RRS DISCOVERY CRUISE 65

15 August - 29 August 1974

Current meter moorings, Biology and

Batfish trials at 8°N, 23°W.

Cruise Report No. 17

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Abbreviations

RMT 1	$1m^2$ Rectangular Midwater Trawl (0.33mm mesh size).
RMT 8	$8m^2$ " " " (5mm mesh size). These nets were always used in combination.
RMT8/25HS	$8m^2$ Rectangular Midwater Trawl (25mm mesh size) high speed net.
NN	Neuston net.
TSD	Temperature, salinity, depth probe.
CM	Current Meter.
PUMP	Pump sampler.
LMD	Photo-diode Light Meter.
FL	Fluorometer
DN	A triangular microplankton net ($0.1m^2$ mouth area, 0.06mm mesh) fastened to the closing bridles of the RMT 1 for sampling microplankton.

Introduction

The programme for Cruise 65 included both physics and biology. The physical work was to be predominantly preparation for participation in the oceanographic programme of Phase III of GATE during Cruise 66. The aims were to lay the three 'E' current meter moorings forming the central triangle of the C-scale array and to make trials with the Batfish system to get it into a fully operational state and to gain experience in using it. The principal objectives of the biological programme were to collect material for an investigation into the possible existence of biochemical cycles associated with the diurnal migrations of pelagic decapods, to collect samples of micronekton and zooplankton from depths between 2000m and 5000m and to obtain live material for physiological work.

Due to problems with the current meter moorings much more time than anticipated had to be devoted to this part of the programme with the consequent loss of time on other parts.

Itinerary

The ship had arrived in Dakar on 13th August at the end of Cruise 64 and the whole of the 14th and the morning of the 15th August were spent in preparing the toroidal buoys for the current meter moorings. The ship sailed for 8°N, 23°W in the GATE C-scale area at 1200/15. The P.E.S. fish and the surface salinity/temperature probe were streamed shortly after sailing and echo-sounder watches were started.

The Batfish was launched at 2200/16 August but had to be recovered at 0030/17 because of loss of control due to leakage of hydraulic fluid. It was decided to lay the mooring at 8°42'N, 23°12'W (E3) first and in approaching the position the opportunity was taken to pass over the proposed site of the E1 mooring at 8°42'N, 22°57'W; the bottom was found to be very irregular. An echo-sounder survey of the E3 mooring position was combined with a Batfish grid during the night of 17/18 August and the laying of the mooring occupied most of the daytime of 18 August. This was followed by several fixes taken while doing 3 TSD dips. A similar echo-sounder survey and Batfish grid was worked over the E2 mooring position during the night of 18/19 August followed by the laying of the E2 mooring during the daytime. When the anchor was thought to have settled the toroidal buoy was riding rather low in the water so additional buoyancy in the form of a four foot sphere was tethered to it. Four TSD dips to 500m were then made while good position fixes were obtained. The Batfish was then launched and a course made for the proposed position for the E1 mooring and an echo-sounder survey and Batfish grid was worked. The bottom was extremely irregular and it was not until midday of 20 August that a decision could be made on a site for the mooring. The laying of the mooring, which consisted of a 27 foot spar tethered to an anchored toroidal buoy, was completed by 1836/20 and three fixes were obtained.

The biological programme started at 2200/20 with a short shallow haul with the RMT 1 + 8 to test the equipment. This was followed by three dips to 110m with the fluorescence pump attached to the TSD; on the third dip a current meter was also attached. At 0545/21 the first of the planned deep RMT 1 + 8 hauls was started; this was at 3500-3000m and it was completed at 1700/21. It was followed immediately by the first of the RMT 1 + 8 hauls to collect decapod Crustacea for biochemical work. These hauls were taken to coincide with the estimated time of arrival and departure of particular species at their day and night depths and in the gaps between the hauls a series of neuston net samples was taken. Four RMT 1 + 8 hauls and 15 NN hauls were made during the night of 21/22 August.

At 1000/22 a course was made for the E2 mooring to obtain further position fixes and to see that the buoy was riding satisfactorily. While waiting for satellites the opportunity was taken to do a yo-yo calibration series with the CTD in conjunction with water bottles from the forward winch. This was followed by two dips to 150m with the TSD and photo-diode light meter. Although the E2 buoy was still riding rather low in the water Dr. Halpern thought it wise to remove the four foot sphere tethered to it for emergency buoyancy; this was completed by 1623/22. Over the dusk period and evening two more RMT 1 + 8 hauls were made for decapods and for these hauls a fine mesh triangular net (DN) was fitted to the closing bridles of the RMT 1 to obtain samples of dinoflagellates. Between these two hauls two neuston net samples were taken.

