then continued with the winch on notch 1 (0.5-0.7m/sec). When the sledge was within 100-50m of the bottom, the ship's speed was slowed to 1.5 knots for the rest of the haul. After the sledge landed on the sea bed a further 50-80m of wire was paid out, and if it showed a tendency to lift off after this more wire was paid in 20-30m stages until the sledge was fishing continuously.

The inclinometer, which primarily was intended to indicate the degree of opening of the upper net mouth, relied on a pendulum, and therefore it was also affected by a change in the angle of the whole net frame. This was particularly useful as it gave very clear indication of the front of the sledge lifting clear of the sea bed, which could be countered by paying out more wire before the sledge completely left the bottom.

Handling the sledge from Challenger proved to be relatively easy as it was never necessary to lift it more than a foot or so above the deck. From the sledge's stowed position at the foreward end of the poop deck the launch was effected in three operations. The opening/closing mechanism was fixed in the open position by a bracket and the odometer wheel wedged up above the skids. A four legged bridle was attached to the top towing eyebolts and the safety strop eyebolts and the sledge lifted in the horizontal position as far aft on the poop as the reach of the crane would allow. The main warp was then attached in place of the crane and the sledge was lifted further aft by the 'A' frame until the back of the skids rested on the hump across the stern. The main warp was transferred to the towing bridles and the lifting bridles removed, as were the holding devices on the opening/closing mechanisms and the odometer wheel. With the main block on the 'A' frame positioned above the front bar, the front of the sledge was lifted clear of the deck. Slowly putting out the 'A' frame and adjusting the height, using the main warp, the sledge could then be slid gently over the stern without it leaving the deck.

Recovery was equally simple. The main wire was hauled and the 'A' frame brought inboard until the skids were resting against the stern and projecting above it for about half their length. A two legged bridle was attached to the lower towing points and the sledge pulled inboard along the deck by one of the ancillary winches, at the same time slacking off the main warp.

R.G. Aldred

ACOUSTIC COMMAND AND LISTENING SYSTEM

Two major objectives of this cruise were to improve and define the operational limits of (a) the IOS Acoustic Command System as used with the Biological Net Monitor, and (b) the 10 kHz telemetry system as used with the various Biological Net systems. I was concerned with all of (a) and the shipborne receiving and decoding aspects of (b).

Previous experience indicated the probable limiting factor to both aspects to be the shipborne acoustoelectric transducer with the possibility of a minor contribution from sea unit and shipborne electronics. The command receiver cards in two net monitors were replaced with cards as used in the well proved Command Release units. These were then checked at 0°C, which meant any deterioration in their performance at or above that temperature should be due to poor quality received signals. Provision was made in the shipborne electronics to increase the output power, but this was restricted by the power handling ability of the electroacoustic transducers. The main shipborne transducer is known as the P.E.S. single element. This was originally developed for use in a narrow beam deep ocean precision echo sounder array. Its acoustic sensitivity is concentrated in one hemisphere with the peak occurring in the centre, falling to one quarter of the peak at 45° to the base plane, and one sixteenth at twenty degrees. It is normally mounted with the peak sensitivity aimed vertically at the sea bed. A second shipborne transducer is now in routine use, the 'ceramic ring' type. This has acoustic sensitivity of a ring character and thus if mounted with the plane of the ring horizontal has a peak sensitivity in the horizontal falling to one quarter at 45° and one sixteenth in the vertical. However, the conversion efficiency is only threequarters that of the P.E.S. type and in transmission, power is spread over a full sphere. This results in peak sensitivity being less than half that of the P.E.S. element. Performance of the P.E.S. element has been improved in the receiving mode by using the full array and removing the difference between arrival times of signals from a particular direction (beam steering). This raises the sensitivity at 45° to the peak of a single element and that at twenty degrees to one quarter. Propagation in the sea requires a doubling of power to double range to counter spreading losses and at 10kHz a doubling of power to increase range by 3 kilometres to counter absorption losses.

The practical implications of these figures in the sea are for reliable full transceive using normal systems.

	Water Depth	5000m	4000m	3000m	2000m	1000m
Normal PES	Slant Range	8000m	8000m	6000m	5000m	3000m
Element	Up to Angle	30°	30°	30°	30°	30°
Ceramic Ring	Slant Range	8000m	8000m	8000m	6000m	4000m
	Down to Angle	45°	45°	45°	All angles	All angles

Biological requirements are special in two respects. First the large drag on towed nets and wire result in large amounts of wire out for a given fishing depth (a ratio of between two and three to one), giving an acoustic transmission angle of between 20° and 40° to the horizontal. Second, the net systems are towed behind the ship. This results in a full transceive capability required for up to 12 kilometres behind the ship.

All this information was available before this cruise and it was felt that a PES element mounted at 30° to the horizontal would greatly increase obtainable ranges. It would also be useful to study how the system performance varied with transducer angle to establish how critical maintenance of that angle might be.

A lightweight 'dolphin' towed vehicle capable of being towed at speeds to 6 knots was modified to take a backward looking variable angle P.E.S. element mounting bracket. The original design enabled the elements position to be varied and monitored in situ. Due to inadequate time available for preparation the position monitor never worked and failure of a relay and a mechanical snag combined to destroy the gearbox and its spares. However, the bracket was easily modified to enable fixed angles of 15°, 30°, 45° and 60° to the horizontal to be used. For initial experiments 30° was selected and results demonstrated this to be the optimum position. A dolphin carrying a standard ceramic ring transducer was taken along for comparison.

After a short gear checking haul a long range haul in 4000 metres water depth was attempted. The net successfully operated at 9750 metres wire out at an indicated depth of 3850 metres and a temperature of 2.1°C using the standard deck control unit transceiving through the backward looking P.E.S. element. The net was then fished for one hour and successfully closed with the same technique. The net was then hauled to 8779 metres wire out to prevent bottoming where a series of bandwidth trials were carried out. These indicated an increase in power would be useful.

I then calibrated my power amplifier and decided to compare three power levels, x, 1.9x and 2.6x where x is approximately 30 Watts. These were obtainable by quick and easy changes.

A second long haul was then attempted using the second net monitor. This time a higher ship's speed was used to try to obtain even longer ranges in the available depth. The net was opened successfully at 9900 metres wire out using power x through the backward element. The net was again fished for one hour and then closed at 11000 metres wire out. Trials were then conducted while hauling slowly. Power x was proved usable by 10600 mwo, 2.6x was proved as good as laboratory operation at 2°C by 10300 mwo, 1.9x was proved very nearly as good by 9900 mwo, and x was again proved usable by 8600 mwo.

These two hauls further provided very good received signal strengths and bottom echoes when at extreme range.

The backward looking element fixed at 30° was then used for all nets on this cruise all being fished relative to bottom echoes. This was of particular relevance to the very successful near bottom RMT series.

Unfortunately no further long range trials were possible because of the failure of a splice in the main wire limiting the usable range to 5500m.

To summarise these results and conclusions to be drawn from them: two net monitors were successfully fished and operated over wide and comparable command bandwidths at ranges to 11 kilometres in 4 kilometres water depth. RMT, BN, and OTSB net configurations were all fished with the aid of good strength signals and bottom echoes to the full range. This performance was largely attributable to the backward looking P.E.S. element and with the increased command power all nets should be comfortably fishable to a range of 12 kilometres.

Other instrumentation

An alternative to the Mufax for obtaining hard copy and real time monitoring of telemetered signals was evaluated for the first time at sea. This was an X-Y recorder with chart drive giving T. The high inertia of the pen drive systems meant the signals had to be electronically processed to a standard form and could only be displayed every other sweep. In spite of these restrictions the system worked well and is usable for normal beacon location, transponder location and vertical wire work. Resolution is basically good but is fundamentally unable to resolve pulses of less than 20 milliseconds separation and of signal levels approaching sea noise. The system can never be as good as the Mufax and could not cope alone with the complex signals received from units such as Biological net monitors. However at less than one fifth the cost of alternative devices it is a valuable laboratory and mooring aid. In the future it could be an important part of a digital monitoring and recording system.

G. Phillips

SHIP'S INSTRUMENTS

Main Trawl winch monitors - these appeared to have failed during the first haul.

The strain gauge 'fault' was found quickly - missing fuses. The counter 'fault' appeared more serious but as the trawl had already been deployed it was fished by reference to acoustic beacon, a known splice, and manual counting of the metering sheave. After the haul investigation of the main console showed no apparent faults but no control signals from the metering sheave. This was dismantled and the absence of signals confirmed. The magslip unit was removed and mated with its slave and found to be perfect. There was obviously a break in the cable. The main console was lowered and a plug was found to be removed and tucked carefully under the mass of wiring. The cable was checked to the sheave and no obvious faults were present. The plug was connected and the system performed adequately for the rest of the trip although the absence of an operational rate meter was a considerable inconvenience.