At 2335/22 the RMT8/25HS was shot for tests at various speeds upto 7½ knots. At 0200/23, while the net was being hauled, a flashing light was observed dead ahead. Although the ship was some 14 miles from the position in which the E1 mooring had been laid there was little doubt that this was what had been sighted. The net was very quickly recovered and during three more net hauls, one with the RMT8/25HS and two decapod hauls with the RMT 1 + 8, the buoy was kept on the radar until it could be recovered during daylight. Recovery started at 1052/23 and was completed by 1559/23 when the ship returned to the original mooring position. The combined effect of a N.E. current of 1-2 knots and increasing depth to the N.E. were probably responsible for the mooring drifting so it was necessary to find a site with a shallower area to the N.E. before re-laying the mooring. Consequently the night was spent on a further echo-sounding grid to find a suitable site and laying began at 1150/24. Since the spar would have to have been recovered in two days, only the toroidal buoy with one current meter below it was laid. This was completed by 1409/24 and the position fixed by 1626/24 when a course was made to the E2 mooring to see that it was alright. On reaching the position no sign of the buoy could be found although the command pinger could be heard faintly. A search was made until 2215/24 when it was considered that nothing further would be found that night. The E1 mooring was then visited and no drift was observable. Three dips with the TSD and pump were made, the last two incorporating a current meter, and these were followed by six neuston net hauls over dawn. At 0744/25 the E3 mooring was revisited to obtain measurements of the signal strength of the pinger at various ranges for comparison with signals from the E2 mooring and then an acoustic search of the E2 position was made. When the area of maximum signal was established a dahn buoy was laid, the acoustic release was fixed and dragging was carried out on a grid pattern. This was unsuccessful.

At midnight 25 August a Batfish run was started but the fish had to be recovered at 0213/26 due to a fault and so the RMT 1 + 8 was fished to collect material for physiological work. At first light visits were made to the E1 and E3 moorings, both of which were in position and riding well. It was proposed to continue the search for the E2 mooring but on returning to the position six of the glass spheres used for back-up buoyancy were at the surface. These and all other equipment except the buoy, a tension recorder and an acceleration tilt recorder were recovered by 1900/26.

At 2000/26 the Batfish was launched and a course was made for Dakar. After a successful run the Batfish was recovered at 0920/27 and a short haul for euphausiids was made with the RMT 1+ 8. This was followed by two dips to 145m with the TSD and photo-diode light meter and passage to Dakar was resumed at 1454/27. Good time was made through a flat calm and at 1052/28 the speed was reduced and the course altered for a check on the E.M. log calibration. At 1440/28 and again at 1612/28 the ship passed through streaks of fine brown "dust" at the surface and on both occasions the neuston net was fished. The "dust" was too fine to be taken by the net but the second sample contained a very large number of the decapod Lucifer.

Discovery arrived off Dakar at 0430/29 and a number of E.M. log calibration runs were made along a 1 mile course. The P.E.S. fish and surface S/T probe were recovered at 0730/29 prior to entering harbour but at 0900/29 very high winds and heavy rain stopped all ship movements and Discovery eventually entered the fuelling berth in Dakar at 1100/29 August.

I would like to thank all those participating in the cruise for their help and co-operation, in particular Captain G.L. Howe, his officers, petty officers and crew. I should also like to thank Mr. J. Sinclair who, as lookout on watch, sighted the E2 mooring when it had drifted.

Decapod biochemistry and diurnal migration (C.R. Hayes)

It was proposed to investigate the possible existence of biochemical cycles associated with the diurnal migration that many planktonic animals exhibit. Selected decapod species were chosen for their relatively large size, abundance, and ease of identification. These were the congeneric species of *Acanthephyra*: *A. kingsleyi* and *A. acanthitelsonis*; *Systellaspis*: *S. debilis* and *S. cristata*; and *Gennadas*: *G. brevirostris* and *G. talismani*; and a species of *Sergestes* (*Sergestes*), *S. (S.) pediformis*. To eliminate confusion by possible sexual variation the survey material was further restricted to males, obtaining only mature adults where available in sufficient quantity.

Hauls were carried out at selected depths and times to secure the above species just prior to and just after both their upward and downward migrations and also at the midday or midnight depths between. The programme was completed within forty-eight hours. Twelve hauls had been proposed at day depths of 800-700m and 600-500m and night depths of 600-500m and 200-100m. Three of these of lesser importance were cancelled through time shortage. Specimens of all the above species except *S. cristata* were obtained from the appropriate hauls and the material was removed, identified, and frozen as soon as possible after capture. It is hoped that sufficient has been obtained for the biochemical purposes of the experiment.

Chlorophyll a fluorescence studies (P.R. Pugh)

Studies of the horizontal distribution of Chlorophyll *a* in the surface waters were made throughout the cruise. Sea water from the ship's pure sea water supply was passed continuously through an Aminco fluorometer and the levels of fluorescence were sampled every second by the shipborne IBM 1800 computer. The levels were extremely low, at the limit of detection by the machine, and showed no major changes either diurnally or spatially.

During the cruise two series of experiments were carried out to study the vertical distribution of Chlorophyll *a* down to 110m using the submersible pumping system whose inlet was attached to the TSD. At station 8598 two dips were made, the TSD being payed out at 0.1m/sec, and the results showed that there was a large peak in fluorescence at a depth which corresponded with the thermocline. The tubing on the pressure side of the pump became detached at the bottom of the first dip but this was quickly remedied.

As there was this peak in fluorescence in the thermocline it was decided to investigate the changes which might occur in the levels of chlorophyll *a*, due to internal waves, turbulence or the like, at a constant depth. A current meter was attached under the TSD and this was then lowered down to 50m. Sampling was continued for 2 hr and showed some interesting changes in fluorescence which were apparently correlated with temperature fluctuations.

These procedures were also adopted at Station 8617. A single vertical profile of fluorescence was made to 110m, after which a current meter was again attached and the TSD lowered to 40m depth. As there appeared to be no significant changes in the fluorescence or temperature at this depth, sampling was discontinued after 1½ hours and the TSD was lowered further to 50m. At this depth there were some major fluctuations in temperature over a range of 4+°C and with these large-scale fluorescence changes seemed to be correlated. The results have still to be analysed statistically.

Photo-diode Light Meters (P.R. Pugh)

Four dips were made using the Plessey photo-diode light meter system. The light meters had been recently calibrated and were found to give a fairly even response between 400 and 650nm. This unfortunately is a little short of the wavelength range over which it is believed that phytoplankton can photosynthesize but it is a reasonable approximation. Of the two light meters, one, the sea unit, was attached to the frame of the TSD probe while the other, the deck unit, was mounted on gimbals on the monkey island of the ship. They appeared to work well during the two dips at Station 8608 but there was some fault in the frequency counter for the deck unit which resulted in an erratic response. Also it was later discovered that the analogue input to the computer for this counter had been altered and so the data sampling was incorrect. This latter point was corrected for the second two dips (Station 8621) but unfortunately the frequency counter was still not functioning correctly.

All the dips were made down to 145-150m and the results indicated that there was a 4 to 4½ decade drop in the light intensity from the surface to this depth. The instruments were in fact calibrated down to a light intensity of 10^{-8}W/cm² which represents a total, functional range of about 6½ decades, assuming strongest sunlight to be about 50mW/cm² for the wavelengths being considered.

There are still some problems with the system which have to be solved, for instance in the equilibration of the two light meters at the surface so that the attentuation of the photosynthetically active light through the water column can be calculated. However, these first trials with the completed system were very encouraging.

The RMT 8/25HS Net (J.R. Badcock)

This high speed 8m² net was fished twice, both tows being made on the same night. The first net was fished to see what depths could be attained at different speed, with a reasonable amount of wire out. At a speed of 6¾ kts the net fished stably in 152-155m depth with 634 m.w.o. With 1102 m.w.o. the net fished in 229-237m depth at 7½ kts. Speed was then reduced in steps and a maximum depth of 294m was attained at 5¼kts, although the net was still descending at the time of final hauling. The sample contained many specimens of greater size than is usually caught by the standard RMT 8 in comparable depths. Its condition, however, was deplorable and the battered state of many individuals rendered them identifiable only to genus. The second tow was therefore made to see if the catch condition could be improved without a speed reduction by a shortening of the fishing duration. The net was fished at depth (80-72m) for 30 minutes at 7 kts. There was no improvement in the state of the catch.

The tests showed that the net could be fished at a reasonably high speed down to about 300m depth with a fair economy in the amount of warp out, and therefore could be useful for daytime tows. As expected, the animal size was greater than that usually sampled by the standard RMT 8 at similar depths. The main advantages of using a high speed net in preference to a large net, those of handling and taking a reasonable sample with a short fishing duration, however, were totally eroded by the condition of the samples. To catch larger specimens, therefore, it is more desirable to use a larger net fished slowly than to use a high speed sampler of the present design.

Current Meter Moorings (D. Halpern, R. Hendershot, J.W. Cherriman)

An equilateral triangular array (sides 25Km) of surface moorings, each containing wind recorders, meteorological instrumentation, current meters, temperature recorders etc. was deployed to study the mesoscale response of the upper ocean to variable atmospheric forcing. Station E1 was furnished by IOS Wormley, and stations E2 and E3 by NOAA's Pacific Marine Environmental Laboratory (PMEL), Seattle. Table 1 shows the dates of deployment and recovery, and the approximate positions and water depths of the moorings.

RRS Discovery arrived at the proposed site of Station E3 at about 2100/17 August. Using satellite navigation for control a bathymetric survey was made of a 6 x 6 square mile region. The next day mooring E3 was deployed using a modified version of the "buoy first - anchor last" method. The anchor was released at 1600 and the mooring appeared to be successfully installed by about 1730. For the next 6 hours we remained within 1-2Km of the surface float conducting hourly STD measurements and establishing the position of the buoy. We then moved to the proposed position of E2 and once again a bathymetric survey was made. Deployment of mooring E2 began at 1100 19 August and the anchor was released at about 1530. A series of 5 hourly STD casts were made and the position of the surface float was established before we moved to the proposed site of Station E1.

The E1 mooring (IOS No. 173) was laid on 20.8.74 buoy first and designed to have a 7% stretch in the rope section. The weather was calm, and no trouble was experienced during the laying. When the anchor was settled on the bottom, the buoy was laid and finally the dahn buoy tethered to the spar. The whole operation took some 6 hrs. The mooring was fixed by 2 or 3 satellites and appeared to be well anchored, although the toroid looked a little low in the water.

After 2½ days the mooring was found some 14 miles from its position with the toroid well down in the water obviously carrying its anchor. Again the weather was calm and no trouble experienced in recovery.

The mooring was relaid (IOS No. 174 24.8.74) this time with no stretch in the rope, and an extra 200 lbs added to the anchor. The aim was to lay the mooring with the anchor behind a "hill" so that if it drifted to the N.E. again it would run into shallower water. This was achieved but the spar was not tethered this time, being left until the return from Dakar. The mooring was looked at again the next day, and found to be still in position.

On passage to Dakar the tape from the Bergen current meter was read, and it indicated a current of 1 knot at about 030°-040°.