Precision Echo Sounder System - the deployment winch with its large towing sheave and self-contained storage drum is a considerable advance on any other method used. The Mufax control console performance however was considerably down on other systems in operation. I used my own system which is independent until the Mufax auxillary input stage and obtained better performance with 30 watts than the Mufax 650 watts. I then monitored the Mufax generated returns using the single element through the Mufax external signal input and found this to outperform the standard system. This isolated the problem in the pulse power amplifier chassis. The main and the spare were checked and found to be perfect but when plugged in the receiver was not referenced to Cv or the signal return. Reference to the circuit diagram showed this to be originally down using a screened lead to the preamplifier. This had been officially deleted (whited out) but no alternative had been provided. A shorting link was applied to the PPA 0 volts and an improvement of 30dB was experienced. To simplify maintenance the permanent link was made in the access plug and this P.E.S. is now the best I've seen. Later in the cruise a zener diode blew in the marking amplifier and, as we had no spares, one was taken from the spare board. The spare board was not used as the contrast is not quite so good, probably due to lower gain power transistors; it was, however, thoroughly checked.

G. Phillips

TELEMETRY

The temperature telemetering pinger used in conjunction with the OTSB performed faultlessly throughout the cruise despite the severe treatment to which it is subjected during deck handling and on the sea-bed. It is felt however that a useful reduction in the risk of loss or damage to the pinger could be made by cutting an acoustic window through one of the trawl doors and mounting the pinger pressure case on the back.

The new benthic telemeter Ben 1 fitted to the BN1.5 also performed without fault, though not without some concern being felt during the first three hauls when it consistently indicated that the odometer wheel was not revolving. This failure was later convincingly demonstrated to be a mechanical problem and not a malfunction of the sensor or its monitoring electronics.

The circuit incorporated in this monitor which is used to generate a time delay which is directly proportional to the output of the IOS Anglemeter fitted in parallel with the side bar of the top net, is also used as a frequency sensitive switch. The purpose of this is to detect the output frequency of the anglemeter which corresponds to the net being sufficiently open to justify activation of the camera. Confirmation of the successful operation of this switch and camera activation is obtained by a discrete offset of the temperature delay trace on each occasion that the camera film wind-on mechanism has functioned. By this means it was possible when the meter wheel was functioning correctly to identify not only where each frame was taken but also when.

The RMT Net Monitors J5 and J13 were both tested successfully in range trials (as noted elsewhere). J5 was then used exclusively for the remaining hauls. The net delay circuit in J5 was modified in order to use the bottom detector triggers, but towards the end of the first haul using these switches the net trace became erratic, and in the mistaken belief that this was caused by operating the delay offsets on a critical part of the delay characteristic this circuit was modified once more. In retrospect, however, it is clear that the erraticism of the trace was in this instance caused by a developing leak in the interconnecting cable between monitor and release gear. Unfortunately, once this leak had become established it caused the release gear to motor continuously and this in turn allowed sufficient seepage to occur past the shaft seal to render this release gear inoperable for the remainder of the cruise. The 5 pin M & M bulkhead connector in the monitor had also to be replaced.

Since the Net Delay response is asymptotic and not linear like the remainder of the delay circuits it is less than ideal for the number of offsets that are required for peace of mind when fishing with the aid of bottom triggers. It is proposed, therefore, to replace this circuit with a linear version in time for the next cruise and indeed in all future monitors that are produced.

The bottom triggers could themselves stand some modifications as it was found that being dragged across the sea bed caused leaks to occur quickly due to particulate invasion of the connectors. It is clear however that a near-bottom echo sounder attached to the RMT is required as a matter of some urgency in this application since even when the triggers and their associated circuitry are operating at their optimum the precise height of the gear from the sea-bed can still not be determined by this method.