When the moorings were inspected on 24 August the surface float could not be sighted at Station E2, although the acoustic release/pinger was interrogated. At Station E2 the wire cable immediately above the uppermost current meter broke at about 0500 GMT 24 August (according to a preliminary analysis of the mooring line tension recorded at 1000 metres depth) resulting in the loss of the surface buoy (wind and meteorological observations) and of the tension and acceleration/tilt recorders suspended close to the underside of the buoy. On the 25th August, after an acoustic search of the region using a dahn buoy as a radar marker buoy, the acoustic release was fired successfully and a wire drag search was made. A Gifford grappling hook at the end of 4000 meters of cable was towed in a pattern around the site where the strongest acoustic signal was received. For a short time during the grappling operation the tension on the cable increased by nearly 2000 pounds indicating that the E2 mooring line was temporarily seized. Returning to the E2 site on the 26th, a portion of the back-up recovery system (6 glass spheres) was sighted at the surface and all remaining equipment was subsequently recovered.

The recovered current meters, data logger, acoustic release and tension recorder, which had fallen to the bottom, appeared to be in good condition; we examined the tension recorder on the ship and the other instruments will be opened in Barry, on return of the RRS Discovery on 29 September. A pressure/temperature recorder imploded under the great pressures.

A bulletin requesting that all ships be on the lookout for the drifting buoy was issued by GOCC on the 26th August. The Dallas reported a sighting of the buoy at 1800 29 August, but unfortunately was unable to bring it aboard because of insufficient equipment.

Our progress to date could not have been accomplished without the enthusiastic and dedicated support of a large number of individuals, both here at PMEL and elsewhere. The kind cooperation and expertise of all the scientists, officers and crew aboard the RRS Discovery, and of the personnel at the Research Vessel Base, Barry and at the Institute of Oceanographic Sciences, Wormley are greatly appreciated and will long be remembered.

Table 1. Mooring Statistics

Station	Position	Laid	Recovered	Depth (m)	Stretch in nylon	Remarks
E1 (1st lay)	08°43'N,22°53'W	20.8	23.8	4778		Drifted
E1 (2nd lay)	08°41'N,22°58'W	24.8		4670		
E2	08°52'N,23°02'W	19.8	26.8	4950	6%	Cable broke 24.8
E3	08°41'N,23°10'W	18.8		4890	5%	

Batfish Operation (J.D. Woods, R.M. Carson)

1. Aims (in order of priority)

1.1 To bring the batfish system (hardware and software) up to a fully operational state for Discovery cruise 66 during phase III of GATE.

1.2 To gain experience in interpreting real-time sections and maps produced by the connected HP-IBM system.

1.3 To explore the three-dimensional temperature/salinity structure of the top 100 metres in the vicinity of the E moorings before the start of phase III of GATE.

1.4 To carry out the experiment planned by Dr. Pollard (SUDO) involving a closely spaced series of level tows in and just below the surface mixed layer.

2. Summary of batfish operations

Batfish Tow No.	Start (August 1974)	End	Purpose	Result
18	16/2215	16/2330	Initial test of system.	Abandoned. Batfish hydraulic failure.
19	17/1600	18/0800	Pollard experiment*.	Pattern completed. Depth control + 3m.
20	19/0054	19/0800	Cycling 10-100m*.	Pattern completed. HP tape only. No IBM analysis.

Batfish Tow no.	Start (August 1974)	End	Purpose	Results
21	20/0040	20/0814	Pollard experiment*.	Pattern completed except cycling leg at end. Depth control + 3m.
22	22/1230	22/1330	CTD calibration on electric winch.	Successful. Led to new calibration.
23	25/2332	26/0200	Map of 20 km square.	Abandoned. Electric fault in Batfish controller.
24	26/2100	27/0900	Cycling and level tows on passage to Dakar.	Batfish hardware satisfactory. Depth control on level tow + 30cm. Plotting twice real time and failed after leg 8. Data stored successfully.

* During echo sounding surveys at E3 E2 and E1 respectively

3. Batfish engineering (M. Carson)

Towards the end of Cruise 64, the wear of the shaft bearings in the Batfish hydraulic pump became serious, and the pump was renovated. On reassembly, the pump body joint was leaking into its bolt holes; this was not detected on bench test, because the leak was not apparent until after some 20 minutes running time, i.e. when the bolt holes had filled and had begun to leak at their end face. As a consequence of this leak, the first tow on Cruise 65 (Batfish 18) was abandoned.

The next three tows (Batfish 19-21) were completed satisfactorily, though the oil loss was still unacceptably high. The pump was eventually sealed by relapping the joint faces and pump gears, and assembly with jointing compound. Meanwhile, a replacement servo-valve, received at Dakar, was fitted; the Batfish response was markedly improved.

Batfish 23 was abandoned when an electrical fault in the deck-unit deprived the servo of its feedback signal. Batfish 24 was completed satisfactorily; response was very good, and the oil loss slight.

In total the Batfish was towed for 51 hrs, of which 40 hrs were data collection.

4. Results (in order of priorities in 1 above)

4.1a. Batfish hardware was satisfactory during tow 24.
b. Batfish software (i) Errors in IBM operating system remain but can be corrected in an ad hoc manner as they arise.
(ii) Real time sections take twice real time compared with less than real time for same programs when ship system simulated at IOS Wormley.
(iii) Otherwise real time sections program was up to specification. There was no opportunity to test the mapping program.
c. The CTD was calibrated against NIO bottles to produce correction formulae for temperature and pressure sensors (the latter being dominated by temperature affects not previously allowed for; on Cruise 65 this affect may have been more noticeable because the depth range was 0-100m as against 0-400m on cruise 64). Thermal lag in the pressure sensor gave errors of up to 5 metres.

4.2 Six sections were contoured and analysed, but no maps were produced.

4.3 No information was gained concerning the three-dimensional distribution of temperature - salinity. Eight hours were allocated for this part of the programme, but the Batfish failed.

4.4 Two attempts were made to carry out Dr. Pollard's experiment, both on an opportunity basis during echo sounder surveys. The poor depth control (subsequently improved by an order of magnitude) was insufficient to meet the specification for the experiment.

5. Conclusion

The batfish system is in a satisfactory state for Phase III of GATE apart from the slow plotting rate. While only eight hours were allocated for unrestricted batfishing during the cruise, we were able to make useful tests and measurements on an opportunity basis during passage between Dakar and the C-scale area and during echo-sounder surveys. Without the work done on batfish during Cruise 65 it would have been very unlikely that the programme for cruise 66 would start on time; as it is we feel reasonably confident about batfishing during phase III of GATE.

Electronics (E. Darlington)

The MK III P.E.S. electronics with the beam steering unit and the titanium element fish towed from the midships boom was used exclusively on this cruise. The only trouble of any kind was a door switch which stuck occasionally.

The Blue net monitor only was used and it successfully completed the 13 hauls (38hrs 23 mins) made with the RMT 1+8. The prototype integrated circuit depth pinger was also used for two hauls (3hrs 27 mins) without untoward incident.

It was decided shortly before laying the E1 mooring to fit an acoustic release to it despite the fact that we had only one pyro. Mr Wild made up a Tufnol dummy pyro in order to balance the double release mechanism and the electronics were modified accordingly. One of the command pingers was attached at the top end of the nylon line and one immediately above the acoustic release. The acoustic release was attached above the anchor on a 500m strop. The mooring was laid with both command pingers switched on as it was hoped that a bottom echo could be identified from the upper one thus giving a measurement of the stretch of the nylon. In the event no bottom echo was identified from this pinger. From the evidence of the bottom echo from the lower command pinger there was some doubt as to whether or not this mooring was anchored and in fact it was eventually recovered 14 miles from the laying position. During= the recovery the lifting eyes were pulled out of the toroid and we were obliged to fire the release. The mooring was then relaid without a release and only with one command pinger.

During the attempted location and later recovery of the American E2 mooring the AMF transmitter was coupled with the single element of the fish because it was not possible to interrogate with the AMF overside transducer while the ship was underway. The attempted use of the towed hydrophones was unsuccessful because of a fault.

The photo-diode light meter was used on four occasions and functioned satisfactorily although some trouble was experienced with the computer interface.

LOCAL TIME GMT

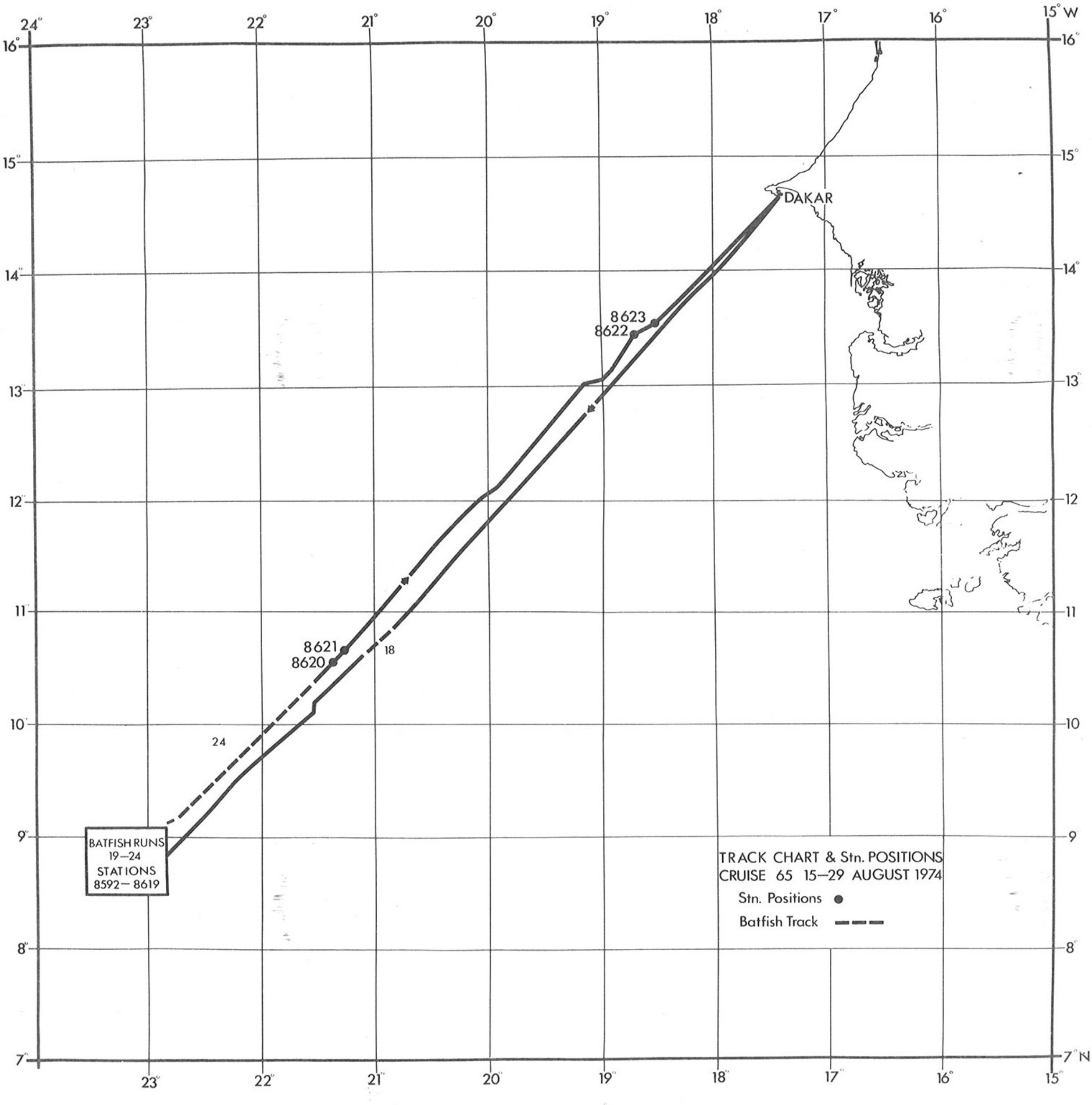
STN.	DATE 1974	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS
8593 # 1	18/ 8	8 41.4N 8 41.3N	23 9.4W 23 9.0W	TSD WB 1	10- 500	1943-2039	WB AT 500M.
8593 # 2	18/ 8	8 41.1N 8 40.9N	23 9.4W 23 9.0W	TSD WB 1	10- 500	2116-2208	WB AT 200M.
8593 # 3	18/ 8	8 40.8N 8 40.7N	23 9.6W 23 9.2W	TSD WB 1	10- 500	2234-2328	WB AT 10M.
8595 # 1	19/ 8	8 51.5N 8 51.6N	23 2.7W 23 2.0W	TSD WB 1	10- 500	1906-1958	WB AT 500M.
8595 # 2	19/ 8	8 51.6N 8 51.9N	23 1.9W 23 1.5W	TSD WB 1	10- 500	2008-2052	WB AT 224M.
8595 # 3	19/ 8	8 52.1N 8 52.4N	23 1.3W 23 1.1W	TSD WB 1	10- 500	2110-2153	WB AT 380M.
8595 # 4	19/ 8	8 52.4N 8 52.6N	23 1.0W 23 0.6W	TSD WB 1	10- 500	2202-2246	WB AT 10M.
8597 # 0	20/ 8	8 36.8N 8 36.6N	23 8.8W 23 11.5W	RMT 1 RMT 8	10- 35	2217-2330 NIGHT	FLOW DIST. 4.35 KM.
8598 # 1	21/ 8	8 36.5N 8 37.4N	23 11.7W 23 10.4W	TSD PUMP FL	0- 110	0015-0122 NIGHT	
8598 # 2	21/ 8	8 37.4N 8 37.8N	23 10.4W 23 9.5W	TSD PUMP FL	0- 110	0123-0209 NIGHT	
8598 # 3	21/ 8	8 38.1N 8 39.8N	23 9.2W 23 6.4W	TSD PUMP FL CM	50- 50	0224-0438 NIGHT	CHLOROPHYLL A/TURBULENCE EXPT.