E. Darlington

GEAR ABBREVIATIONS

BN1.5/3M	Bottom net $1.5m^2$ (closing) with 3 nets and camera
SBN 0.5	Suprabenthic net $0.5m^2$ (on BN1.5/3M)
RMT 1	Rectangular midwater trawl $1m^2$) fished in combination
RMT 8	" " " $8m^2$
OTSB14	Semi-balloon otter trawl 14m headline length

CRUISE 506
29/ 6/79-11/ 7/79

STN.	DATE	START POSITION LAT	LONG	END POSITION LAT	LONG	GEAR	SAMPLER DEPTH(M)	DURATION GMT	FLOW/LOG DIST.(KM)	WATER DEPTH(M)	SHIP SPEED(KN)
50601/ 1	1/ 7							DAWN		848	2.5
		51 19.2N	11 41.1W	51 21.1N	11 42.9W	OTSB14	770- 927	426- 544	5.93 LOG		
50602/ 1	1/ 7							DAY		2018	2.1
		51 1.0N	13 5.7W	51 0.8N	13 5.0W	RMT1	100- 100	1700-1800	0.		
		51 1.0N	13 5.7W	51 0.8N	13 5.0W	RMT8	100- 100	1700-1800	0.		
50602/ 2	1/ 7							DUSK		2018	1.5
		51 1.0N	13 5.9W	51 1.1N	13 8.4W	SBN 0.5	1955-1980	1945-2030	2.63 LOG		
		51 1.0N	13 5.9W	51 1.1N	13 8.4W	BN1.5/3M	1955-1980	1945-2030	2.63 LOG		
50602/ 3	1/ 7							NIGHT		1871	2.6
		51 6.8N	13 16.7W	51 6.9N	13 24.4W	OTSB14	1817-1930	117- 330	9.85 LOG		
50603/ 1	2/ 7							NIGHT		4000	1.5
		49 46.2N	14 1.5W	49 44.4N	14 0.5W	SBN 0.5	4000-4000	2310- 17	3.40 LOG		
		49 46.2N	14 1.5W	49 44.4N	14 0.5W	BN1.5/3M	4000-4000	2310- 17	3.40 LOG		
50603/ 2	3/ 7							DAY		3980	2.1
		49 53.9N	14 8.9W	49 55.7N	14 11.5W	RMT1	3720-3940	746- 852	4.63 FLOW		
		49 53.9N	14 8.9W	49 55.7N	14 11.5W	RMT8	3720-3940	746- 852	4.63 FLOW		
50603/ 3	3/ 7							DAY		3925	2.6
		49 53.4N	14 4.1W	49 50.8N	13 59.3W	RMT1	3500-3710	1728-1830	4.45 FLOW		
		49 53.4N	14 4.1W	49 50.8N	13 59.3W	RMT8	3500-3710	1728-1830	4.45 FLOW		
50604/ 1	4/ 7							DUSK		3530	1.5
		50 6.1N	13 53.0W	50 6.4N	13 49.9W	SBN 0.5	3490-3550	1931-2028	3.73 LOG		
		50 6.1N	13 53.0W	50 6.4N	13 49.9W	BN1.5/3M	3490-3550	1931-2028	3.73 LOG		
50605/ 1	5/ 7							NIGHT		2875	1.5
		50 11.6N	13 32.4W	50 11.2N	13 29.0W	SBN 0.5	2820-2930	217- 308	4.12 LOG		
		50 11.6N	13 32.4W	50 11.2N	13 29.0W	BN1.5/3M	2820-2930	217- 308	4.12 LOG		
50605/ 2	5/ 7							DAY		2735	1.7
		50 6.5N	13 12.0W	50 5.9N	13 7.2W	RMT1	2640-2750	907-1030	5.71 FLOW		
		50 6.5N	13 12.0W	50 5.9N	13 7.2W	RMT8	2640-2750	907-1030	5.71 FLOW		