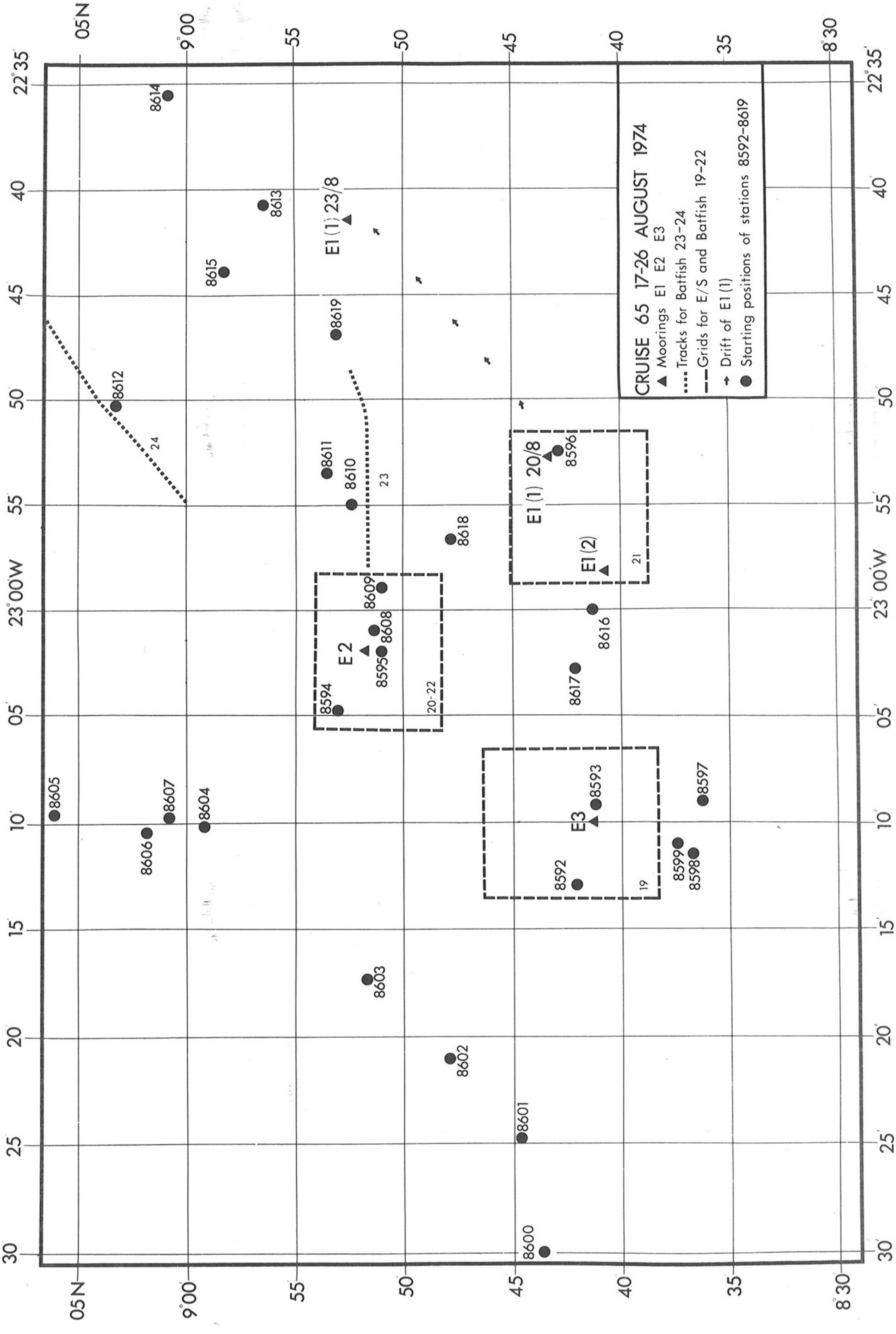
STN.	DATE 1974	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8599	21/ 8	8 39.5N	23 13.8W	RMT 1	3000-3500	0827-1427		
# 0		8 42.9N	23 23.4W	RMT 8		DAY	FLOW DIST. 18.47 KM.	
8600	21/ 8	8 43.8N	23 28.6W	RMT 1	500- 600	1804-1904		
# 0		8 44.0N	23 26.1W	RMT 8		DAY	FLOW DIST. 3.82 KM.	
8601	21/ 8	8 44.5N	23 24.8W	NN	0- 0	1936-1948		
# 1		8 45.5N	23 24.1W			DUSK		
8601	21/ 8	8 45.5N	23 24.1W	NN	0- 0	1950-2002		
# 2		8 46.8N	23 23.4W			DUSK		
8601	21/ 8	8 46.8N	23 23.4W	NN	0- 0	2004-2016		
# 3		8 48.0N	23 22.7W			DUSK		
8601	21/ 8	8 48.0N	23 22.7W	NN	0- 0	2017-2029		
# 4		8 49.2N	23 22.1W			DUSK		
8602	21/ 8	8 49.5N	23 20.7W	RMT 1	114- 200	2103-2203		
# 0		8 50.8N	23 18.5W	RMT 8		NIGHT	FLOW DIST. 3.86 KM.	
8603	21/ 8	8 51.8N	23 17.3W	NN	0- 0	2225-2237		
# 1		8 52.5N	23 16.5W			NIGHT		
8603	21/ 8	8 52.6N	23 16.4W	NN	0- 0	2239-2251		
# 2		8 53.4N	23 15.5W			NIGHT		
8603	21/ 8	8 53.4N	23 15.5W	NN	0- 0	2252-2304		
# 3		8 54.4N	23 14.5W			NIGHT		
8603	21/ 8	8 54.4N	23 14.5W	NN	0- 0	2306-2318		
# 4		8 55.3N	23 13.5W			NIGHT		
8603	21/ 8	8 55.5N	23 13.4W	NN	0- 0	2321-2333		
# 5		8 56.4N	23 12.5W			NIGHT		

STN.	DATE 1974	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8603 # 6	21/ 8	8 56.5N 8 57.3N	23 12.4W 23 11.5W	NN	0- 0	2335-2347 NIGHT		
8603 # 7	21/ 8	8 57.5N 8 58.3N	23 11.3W 23 10.5W	NN	0- 0	2349-0001 NIGHT		
8604 # 0	22/ 8	8 59.7N 9 5.0N	23 9.9W 23 10.5W	RMT 1 RMT 8	100- 200	0034-0234 NIGHT	RMT8/HS COMPARATIVE HAUL FLOW DIST. 7.60 KM.	
8605 # 1	22/ 8	9 5.9N 9 4.9N	23 8.9W 23 9.4W	NN	0- 0	0424-0436 NIGHT		
8605 # 2	22/ 8	9 4.9N 9 4.0N	23 9.4W 23 9.8W	NN	0- 0	0437-0449 NIGHT		
8605 # 3	22/ 8	9 3.9N 9 2.9N	23 9.8W 23 10.2W	NN	0- 0	0451-0503 NIGHT		
8605 # 4	22/ 8	9 2.9N 9 1.7N	23 10.2W 23 10.6W	NN	0- 0	0504-0516 NIGHT		
8606 # 0	22/ 8	9 1.9N 9 3.7N	23 10.7W 23 9.1W	RMT 1 RMT 8	110- 200	0536-0636 NIGHT	FLOW DIST. 3.38 KM.	
8607 # 0	22/ 8	9 1.9N 9 4.2N	23 8.7W 23 7.1W	RMT 1 RMT 8	700- 800	0830-0931 DAY	FLOW DIST. 4.07 KM.	
8608 # 1	22/ 8	8 51.4N 8 51.5N	23 1.6W 23 1.5W	TSD LMD	0- 150	1457-1515 DAY	LIGHT METER TEST	
8608 # 2	22/ 8	8 51.5N 8 51.5N	23 1.5W 23 1.4W	TSD LMD	0- 150	1516-1528 DAY	LIGHT METER TEST	
8609 # 0	22/ 8	8 52.1N 8 53.6N	22 57.6W 22 55.5W	RMT 1 RMT 8 DN	700- 785	1800-1900 DAY	FLOW DIST. 3.38 KM.	