STN.	DATE	START POSITION LAT	START POSITION LONG	END POSITION LAT	END POSITION LONG	GEAR	SAMPLER DEPTH(M)	DURATION GMT	FLOW/LOG DIST.(KM)	WATER DEPTH(M)	SHIP SPEED(KN)
50606/ 1	6/ 7							NIGHT		1115	1.5
		50 40.4N	14 9.8W	50 40.1N	14 10.8W	SBN 0.5	1110-1120	122- 153	0.60 LOG		
		50 40.4N	14 9.8W	50 40.1N	14 10.8W	BN1.5/3M	1110-1120	122- 153	0.60 LOG		
50606/ 2	6/ 7							DAWN		1100	2.4
		50 40.8N	14 4.1W	50 42.1N	14 1.3W	OTSB14	1080-1120	504- 611	4.82 LOG		
50606/ 3	6/ 7							DAY		1195	2.0
		50 39.9N	13 59.3W	50 39.9N	14 5.1W	RMT1	1090-1160	1026-1226	6.70 FLOW		
		50 39.9N	13 59.3W	50 39.9N	14 5.1W	RMT8	1090-1160	1026-1226	6.70 FLOW		
50606/ 4	6/ 7							DAY		1100	2.1
		50 42.1N	14 4.3W	50 42.7N	13 59.1W	RMT1	400- 500	1354-1524	6.61 FLOW		
		50 42.1N	14 4.3W	50 42.7N	13 59.1W	RMT8	400- 500	1354-1524	6.61 FLOW		
50606/ 5	6/ 7							DAY		1130	1.5
		50 43.1N	13 56.1W	50 42.7N	13 57.0W	SBN 0.5	1120-1140	1723-1750	1.83 LOG		
		50 43.1N	13 56.1W	50 42.7N	13 57.0W	BN1.5/3M	1120-1140	1723-1750	1.83 LOG		
50607/ 1	7/ 7							DAWN		706	2.5
		51 1.7N	14 12.1W	51 1.4N	14 7.3W	OTSB14	700- 712	339- 450	5.19 LOG		
50607/ 2	7/ 7							DAY		700	1.5
		51 1.4N	14 6.4W	51 1.4N	14 7.5W	SBN 0.5	700- 700	656- 723	0.64 LOG		
		51 1.4N	14 6.4W	51 1.4N	14 7.5W	BN1.5/3M	700- 700	656- 723	0.64 LOG		
50607/ 3	7/ 7							DAY		686	2.2
		51 3.2N	14 14.2W	51 4.9N	14 19.9W	RMT1	655- 680	1005-1205	6.00 FLOW		
		51 3.2N	14 14.2W	51 4.9N	14 19.9W	RMT8	655- 680	1005-1205	6.00 FLOW		
50607/ 4	7/ 7							DAY		690	2.9
		51 4.6N	14 21.7W	51 5.2N	14 29.3W	RMT1	0- 650	1301-1349	3.19 FLOW		
		51 4.6N	14 21.7W	51 5.2N	14 29.3W	RMT8	0- 650	1301-1349	3.19 FLOW		
50608/ 1	7/ 7							DAY		512	2.6
		51 19.5N	14 20.7W	51 19.5N	14 20.3W	RMT1	460- 495	1748-1818	2.20 FLOW		
		51 19.5N	14 20.7W	51 19.5N	14 20.3W	RMT8	460- 495	1748-1818	2.20 FLOW		

STN.	DATE	START LAT	POSITION LONG	END LAT	POSITION LONG	GEAR	SAMPLER DEPTH(M)	DURATION GMT	FLOW/LOG DIST.(KM)	WATER DEPTH(M)	SHIP SPEED(KN)
50608/ 2	7/ 7							DAY		510	1.5
		51 19.3N	14 22.3W	51 19.3N	14 24.3W	SBN 0.5	510- 510	1921-2004	0.93 LOG		
		51 19.3N	14 22.3W	51 19.3N	14 24.3W	BN1.5/3M	510- 510	1921-2004	0.93 LOG		
50609/ 1	8/ 7							NIGHT		400	1.5
		51 39.7N	14 16.5W	51 39.5N	14 16.5W	SBN 0.5	400- 400	9- 25	0.30 LOG		
		51 39.7N	14 16.5W	51 39.5N	14 16.5W	BN1.5/3M	400- 400	9- 25	0.30 LOG		
50609/ 2	8/ 7							NIGHT		408	2.6
		51 38.7N	14 20.6W	51 38.0N	14 22.4W	RMT1	380- 395	231- 301	1.89 FLOW		
		51 38.7N	14 20.6W	51 38.0N	14 22.4W	RMT8	380- 395	231- 301	1.89 FLOW		
50609/ 3	8/ 7							DAWN		408	2.5
		51 36.7N	14 20.7W	51 36.8N	14 15.1W	OTSB14	405- 410	453- 553	4.45 LOG		
50610/ 1	8/ 7							DAY		980	1.5
		51 26.5N	13 24.1W	51 26.1N	13 24.7W	SBN 0.5	980- 980	1143-1202	0.33 LOG		
		51 26.5N	13 24.1W	51 26.1N	13 24.7W	BN1.5/3M	980- 980	1143-1202	0.33 LOG		
50611/ 1	8/ 7							DAY		1387	3.0
		51 19.5N	13 15.3W	51 15.6N	13 20.0W	OTSB14	1365-1410	1540-1710	5.56 LOG		
50612/ 1	8/ 7							NIGHT		1530	2.4
		51 14.5N	13 14.7W	51 13.1N	13 17.9W	RMT1	1440-1475	2207-2307	3.82 FLOW		
		51 14.5N	13 14.7W	51 13.1N	13 17.9W	RMT8	1440-1475	2207-2307	3.82 FLOW		
50613/ 1	9/ 7							DAY		2440	1.5
		50 29.5N	13 2.3W	50 29.7N	13 3.4W	SBN 0.5	2440-2440	819- 853	2.07 LOG		
		50 29.5N	13 2.3W	50 29.7N	13 3.4W	BN1.5/3M	2440-2440	819- 853	2.07 LOG		