STN.	DATE 1974	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8610 # 1	22/ 8	8 54.5N 8 53.6N	22 54.0W 22 54.0W	NN	0- 0	1949-2001 DUSK		
8610 # 2	22/ 8	8 53.5N 8 52.5N	22 54.1W 22 54.2W	NN	0- 0	2003-2015 DUSK		
8611 # 0	22/ 8	8 54.2N 8 56.8N	22 53.6W 22 53.5W	RMT 1 RMT 8 DN	500- 600	2103-2203 NIGHT	FLOW DIST. 3.60 KM.	
8612 # 0	22/ 8	9 3.4N 8 53.6N	22 50.2W 22 44.1W	RMT 8/25HS	0- 294	2335-0202 NIGHT	FISHING DEPTH CA. 150-250M.	
8613 # 0	23/ 8	8 56.4N 9 0.8N	22 40.5W 22 35.6W	RMT 8/25HS	0- 158	0304-0414 NIGHT	FISHING DEPTH CA. 72-75M.	
8614 # 0	23/ 8	8 57.1N 8 58.0N	22 40.7W 22 42.5W	RMT 1 RMT 8 DN	500- 600	0554-0654 NIGHT	DN EVERTED-CATCH LOST FLOW DIST. 3.20 KM.	
8615 # 0	23/ 8	8 58.2N 8 56.9N	22 45.0W 22 46.7W	RMT 1 RMT 8 DN	500- 600	0815-0915 DAY	DN EVERTED-CATCH LOST FLOW DIST. 3.14 KM.	
8617 # 1	25/ 8	8 42.7N 8 43.6N	23 2.1W 23 1.3W	TSD PUMP FL	0- 110	0107-0206 NIGHT		
8617 # 2	25/ 8	8 44.0N 8 45.3N	23 0.8W 22 59.5W	TSD PUMP FL CM	40- 40	0233-0400 NIGHT	CHLOROPHYLL A/TURBULENCE EXPT.	
8617 # 3	25/ 8	8 45.3N 8 46.7N	22 59.5W 22 57.3W	TSD PUMP FL CM	50- 50	0401-0602 NIGHT	CHLOROPHYLL A/TURBULENCE EXPT.	

STN.	DATE 1974	POSITION LAT	LONG	GEAR	DEPTH (M)	FISHING TIME GMT	REMARKS	LOCAL TIME GMT
8618 # 1	25/ 8	8 47.1N 8 48.4N	22 56.9W 22 56.7W	NN	0- 0	0620-0632 DAWN		
8618 # 2	25/ 8	8 48.4N 8 49.7N	22 56.7W 22 56.5W	NN	0- 0	0634-0646 DAWN		
8618 # 3	25/ 8	8 49.7N 8 50.9N	22 56.5W 22 56.3W	NN	0- 0	0648-0700 DAWN		
8618 # 4	25/ 8	8 50.9N 8 52.1N	22 56.3W 22 56.1W	NN	0- 0	0702-0714 DAWN		
8618 # 5	25/ 8	8 52.2N 8 52.3N	22 56.1W 22 56.8W	NN	0- 0	0717-0729 DAWN		
8618 # 6	25/ 8	8 52.4N 8 52.5N	22 56.9W 22 57.7W	NN	0- 0	0731-0743 DAWN		
8619 # 0	26/ 8	8 53.6N 8 58.8N	22 49.3W 22 52.8W	RMT 1 RMT 8 DN	800-1000	0344-0614 NIGHT	FLOW DIST. 8.84 KM.	
8620 # 0	27/ 8	10 32.5N 10 35.1N	21 21.8W 21 18.1W	RMT 1 RMT 8 DN	210- 500	1102-1302 DAY	FLOW DIST. 7.52 KM.	
8621 # 1	27/ 8	10 37.5N 10 37.6N	21 15.8W 21 15.9W	TSD LMD	0- 145	1357-1419 DAY	LIGHT METER TEST	
8621 # 2	27/ 8	10 37.6N 10 37.7N	21 15.9W 21 16.2W	TSD LMD	0- 150	1420-1444 DAY	LIGHT METER TEST	
8622 # 0	28/ 8	13 25.2N 13 26.3N	18 43.8W 18 43.8W	NN	0- 0	1440-1450 DAY		
8623 # 0	28/ 8	13 30.6N 13 32.2N	18 33.4W 18 32.0W	NN	0- 0	1612-1635 DAY		


24°
23°
22°
21°
20°
19°
18°
17°
16°
15° W
16°
15°
14°
13°
12°
11°
10°
9°
8°
7°
7° N
DAKAR
8623
8622
8621
8620
18
24
BATFISH RUNS
19–24
STATIONS
8592– 8619
TRACK CHART & Stn. POSITIONS
CRUISE 65 15–29 AUGUST 1974
Stn. Positions
Batfish Track


CRUISE 65 17-26 AUGUST 1974
Moorings E1 E2 E3
Tracks for Batfish 23-24
Grids for E/S and Batfish 19-22
Drift of E1 (1)
Starting positions of stations 8592-8619
E1 (1) 23/8
E1 (1) 20/8
E1 (2)
E 2
E3
22°35'
23°00'W
05N
9°00'
8°30'
8592
8593
8594
8595
8596
8597
8598
8599
8600
8601
8602
8603
8604
8605
8606
8607
8608
8609
8610
8611
8612
8613
8614
8615
8616
8617
8618
8619
19
20-22
21
23
24