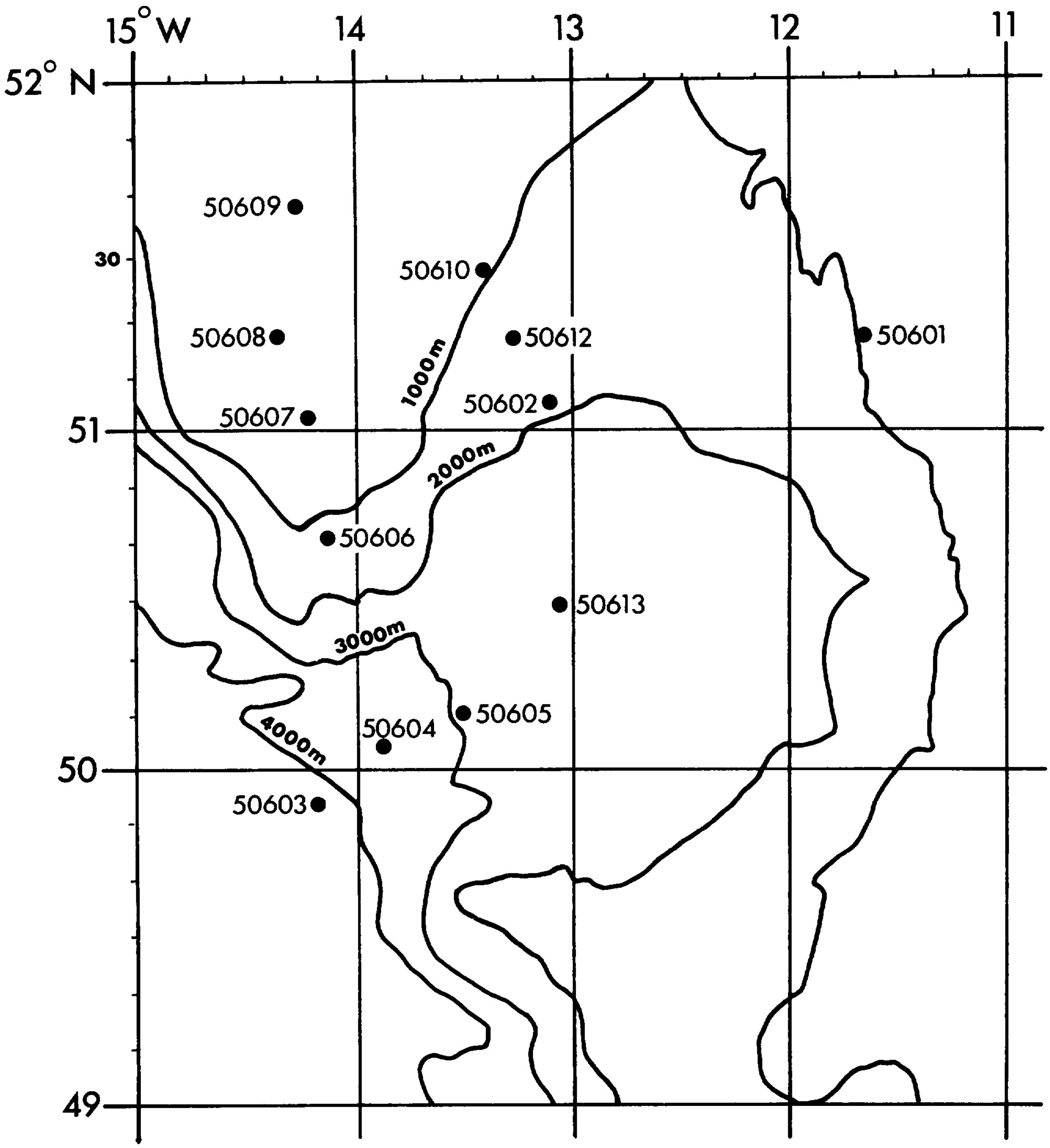
15° W
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FIGURE 1